

ARC India NEWS

Esri India Magazine

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Article

Answering Emergency Management Information Needs

Event Coverage

Esri India attends India Geospatial Forum 2012

Case Study

GIS-Based Statistical Landslide Susceptibility Zonation: A Case Study in Ganeshganga Watershed, the Himalayas



Emergency and Disaster Management

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One of the challenges which the world has been facing over centuries is natural calamities. Floods, fire, tsunami, cyclones, hurricane, earthquake, etc. hit various parts of the world. These natural disasters are great levelers- they strike at any part of the world, and they do not differentiate between a developed or developing country. So, managing and mitigating disaster is an universal need and the countries around the world have to and are working together in sharing information and working on technologies to minimize the damage.

Over the past couple of decades, we are also witnessing man-made disaster- the classic example being the 9/11 attack in the US and the 26/11 attack in Mumbai. This is a new dimension that needs to be factored when any one plans for disaster management.

In managing disasters- whether it is natural or man-made, location information is very crucial. Whether it is for warning the people to move to safer location before an impending disaster, or to help the relief and rescue operations, without information on the exact location, it is impossible to manage.

So, there is a growing demand and desire for vigorous situational awareness delivered in the form of maps for Disaster Management. I believe we have just begun to scratch the surface on how dynamic data that's fused with GIS-driven digital maps can support various missions within the disaster/emergency management sector. From the terrorist attacks of September 11 through Hurricane Katrina to more recent emergencies like Haitearthquakes, tusnamis, tornadoes and floods, a fundamental lesson learned has been that capturing and sharing real-time information is essential to effective response and incident management. GIS has become an effective tool in the complete Disaster Management Cycle from preparedness to recovery. The common picture seen across was supporting the initial assessment of the disaster to establishing the recovery process. This platform not only witnessed various GIS applications being implemented from using handheld mobile devices to delivering fast track real-time maps and warning systems for future. Social media and crowd sourcing, is playing an important role when integrated with geospatial technology it can be mapped, thus resolving some of the challenges in the course of a Disaster Recovery. For eg. In the recent Haiti disaster the initial information to the world was an impact of Social media. The ability to make social media more valuable and relevant during the course of any mitigation plan we have to begin to figure out the how the various GIS tools such as hot spot mapping, proximity to services or supplies, routing and other tools can become more apparent. Esri is developing free downloadable templates that will enable our users to integrate geographic-based social media into their Web-based mapping applications. The question arises how ready are we?

As I have mentioned earlier, disaster strikes anywhere irrespective of the caste, creed, religion or wealth of a nation. So, there is a need for a cohesive National Disaster Plan that will give the opportunity to exercise existing capabilities along with Geospatial capabilities to prevent, prepare for, respond to, and/or recover from major disasters, man-made or natural, and other emergencies in a complex multiagency environment. This cannot be done only by one agency- various government departments, NGOs, private sector companies and the society at large should play an active role in contributing to the efforts that go in managing and mitigating disaster.

I am confident that with the increasing adaption of geo spatial tools combined with the spread in usage of mobile and internet technology will make the disaster management more efficient and reduce the damage and the loss of lives.

S Sridhar

President & COO

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Editorial and Content Coordinatino: ESRI India Team

Corporate Office

B1/H 9, Colosseum, Mohan Cooperative Industrial Area, Mathura Road, New Delhi – 110044, INDIA Tel: +91 11 40570700 / 701 | Fax: +91 11 40570516
Email: info@esriindia.com

Regional Office

- New Delhi** : B1/H 9, Colosseum, Mohan Cooperative Industrial Area, Mathura Road, New Delhi – 110044, Tel: +91 (11) 4057-0700, 701 Fax: +91 11 40570516; Email: vishal.anand@niit-tech.com; newdelhi@esriindia.com
- Hyderabad** : 3rd Floor, Prashanti Complex, Basheerbagh, Hyderabad - 500 063 Andhra Pradesh Tel: +91 (40) 66633616, 66741134 Fax : +91 (40) 23231567; Email: Sathish.Girinatham@niit-tech.com; hyderabad@esriindia.com
- Bangalore** : 4th Floor, Ramakrishna Towers, 31/2, Rupena Agrahara, Begur Hobli, Hosur Road (Near Silk Board (Flyover), Bangalore -560 068 Karnataka ;Tel: +91 (80) 30289500, 30289652; Fax: +91 (80) 30289656 Email: Srikantha.M@niit-tech.com; bangalore@esriindia.com
- Chennai** : 46, Third Floor, Garuda Building, Cathedral Road, Chennai – 600 086, Tamil Nadu Tel : +91 44 4591 1050 +91 44 4591 1050; Fax : +91 (44) 28213206 ; Email: Sathish.Venkatesan@niit-tech.com, chennai@esriindia.com
- Mumbai** : 106-107, Marwah Complex, Krishanlal Marwah Marg, Off Saki-Vihar Road, Andheri (East), Mumbai-400072, Maharashtra Tel: +91 (22) 40103200; Fax: +91 (22) 40103444 Email: Ketan.Shinde@niit-tech.com; mumbai@esriindia.com
- Kolkata** : EM4/1, 2nd floor, Sector V (Techno India building); Salt Lake, Kolkata 700 091, West Bengal Tel: +91 (33) 3038 1000; Fax: +91 (33) 2357 7713 Email: Prabhat.1.Ranjan@niit-tech.com; kolkata@esriindia.com
- Ahmedabad** : 103 Anhill Complex 88/B, Swastik Society; Off CG Road, Navarangpura; Ahmedabad-380009, Gujarat; Tel: +91 9898096276, 9016507980; Email: Iyer.Kumar@niittech; ahmedabad@esriindia.com

Branch Offices:

Bhopal: +91 9971611366, Chandigarh: +91 9646070100, Dehradun: +91 9719406883 Lucknow: +91 9369914350, Nagpur: +91 9890196005, Thiruvananthapuram: +91 9995411777

Designed by:



NIIT GIS's Vice Chairman Mr. Rajesh Mathur conferred with Lifetime Achievement Award @ India Geospatial Forum 2012

NIIT GIS Ltd., the GIS solutions provider, today announced that Mr. Rajesh C Mathur, Vice Chairman, NIIT GIS Ltd., was awarded the Lifetime Achievement Award by Mr. M. Shashidhar Reddy, Vice Chairman, National Disaster Management Authority (NDMA), at the India Geospatial Forum at Gurgaon

Mr. Mathur was acknowledged for his association with geospatial industry for over two decades in India. He has been instrumental in helping NIIT GIS attain a leadership position and become the number one Company as an essential contributor in enabling many Mission Mode Programmes. Conferring the Lifetime Achievement Award, Mr. Sanjay



Kumar, CEO, Geospatial Media and Communications said, "Rajesh has been instrumental and few amongst the first few in this country who have pioneered in creating awareness and demonstrating benefits of this wonderful technology in different walks of life in India. He also mentioned that his association with professional societies including INCA, ISG, FICCI and AGI have provided necessary vision, guidance and direction towards fulfilling their objectives within the broader framework of development of geospatial community in India". Accepting this prestigious honor, Mr. Rajesh Mathur said "I am honoured to receive this recognition from Geospatial Media and Communications. NIIT GIS plays an

imperative role in both domestic and international community in shaping Imaging and GIS thoughts and concepts. ●

Orissa Govt. initiates GIS School Mapping Project

Odisha Primary Education Programme Authority (OPEPA) has an agenda to achieve the goals of Universal Elementary Education (UEE) under SarvaShikshaAbhyan. OPEPA has accumulated a very comprehensive data bank of the schooling system in the state through a sustained implementation of the DISE (District Information System for Education) and e-Shishu project, a very strong MIS framework. The School Information System (SIS) is one of the components of the e-Shishu project and entails the mapping of lat-long coordinates of all schools in the state along with listing of available infrastructure in each school. GIS plays an important role ensuring the delivery of primary education to each child in the state.

Literacy and education being the sole motto with OPEPA and with ArcGIS technology for School Mapping was able to successfully demonstrate a proof of concept for the utility of a full scale GIS component in their MIS structure accepting the prognosis regarding the value of GIS as a tool for planning, implementing and monitoring state level initiatives for delivering universal primary education. ●

NIIT GIS develops a Mobile GIS for Forest Conservation & Surveillance

Recent technological advancements incorporating Mobile-based GIS has helped the Forest Departments to resolve issues through spatially enabled decision making. Our Projects team has developed a wonderful application "PDA/Smart phone based Surveillance and Tracking system" that has been implemented for Indian Forest Department. Today this Mobile GIS system is being used in forest-governance through monitoring, incident management and analyzing of geospatial data.

In this novel system, all forest personnel would be equipped with Mobile Devices for transmission of voice, data and location information to the Control Center. Transmission of these coordinates to the central server enables the senior-level offices to monitor the staging of forest personnel from a web-based application that helps to visualize a real-time patrolling coverage at the server-end. In situations of emergency, reinforcements can be called in and/or rushed with a better understanding of field situation. Manual transmission of events (i.e. Forest

Fire, Encroachments, and Sighting of Injured Animal) constitutes a very important functionality, since the generated dataset would enable better formulation of specific management interventions. This mobile based solution is definitely improving the forest protection and surveillance activities carried out by the forest department, thereby reducing the response time in case of emergency events. Due to the utilization of an enterprise-level database for GIS, this system enables the senior-level officers leveraging the geospatial intelligence to make impromptu decisions. ●

GIS Supports Strategic National Health Programs in the Country

The Ministry of Health and Family Welfare (MoHFW) is the apex governmental body responsible for implementation of National Health programmes running in the country. The Government of India launched the National Rural Health Mission (NRHM) while making the Health Delivery System more responsive to the health care needs of the people of India. In light of the fact that the Mission is ambitious with very tight targets, the MoHFW has in place an elaborate Monitoring and Evaluation system, namely the Health Management Information System (HMIS)? to monitor and evaluate the impact of its health programmes and provide key inputs to policy formulation and interventions.

MoHFW has initiated the HMIS Augmentation where it will Augment the HMIS Application & Facilitate its Roll-out across the country upgrading the existing analytical package and GIS based HMIS Portal Enablement using various tools / cots/off-the-shelf solutions / products delivering features such as messaging, bulletin board, search engine, content management, dashboards, personalization. This will further integrate with HMIS application data hosted at NIC Data Centre at New Delhi. Esri GIS technology significantly builds up the HMIS and the strong technology behind Esri enterprise GIS which is the most robust, widely accepted platform can also support their mission of huge spatial analysis across India became the backbone of the HMIS project. ●

Esri Releases National Geographic World Basemap :Highly Detailed Basemap Accessible via ArcGIS Online

This section of the National Geographic World Map shows Europe at a small scale.

Redlands, California—In cooperation with National Geographic, Esri released the National Geographic World Map. Esri and National Geographic collaborated to produce a distinctive basemap that reflects National Geographic's cartographic design, typographic style, and map policies. Designed to be aesthetically pleasing, the National Geographic World Map is for users who want to display minimal data on a vibrant, highly detailed background. The map is currently available at ArcGIS Online in the basemap gallery.

The new basemap combines a century-old cartographic tradition with the power of GIS technology to produce a distinctive Internet-based map service serving GIS, consumer, education, and mobile users. This new map will be added to Esri's collection of existing basemap services designed for different uses and needs. All Esri basemaps are freely accessible for internal- and external-facing sites.

Esri ELA Supports Maryland's Nationally Recognized GIS Program :ArcGIS Software Empowers Agencies to Deliver Transparency and Accountability

Redlands, California—The State of Maryland has acquired an Esri enterprise license agreement (ELA) that provides unlimited access to ArcGIS software to staff in its agencies. Under Governor Martin O'Malley's leadership, the state uses



GIS for much of its work including groundbreaking transparency and accountability initiatives such as StateStat, GreenPrint, and PlanMaryland. Now, access to the software will extend to all corners of state government.

"The drive for this came down from the top," said Kenny Miller, deputy geographic information officer, State of Maryland. "Governor O'Malley is such a tremendous supporter of using GIS technology to improve decision making and transparency that he wanted all the agencies to have access so they can adopt GIS in their business missions."

Agencies that did not have GIS software can now spatially enable their data to make workflows more efficient and map complex issues for greater clarity. For example, the Department of Legislative Services hadn't previously used GIS but immediately secured licenses once the ELA was in place. Staff will use the software to map capital and operating budgets for legislators who can then spatially analyze impacts of budgetary decisions.

For more information on Esri ELAs, visit esri.com/ela. ●

New Version of Esri Aeronautical Solution Improves Data Quality for Airports

The Esri Aeronautical Solution—Airports GIS Package version 2 is now available for download from Esri. This updated offering expands the number and types of preconfigured automated validation checks to include those used by the Federal Aviation Administration (FAA) during data submission as well as critical and noncritical attributes.

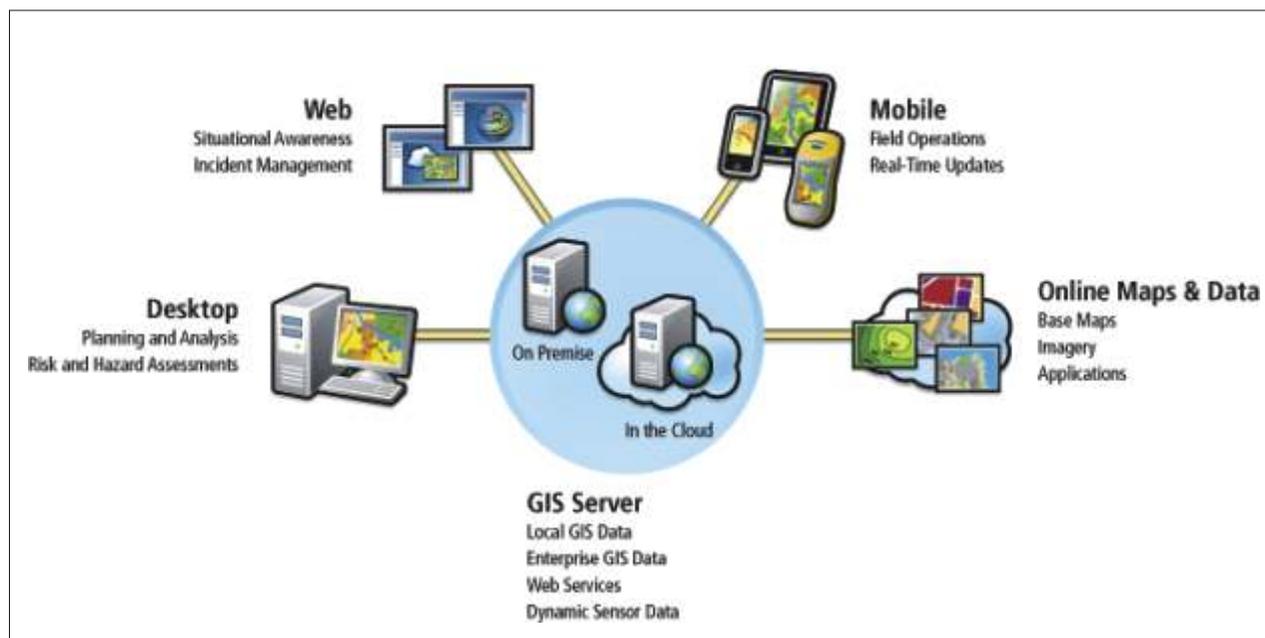
Esri Aeronautical Solution—Airports GIS Package is a software suite specifically developed to help US airports and the consultant community meet the requirements of the FAA Airports Surveying—GIS program. Version 2 includes more than 300 preconfigured validation checks developed from the FAA's 18B specification, enabling airports to improve their data quality and better comply with FAA review.

Current Esri Aeronautical Solution customers can simply download the Airports GIS Package from the Aeronautical Solution Resource Center. New customers can take advantage of special pricing for the Esri Aeronautical Solution—Airports GIS Package until the end of June 2012. For full details, please contact an Esri representative at aero@esri.com.

For more information, visit esri.com/airportsgis. ●

ArcGIS as a System for Emergency/Disaster Management

The ArcGIS provides a system for emergency/disaster management that supports all facets of the mission including preparedness, mitigation, response and recovery.



Desktop

GIS spatial analysis and modeling power provide the tools necessary to perform a thorough risk and hazard assessment. Not only can GIS quickly map and display critical infrastructure, populations, and other community values exposed to natural and technological hazards, it can also model potential events to determine consequence and loss. This type of work is typically performed by a GIS technician using the power of ArcGIS for Desktop technology.

Web

A web-based GIS enabled common operating picture (COP) provides an essential geographic context of the jurisdiction with base layers of information (imagery, streets, critical infrastructure, elevations, etc.) GIS can also consume and publish dynamic GIS data and services from other systems (weather, traffic cameras, video, GPS, 911 calls, etc.). Operational analytics (demographic analysis, plume modeling, road closures, etc) on the GIS platform can be performed by fusing base map data with dynamic data. This type of technology is configured for use by operations personnel and does not require a GIS analyst.

Mobile

Mobile GIS technology now provides the capability to support a number of missions within the emergency management workflow. These capabilities include providing access to the common operating picture (COP) in the field, the ability to

provide updates to this data from the field in tactical and administrative operations, and the ability to collect all types of GIS and non GIS data that can be transmitted to the COP for visualization within a geographic context. ArcGIS for Windows Mobile is configurable for use in the field with very little training required.

Online Maps and Data

ArcGIS Online and ArcGIS.com provide access to all types of GIS data, imagery, and applications and is a key component of the ArcGIS system for emergency/disaster management. A variety of worldwide base maps are available including imagery, streets, topography, community base maps and more. Emergency personnel can create private or public groups to exchange map data, projects, and presentations.

GIS Server

ArcGIS for Server is the core component of the GIS system for emergency/disaster management. It can be deployed within the emergency management facility or can be hosted in the cloud and provided as a GIS service. ArcGIS for Server provides the platform for the organization and management of GIS data available to the desktop for planning and analysis for enhanced decision support and analysis of unfolding events. It manages mobile connections to consume updates and edits which are stored in the database and published to the COP. It also enables access to dynamic data, services, and other online GIS data that is made available to all other GIS clients and viewers within the system

Access and Edit Esri Maps on Kindle Fire

Esri users can now access ArcGIS data and mapping capabilities on Amazon's popular Android tablet, Kindle Fire. ArcGIS for Android, also available on iOS devices, Windows Phones, and other Android devices, lets users access, edit, and share maps. The free app can be downloaded directly from the Amazon Appstore for Android.

ArcGIS for Android is a native application that serves as a mobile gateway into the ArcGIS system. It provides an intuitive user experience for querying map layers and data. With it, users can quickly access their own maps and data authored in ArcGIS Online as well as collect and edit geographic data. ArcGIS for Android includes a Favorites feature that accesses popular



maps quickly; a tool for measuring area and distance; and the ability to display data in popups that support images, charts, links, and more.

ArcGIS for Android is built on Esri's ArcGIS Runtime Software Development Kit (SDK). This SDK lets developers create custom spatially enabled applications for Kindle Fire and other Android devices and is designed to use web services available from ArcGIS Online. Apps built using the SDK can be deployed within the enterprise or to the public via the Amazon Appstore for Android and Google Play. ●

Source:
<http://www.esri.com/software/arcgis/smartphones/>

BAO for Smartphones and Tablets



Overview

With the free Business Analyst Online (BAO) app, you can access key demographic and market facts about any location in the US using your Smartphone or tablet.

Visiting a potential new site? The BAO app gives you answer four key questions:

- What types of people live there?

Get a quick demographic and market snapshot including

location, age, income, education, and consumer spending.

- How do they differ from the people in another location?

Compare the demographic and market data for two locations or one location vs. the entire U.S.

- What other businesses are in the area?

Scope out the competition or locations of businesses that complement yours.

- Is this a good location based on your needs?

Set your desired criteria and find out how your location matches up. Purchasing a subscription to the full BA Web application gives you access to even more data and analysis within the app including up to 50 detailed reports and the ability to change the analysis area based on drive time, miles, or custom trade area. ●

Key Features

- Use on iOS and Android smart phones and tablets.
- Get up-to-date facts, using the latest Esri Data, about prospective customers (e.g., Age, income, education, home ownership, lifestyle, and spending habits).
- Compare one address against another or against the county, state or US.
- Analyze an area within one-mile of your location.
- Instantly determine if a location fits your needs with Smart Map.
- Share your facts with others via e-mail.

Subscribers to the full BAO Web application get even more functionality within the app:

- Access up to 50 BAO reports and more detailed data.
- Adjust the analysis area up to a 100-mile radius, 60-minute drive time, or custom trade area. ●



ArcGIS Data Reviewer 10.0

Improve The Integrity of Your Spatial Data by Automating Data QA/QC In Turn Save Time and Reduce Overhead

Introduction

ArcGIS is complete system for designing and managing solutions through the application of geographic knowledge. It enables you to perform deep analysis, gain a greater understanding of your data, and make more informed high-level decisions. ArcGIS is developed by ESRI and is a collection of products integrated into one framework that enables GIS application development and use for individuals and enterprises. The family of software products are available to share and analyse data over Web, Desktop and Mobile Devices.

ArcGIS Data Reviewer (formerly known as GIS Data ReViewer) is a component of ArcGIS and an extension to ESRI's flagship ArcGIS Desktop products (ArcView, ArcEditor and ArcInfo) that provides a complete system to automate and simplify data quality control (QC) process. The current release includes several enhancements over the previous version to meet the QC challenges of the geospatial data and centrally manage the error QC lifecycle process - finding, correcting, and verifying errors - thereby eliminating any paper trail associated with traditional QC processes.

This is the unique product for carrying out GIS data QC that is currently available in GIS industry.

Installation and licensing: The product comes in a single DVD with free tech support and upgrades for a year. Users can register the product using online authentication or using email. The following main tools are exposed to the users through Data Reviewer toolbar.

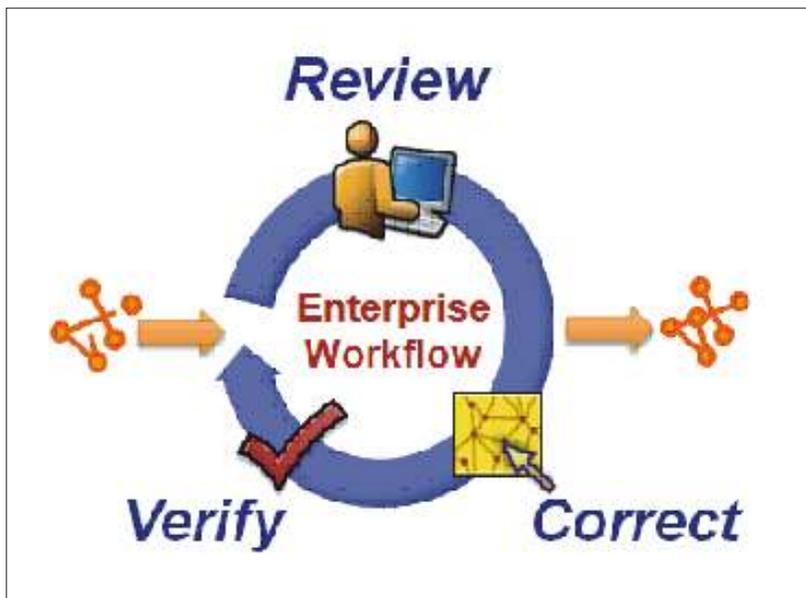
- ✓ Reviewer Session Manager
- ✓ Positional Accuracy Assessment
- ✓ Checks and Batch Job Manager
- ✓ Data Reviewer service
- ✓ The Reviewer table
- ✓ Data Reviewer toolbox
- ✓ Reports

Get extensive Help and Tutorial with Sample data:

A good starting point for any program is the Help system. The product contains extensive help system and also includes Tutorial with sample data that is designed to familiarise new users with GIS QC process concepts adopted in the Data Reviewer. The help is also available online at <http://resources.arcgis.com>. The optional advanced professional trainings are available from the ESRI India.

Manage your data review sessions:

The Reviewer Session Manager is used to create, start and stop Reviewer sessions and configure other properties related



to a Reviewer session. Basic properties for a Reviewer session include the Reviewer workspace, with session information like the user name; and the session ID and name. It also includes settings for displaying other required columns in the Reviewer table.

Simplify the Data Quality Control Process Using Automated Batch Checks:



A check is to validate data against a specific condition. For example, the Geometry on Geometry check can be used check whether all electricity consumer service lines are connected to a pillar or service pole.

The data reviewer comes with 42 configurable Rule-Based geometric and attribute validation error checking functions with the ability to develop and apply hundreds of additional customized checks. These have been grouped under 11 logical categories for easy access and identification like Database Validation checks, Default checks, Duplicate



Geometry checks, Feature on Feature checks, Polyline checks, Spatial Parameter Evaluation checks, Table checks, Topology checks, Z Value checks and Advanced checks.

The Reviewer Batch Job Manager is used to create, modify, and validate batch jobs, or groups of checks. The Version Differences command allows to view differences between the geodatabase version being edited and any other version of the geodatabase.

Speedup your Visual Data Review:

The grid feature class can be used during Reviewer sessions to manage both visual and automated quality control. With Reviewer, the polygon grid can be associated with the Reviewer table and the grid information associated with

individual records. Cells that contain features that have been recorded as records in the Reviewer table have the QC_GRID field populated with polygon grid information. The tools also provide the facility to automatically colour code the status of the Review status like Reviewed, Corrected and Verified.

The Notepad Sketch tool provides facility to digitize missing feature directly into a map and automatically adds it as a record in the Reviewer Table.

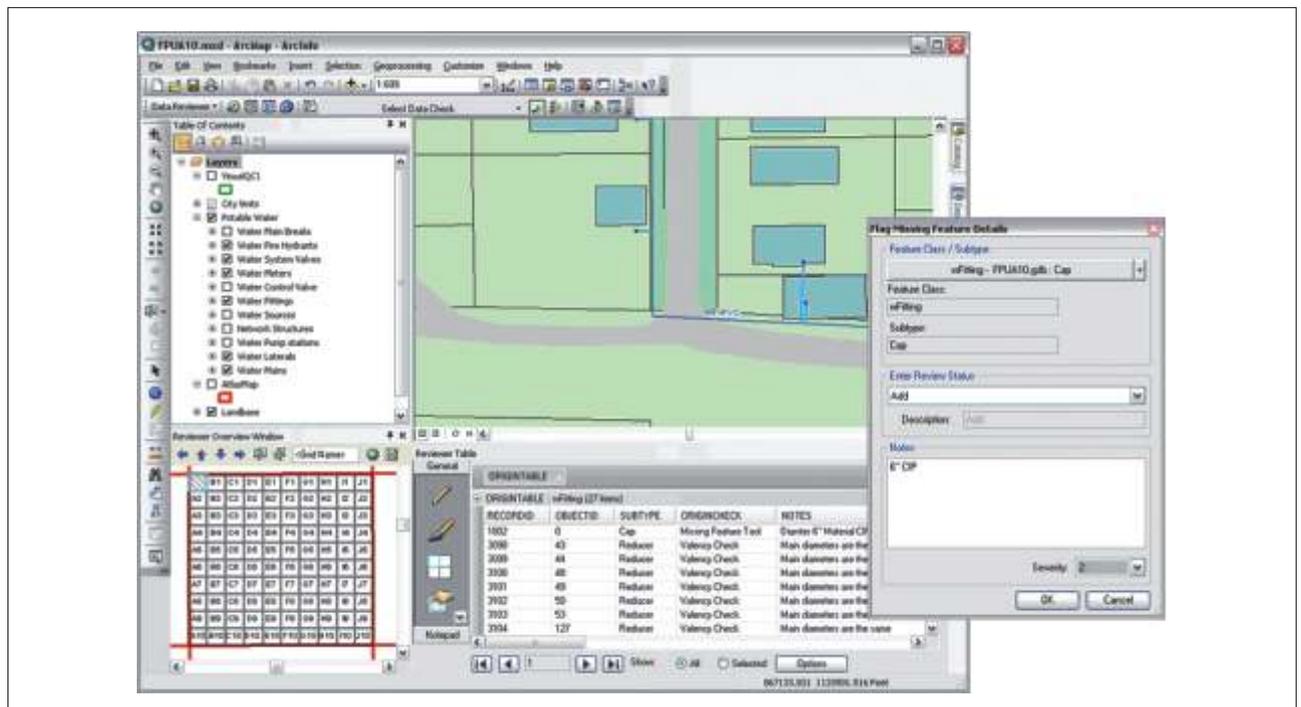
The Flag Missing Feature tool is used to indicate the location of a missing feature according to the feature class and subtype to which it belongs.

Manage errors through interactive table:

The Reviewer table is a heart of the Data Reviewer where it displays the records or results that have been found while running batch job or individually and that have been committed through manual or visual review processes. Using the Reviewer table, you can zoom to individual features that have been recorded in the Reviewer table as well as zoom to their individual parts as applicable. The QC process adopted in ArcGIS Reviewer involves mainly three simple steps - Review, Correct and Verify.

Once the record has been added in reviewer table, by either automated review of visual review, next step is to do correction. During correction phase, correction status can be updated along with information like evaluation and explanation.

The information populated, includes Correction Technician, Correction Date, and Correction Status. The Correction Technician and Correction date are automatically populated. If series of corrected and that have required the same type of correction, you can update multiple records at once. Similarly while updating the Verification status using the reviewer table, default information is automatically populated.



Automatically Generate QA Report:

The report module allows to create different reports based on the records in the Reviewer table or sampling report and report is automatically generated as Microsoft Excel spreadsheets. This allows customizing the formatting for the spreadsheet as needed.

The QA report includes the data inventory, feature counts, automated checks, visual checks, and a summary.

The different types of reports readily available are as follows: Automated Check Report By Group, Automated Check Report By Origin Table,

RECORDID	OBJECTID	REVIEWERCATEGORY	CATEGORY	REVIEWERCODE
773	8856	1	Feature Record	228
774	8857	1	Feature Record	228
775	8858	1	Feature Record	228
776	8859	1	Feature Record	228
777	8860	1	Feature Record	228
778	8861	1	Feature Record	228
779	8862	1	Feature Record	228
780	8863	1	Feature Record	228
781	8864	1	Feature Record	228
782	8865	1	Feature Record	228
783	8866	1	Feature Record	228
784	8867	1	Feature Record	228
785	8868	1	Feature Record	228
786	8869	1	Feature Record	228
787	8870	1	Feature Record	228

Fact	Job Name	Table Name	Record Count	Check Type	Check File	Records Validated	Total Results	Total Percent Accuracy	Defect Results	Defect Percent Accuracy
RevTutorial	2/29/2012 3:01:58 PM	Attribute Checks	116283			16676	86.90%	15396	86.98%	
		Execute SQL Check	509			72	86.96%	0	100.00%	
		Execute SQL Check (Buildings)(Buildings)	31			0	100.00%	0	100.00%	
		Execute SQL Check (Cemeteries)(Cemeteries)	0			0	#####	0	#####	
		Execute SQL Check (GolfCourses)(GolfCourses)	3			0	100.00%	0	100.00%	
		Execute SQL Check (Hospitals)(Hospitals)	4			0	100.00%	0	100.00%	
		Execute SQL Check (Lakes)(Lakes)	0			0	#####	0	#####	
		Execute SQL Check (LandmarkAreas)(Landmark Areas)	56			0	100.00%	0	100.00%	
		Execute SQL Check (MajorRoads)(MajorRoads)	378			72	80.96%	0	100.00%	

Automated Check Report By Subtype, Report By Total Record Count and Sampling Report.

It also has a tool to count number of features in the map based on feature classes and subtypes, respectively.

Assess Positional Accuracy of your spatial Data:

The Positional Accuracy Assessment tool (PAAT) allows to compare two spatial data layer to assess a data layer's accuracy in relation to a reference layer of known or unknown accuracy. The tool automatically calculates circular error (CE) and linear error (LE). Confidence level for the feature class or raster being evaluated can be at the 90, 95, or 99 percent level. It also has a built in tool to generate report on positional accuracy.

The PAAT tool has the option to use National Geospatial-Intelligence Agency (NGA) standard or United States Geological Survey (USGS) standard for reporting and in turn

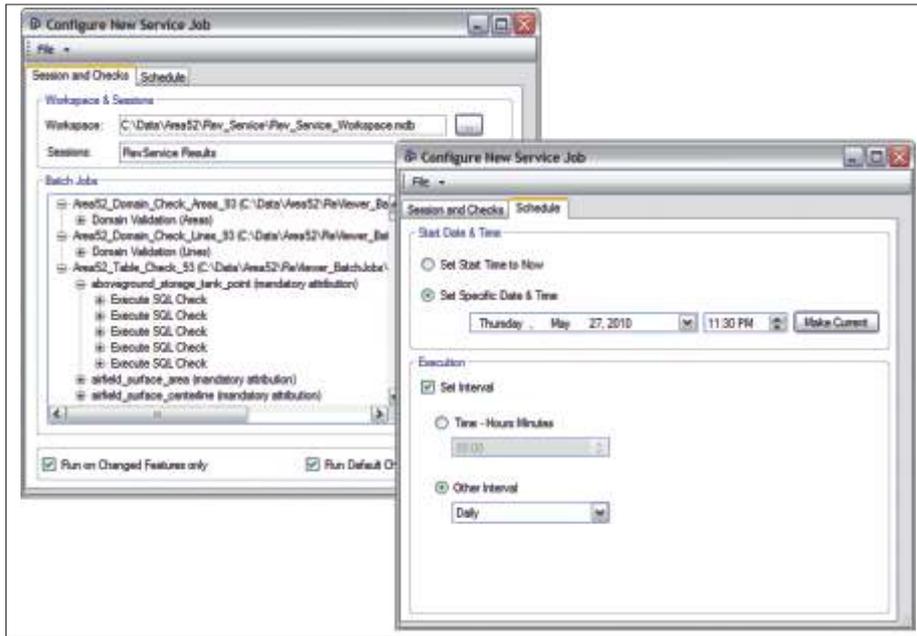
helping the users to meet the regulatory standards.

Schedule Data Checks Using the Reviewer Service:

Similar to running a batch job using the Reviewer Batch Validate tool, the Reviewer service - a Windows service, validates and runs batch jobs and writes the results to the Reviewer table in a specified Reviewer session. Batch jobs can be scheduled to run once at a specific date and time or to run repeatedly at regular intervals during off peak hours to utilize resources effectively. The software automatically generates service log files to track the current status of the service and results returned by batch jobs in the service job file.

Data Reviewer toolbox:

The Data Reviewer geoprocessing toolbox contains scripts and tools that allow you to create a Reviewer session and run a batch job.



Product Review Summary:

ArcGIS Data Reviewer is best suited for every organization that acquires, creates, converts, and maintains spatial data. It automates and simplifies QC process using out-of-the-box, user-configurable checks that are sharable across organization. It also Tracks who reviewed and corrected your data and when by automatically capturing user information and a date/time stamp resulting in saving significant man hours. As it supports versioned data, it can be can ensured that changes to versions are correct before reconciling and posting

Integrate with ArcGIS Workflow Manager: The Data Reviewer custom steps and tokens can be used to automate selected Data Reviewer functions as part of a Workflow Manager workflow. These steps and tokens allow you to create a Reviewer session for your job, run Reviewer batch jobs directly from a workflow, and automatically start the job's Reviewer session when ArcMap is started.

to the parent or master version. It helps in freeing up resources by scheduling data checks to run at specified dates and times-often.

In a nutshell, ArcGIS Data Reviewer saves time, organizational resources and man hour especially expensive skilled and experienced manpower by automating the complex spatial data quality checksand also in turn helping to improve the integrity of the spatial data ●

Get more Information From Imagery and Data

ENVI – The premier software Solution used to extract information from geospatial imagery

ENVI for ArcGIS Server – Author, publish and distribute image analysis tools to the ArcGIS enterprise

E3De - addresses user needs across industries to quickly and accurately get 3-D products from data.

IDL – The Scientific programming language used to create meaningful visualizations from complex data

EXELIS

Visual Information Solutions



For More Details Contact :
NIIT GIS Ltd. B1 / H9, MCIA, Mathura Road, New Delhi - 110044
Tel: +91 11 40570700 / 701 Email: ENVI@esriindia.com

Answering Emergency Management Information Needs

Whether modeling disaster consequences or alerting residents to an impending tsunami, GIS-driven maps and apps help emergency personnel save lives, mitigate property damage, and speed recovery.

maps and static images both suffered from latency and the absence of interactivity. The timeliness of both products was dependent on the update cycle and could not provide the most current information. Maps generated to answer one set

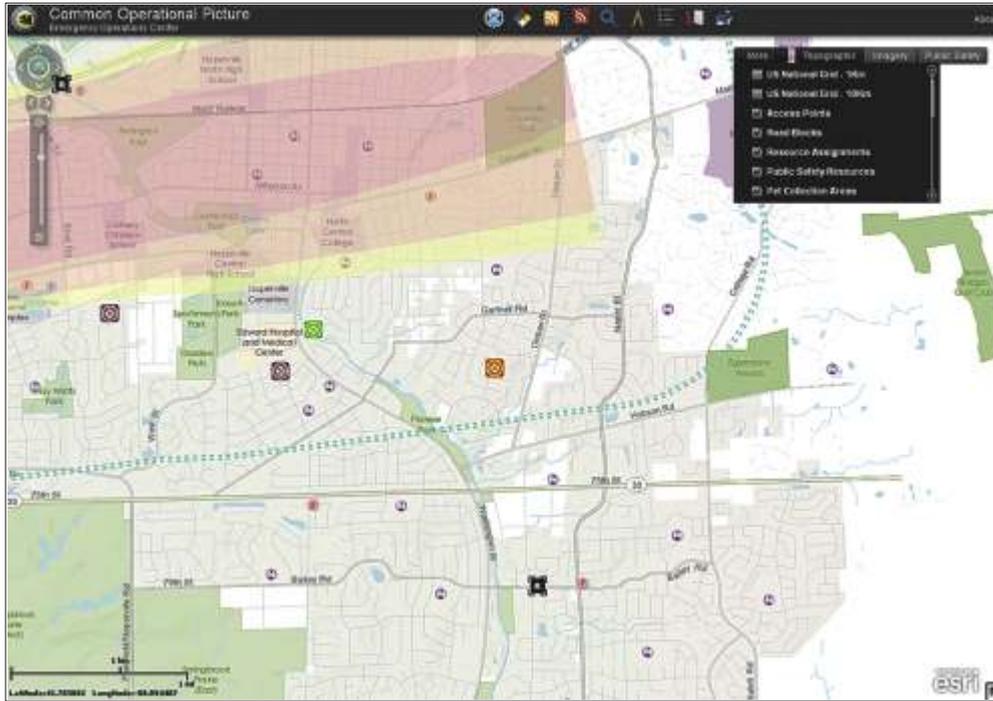


Live incident response apps can work two ways. They can share information about a disaster or capture additional data from Facebook, Twitter, Flickr, and YouTube posts.

Situational awareness is the key to effective emergency management. The GIS-driven common operating picture (COP) has evolved over the past decade to furnish situational awareness and support missions across all phases of the emergency management cycle. COP is enhanced by GIS technology, not by the implementation of a single application. GIS is a platform for developing mission-specific applications that incorporate the abundance of GIS-ready data with operational data continually updated from the field to support analysis, decision making, and collaboration. Before GIS was applied to emergency management, the information base for decisions was often limited to the work experience and intuition of individual emergency managers. GIS tremendously expanded the resources managers could consider when evaluating a situation. Initially, GIS use focused on response efforts, especially the production of paper maps for briefings and personnel in the field. Static maps produced by the first Internet mapping websites also improved situational awareness for managers and incident commanders and kept the public informed. However, paper

of questions could not be queried to answer new questions spawned by response situations in constant flux or address additional scenarios when working on planning, mitigation, or preparedness efforts. The initial challenge when setting up emergency management GIS applications was assembling and integrating the most current and accurate datasets. Because disasters don't respect jurisdictional boundaries, at least some of the required data would likely have to come from other government agencies or organizations. Building and maintaining regional foundation datasets to meet this need was a formidable task from both technological and organizational standpoints.

New patterns of GIS have emerged that answer needs for timeliness, interactivity, accessibility, and collaboration. ArcGIS Online is a pivotal part of these new capabilities. By using an open pattern of implementation that extends into the cloud, ArcGIS Online replaces downloading, processing, and managing datasets with accessing geospatial information contained in map services, map layers, and tools. Topographic, imagery, shaded relief, ocean, reference, and



The Public Safety Common Operational Picture template, available from arcgis.com, offers a standard overview of an incident, providing information that enables the incident commander and any supporting agencies to make effective decisions.

other basemaps, created by Esri and available from ArcGIS Online, can be immediately incorporated as a foundation for mapping operational layers. In addition to a gallery of basemaps, ArcGIS Online hosts a community of users who share maps, services, layers, apps, and tools that can be used to create intelligent maps by mashing up these resources with local operational data.

Demographic information, important to all aspects of emergency management, can be accessed as thematic map layers created by Esri and available from arcgis.com. These layers are based on current-year demographics. In addition to free resources, a full spectrum of ready-to-use, high-quality geospatial data licensed from industry-leading providers or built with Esri's proven methodologies can also be purchased. Furnishing data to web apps and desktop GIS as map services also allows the use of live feeds that are critical when responding to the rapidly unfolding events of an incident. Dynamic data from the Pacific Disaster Center is available as an ArcGIS for Server service as well as live feeds for wind speed and direction, US weather warnings, and ground motion and shaking intensity.

Providing a wealth of data already configured in maps, map templates, and map layers means that data can be used immediately in interactive maps that can be styled, searched, queried, embedded, and shared. The development and release of ArcGIS APIs for JavaScript, Flex, and Silverlight have furthered the goal of making current geospatial information accessible and comprehensible to nonspecialists. Interactive maps and apps for the web and mobile devices created with web mapping APIs can mash up online services, incorporate GeoRSS and social media feeds, and add tools and widgets. Extending GIS using cloud computing platforms, such as ArcGIS for Server deployed on the Amazon Elastic Compute Cloud (EC2), has made web maps and apps almost instantly accessible for response to disasters. Deploying ArcGIS for Server via EC2 lets responders rapidly provide services without procuring hardware, installing software, or impacting existing on-premises infrastructure. An Amazon Machine Image (AMI)

obtained from Esri comes with ArcGIS for Server installed and configured along with ArcGIS for Desktop, ArcSDE on Microsoft SQL Server Express, and 100 GB of attached storage. ArcGIS for Server can be configured to automatically spin up new instances during demand spikes and efficiently distribute capacity across instances. The value of GIS in the cloud was demonstrated in 2010 when extensive flooding covered three-quarters of the state of Queensland, Australia. Responding agencies needed quick access to information on this rapidly changing situation. Ben Somerville and Nick Miller of Esri

Australia Pty. Ltd. stood up a COP app in just 12 hours that gave access to the latest, most accurate information on the situation in Brisbane.

Live incident response apps have become an increasingly popular method for sharing information about a disaster or capturing additional data from the public via posts to Facebook, Twitter, Flickr, and YouTube. Simply download the Public Information Map template to learn how to create and deploy public media maps. To use data from social media for advanced visualization, the Ushahidi2ArcGIS ArcGIS for Desktop add-in prototype connects to aUshahidi instance with the API enabled and can download Ushahidi data into a geodatabase.

Mobile devices enabled by mobile, global networks let responders enjoy bidirectional situational awareness in near real time. The Alabama Marine Police demonstrated how bidirectional capability could be applied to a large-scale disaster event. Responding to the massive oil spill in the Gulf of Mexico caused by the Deepwater Horizon incident in 2010, crews documented the location of booms and other apparatus using focused apps on mobile devices. Maps, data, images, and video were immediately transmitted to incident command via a Broadband Global Area Network (BGAN). A Flex-based viewer displayed current maps at daily briefings. The result: everyone in a five-state area could see the same information at the same time—a tremendous leap forward in situational awareness. Beyond heightened situational awareness and improvements in the processes associated with the entire emergency management cycle, GIS—through the GeoDesign framework—is being applied to the underlying cause of an increasing number of natural disasters: climate change.

GeoDesign, which brings together geospatial technologies and design processes to create innovative outcomes, is being used by governments, and nongovernmental organizations (NGOs) to make existing communities more resilient and new communities more sustainable. ●

Geographic Information Systems Providing the Platform for Comprehensive Emergency Management

Introduction Emergency management organizations are government agencies at federal, state, and local levels that are charged with reducing community vulnerability and establishing capabilities to manage and quickly recover from emergencies.

Over the last several years, emergency management has become more complicated. Large-scale emergencies seem to be more prevalent, and new threats exist. The need to plan for, prevent, and reduce the consequences of emergencies is greater than ever. Emergency management has the responsibility to collaborate with and coordinate and facilitate multiple departments in planning, response, and recovery. This article will illustrate how geographic information system (GIS) technology effectively improves the workflow in all phases of emergency management and supports the requirements of the recently released emergency management principles.

The emergency management mission and workflow are organized into four phases.

Mitigation

Mitigation efforts attempt to prevent hazards from developing into disasters altogether or reduce the effects of disasters when they occur. The mitigation phase differs from the other phases because it focuses on long-term measures for reducing or eliminating risk. Successful mitigation is a direct result of comprehensive planning and analysis.

Planning and Analysis

Emergency management planning is the process of analyzing a community's hazards, risks, and values to determine its vulnerabilities to natural, technological, and terrorist based disasters. A comprehensive risk and hazard analysis provides the foundation for the development of mitigation, preparedness, response, and recovery plans. Emergency management planning requires acquiring, integrating, and analyzing vast amounts of information and data in a variety of disparate formats to develop a comprehensive risk based emergency management program.

GIS technology provides the capability to map and analyze hazards of all types and visualize their potential impacts. When hazards are fused with critical infrastructure, population densities, and other community values, vulnerabilities can be observed, modeled, and better understood. Based on the potential impact of any particular hazard to critical values, priorities for mitigation can be established. Contingency and response plans can also be developed based on important values at risk. The risk and hazard assessment provides the foundation for the overall emergency management program. GIS optimizes the planning analysis process as follows:

1. Identify and map natural and technological hazards:

- Natural hazards may include
- Earthquake faults
- Storm surge exposure
- Flammable vegetation
- Areas prone to severe weather events

- Landslides
- Floods
- Technological hazards may include
- Hazardous materials locations
- Transportation corridors where hazardous materials are routinely shipped (rail, highway, etc.)
- Nuclear power plants Petroleum processing and storage facilities

2. Identify and map critical values at risk:

- Population densities
- Critical infrastructure including government facilities hospitals, utilities, and public assemblies.
- Natural resource concerns including scarce natural resources and plant and animal habitats

3. Identify values at risk that reside within the impacted areas of natural and/or technological hazards. GIS is used to model potential events (plumes, explosions, floods, earthquakes, etc.) and display projected areas of extreme, moderate, and light damage that could be caused by the event. Casualties can also be projected. Priorities for mitigation and emergency contingency and response plan development are highlighted through the use of GIS.

4. Develop site-specific strategies for mitigation to reduce losses; mitigation includes activities that prevent an emergency, reduce the chance of an emergency, or reduce the damaging effects of unavoidable emergencies. Mitigation activities take place before and after emergencies. Other mitigation functions may include enforcing building and fire codes, designating specific routes for hazardous materials shipments, requiring tie-downs for mobile homes, and shipping regulations for hazardous materials. Evaluate and model alternative mitigation strategies. Determine the best strategy for protecting critical assets from catastrophic damage or loss and reduce casualties.

Mitigation encompasses the comprehensive steps taken to prevent emergencies, reduce loss, and provide a proactive approach to the overall emergency management program. The hazard and risk assessment within the planning process provides the framework for decisions that are made in the preparedness phase.

Preparedness

Emergency managers develop plans of action for when disaster strikes. Priorities for action plan development are identified in the planning and analysis process. Common preparedness measures include some of the following:

- Critical facility emergency contingency plans
- Communication plans with easily understandable terminology and chain of command
- Development and practice of multi agency coordination and incident command
- Proper maintenance and training of emergency services
- Development and exercise of emergency population warning methods combined with emergency shelters and

evacuation plans and the stockpiling, inventory, and maintenance of supplies and equipment

- Developing the facilities, staff, equipment, and tools necessary to plan, monitor, and facilitate emergency management decision making and information sharing

GIS technology is utilized for preparedness as follows:

- Site selection for adequate evacuation shelters with consideration of where and how extensively an emergency might occur
- Selecting and modeling evacuation routes
- Considerations for time of day
- Considerations for road capacity versus population, direction of travel, etc.
- Identification and mapping of key tactical and strategic facilities
- Hospitals
- Public safety facilities
- Suppliers to support response (food, water, equipment, building supplies, etc.)
- Training and exercises to test preparedness
- Identify incident locations and impacts; map incident perimeters.
- Model the incident (plumes, spread, etc.).
- Collect damage assessment, identify casualties, and prioritize for allocation of public safety resources.
- Develop and distribute incident action plans.
- Providing a key capability for the 'command and control information system that enables situational awareness and incident management support

To achieve comprehensive preparedness, a great deal of information must be gathered and managed. When disasters strike, the right information must be available at the right place to support emergency decision requirements. GIS, in addition to supporting the preparedness workflow, is a powerful data management system.

Data Management

Data management is the development, execution, and supervision of plans, policies, programs, and practices that control, protect, deliver, and enhance the value of data and information assets. In the context of emergency operations, data management is gathering, managing, processing, and distributing information to users and across systems when and where needed. It is the capability to store, manage, update, and provide access to all of the unit's data through well-designed computer system architecture to meet the emergency management mission.

GIS provides a platform for the management of geographic data and disparate documents (plans, photographs, etc.) necessary to meet the emergency management mission. GIS provides a capability to access information based on the geographic location to which it pertains, allowing users to get various types of information from the map display. This could include emergency response plans, mitigations plans, and contact lists. The management of resources is essential to

support the emergency management mission. Resources include public safety resources, as well as civilian resources (and their

locations), such as dump trucks, buses, dozers, hardware suppliers, and food and water resources. When these types of assets are inventoried and accessible through GIS, the appropriate resources (proximity to an emergency) can be contacted for timely response. One of the most complex challenges of incident management is managing the location, status, and capabilities of all of the resources needed to meet incident requirements. Managing resources requires current and accurate data. GIS provides the ability to visualize all types of resources and their current availability and location for effective incident management.

In addition to managing existing data assets, GIS can access and display relevant dynamic data (camera feeds, weather, traffic, hospital status, automated vehicle location [AVL], incidents, sensors, etc.) to provide situational awareness for decision support. Without comprehensive data management, it is difficult to achieve and maintain accurate situational awareness.

Situational Awareness

Situational awareness is being aware of what is happening around you to understand how information, events, and actions will impact your goals and objectives both now and in the near future. This is especially important where information flows are high and poor decisions may lead to serious consequences. In the context of an Emergency Operations Center (EOC), achieving timely situational

awareness is essential to maintain an understanding of events, incidents, and developments to anticipate, respond to, and manage actual or potential emergencies. GIS provides situational awareness through a common operating picture. A GIS map display with relevant GIS data (critical infrastructure, imagery, hazards, etc.) integrates dynamic event data (sensors, cameras, traffic,

incidents, etc.) to represent the current situation throughout the jurisdiction, region, or nation. Comprehensive situational awareness provides the capability for emergency management personnel to make better decisions that can then be quickly displayed, shared, and understood by those who need to take action. The common operating picture can be enhanced when response plans, contingency plans, and other documents are linked to the location(s) for which they were developed. Rapid access to planning information through the common operating picture begins to "operationalize" the planning process. Examples of how GIS provides accurate situational awareness through a common operating picture include:

- Maintaining and displaying the status of emergency and non emergency events
- Designating and mapping incident locations/perimeters
- Site selection analysis for
- Hot zones
- Incident Command Post (ICP) locations
- Additional evacuation sites
- Staging areas

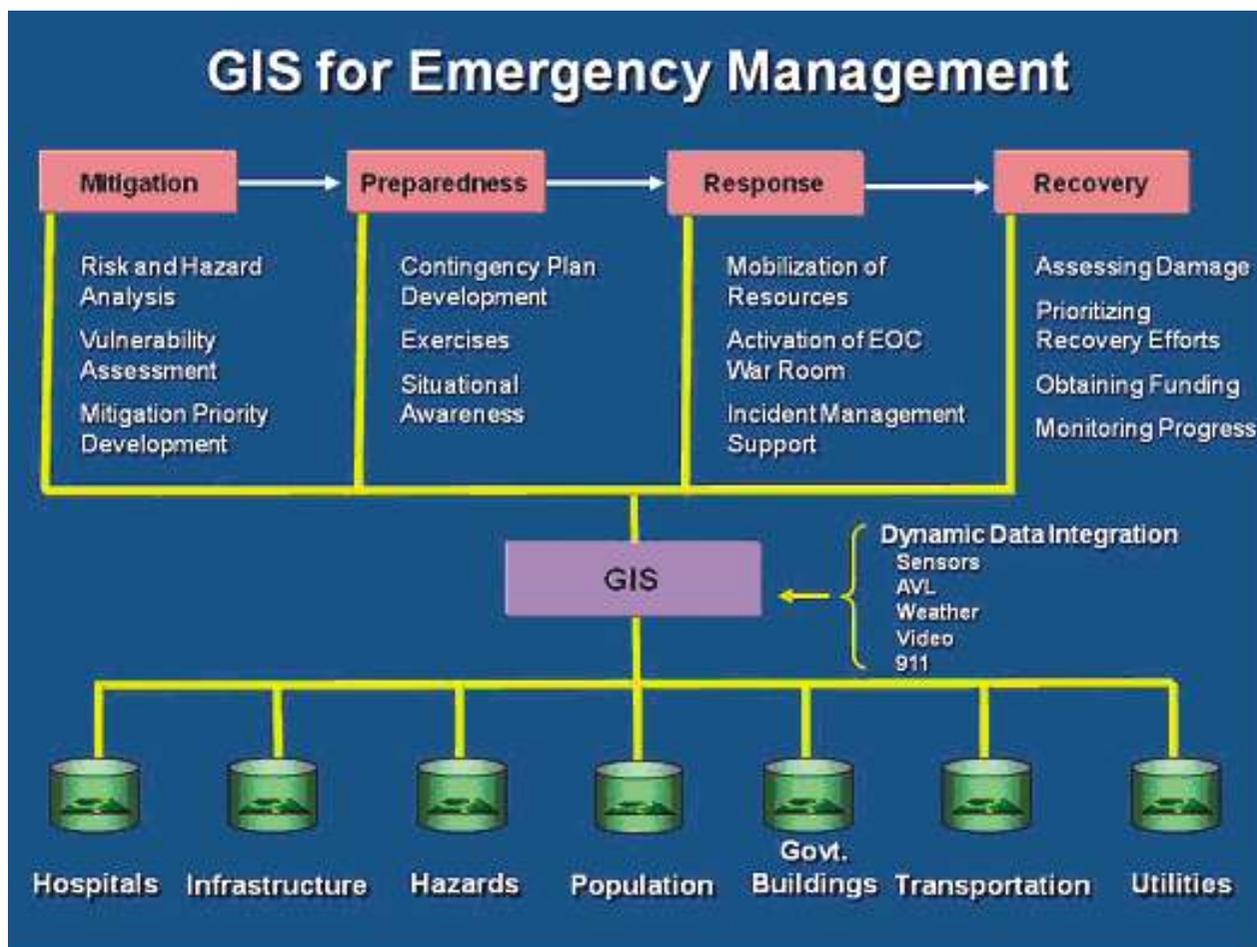
"GIS technology effectively improves the workflow in all phases of Emergency Management"

- Logistical support and supply caches
- Drop points
- Division and branch boundaries
- Heliports
- Temporary medical facilities
- Maintaining and displaying the status of public safety resources both locally and in adjoining jurisdictions
- Modeling and displaying plumes, weather events, wildfires, floods, etc.
- Analyzing consequences and losses
- Determining intersections that should be closed (based on incident perimeter or plume) and transportation routes that avoid closures
- Importing and displaying damage assessment from mobile devices
- Displaying and printing appropriate incident command system (ICS) incident action plan maps
- Operations maps
- Logistics maps
- Tactical maps
- Air deployment maps
- Transportation maps
- Incident prediction maps

Response

Emergency management assists in the mobilization of emergency services and resources to support first responders for complex emergencies. This can include specialist rescue teams, logistical support, public safety, volunteers, nongovernmental organizations (NGOs), and others. The Emergency Operations Center is responsible to support incident management operation needs and maintain continuity of operations for the community. Acquiring, managing, and maintaining status of resources from various locations is an important function. GIS supports the response mission as follows:

- Provide warnings and notifications to the public and others of pending, existing, or unfolding emergencies based on the location or areas to be impacted by the incident. Areas in harm's way can be identified on the map, and mass notification can be performed from a GIS.
- Determine appropriate shelter activations based on the incident location and optimum routing for affected populations to access appropriate shelters.
- Maintain shelter location continuity of operations: supply inventories, external power requirements, shelter population capacities, etc.
- Identify the locations and capabilities of existing and mutual aid public safety resources.
- Provide facilities for the assembly of department heads to collaborate, make decisions, and develop priorities. Provide the capability to create remote connections to the command



center for officials and others who need to participate but are unable to come to the command center.

- Establish the capability to collect and share information among department heads for emergency decision making to support emergency operations and sustain government operations.
- Establish the capability to share information and status with regional, state, and federal agencies.
- Support incident management operations and personnel, provide required resources, and exchange internal and external information.
- Maintain incident status and progress; facilitate damage assessment collection and analysis.
- Assure the continuity of government operations for the jurisdiction considering the impacts of the emergency.
- Prepare maps, briefs, and status reports for the executive leadership (elected officials) of the jurisdiction.

Recovery

The aim of the recovery phase is to restore the affected area to its original state. It differs from the response phase in its focus; recovery efforts are concerned with issues and decisions that must be made after immediate needs are addressed. Short-term recovery is focused on restoring essential services and support. Long-term recovery efforts are concerned with actions that involve rebuilding destroyed property, re-employment, and the repair of essential infrastructure. GIS is integral for recovery by providing a central information repository for assessment of damage and losses that provides

- Identification of damage (triage based on degree of damage or complete loss). GIS allows inspectors to code parcels with the degree of damage in order to visualize specific problems as well as area trends. (GIS on mobile devices expedites the difficult damage assessment problem and can include photographs and damage reports linked to the specific geographic sites.)
- Overall damage costs and priorities for reconstruction efforts based on appropriate local criteria
- Locations of business and supplies necessary to support reconstruction
- Assess overall critical infrastructure damage and determine short-term actions for the following:
 - First aid and health
 - Additional shelter needs
 - Optimum locations for public assistance
 - Alternate locations for government operations if government facilities are damaged
 - Alternate transportation routes for continued operations
 - Monitoring progress by specific location of reconstruction efforts for both long term and short-term needs
 - Publishing maps to share information with the public and other government organizations of progress toward recovery objectives

Field Operations

Both response and recovery require close coordination and

information exchange between the field and EOC. These requirements are often needed under stressful, chaotic conditions, when good information is required to support critical operations. GIS provides the capability for rapid data exchange that is easy to assimilate, understand, and act on. This capability allows EOC to provide elected officials, department heads, and other stakeholders with accurate situation status and data about actual and potential impacts. Current and timely information is also essential in order to provide the public with information such as shelter locations, evacuation routes, road closures, and hazard areas. Mobile GIS data can be easily integrated into the common operating picture and visualized, shared, and acted on without delay. When the common operating picture is current, better decisions can be made. These capabilities are important during response but can play a very important role during recovery. Using mobile GIS in field recovery operations provides the EOC with a capability to rapidly integrate and display damage impacts from field inspectors in various locations.

In non emergency situations, mobile GIS benefits data collection for planning, analysis, mitigation, and response. Data collected using mobile GIS in the field can be downloaded wirelessly or with physical docking as required. Detailed geospatial and other data (pictures, forms, etc.) can be collected and added to EOC's enterprise GIS for use in planning, preparedness, response, and recovery.

Conclusion

As the emergency management profession continues to be refined, the requirements to deal with complex issues across a variety of disciplines and stakeholders increase. Disaster

“GIS provides a platform for the storage and management of all types of data that can be easily accessed for emergency decision support”.

events are increasing, populations are moving into more disaster-prone landscapes, and new threats exist. To meet the demands, professional tools and technology are required. GIS technology can serve a variety of purposes in supporting the work flows and mission of the emergency management profession. Comprehensive emergency management requires coordination

and collaboration among many stakeholders—department heads, elected officials, privately held business, the community, and others. The collection of information, analysis of community vulnerabilities, development of mitigation strategies, and overall risk management preparedness is daunting. When emergencies occur, key stakeholders must share information on the scope of the event and collaborate on the most effective way to manage the incident and maintain government operations. Emergency Operations Centers activate their situation status rooms where various officials meet, share information, and provide their expert input for emergency decision support. GIS provides a platform for the common operating picture, where dynamic data can be integrated to create a picture of events; their relationship to critical infrastructure can be shared with remote locations, which reduces the need to have everyone in one location. GIS provides a platform for the storage and management of all types of data that can be easily accessed for emergency decision support. The advent of mobile GIS enables geographic updates from the field that are immediately posted to the common operating picture, creating actionable information. The use of GIS is improving how emergency management professionals do their work. ●

GIS Technology Critical to Managing Japan Disaster

GIS technology is helping the world understand and react to the Japan earthquake and tsunami events in real time. GIS is helping the Japanese recover in a number of key ways; first and foremost the technology is enabling them to map out the vitally important logistics of moving people and resources to and from Japan. GIS helped individuals track down their loved ones and GIS tools also supplied critical information to Japanese civilians, military and the rest of the world.

GIS to facilitate precise position referencing with GPS, web

map portals and hardcopy maps, while enabling a practical system of geoaddresses and a universal map index. Without GIS technology, these tools could not supply GIS modeling and mapping software provider, Esri, has developed a social media map to track updates related to recent events. The application pulls the social media and creates a specialized map to track incidents. Esri also has a trend analysis map to visualize community reports. Here are the following two excerpts written and researched by Esri staff in understanding the devastation happened across Japan.

Understanding Japan's Earthquakes from a Geospatial Perspective

By Joseph Kerski, Esri Education Manager

Disasters such as the recent magnitude 9.0 earthquake that rocked Japan and triggered a deadly tsunami are being studied today by scientists and other researchers using geospatial technology. Their authoritative research will be published in the weeks, months, and years to come.

Whether natural or human caused, hazards take place across space and time and, therefore, can be better understood

using GIS, spatial data, and the geographic framework. While scientists run models and test hypotheses, viewing a variety of maps of earthquake-related web GIS maps and using ArcGIS for further analysis can give everyone a better geospatial perspective of what occurred. Mapping options seem to be increasing by the day. Over the past 18 months, Esri has hosted social media maps using ArcGIS Server for many of the major world events that have occurred during this time



This map displays social media from Ushahidi, YouTube, Twitter, and Flickr related to the earthquakes, tsunami, and nuclear plant disasters in Japan, along with the location of recent quakes.

period, including the political unrest in Egypt; the Gulf of Mexico oil spill; and the earthquakes in Haiti, Chile, New Zealand, and Japan. This map shows the earthquakes that occurred leading up to and following the massive quake off the coast of Japan on March 11, 2011. United States Geological Survey (USGS) provided the data. It contains a shakemap, which measures how people there felt the earthquake. The map also has Twitter, Facebook, and YouTube links that can be used to learn about the events through real-time postings by people on the ground in these locations. As always, the data user needs to critically examine where these postings have come from, but these citizen-science collected datasets are becoming valued components in not only understanding hazards but also coordinating rescue operations that save human lives.

Esri has also posted the How Japan Shifted map, which shows how much the country's landmass shifted because of tectonic plate movement. The landmass shift was derived using products acquired from NASA's Jet Propulsion Laboratory (JPL). The map includes a time slider tool that shows the location and time of aftershocks of a magnitude greater than 5.0. Also, the Tsunami Movement map models the movement of a tsunami in the Pacific Ocean. The Pacific Disaster Center (PDC) created a model that predicts how a tsunami would travel given an earthquake the size of the magnitude 9.0 that struck off the coast of Sendai, Japan.

ArcGIS Online's Maps and Apps

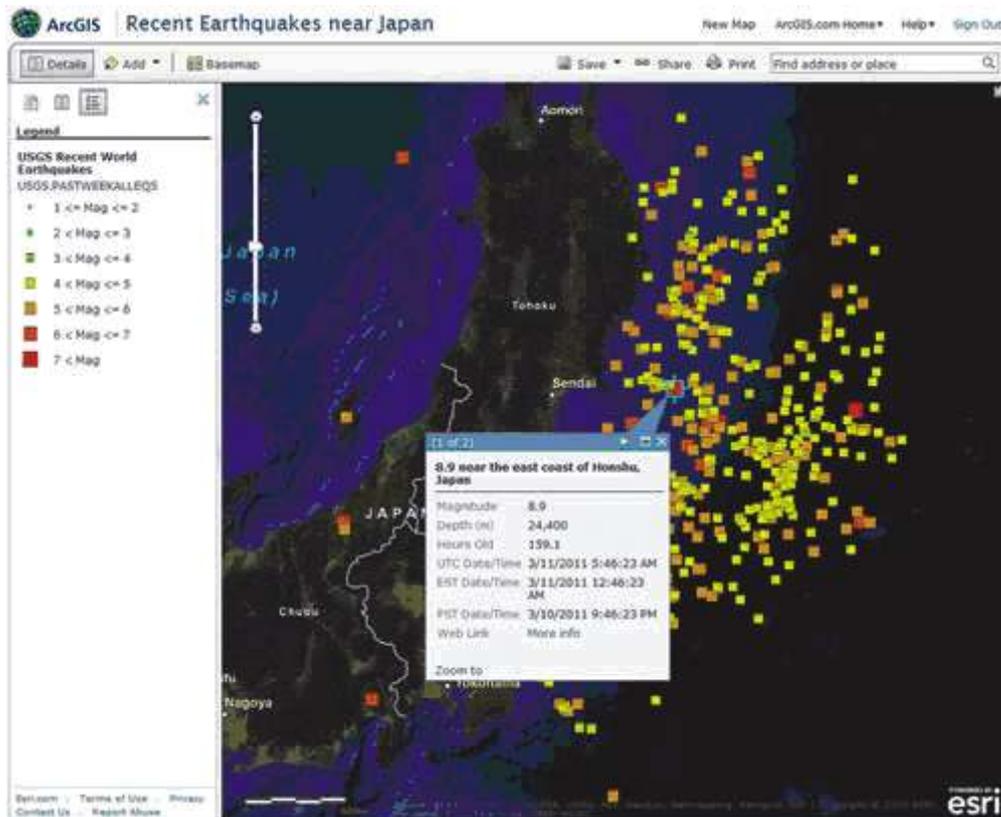
ArcGIS Online includes a powerful set of maps and applications for analyzing events such as the earthquake that struck off Japan's northeast coast. Search the site for "latest earthquakes" or "recent earthquakes near Japan." The search will yield web maps that show the cluster of earthquake epicenters. Click on the icons to view, in a pop-up window, the location, magnitude, time, and depth of each quake and other information. The pop-up window also has a Zoom to button that lets you zoom in closer to see where the quake occurred.

Spatial analysis is also increasingly possible on mobile devices. QuakeFeed is an app from Artisan Global that runs on iPhone. It allows the listing, mapping, and querying of current earthquakes anywhere in the world. This image (right) shows epicenters of quakes in and around Japan according to data taken from a smartphone a week after the major earthquake struck.

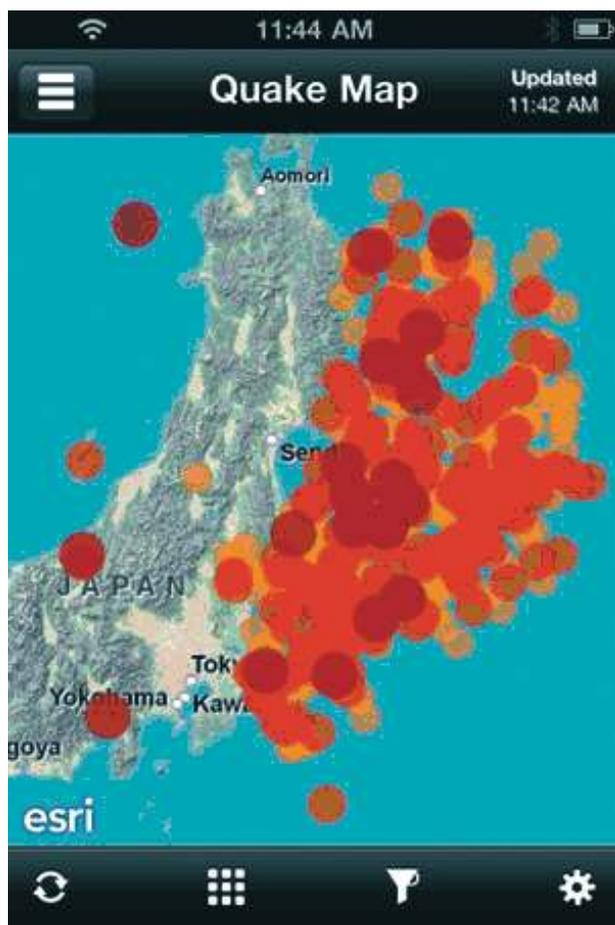
Another easy way to start examining the earthquake cluster, tsunami, and environmental situation is to investigate the latest earthquake data from Japan and elsewhere at this USGS-hosted site. The data at this site can be examined spatially using the online map at USGS. To ask deeper questions, this data can be saved as a text file, then brought into ArcGIS and analyzed by mapping the data on latitude and longitude coordinates. The distribution of the earthquakes can be compared with plate boundaries to determine how many earthquakes occurred within a certain distance of the plate boundaries. These plate boundaries can be found as a layer package in ArcGIS Online.

Population data can also be added as a layer package or a map service called ESRI_Population_World at ArcGIS Online to determine how many people lived within 10 kilometers of the coast or 100 kilometers of the magnitude 9.0 earthquake's epicenter. The mean center and directional distribution of the cluster of earthquakes can be measured with the Spatial Statistics toolbox in ArcGIS.

A large cluster of 165 earthquakes struck off the east coast of Honshu, Japan, March 9-11, including the biggest quake. But was this cluster unusual in comparison with past seismic activity in the region? To find out, compare the pattern of earthquakes that occurred over these three days against all the earthquakes from a particular year. The 23,581 earthquakes that occurred during 2001 were chosen and examined at a scale that includes all of East Asia. The cluster no longer appears significant: the ocean east of Honshu is prone to earthquakes, though the magnitude 9.0 earthquake was the fourth largest ever recorded according to the



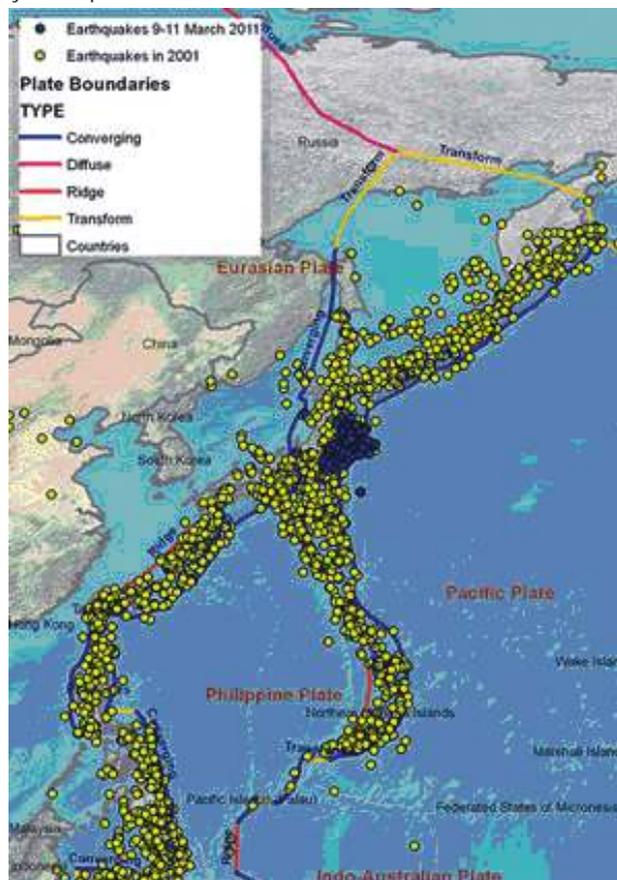
An examination of recent earthquakes in Japan using ArcGIS Online reveals the cluster of earthquakes northeast of the island of Honshu. Individual earthquakes may be selected and examined, all in the online environment using a standard web browser.



This image shows epicenters of quakes in and around Japan using the QuakeFeed application. The image was taken from a smartphone a week after the major earthquake struck.

historical USGS earthquake data examined. In mapping the data, notice the X-shaped pattern of earthquakes with the center of the X on Honshu. Also notice an unnamed, wedge-shaped plate extending northward, underlying the seismically active Kamchatka Peninsula in the far east of Russia. More could be done with the tools and data, but this illustrates how a GIS can be effectively used to understand the events spatially and temporally.

GIS and the spatial perspective gives people a deeper understanding of natural disasters. That helps them become more aware of natural hazards like earthquakes and better prepare for them. Organizations also can use GIS to make the wisest choices possible about how to help those in need. What will you do with the plethora of data and GIS tools at your disposal? ●



Comparing historical earthquakes from 2001 to the earthquakes that occurred March 9-11, 2011, in ArcGIS shows that while the magnitude of the recent earthquake was unusually large, the clustering of earthquake epicenters to the northeast of Honshu is commonplace. Examining the data in this way also reveals that the plate boundaries in this region form an X, with Japan at the center of the X.

Looking Up for Answers on the Ground : Providing first responder maps for the 2011 Japanese Earthquake and Tsunami

By Karen Richardson, Esri Writer

A professor of anthropology used his remote-sensing expertise, developed exploring ancient cultures, to aid emergency response to the Tohoku earthquake and tsunami.

Dr. Terance L. Winemiller, GISP, associate professor of anthropology and geography at Auburn University, Montgomery (AUM), in Alabama, took his first GIS course while in graduate school. His interest in geospatial technology led him to become a specialist in remote sensing. He found GIS was the perfect tool for interpreting ancient cultures by constructing maps of archaeological sites that had never been

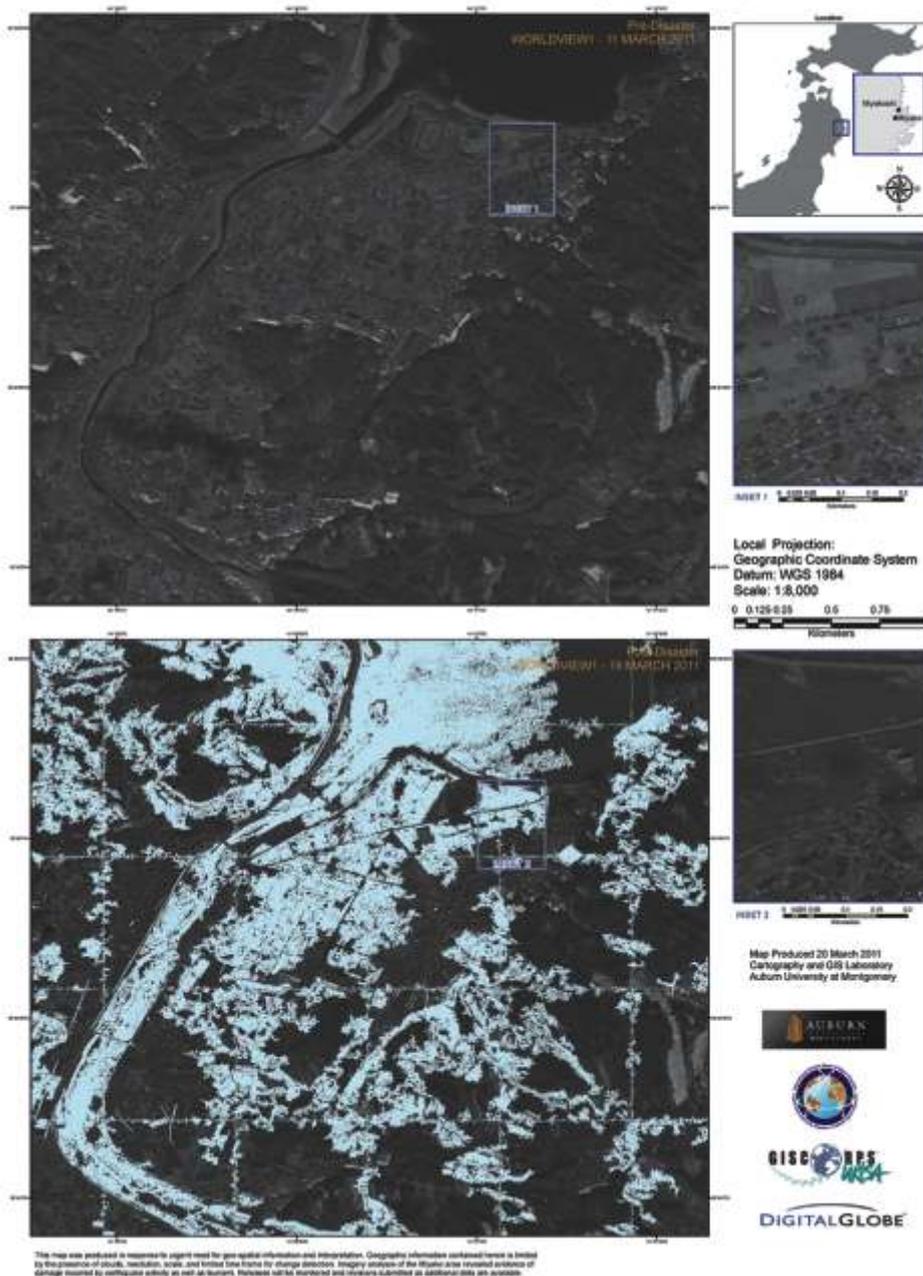
mapped before. Employing total stations and GPS collectors, he gathers data he uses to construct maps in ArcGIS in both two and three dimensions.

His interest in mapping led him to develop a GIS program at AUM in 2004—the first at the university. Today the program includes as many as eight courses for bachelor and master programs. A site license provides students with access to Esri software.

A Call to Action

On March 11, 2011, a powerful 9.0-magnitude earthquake

Tsunami Affected Areas - Miyako, Japan



Winemiller's team processed vast amounts of data from a variety of sensors and platforms. Imagery analysis of the Miyako area revealed evidence of damage incurred from earthquake activity as well as tsunami.

hit Japan, unleashing a massive tsunami that crashed into Japan's northeastern coast, resulting in widespread damage and destruction. Japanese officials soon realized that they needed to understand the extent of the damage in order to help their citizens. Satellite sensors provide global coverage so the damage caused by natural disasters can be assessed using current and historical imagery. The worldwide remote-sensing community was asked to help.

When a major disaster strikes, the International Charter on Space and Major Disasters takes effect. This charter, first initiated by the European Space Agency, provides space satellite data to relief organizations responding to these events. The US Geological Survey (USGS) was as part of the US team of signatories to this charter. USGS, working through GISCorps, an organization composed of GIS professional volunteers, requested help processing and analyzing imagery

from Japan. Winemiller, along with Christopher Blair and Sissy Speirs, two student assistants who gave up other plans for their spring break, volunteered, and AUM became one of four universities in the United States that helped process and analyze imagery related to the disaster.

Efficient Workflow When Every Second Counts

Winemiller was given access to more than 1,200 different imagery datasets. Less than two days after the disaster, the team began working on the project. They searched for imagery on the USGS Earth Resources Observation and Science (EROS) Hazards Data Distribution System (HDDS) public and restricted databases and public sites for coverage of the three areas in Japan they were assigned: Miyagi-Kamaishi, Iwate-Miyako, and Iwate-Miyakoshi.

"We were looking for images of both pre- and postdisaster to understand the changes that occurred and the amount of damage that was done," said Winemiller. "We studied the geology of the areas we were assigned to assess earthquake damage and, of course, damage from the tsunami, which was the easiest to identify."

Time mattered. Winemiller's team had to sift through and process vast amounts of data from a variety of sensors and platforms. They needed to easily process and analyze

this imagery and produce detailed maps. They chose ENVI image analysis software for image processing and image analysis and ArcGIS for GIS analysis and mapping production.

The automated image preprocessing tools in ENVI were used to prepare the imagery for viewing and additional analysis within ArcGIS. Imagery was resampled to create a uniform pixel count and pixel size so different images could be registered and fused together. Subsetting cropped images to focus them on areas of interest. Georeferencing established the correct position of an image relative to other images or on a map. Building a mosaic combined multiple images together into one larger scene.

After enhancement in ENVI, the images were pulled into ArcGIS to create before and after insets from the layouts of the same locations. From these insets, they created maps. The



US Naval helicopters deliver food, donated by the city of Ebina, Japan, to survivors of the earthquake and tsunami. (Photo courtesy of the US Navy/Released Official Navy Photos, used under Attribution Common License)

maps were uploaded to USGS, which provided them to first responders on a secure server.

"Some of the locations in Japan had little or no communication after the disaster, so the responders had no idea what was going on there," said Winemiller. "We found the layout capabilities of ArcGIS 10 to be the perfect tool because it was user-friendly, making it easy to pull in imagery. I don't think we could have done this with any other solution."

Many Imagery Sources

Imagery for this project came from sensors aboard IKONOS, SPOT, WorldView-1 and -2, QuickBird, Landsat, and many other satellites. First, the team looked through the imagery to determine coverage and see if the imagery could be used for this mission. They opened files in ENVI, which supports panchromatic, multispectral, hyperspectral, radar, thermal, and lidar imagery types. Winemiller and his students soon realized that a large percentage of the imagery required enhancement to improve clarity. They matched up images from different sources pixel for pixel and linked them together to create rasters that accurately mapped areas for damage assessment.

The need to get imagery to responders on the ground as quickly as possible limited opportunities for performing detailed image analyses. Initially, visual comparisons of the processed before and after scenes were performed to identify the areas with the most damage. Later, Winemiller used the feature extraction tool in ENVI on pre- and postearthquake

imagery to identify grids, building footprints, and other items to more accurately compare images.

After the images were processed in ENVI, the team output the images as GeoTIFFs and imported them as datasets into ArcGIS, where the detailed maps were created using the enhanced and processed imagery. ENVI's advanced image analysis tools are also available directly from the ArcGIS environment for users who wish to access them through either a desktop or server environment. "The workflow between ENVI and ArcGIS was a piece of cake," said Winemiller.

Getting Maps to Responders Quickly

Satellite imagery has become a major component of postdisaster relief efforts like the one in Japan. The global coverage of satellite sensors makes them ideal for providing the imagery required when time is at a premium after a disaster.

Within 36 hours after the first request, Winemiller and his team of students had useful maps showing accurate pre- and postevent information so damage could be assessed. "Using satellite imagery with this solution enabled us to create up-to-date maps providing emergency responders in Japan with the critical situational awareness they need to understand which areas were affected, what the damage extent was, and what resources were needed," said Winemiller. "We were happy to help our global neighbors and provide our students with a terrific learning opportunity involving a real-world situation." ●



SOURCE:
<http://www.esri.com/industries/public-safety/emergency-disaster-management/success-stories.html>

Esri India attends India Geos



Esri India made its presence felt at the India Geospatial Forum 2012 held at the Apparel House in Gurgaon during February 7-9, 2012 recently. Esri India was one of the Gold sponsors at the forum and also partnered for a vertical seminars on Geo-Infra and Geo-Gov 2012. The three day conference and exhibition aimed at the significance of geospatial technology for developing and shaping up the nation. The forum was attended by 1162 delegates with significant participation from land administration department and survey organisations.

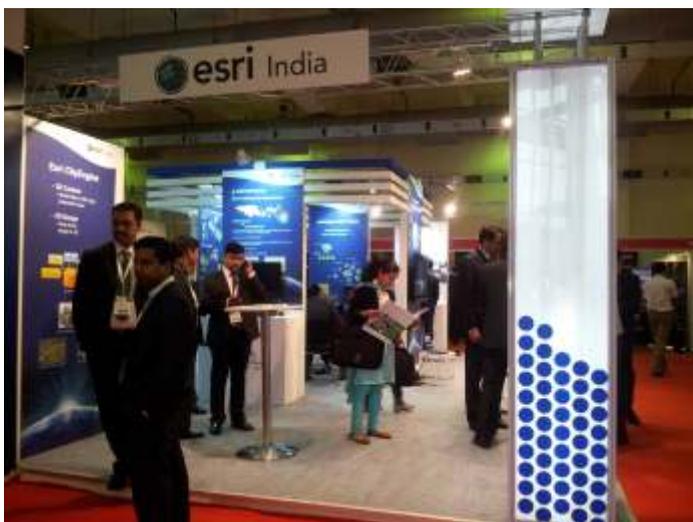
The theme of the forum was "Geo-Budget - Enabling Sustainable Growth" that captured the issues and challenges of how the technology can be used in various fields to speed up the country's growth and to learn about the latest happenings in the field of geospatial technology.

The forum was inaugurated in the presence of the dignitaries such as Anil Kumar Sinha, Vice Chair, Bihar State Disaster Management Authority, Government of Bihar; Alok Perthi, Secretary, Ministry of Coal, Government of India; Dr. Shailesh Nayak, Secretary, Ministry of Earth Sciences, Government of

India; KK Singh, Chairman & Managing Director of Rolta India Ltd; Saumitra Chaudhuri, Member Planning Commission, Government of India; All the dignitaries spoke towards the rapid pace at which the nation is heading way to development in the country.

The highlight of the forum was the three plenary panels that were organised. The panelist on the Plenary panels were represented by the distinguished personalities from the government and stalwarts from the geospatial industry. First Plenary Panel Session - Managing National Development Programmes through Geo-ICT which focused on the instances of geo-ICT role and deliberated on various issues related to it. Second Plenary Panel Session - Dimensions & Directions of Geospatial Technology highlighted how geospatial technology is heading its way to the future and the same is being appreciated by the industry as well. Third Plenary Panel - Enterprise Resource Planning for Infrastructure and Utilities that talked about how infrastructure is going to play an important role in the development of the country.

Geospatial Forum 2012



esri India



Mr. Rajesh C Mathur, Vice Chairman, Esri India was one of the panelists during the Plenary panel session on Dimensions & Directions of Geospatial Technology where he gave the industry perspective how cloud technology is being highly appreciated and will accelerate business. He also mentioned how Esri's technology can aid geospatial industry to maximize ROI using cloud.

The highlight of the India Geospatial Forum were the Geospatial Awards honoring the Excellence and leadership in this domain. The geospatial excellence awards was given in the field of Agriculture, Disaster Management, Land Administration, Telecommunication, Urban Planning, e-Governance, Natural Resource Management, Infrastructure & Engineering. The Rachapudi Kamakshi Gold Medal for Young Geospatial Scientist Memorial Award was given to Dr. M B Rajani, Asst. Prof. NIIT University and Phd Student (Indian Institute of Science).

The India Geospatial Leadership Awards were given to the individuals and organization for their significant contribution to the Geospatial community. These awards were given in

different categories such as the premier Geospatial State: State of Madhya Pradesh; Geospatial Project of the Year: Integrated Coastal Zone Management; Geospatial Data Portal: Maps.mapmyindia; Young Geospatial Entrepreneur: Sudhakar Reddy Arumalla; Capacity Building & professional Development: Dr. PS Roy; Corporate Leadership: Dr. BVR Mohan Reddy; Lifetime Achievement: Mr. Rajesh C Mathur.

Esri India also got opportunity to leverage its technology know how during the technology show and vertical conference on Geo-Infra and Geo-Gov during the forum proceedings. Mr. Rakesh Raina, Vice President, Esri India highlighted his viewpoint during the Geo-Gov session on geo-enabling the governance. He also mentioned the convergence of geospatial with e-governance is there in India, it does not have a strong presence in practice that needs to be strengthened. He emphasized on the State GIS for cohesive operation, decision making and communication. Mr. Nikhil Kumar, Head Partner & Alliances gave the overview of Esri technology and its futuristic directions in the geospatial domain during the industry technology show.

In addition to networking with the geospatial community Esri India took the opportunity to showcase and share its perspectives and demonstrated its product and solutions by participation in Exhibition. This helped us to understand the landscape and opportunities for Esri India going forward. ●

GIS-Based Statistical Landslide Susceptibility Zonation: A Case Study in Ganeshganga Watershed, the Himalayas

Abstract:

Landslides are one of the most widespread natural phenomena that are witnessed in the Himalayan terrain, causing colossal damage to property and infrastructure, besides loss of human lives and livestock almost every year. In order to reduce the risk emanating from potential landslide, there is a need to generate a comprehensive Landslide Susceptibility Zonation (LSZ) map. Inspection of literature reveals a number of concepts, methodology and techniques of LSZ have been attempted, viz. heuristic, statistical and deterministic. In the present study, an attempt has been made to generate LSZ map of the study area using bivariate statistical modified Information Value (InfoVal) method in a small watershed in the Himalayas. The various causal factors responsible for landslide occurrence have been considered and the corresponding thematic layers have been generated using remote sensing and GIS techniques. The relative importance of these layers for causing landslides has been evaluated using modified InfoVal method and a landslide susceptibility zonation (LSZ) map has been generated. The accuracy of the LSZ map has been evaluated using success rate method which indicates 91.74% of landslide prediction accuracy.

Keywords: Landslide susceptibility zonation (LSZ), InfoVal, GIS, Remote sensing

Introduction: The study of landslides has drawn worldwide attention mainly due to increasing awareness of the socio-economic impact of landslides, as well as the increasing pressure of urbanization on the mountain environment (Aleotti and Chowdhury 1999). In order to reduce the damage caused by landslide initiations and reactivations, a landslide susceptibility map is really needed (Van Den Eeckhaut et al., 2006). The concept of landslide susceptibility and landslide susceptibility assessment have been introduced in the past couple of decades and various methodologies have been developed for evaluating the devastating power of landslides and its associated processes.

Numerous studies have been carried for LSZ by various researchers across the globe. Landslide susceptibility may be generated through heuristic (Anbalgan, 1992, Saha et al. 2002), deterministic (Terlien et al., 1995, Gokceoglu and Aksoy 1999, Dahal et al., 2008) and statistical approaches (Yin and Yan, 1988; Van Westen, 2000; Suzen and Doyuran, 2004; Saha et al., 2005; Kanungo et al., 2006; Mathew et al., 2007; and Chauhan et al., 2010 among others). The aim of this paper is to discuss the application of bivariate statistical methods, namely InfoVal with modification as proposed by Oztekin and Topal, 2005 and Cevik and Topal, 2003 for landslide susceptibility mapping in a raster-based GIS environment in a part of Garhwal Himalaya.

Methodology:

The InfoVal method is an indirect statistical approach that facilitates assessing the landslide in an objective way. The considered causal factors are individually crossed with the landslide distribution and the weighted values based on

landslide densities are calculated for each parameter class. InfoVal is defined as the logarithm of the ratio between the density of landslide in a class over the density of landslide for the whole study area.

$$w_i = \ln \left(\frac{\text{Densclas}_i}{\text{Densmap}} \right) = \ln \left(\frac{\frac{\text{Npix}(S_i)}{\sum \text{Npix}(S_j)}}{\frac{\text{Npix}(N_i)}{\sum \text{Npix}(N_j)}} \right) \text{----- (1)}$$

where, W_i is the weight given to the i th class of a particular thematic layer, Densclas_i is the landslide density within the thematic class, Densmap is the landslide density within the entire thematic layer, $\text{Npix}(S_i)$ is the number of landslide pixels in a certain thematic class, $\text{Npix}(N_i)$ is the total number of pixels in a certain thematic class, and n is the number of classes in a thematic map. The natural logarithm is used to take care of the large variation in the weights (Saha et al., 2005).

The weight map of considered causal factors can be overlaid and integrated in GIS environment and InfoVal (Total weight W_i) of each pixel in the study area can be determined. The relative susceptibility of a terrain unit to the occurrence of a particular type of slope movement is given by the total weight W_i . The larger the value, greater the risk while smaller the value, lesser the risk to landslide occurrence.

However, the conventional InfoVal method, takes into consideration that each parameter/thematic map has an equal effect on landslides, which may not be the case in reality (Oztekin and Topal, 2005). Therefore, a weighting factor (W_f) for each parameter map has been produced. For this purpose, first the W_i value of different parameters of each pixel was determined by the method stated above, then, all pixel values belonging to each layer were summed. By using the maximum and minimum of all layers, the results were stretched (Cevik and Topal, 2003). Finally, the weighting factor ranging from 1 to 100 for each layer was determined by the following formula:

$$W_f = \frac{(TW_{i\text{value}} - \text{Min}TW_{i\text{value}})}{(\text{Max}TW_{i\text{value}} - \text{Min}TW_{i\text{value}})} * 100 \text{----- (2)}$$

where, W_f is the weighting factor calculated for each layer, $TW_{i\text{value}}$ is the total weighting index value of cells within landslide bodies for each layer, $\text{Min}TW_{i\text{value}}$ is the minimum total weighting index value within selected layers and $\text{Max}TW_{i\text{value}}$ is the maximum total weighting index value within selected layers.

Study area:

A small watershed of about 50 Km² area, namely Ganeshganga watershed in Chamoli district of Uttarakhand state in India has been selected as the study area to test the success of modified InfoVal method. The study area is characterised by rugged mountains and steep slopes on which rests the unconsolidated soil and earth material vulnerable to failure. The Ganeshganga watershed is bounded between 30°25'10" to 30°29'45" North latitude and 79°28'25" to 79°35'10" East Longitude (Figure 1).

Database preparation:

The statistical approach for LSZ mapping requires spatial distribution of various controlling factors influencing

landslide incidence along with the landslide infested locations. It is therefore necessary to prepare the inventory of existing landslides apart from this a number of thematic maps on specific factors or parameters related to the occurrence of landslides. The thematic maps of geo-environmental, hydrologic and anthropogenic factors that are considered to be influential in inducing landslide in the study area are listed in Table 1. These maps were derived from high resolution IRS P5 (Cartosat-1) and IRS P6 (Resourcesat-1, LISS-IV) data with spatial resolutions of 2.5m and 5.8 m, respectively. The database creation involves processing of data from various sources, in the present study ENVI 4.3 and ERDAS Imagine 9.3 (with LPS) has been used for Image processing and DEM generation. Various modules of ARC GIS 9.3 software viz ARC Map, ARC Catalogue, ARC scene has been used for generation, extraction, visualization, management and integration of various thematic layers and to perform GIS based analysis. Apart from remote sensing data, auxiliary data like Survey of India (SOI) Topographic maps (1:50,000 scale), Geological Survey of India (GSI, 2002) lithological and structure maps (1:50,000 scale), published literature/reports and field checks have been incorporated to make a comprehensive database.

Data integration and analysis:

To evaluate the contribution of each factor towards landslide hazard, the existing landslide distribution data layer has been compared with various thematic data layers separately. The number of landslide pixels falling on each class of the thematic data layers has been recorded and weights have been calculated using the equation 1 and these weights are given in Table 2. Further these weights have been stretched using formula (Cevik and Topal, 2003) given in equation 2. Finally, the weighting factor ranging from 1 to 100 has been assigned based on the degree of influence of the factor in initiating landslide in the study area. The weight factor (Wf) was multiplied with the weight of individual classes (Wi). The resultant weighted thematic maps have been overlaid and numerically added to generate a Landslide Susceptibility Index (LSI) map.

$$LSI = SI + As + RI + Li + Stden + Stdis + Lmden + Lmdis + Drden + Drdis + Luc + Rd$$

Where SI, As, RI, Li, Stden, Stdis, Lmden, Lmdis, Drden, Drdis, Luc and Rd are the product of derived weights and weight factor for slope, aspect, relative relief, lithology, structure density, distance to structure, lineament density, distance to

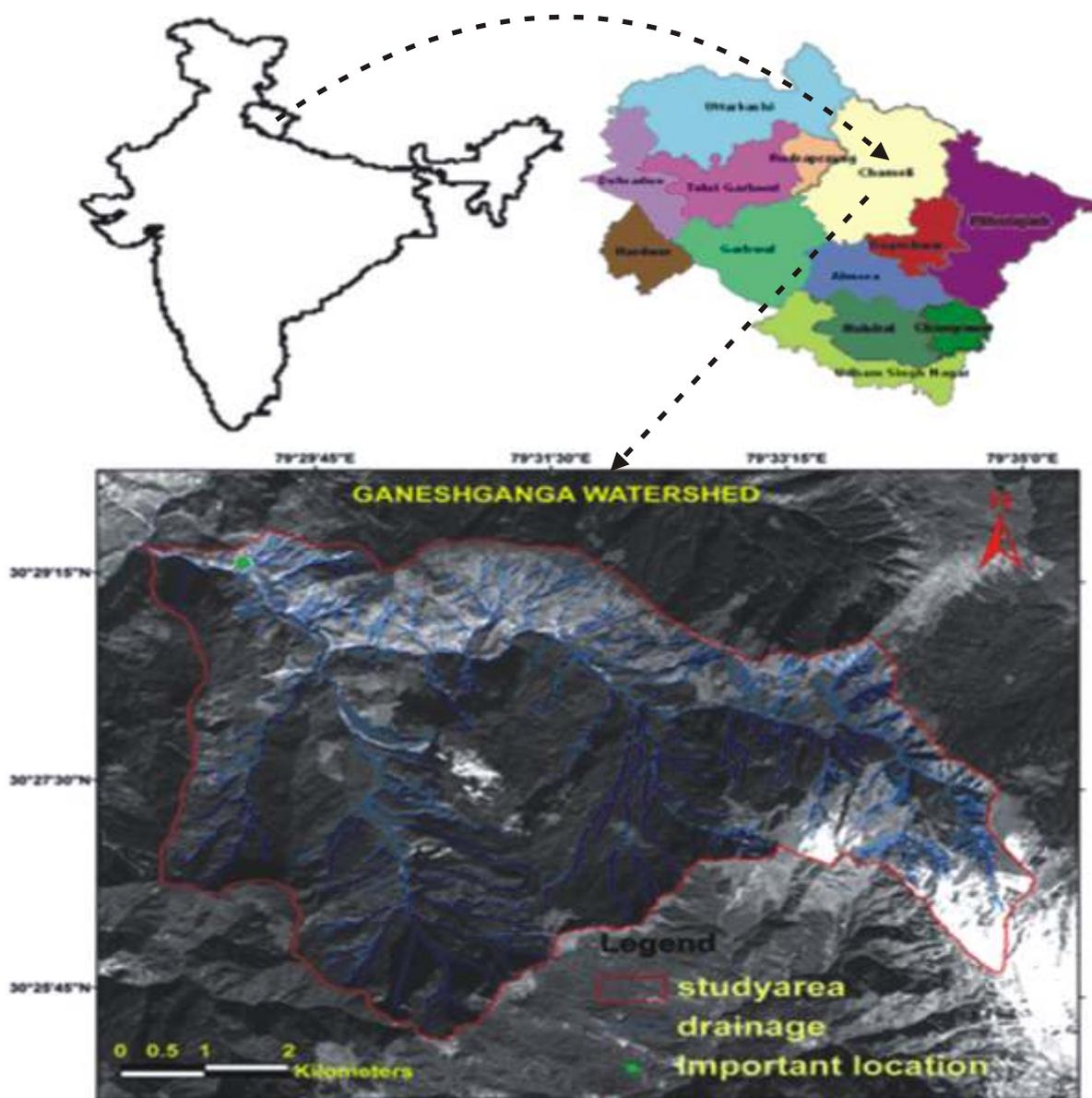


Figure1: Study area location

lineament, drainage density, distance to drainage, land use and land cover and distance to road respectively.

The analysis of relationship between landslide occurrence and factors considered illustrates that the weight factor (Wf) of Lithology layer has got the maximum weightage i.e. 100 while the minimum weightage i.e. 1 has been assigned to Aspect after stretching. Other parameters have been assigned weights based on their relative contribution towards slope failure in the study area. The derived weights were assigned to the classes of each thematic, respectively, to produce weighted thematic maps, which have been overlaid and numerically added in GIS environment to produce a Susceptibility Index (SI) map. The SI values thus produced are found to lie in the range from -491.134 to 248.025.

Dividing these values into susceptibility classes was, however, not easy as there are no statistical rules which can guide the categorizing of continuous data automatically. In the present study the cumulative frequency curve of susceptibility index values has been segmented into four zones representing four landslide susceptibility zones, viz., highly susceptible (HS),

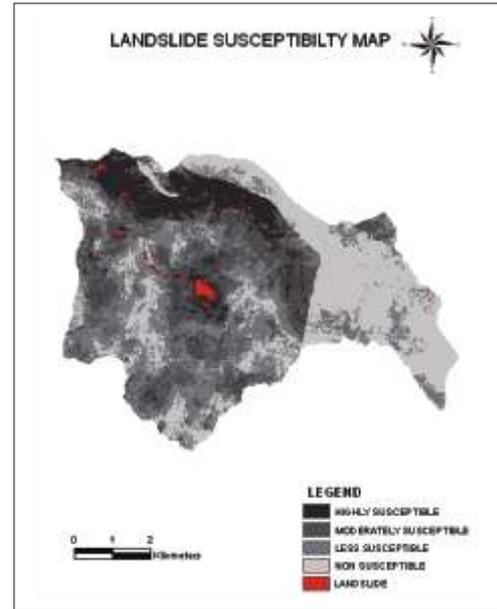


Figure 2: Landslide susceptibility zonation map

Table 1: Parameters considered and source of estimation.

SI No	Parameters	Source
1.	Slope	DEM generated using IRS P5 (CARTOSAT-1) stereo data
2.	Aspect	-Do-
3.	Relative relief	-Do-
4.	Lithology	Geological map (Source: GSI, Lucknow 2002)
5.	Structure density	Digitised structure layer based on Geological map (GSI Lucknow) and IRS P6 (LISS -IV) image
6.	Distance to structure	-Do-
7.	Lineament density	Digitised lineament layer based on IRS P5 (CARTOSAT-1) PAN data and IRS P6 (LISS -IV) image
8.	Distance to lineament	-Do-
9.	Drainage density	Digitised drainage layer using IRS P5 (CARTOSAT-1) PAN data, IRS P6 (LISS -IV) image and SOI topographic sheet
10.	Distance to drainages	-Do-
11.	Land use and land cover	Land use and land cover map prepared using IRS P5 (CARTOSAT-1) PAN data, IRS P6 (LISS -IV) image and SOI topographic sheet
12.	Distance to road	Digitised road layer using IRS P5 (CARTOSAT-1) PAN data, IRS P6 (LISS -IV) image and SOI topographic sheet
13.	Landslide incidence	Fused IRS P5 (Cartosat-1) pan data and IRS P6 (LISS-IV) data and subsequent field Verification.

moderately susceptible (MS), less susceptible (LS) and non susceptible (NS) zone (Refer figure 2).

Model validation

The landslide susceptibility analysis result has been tested using the set of landslides used to build the model. Testing was performed by comparing the known landslide location data with the landslide susceptibility map. Based on a given LSZ map, the cumulative percentage of landslide occurrences in various susceptibility classes ordered from highly susceptible to non susceptible can be plotted against the cumulative percentage of the area of the susceptibility classes. This curve (figure 3), referred to as the success rate curve in the literature (Chung and Fabri, 1999, 2003; Remondo et al., 2003) is used to explain how well the model

predict landslides. The graph represents the potential capability of the InfoVal model. The area under curve (AUC) can be used to evaluate the prediction accuracy and the total area equal to one denotes perfect prediction. In the present study the ratio calculated for Figure 3 is found to be 0.9174 which implies prediction accuracy is 91.74 %.

Conclusion:

Every year landslides cause huge loss of human life and property in mountainous areas across the globe. There is an inescapable requirement to have landslide susceptibility zonation map so that disaster prone areas can be delineated. The local authorities can make use of this data for disaster preparedness and implement mitigation techniques. The present research demonstrates the application of statistical

Table 2: Infoval weight (Wi) and Weighting factor (Wf) of all the considered landslide causal factors

CLASSES	NO OF LANDSLIDE PIXEL (IN THAT CLASS)	TOTAL NUMBER OF PIXEL (IN THAT CLASS)	INFOVAL Wi	Wf
(A) SLOPE				13.62
3.62				
<15°	53	10421	-0.48	
= 15° and < 25°	220	30545	-0.14	
= 25° and < 30°	232	20251	0.33	
= 30° and < 35°	246	19620	0.42	
= 35° and < 40°	170	16825	0.20	
= 40° and < 45°	56	12123	-0.58	
= 45° and < 60°	34	12385	-1.10	
= 60°	0	427	0	
(B) ASPECT				1.00
N	10	23066	-2.95	
NE	24	21842	-2.02	
E	32	10432	-0.99	
SE	29	2447	1.83	
S	126	6667	1.09	
SW	164	15617	1.29	
W	469	19770	-0.04	
NW	157	22708	-5.23	
Flat	0	48	0	
(C) RELATIVE RELIEF				13.41
<20m	173	28818	-0.32	
20 to <40m	706	62637	0.31	
>40m	132	31142	-0.67	
(D) LITHOLOGY				100.00
Dolomitic limestone	906	64854	0.53	
Quartzite Sericite schist	78	24335	-0.94	
Chloritic Quartzite	11	511	0.96	
Amphibolite	16	31673	-2.79	
Quartzite Sericite Schist with bands of Quartzite	0	1224	0	
(E) STRUCTURE DENSITY				15.58
< 0.5km/km ²	302	72644	-0.68	
0.5 to < 1.0 km/km ²	130	9711	0.48	
=1.0 km/km ²	579	40242	0.56	
(F) DISTANCE TO STRUCTURE				17.73
< 500m	764	54262	0.53	
500 to < 1000m	211	33320	-0.26	
> 1000m	36	35015	-2.08	
(G) LINEAMENT DENSITY				21.95
< 0.5 km/km ²	59	42314	-1.78	
0.5 to < 1.0 km/km ²	173	41682	-0.69	
= 1.0 km/km ²	779	38601	0.89	
(H) DISTANCE TO LINEAMENT				18.74
< 200m	929	69948	0.48	
200 to < 400m	78	37599	-1.38	
400 to < 600m	2	10521	-3.77	
= 600m	2	4529	-2.93	

CLASSES	NO OF LANDSLIDE PIXEL (IN THAT CLASS)	TOTAL NUMBER OF PIXEL (IN THAT CLASS)	INFOVAL WI	Wf
(I) DRAINAGE DENSITY				16.54
< 2 Km/Km2	136	3060	1.68	
2 to < 4 Km/Km2	338	2720		0.41
4 to < 6 Km/Km2	180	38821	-0.58	
6 to < 8 Km/Km2	118	29537	-0.72	
>= 8 Km/Km2	239	23975	0.19	
(J) DISTANCE TO DRAINAGE				17.39
< 200 m	544	99969	-0.42	
200 to < 400m	230	16680	0.51	
400 to < 600m	191	4722	1.59	
600 to < 800m	46	1226	1.52	
(K) LAND USE AND LAND COVER				37.24
Dense forest	6	13040	-2.89	
Moderate dense forest	27	32745	-2.30	
Open forest	48	28770	-1.60	
Agricultural land	160	23703	-0.20	
Scrub land	366	16456	0.99	
Barren land	24	4641	-0.47	
Landslide Debris	379	3108	2.69	
Settlement area	1	134	-0.10	
(L) DISTANCE TO ROAD				13.41
< 500m	116	4010	1.26	
500 to < 1000m	57	3751	0.61	
= 1000m	838	114836	-0.12	

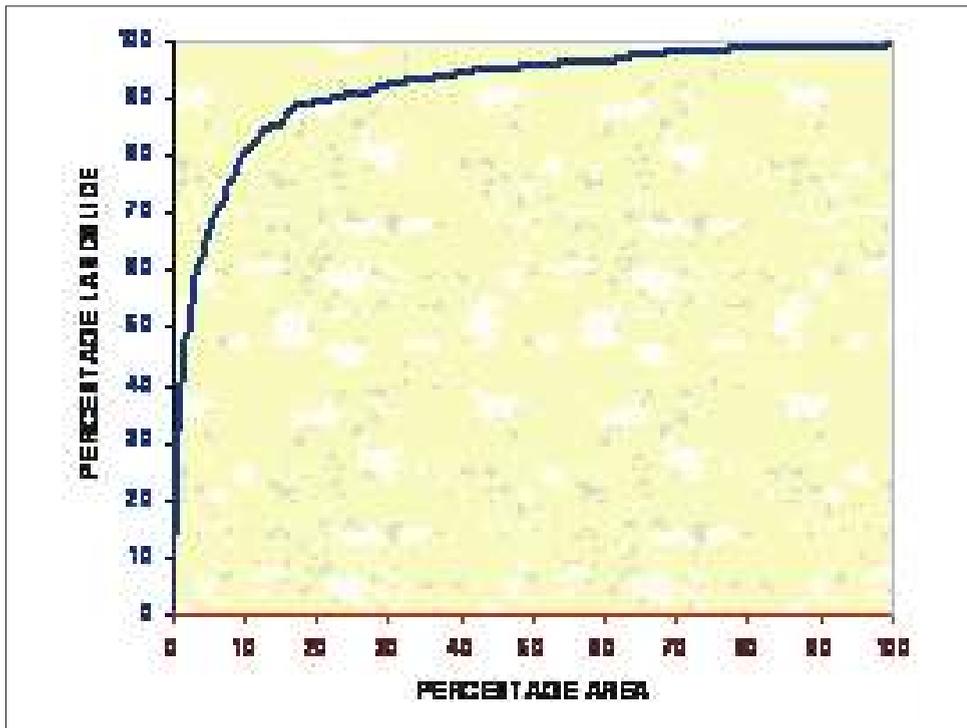


Figure 3: Prediction performance of the modified Infoval model

based modelling for landslide susceptibility mapping in part of the Himalaya, which is prone to frequent occurrence of landslides. The potential of remote sensing and GIS has been exploited in database preparation and at integration stages. It is hoped that the zonation of landslide susceptible areas may help in effective and efficient management of landslide related hazard.

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S KUNDU 1,2, D C SHARMA 2, A K SAHA 3, C C PANT 1 and J MATHEW 4

1 Dept. of Geology, Kumaun University, Nainital -263001 (India)

2 Defence Institute of Geospatial Information and Training (DIGIT), Delhi Cantt -110010 (India)

3 Dept. of Geography, Delhi University, Delhi -110007 (India)

4 NRSC Headquarters, ISRO, Hyderabad - 500625 (India)

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M. Tech GIS Programme at NIIT University

Introduction

The NIIT University (NU), a not-for-profit institution, is sponsored by NIIT Limited, and it inherits close to three decades of its rich experience, know-how and global reputation. The NIIT University is equipped with state-of-the-art technology-enabled teaching and a strong research-focused curriculum, some of which originated in NIIT's incubation lab viz. Centre for Research in Cognitive Systems (CRCS) on IIT Delhi campus. The NIIT University (NU), which is located in the foothills of Aravali range in Neemranahas not only advantage of location to foster high quality education and is designed as a walking campus without motor vehicles. NU visions to be the leading Centre of innovation and learning in emerging areas of the knowledge society. NU strives to offer a unique education experience to its students by following the principles of industry-linked, technology based, research-driver, and seamlessness in their curriculum, faculty interactions and exposure of students to the real world. While there NU offers master's programme in other specialized fields, its GIS programme is very different and oriented towards providing more decision makers, programmers, and project managers. In India, several Universities face severe resource crunch and lack partnerships with global organizations to update their GIS facilities and course curriculum that is relevant to the industry. In contrast, NU M.Tech GIS Programme is research driven and offered with support from Esri Inc, California, USA , the world's leading organization in development of GIS software and Esri India, a sister company to the university.. This Programme will enable professionals to start a challenging and rewarding career in the rapidly emerging area of GIS. Professionals pursuing this Programme will get a comprehensive exposure to GIS components like Geospatial modeling and database, Cartography, GIS programming, Remote sensing for GIS and relevant elective courses like GIS and Urban Planning, Advanced GIS platform programming (Mobile, Web and Cloud), Geoinformatics for environment, etc. The Programme

will focus on spatial thinking, technology and applications of GIS, GPS fundamentals and techniques, Geospatial project management and field techniques, exploring geospatial nature of regions, economy, demography, occupation profile, applications of GIS for humanities, etc. Graduates will be fully prepared for positions as GIS Project Managers, Applications Specialists, Systems Engineers and GIS Business Development Managers. They will also have the option to pursue doctoral research at NU.

Curriculum of the M. Tech Programme. Innovative Pedagogy
The Programme is designed to serve professional development at the workplace and, hence, is characterized by the pedagogic innovation of Education-Work Linkage. The new pedagogy is based on the insight that the workplace while being a place to do business-related work is also a continuous learning environment where education can happen. Academic instruction components such as Lectures, Tutorials, Practicals and Projects are integrated with business objectives leading to work-based instruction components. The programme will have blended curriculum entailing classroom sessions, virtual classroom & internship, and will impart knowledge & skills in core and advanced GIS areas with strong industry practice and novel research. This programme is uniquely designed to provide academic competencies, workplace competencies, industry wide technical competencies, industry sector technical competencies and management competencies. Creative Structure

The 2-Year, 73-Credit Programme consists of 4 semesters. The courses are categorized into University Core (to inculcate NU's core principles), Professional Core (to gain proficiency in domain area), Professional Electives (for specialization in an industry-specific domain), R&D Project (to inculcate a strong research bend of mind), Open Elective (for management competencies) and Internship (to build linkage with Industry-work or Industry-oriented research).

The first two semesters are devoted to theoretical and hands-on practical training of foundation and advanced courses at NIIT University. This is followed by Industry Internship with virtual classroom instruction in the third semester. Students continue Industry Internship working on real life projects in the fourth semester leading to the completion of the programme. Thus, students stay at NIIT University campus only for the first two semesters. Technology-based Seamless Delivery

To enable students to pursue the M. Tech Programme alongside their work, the Programme design has two delivery components:

1. On-campus component – NU firmly believes that experiential hands-on learning should be an integral part of all its courses. Students will spend one full year in the campus to carry out laboratory work. NU's Laboratories are designed more in the nature of Industry Innovation Centres rather than University laboratories. Further the activities are designed as mini-projects than isolated exercises.
2. Virtual Classroom component – NU has fully equipped web conferencing studios to have two-way interaction with its students located anywhere on the globe. This component is used to deliver lectures and carry out one-to-one student mentoring and guiding as well as interacting with industry-supervisors in the third semester.

World-class Mentors

NU's core faculties are more in the nature of mentors and

have a considerable portfolio of intellectual capital to their credit. The faculty has a combined industrial experience of over a hundred person-years and have several granted patents in USA and India. NU faculty members have been responsible for creating innovative pedagogies and technology-enabled learning products. The faculty has created award-winning products that can be seen in action across the globe. The team also has a large portfolio of papers published in reputed international conferences and peer reviewed international journals. Apart from the core faculty, NU also has a vast network of global professionals drawn from the industry and academia who will participate in the delivery of the Programme. GIS Infrastructure

To match the ever changing technology the GIS lab of NU is highly equipped with high speed machines, wireless broadband internet, latest GIS and image processing software such as ArcGIS 10, ENVI, ERDAS Imagine, Geomatica, Photogrammetry suit of Leica, etc. Thus, with the eminent faculties, industry linked curriculum, provision of internship and latest infrastructure, the students graduating from NU will be the leaders for future GIS.

Scholarship

The major highlight of the programme is scholarship of \$ 4000 per year per student provided by ESRI, Inc., California to promote GIS education in India through NU. This scholarship supports talented students in pursuing the degree and takes care of most of the programme's expenses. Stipend

During internship (in the third and fourth semester), all enrolled students will get a stipend at par with the MBA graduates from the organizations that have supported this Programme.

Placement

All enrolled students in the founding batch will be placed at par with the MBA graduates in GIS organizations that have supported this Programme.

For More Details Contact

Dr. Debopam Acharya Assistant Professor



NIIT University
Neemrana, NH-8 Delhi-Jaipur Highway
District Alwar, Rajasthan – 301 705
Email: Debopam.Acharya@niituniversity.in
Web: www.niituniversity.in
For MTech Toll free no. 1800-3002-5454



ArcGIS Desktop 10.0

1. How do you use “traditional” editing in ArcGIS 10.0?

- You can modify the editing framework so that you are using the old editing toolbar etc., through the Advanced ArcMap Settings. In ArcGIS 10, this is stored by default in C:\Program Files\ArcGIS\Desktop10.0\Utilities. You must have all Esri products turned off before you open this program.?

Go to the Editor tab and turn off the checkbox for “Create features using templates” – this will revert to the old toolbar. You can set a number of things here, notably the default colour scheme in the Symbols/Graphics tab. Click Apply before closing the Advanced ArcMap settings, remembering you can reset all values to default later (if required).

2. Create a 9.x compatible geo data base in 10?

- For sharing data among various versions, the Create geodatabase tool now allows you to create older versions of the Geodatabase.
- Once a 9.x Geodatabase is created, you can copy features from ArcGIS 10 into an older geodatabase to share with other users (obviously only ArcMap 10 users can do this).

3. Timesaver Trick while you pan and zoom in Arcmap

- while holding b and the left mouse button, moving the mouse up/down will zoom in/out; or,
- while holding b and the right mouse button, moving the mouse will pan in the direction of movement.

4. Using Python to Fix Broken Links

- find And Replace Work space Path or find and ReplaceWorkspace Paths allows you to substitute an entire or partial string for a layer or table’s workspace path.
- Example:
 - Import arpy
 - Mxd=.mapping.MapDocument(r"C:\Project\Proect.mxd")
 - Mxd.FindAndReplaceWorkspacePaths(R"C:\Project\Data", R"C:\Project\Data2")
 - mxd.saveACopy(r"C:\Prject\Project2.mxd")
 - del mxd
- replaceWorkspaces or replaceDataSource allows you to change the workspace path, workspace type, and / or change the dataset name.

5. How to recover a Lost Toolbar

Scenario 1: The toolbar is just plain gone If the toolbar has just completely disappeared, chances are that the little X in the top-right corner has gotten clicked, therefore closing it. Right-click anywhere on a toolbar and choose the toolbar you want from the list Go to View ??Toolbars and choose the toolbar you want from the list Scenario 2:

The toolbar has been moved partly off-screen and you can’t reach the handle to move it back

Double-click on an empty space on the toolbar. This will dock the toolbar, thus bringing it into view for you to do with as you please. You might have to resize the toolbar in order to get an empty space to double-click on, but it can be done!

Scenario 3: You can’t reach/see all of the on your docked toolbar

If some of the buttons on your toolbar are unreachable, it is likely because it has been docked in a spot that doesn’t have enough room to accommodate all of the buttons. Move the toolbar to another docked spot with more room Un-dock the toolbar.

6. If the File menu is slow to open:

- Open Customize window, navigate to the file menu, and delete the {Sign in }menu item

7. To check if Field Exists for ArcGIS 10 using Python

```
def FieldExist(featureclass, fieldname):
    FieldList = arcpy.ListFields (featureclass, fieldname)
    fieldCount = Len(fieldList)
    if (fieldCount == 1):
        return True
    Else:
```

8. Excluding Some Text While Labeling:

Using VBScript to exclude portions of a field that you do not wish to label

Example: Field for Road Diameter reads “ 63 meters (63.0 mts)”

Want to label “ 63?”

In the Layer Properties > Label Tab > Label Expression > Expression window

```
Left([size_d], InStr([size_d], "l")-2)
```

This line tells the label engine to start from the left side of the string and label until it gets to an “l” then go back 2 yielding 63 from 63 meters (63.0 meters)

9. Multicolored, multi-line labels:

This can be useful for labeling old and new IDs. In order to show both, but each a different color one above the other.

In the layer properties window select the Labels tab Select “Expression”

To have the New ID on top and the Old ID on the bottom:

[New_ID]&vbnewline&[Old_ID]To have each a different color:

```
<CLR Red='165'>" & [New_ID] & "</CLR>"
&vbnewline&"<CLR blue='199'>" &[Old_ID]&"</CLR>"
```

IPhone Project

NIIT-GIS developed a native iPhone application for one of the US based client. This application was a solution for supporting onsite inspection and to generate instant report associated with the parcels which they are currently inspecting. The key functions which were provided in the application were:

User Authentication

Loading of US state Map using Map Services (Code snippet below)

Searching parcels through GPS and highlight the selected parcel on map (Code snippet provided below)

Generate report associated to selected parcel and mail to user

To develop native application for iPhone based on ArcGIS Server API along with Web services launched on Server, we require given below developer environment:

Software: ESRI ArcGIS Server 9.3.1 (Map Services)

Development IDE : XCode 4.x IDE, Objective C, IOS 4.3 and above

Hardware : Intel based Mac machine (2 GB of RAM, 160 GB of HDD), Lion (OS X 10.7)

User Interface for iPhone



Code Snippet : Adding a MapService to Map Control of iPhone

In 'classes/JSON' directory of current IPhone Application, we can find .h file of 'ApplicationViewController', in that file properties of all controls on map were defined and initiated. In the same file the URLs for the map services were defined.

```
#define kTiledStreetMapServiceURL
@"http://www.onemap.sg/ArcGIS/rest/services/basemap/MapServer"
```

```
#define kTiledImageryMapServiceURL
@"http://www.onemap.sg/ArcGIS/rest/services/lot_view/MapServer"
```

```
#define kTiledReliefMapServiceURL
@"http://server.arcgisonline.com/ArcGIS/rest/services/ESRI_ShadedRelief_World_2D/MapServer"
```

// Given below code for assigning the above defined URL string to the ArcGIS Map layer.

```
AGSTiledMapServiceLayer *streetLayer =
[[AGSTiledMapServiceLayer alloc]
```

```
initWithURL:[NSURL
URLWithString:kTiledStreetMapServiceURL]];self.streetView
= [self.mapView addMapLayer:streetLayer
withName:@"Street"]; [streetLayer release];
```

```
AGSTiledMapServiceLayer *imageryLayer =
[[AGSTiledMapServiceLayer alloc]
```

```
initWithURL:[NSURL
URLWithString:kTiledImageryMapServiceURL]];
self.imageryView = [self.mapView
addMapLayer:imageryLayer withName:@"Imagery"];
[imageryLayer release];
```

Code snippet : Display GPS Location on iPhone

The given below code snippet get the GPS location using iOS API. In '.m' file 'Applicationviewcontroller', a method with the name 'ShowLocation' will be called, in which the latitude & longitude of the mobile device will be identified and those values will be converted to map projected coordinate points using a geometry service which was published on server.

```

- (IBAction)showLocation:(id)sender {
    self.routingView.hidden= YES;
    self.tableView.hidden= YES;
    self.mapView.hidden= NO;
    self.routingResultView.hidden = YES;
    self.mapView.callout.hidden = YES;
    mapActivityInd.hidden = NO;
    [mapView bringSubviewToFront:mapActivityInd];
    [mapActivityInd startAnimating];
    CLLocation *location = self.locationManager.location;
    double lat = location.coordinate.latitude;
    double lon = location.coordinate.longitude;
    if (lon<100){
        return;
    }
    if (lat<1){
        return;
    }
    if (testFlag==0)
    {
        flag=@"Geom1";
        responseData= [[NSMutableDictionary data] retain];

        NSString *latStr=[NSString
stringWithFormat:@"%f",lat];

        NSString *lonStr=[NSString
stringWithFormat:@"%f",lon];

        NSString *requestString = @"<Provide Geometry
Service URL with input and output coordinate system
IDs>";

        requestString = [requestString
stringByReplacingOccurrencesOfString:@"xx"
withString:lonStr];

        requestString = [requestString
stringByReplacingOccurrencesOfString:@"yy"
withString:latStr];

        NSURLRequest *request = [NSURLRequest
requestWithURL:[NSURL URLWithString:requestString]];
        [[NSURLConnection alloc] initWithRequest:request
delegate:self];

        testFlag=1;
    }
}

//Once after receiving the response (JSON format response)
from the server , in the 'connectionDidFinishLoading'
method we are checking whether the response we got
from the server is the format of 'GEOMETRY' or not.
if(flag==@"Geom1"){
    NSDictionary
*luckyNumbers = [responseString JSONValue];
    NSArray

```

```

*textVal=[luckyNumbersobjectForKey:@"geometries"];
    NSString *xCoord;
    NSString *yCoord;
    for (NSDictionary *luckyNumbersNew in textVal ){
        xCoord=[luckyNumbersNew objectForKey:@"x"];
        yCoord=[luckyNumbersNew objectForKey:@"y"];
    }
    float lon = [xCoord floatValue];
    float lat = [yCoord floatValue];
    lon1 = lon;
    lat1 = lat;
    AGSEnvelope *envelope = [AGSEnvelope
envelopeWithXmin:lon - 90
    ymin:lat - 90
    xmax:lon + 90
    ymax:lat + 90
    spatialReference:self.mapView.spatialReference];
    [self.mapView zoomToEnvelope:envelope
animated:YES];
    // Get reference to the graphics layer
    id<AGSLayerView> graphicsLayerView =
[self.mapView.mapLayerViews
objectForKey:@"GraphicsLayer"];
    AGSGraphicsLayer *graphicsLayer =
(AGSGraphicsLayer*)graphicsLayerView.agSLayer;
    // Clear graphics
    [graphicsLayer removeAllGraphics];
    // Create a marker symbol using the Location.png
graphic
    AGSPictureMarkerSymbol *markerSymbol =
[AGSPictureMarkerSymbol
pictureMarkerSymbolWithImageNamed:@"GpsDisplay.png"
];
    // Create a new graphic using the location and marker
symbol
    AGSGraphic* graphic = [AGSGraphic
graphicWithGeometry:[envelope center]
symbol:markerSymbol attributes:nil
infoTemplateDelegate:nil];
    // Add the graphic to the graphics layer
    [graphicsLayer addGraphic:graphic]; testFlag=0;
    [mapActivityInd stopAnimating];
    mapActivityInd.hidden = YES;
}
}

```

In the Above code, we are splitting the response from the server as 'Xcoord' and 'Ycoord', then from those values an envelop was created to set map extent on mobile device, a graphic layer was created with above coordinated and added to map.

The Strauss Center Uses Esri Technology to Better Target Aid

Mapping Tool Provides Insight into How Climate Change Is Affecting the Security of African Nations Active Aid Projects in Malawi

Redlands, California—The Strauss Center's Climate Change and African Political Stability (CCAPS) program has implemented Esri technology to view how climate change impacts vulnerable populations in Africa. CCAPS created the dynamic mapping tool in partnership with AidData for use by researchers, policy makers, journalists, and citizens. Users can visualize any combination of CCAPS data on climate change, conflict, and aid on a map to discover how different forces overlap or intersect.

"This mapping tool allows policy makers to analyze data from multiple sources at once, providing integrated analysis of the drivers and responses related to security risks stemming from climate change," said Francis J. Gavin, director of the Strauss Center.



The tool is already being used in the country of Malawi for a solution that tracks and reports on the country's external funding. Aid information is mapped along with data on climate change vulnerability and incidents of conflict. This sheds light on whether aid is effectively targeting regions where climate change or conflict poses the most significant risk to the sustainable development and political stability of the country.

"Climate change poses an enormous threat to the livelihoods of millions of Africans," said Jean-Louis Sarbib, CEO of Development Gateway. "The level of risk, however, is not evenly spread and certainly doesn't respect national boundaries. To ask critical questions about how development assistance can reduce vulnerability, you need hyperlocal data on climate and also on aid-funded interventions. This is what the new CCAPS mapping tool shows in a digestible, interactive way."

By integrating CCAPS research on climate change, along with existing datasets such as topographic maps, imagery, and thematic information on conflicts, the CCAPS mapping tool aims to provide the most comprehensive view possible of climate change and security in Africa.

"The great work of these organizations is a real game changer for the development community," said Jack Dangermond, president of Esri. "Being able to create a tool that allows people to communicate with others all over the world using maps is powerful. I am impressed with the work being done and excited to see what they will think of next."

CCAPS and AidData will continue to release upgrades to the mapping tool throughout 2012. The current mapping tool is available to use now at www.strausscenter.org/ccaps/mappingtool. For more information on AidData, go to www.aiddata.org. Learn more about GIS solutions for climate change from Esri at esri.com/climate. ●

Arby's® Assesses Market Footprint with

Esri Business Analyst: A Single-Platform Approach Improves Efficiency and Provides More Time to Focus on the Customer

Redlands, California—Atlanta-based Arby's Restaurant Group, Inc. has licensed Esri Business Analyst software and business data to help with corporate decision making. The second largest quick-service sandwich chain in the United States, Arby's is using the location-based system to more accurately assess its restaurants and trade areas including growing, remodeling, and relocating restaurants.

"Esri's Business Analyst has saved our GIS analyst countless hours and has had a positive impact on the Business Development department," said Dave Conklin, senior vice president, Business Development, at Arby's Restaurant Group, Inc..

Arby's can now update the locations of its restaurants and business development activity on designated market area (DMA) maps, which describe the activity taking place in individual markets. These maps are readily accessible to users, including development teams working in the field, through the Arby's intranet. Since the implementation, the teams are able to more easily and quickly monitor the business climate around each restaurant. This provides an opportunity for the organization to model different market scenarios to better serve its current customers and attract new ones.

"We are pleased to provide a single-platform approach for managing and analyzing business data to Arby's staff," said Simon Thompson, director of global commercial industry, Esri. "With an enterprise system, Arby's can scale to meet the changing business landscape with tools that make it competitive in the marketplace."

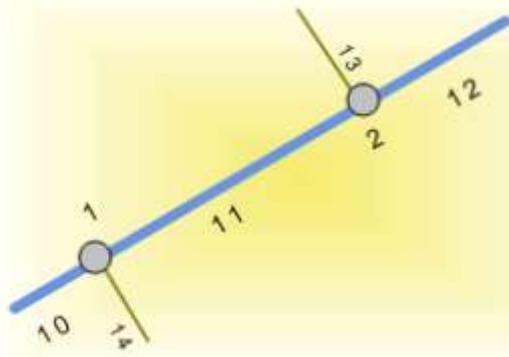
For more information on how Esri solutions help businesses, visit esri.com/business. ●

Did You Know That.....

About Spatial Relationships and Behavior...

In addition to the GIS data types, features and rasters often participate in relationships with other features and with attribute values held across multiple tables. These spatial and attribute relationships, as well as certain behaviors, can be modeled by extending the three fundamental types of geographic information.

Here are a few examples of spatial and attribute relationships.



Water junction fittings (Points)

OID	Shape	Equip ID	Valve Type
1		816-32	T203
2		816-45	Y53

Networks

Some linear features are connected. For example, street segments connect in a road network, pipes connect in a water network, stream lines connect in a hydro network, and electrical lines connect in an electrical network. Networks can be traced, for example, to find the fastest travel route, to identify the valve to turn off in a water network, or to trace river flow downstream.

Water mains (Lines)

OID	Shape	Diameter	Material
10		8	Concrete
11		10	PVC
12		8	Concrete

Water services (Lines)

OID	Shape	Service ID	Material
13		1001	Cast iron
14		1002	Copper

Related tables

Often, much of the descriptive information about features is held in separate attribute tables. Attributes from these separate attribute tables can be associated with each feature using standard relational database methods.

Object ID	Owner ID	Owner name	Percent owned
62932	12416	Mr Poulenc	50
62932	14562	Ms Beach	50
67810	16733	Ms Zwilich	100
62866	18930	Mr Satie	100
53956	21394	Mr Ravel	100
56460	26669	Mr Puccini	100

Object ID	Shape	Shape length	Shape area	Parcel ID	Assessed value	Type
14352	Polygon	407.3	10678.8	56460	\$58,000.00	6
17234	Polygon	438.5	12371.4	53956	\$56,000.00	6
19923	Polygon	395.0	9242.8	62866	\$45,000.00	6
23049	Polygon	396.4	9241.4	67810	\$52,000.00	6
26965	Polygon	421.5	9482.5	62932	\$47,000.00	6

Topologies

Many features are adjacent to one another and have coincident geometry; for example, adjacent counties, parcels, and other administrative areas share coincident edges.



Summary

All types of geographic information—features, rasters, and attributes—can participate in these spatial and attribute relationships. In a GIS, such relationships are modeled using extended data types such as topologies and networks. In addition, many types of spatial relationships can be discovered and identified by applying a series of spatial operators to the geographic objects. For example, you can create buffer zones of a given distance around features and perform a polygon overlay with another dataset to identify features that are near others in your GIS.

ArcGIS FAQ's

1. Does ESRI support 64-bit processors with ArcGIS 10.0 products

Support for 64-bit processors/operating systems ArcGIS 10.0 on Windows is supported on 64-bit processors and operating systems. In addition to Windows, ArcReader Standalone is supported on a Solaris 64-bit environment running as a 32-bit application. ArcReader 10.0 on 64-bit Linux is supported on Red Hat Enterprise Linux (RHEL) 4, (RHEL) 5, and SuSE 10.

ArcGIS Desktop on 64-bit ArcGIS Desktop 10.0 applications is natively 32-bit applications but take advantage of a technology known as large memory awareness. This means that individual processes, such as ArcMap.exe, may be capable of accessing more than 2GB of memory (up to 4GB) when run on a 64-bit OS. Note that some functionality and third-party libraries that are part of ArcGIS are not compatible with large-address-awareness, and as such, some portions of ArcGIS may not be able to address more than 2GB even when running on a 64-bit OS.

Terminal Server Support for 64-bit operating systems Terminal server technologies running on 64-bit operating systems are able to provide ArcGIS Desktop applications with up to a 4GB address space.

2. What is hyper-threading and multi-core or multi-CPU hardware?

Windows CPU manufacturers Intel and AMD are expanding performance capabilities of new processor technology with hyper-threading and multi-core processors. Hyper-threading is a way to virtualize two processors on a single physical core and is not to be confused with process threads, which may be a feature of an application. Hyper-threading improves system performance by allowing the operating system to run two independent processes apparently simultaneously on a single physical core. Multi-core processors provide more than one core on a single physical processor socket and are therefore a way to package more capacity on a system. Multi-core processors improve system computing capacity by making each core available as an independent CPU. Both technologies add available computing power to a system, but do not guarantee an application can use it.

3. Does ArcGIS Desktop runs on a multi-core or multi-CPU hardware and take advantage of its capability?

ArcGIS Desktop applications, for example ArcMap and ArcCatalog, are fully supported on multi-processor and multi-core computers, but in versions prior to ArcGIS 10, a single

ArcGIS Desktop application session does not take advantage of multiple CPU systems, (for example, dual or multi-core processors). This is because ArcGIS Desktop 9.3.1 and earlier applications utilize only sequential process threads.

At ArcGIS 10, Desktop applications can take advantage of multiple cores. When using a basemap layer or accelerated raster layer in ArcGIS 10 applications, multiple threads are started to perform drawing and blending operations, and because these operations occur in another thread, they can take advantage of another processor core. As a result, the application's user interface remains more responsive than at previous releases. At ArcGIS 10, background geoprocessing can make use of another core; one core can execute the geoprocessing task and another can respond to user interface (foreground) operations. On a 64-bit edition of Windows, the available memory for all executing 32-bit applications is enlarged, making it beneficial to equip 64-bit Windows machines with more RAM. For example, at least 8GB of RAM would be beneficial if expecting to run two heavy processing tasks, one as a background geoprocessing task and one from a standalone Python script. Some slight performance improvement from multi-processor systems can be experienced with any ArcGIS Desktop application. Concurrent operating system threads, e-mail, security checks, backups, and many other additional background application processes can be supported on the additional CPU resources without impacting ArcGIS Desktop application productivity. On a single-CPU system it is possible to consume all the CPU resources from a single ArcGIS Desktop session, for example, when running a heavy geoprocessing task. At

ArcGIS 9.3.1 or earlier, if running the same process on a dual-CPU or dual-core processor, the system CPU utilization peaks out at slightly above 50% with minimal performance gain. To fully utilize the resources of both CPUs for another busy thread from a separate process, a separate ArcGIS Desktop session or script or another application needs to exist. ArcGIS power users, when working in multiple concurrent sessions, can take advantage of a multiple CPU environment. An easy way to accomplish this is to run multiple applications; for example, any combination of ArcGIS Desktop applications and standalone Python scripts. A multi-CPU workstation can significantly enhance heavy geoprocessing and/or heavy map production workflows that make use of multiple ArcGIS sessions within a single user workflow. ArcGIS power Python scripters can write geoprocessing tools that make use of the subprocess or multiprocessing modules, which may enable the use of more or all available cores by running separate concurrent processes. Scripts using Python's subprocess module can import ArcPy in multiple concurrent subprocesses, but in the case of multiprocessing, spawned processes and process pools cannot import ArcPy and should be limited to computational functions, which lend themselves to parallelization. ●



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