GET A PLAN! Automatically Generating Disaster Preparedness Plans Using WILBER

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ABSTRACT

It is common knowledge that having a relevant disaster preparedness plan is helpful for saving lives and money during an actual crisis. However, few individuals and families have a plan in the United States. Less than 10% of US states provide online resources for individuals and families to develop customized basic disaster plans. Those states sometimes offer additional information particular to their areas. **However, existing online resources could be extended nationally by automatically providing additional plan information based on localized threats (e.g. climate, terrorism, etc.) within a geographical area.**

Wilberforce University has designed a solution called Wilberforce's Information Library Boosting Emergency Response (WILBER) which utilizes an interdisciplinary approach to automatically generate information based on localized threats within a geographical area to extend a basic disaster preparedness plan for individuals and families. WILBER combines current and historical information from Geographical Information Systems (GIS), risk assessment, wireless sensors, and computing.

Keywords

Disaster recovery, disaster preparedness, emergency plans, geographic information systems, risk analysis, wireless sensors.

DISASTER PLANNING IS ESSENTIAL

Nearly half the people in the United States believe they will personally experience a major disaster such as a terror attack or a catastrophic weather emergency within the next five years (National Center for Disaster Preparedness 2007). There is a concern that the country will not be prepared to face highly impacting disasters, such as bio-terrorism (General Accounting Office 2003). Despite the high perceived threat individually and nationally, only one-third (34%) of Americans have started preparing or are prepared for a major disaster (National Center for Disaster Preparedness 2007). Strikingly, 43% are not planning to do anything about preparing (National Center for Disaster Preparedness 2007).

Some states have taken the lead in helping citizens easily and conveniently develop emergency plans. For example, Minnesota's codeReady is a statewide initiative to help its citizens prepare for emergencies. After the user provides household information, describes household members, and answers plan questions, the site creates a custom emergency plan which includes a communication plan, a stay plan (sheltering-in-place), go plan (evacuation), and unique situation and special needs plan. The codeReady initiative also helps citizens create an emergency kit by providing a customized shopping list and supply checklist based on household characteristics. Similarly in California, CaliforniaVolunteers maintains an online application that creates customized disaster preparedness plans for individuals and families. The State of Florida has a Disaster Planning website for families, but it expands its personalized disaster plans creation capabilities to businesses as well. Both the Florida and California applications are available in Spanish which broadens participation. State-level initiatives are important in preparing citizens for disasters and help simplify the process for preparing a disaster plan. However, they (1) generally lack geographic impact outside the state's boundaries and (2) do not generally provide information about preparation for historically

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relevant disasters for a particular area without in-depth research or knowledge. Thus, many Americans who live in others states may have limited benefits from state-level systems.

There have been efforts to automate generation of disaster preparedness plans for certain types of institutions. For example, dPlan is an online disaster-planning tool specifically designed for cultural and civic institutions. While these applications can provide comprehensive plans, they may not appropriate for individual or family use. In the case of dPlan, it is only available to non-profit organizations such as libraries, museums, archives, historical societies, and other related institutions. Finally, the marketplace has produced a few for-profit applications such as Emergency Plan Now, which provides emergency action plan for businesses for a fee. Offices and retail establishments are the most common customers and the emergency plan focuses on a wide range of emergencies including crime, medical emergencies and natural disasters. For many businesses and individuals alike, however, the use of commercial providers of disaster preparedness plans can be cost prohibitive.

INTRODUCING WILBER

Wilberforce University's Information Library Boosting Emergency Response (WILBER) System is an easy-to-use, online information system that helps citizens better prepare for disasters, especially technological disasters such as terrorism and nuclear disasters. It automates some processes to help provide an extended basic disaster plan, along with a host of preparedness tools. WILBER is sponsored by the Department of Energy (DOE) National Nuclear Security Administration (NNSA).

The WILBER system creates customized emergency information for users based on an address in the United States and relevant threat information for a particular area. Threats include natural (e.g., climate) and man-made (e.g., wild fires and terrorism). WILBER allows users to assess their exposure to risks in the community and develop extended plans based on those risks. In educating citizens how to prepare for certain disasters within their area, it is expected that the plans generated by WILBER will lower risks. Future research will need to be conducted to determine the actual impact. WILBER allows for improved emergency preparedness by citizens and reduces overall risk by providing localized extended information prior to a disaster. Coupled with real time condition assessment within a distributed system using wireless sensor networks, WILBER creates safer communities before disaster strikes.

Initially WILBER concentrates on disaster plan preparation for individuals and families. In future phases, WILBER will extend to the business community. Shockingly, about 93% of all unprepared businesses fail following a significant disaster (Louderback 1995; Nelson 2006) so there is a need for a product like WILBER in the private sector as well. In the third and last stage of development, WILBER will eventually assist small local governments in creating disaster plans for their communities.

WILBER is composed of the following components as illustrated clockwise in Figure 1: (1 - highlighted in green) computing and mathematical sciences, and IT management; (2 - highlighted in orange) geographic information system; (3 – highlighted in turquoise) wireless sensors; and. (4 – highlighted in blue) risk assessment.

Computing, Mathematical Sciences, and IT Management

Computing is the glue that brings all the disciplines together for WILBER as seen in Figure 1. It provides the means to automate the processes to produce a disaster plan. In order to keep computing costs low, open source technologies were considered. For an open source distributed system, the Globus toolkit is a grid that can be used to balance the load of activities

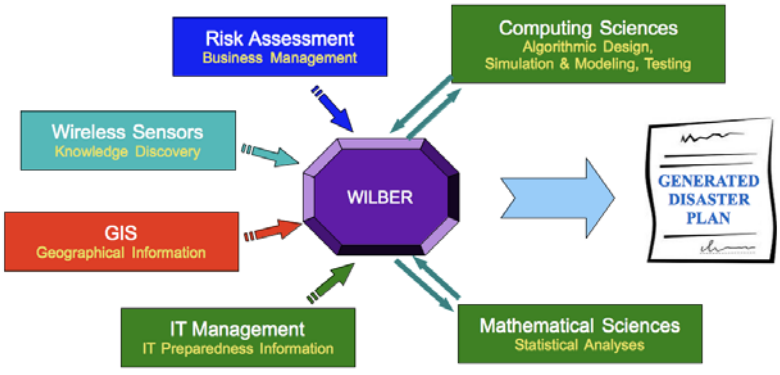

Figure 1. Interdisciplinary Approach for the WILBER System

across a number of machines in a geographically distributed manner (Globus 2010). The work is done seamlessly in a way to mimic a single (very powerful) computer. In general, a grid helps decrease the amount of time it would take to get complex jobs completed on a single machine.

Data was aggregated using publicly available data, primarily from federal agencies such as the Federal Emergency Management Agency (FEMA), the Environmental Protection Agency (EPA), and the National Oceanic and Atmospheric Administration (NOAA). That data are used among three main processes as seen in Figure 2, which are broken down as follows:

1. **Location**. The user enters an address.
2. **Process the Location**. Current and historical data within a 2, 5, 10, and 20 mile radius of that address are used to assess potential hazards in terms of weather, climate, chemicals, population, structures, businesses, etc.
3. **Generate the Disaster Plan**. The skeletal framework for the disaster plan comes from FEMA. Then the details collected from Step 2 are used to generate a basic disaster plan for the user's particular area.
4. **Simulate the Results**. This simulation is critical to helping the general populous understand the need for a plan in the first place. It helps them to see a simulated example of impacts in terms of loss of life and costs if a disaster preparedness plan is in place versus if no plan exists. (This assumes that the plan has been tested for usefulness.)

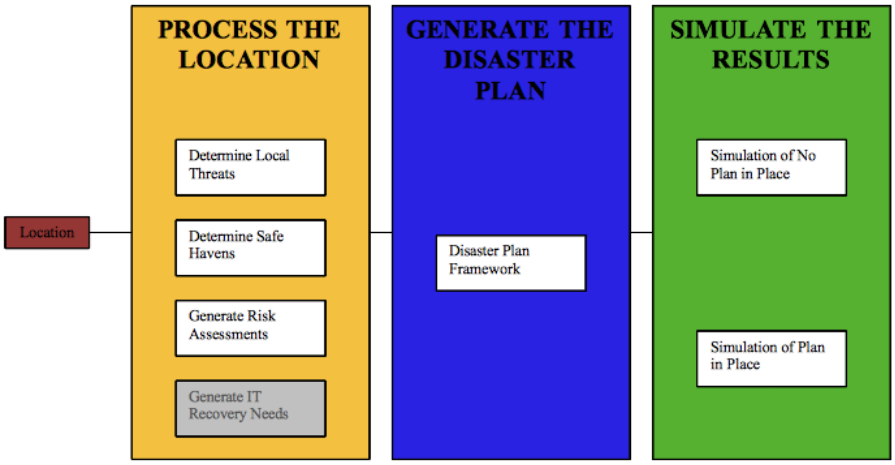

Figure 2. Disaster Plan Automated Generation and Simulation Flow

Geographic Information System (GIS)

WILBER has a comprehensive GIS which includes imagery, infrastructure, demographic, and environmental data. WILBER's GIS models simulate possible disasters focusing on terrorism threats and the main natural hazards affecting the area: e.g. floods, tornados, and earthquakes. The geographic extent of WILBER focuses on Greene County, Ohio as a case study, but it also includes data covering the entire continental United States. Although WILBER initially focuses on citizen disaster preparation, the GIS component is designed for many levels of uses from citizens to businesses to local government. Additionally, the GIS component can be applied to a multifaceted array of problems from simple map creation to advanced spatial analysis. Not only is WILBER's GIS useful before a disaster for preparedness, it is a formidable tool for use after a disaster for the purposes of recovery.

Local government users are able to use WILBER's GIS to complete many tasks including model potential events such as plumes, explosions, floods, and earthquakes; select and model evacuation routes, considering time of day, road capacity versus population, direction of travel, etc.; provide warnings and notifications to the public and others of pending, existing, unfolding emergencies based on the location or areas to be impacted by the incident. WILBER's GIS is also useful to businesses by allowing a business owner to assess their exposure to disaster-based risks in the community and develop plans based on those risks.

Most data contained in WILBER is publicly available or collected in the field using global positioning systems (GPS). WILBER also incorporates real-time data, such as temperature, wind speed and direction, via wireless sensors as described below.

Wireless Sensors

Wireless sensor networks (WSNs) have been an important application with the advent of powerful and efficient wireless sensor nodes along with increased usage demands. The main applications of wireless sensor networks are monitoring and target tracking in remote environments. As catastrophic disasters plague particular areas, WSNs become very useful for keeping communication ties and collecting information about damages.

Mobile robots with applicable sensor nodes can investigate a perilous area following a disaster. Mobile robots in a WSN require the following for efficient and proper navigation: sensor selection, map building, localization, and path planning. WILBER will collect information from the robots and determine the following: real time conditions, field data collections (frequency and analysis), and environmental assessments (e.g. soil and water). WILBER will also be used to perform analyses and help make informed decisions about the current risks.

Risk Assessment

Risk management is a systematic approach to set the best course of future action under anticipated uncertainty by identifying, assessing and mitigating risk issues. A crucial first step is to accurately anticipate/assess risks. Risk Analysis involves identifying and characterizing risk in terms of the anticipated magnitude and frequency of occurrence, and evaluating the potential impact based on its interaction with the underlying asset base. The following questions must be answered: (a) What can go wrong? (b) How likely is it to happen? and (c) What are the (estimated) consequences? This 'triplet' definition emphasizes the development of projected scenarios as part of the risk assessment process (NASA 2002).

Risks span a broad spectrum ranging from internal malfunctioning or failure of a process, from business risks to catastrophic natural and man-made events (including terrorism). Thus a variety of hazards was assessed in the context of populating WILBER with disastrous scenarios relevant to an area. Initial efforts focused on Ohio areas including Greene County and Wright Patterson Air Force Base - an enterprise of strategic military significance and an economic powerhouse. Initially, risk analysis was carried out for individual hazards.

Relevant information on risks was compiled from a variety of government, business, economic and academic sources. Moreover, WILBER generates threat data. FEMA HAZUS MH simulations were used to manually assess losses/impacts from natural hazards such as floods and earthquakes. To assess risk for terrorism scenarios, data will be extracted from published literature and national terrorism databases. In all cases, inputs (e.g. asset base, hazard data, and demographics) and outputs (economic losses, casualties) will be fed into WILBER.

CONCLUSION

Disaster planning is no longer an option, but a necessity. WILBER automatically extends basic disaster preparedness plans by adding useful information about localized threats for the general populace on a low-cost platform. Having a basic disaster plan in place with additional relevant information is useful for every citizen and overall national security. The WILBER system provides an interdisciplinary approach to extend a basic disaster preparedness plan to help the nation as a whole be better prepared for major disasters such as terrorism, tsunamis, tornadoes, and hurricanes. In the future, case studies for the greater Dayton, Ohio area will be conducted to determine the actual impacts of extending basic plans to include localized threat information. WILBER will also be extended for small businesses and local governments.

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