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Software Approaches for Monitoring of Climatic Changes and Disaster Management

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***Abstract*— Climate change has an impact on the biophysical environment and also human activity. It imposes a range of new challenges for technology development, research, and information and knowledge exchange. Recent advances in ICT have emerged as a critical factor in the development process and can play an equally important role in the climate change challenge. Based on a comprehensive review of the existing literature this paper outlines the impacts of weather change over a region and the range of new and emergent ICTs. These can be applied to climate change issues and investigates their use in developing countries. It also discusses the innovative uses of established technologies and their potential benefits in the process of monitoring the climatic changes and disaster management.**

***Index Terms*— Impacts of climate change, Research, ICTs, Disaster management**

I. INTRODUCTION

Over the past decade advances in ICT have lead to a large amount of changes in human and economic activity, and emerged as a critical ingredient in the development process. Similarly, ICTs can play a major role in adapting to climate change by collecting, analysing and information sharing. Advances, especially in space based systems, geographical information systems (GIS), wireless broadband technologies, wireless sensor networks (WSN), mobile (cellular) technology and soft technologies such as Webbased tools (i.e. Web 2.0) and information systems have resulted in technologies that are well suited to the climate change challenge [1]. There are a number of overall areas within the climate change domain where ICTs can be useful to governments, vulnerable communities and scientists. This paper concentrates on the effects and impacts of climate changes and adoption of emergent technologies in these three broad and interrelated activities: (1) monitoring of climate change and the environment, (2) disaster management, accounting for preparation, early warning systems (EWS), and response and recovery, and (3) Adaptation to climate changes.

Changes in climate have a severe impact on our society through impacts on a number of different aspects such as social, cultural, and natural resources. For instance, climatic changes affect human health, infrastructure systems, transportation systems, and also food, water and energy supplies.

For developing countries, it is very important to understand their local climate and be able to predict climate change impacts. Adequate local and national observation networks and access to the data captured from other global and regional networks should be made available in these countries. Therefore, weather monitoring

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systems become an important aspect.
Responding to natural disasters in a timely and effective manner is very important especially in developing countries, because in addition to the immediate crisis vulnerable communities of people suffer excessively from the secondary post-disaster effects that compound the tragedy. In several cases, the existing telecommunication infrastructure will be significantly or completely destroyed by an extreme weather event. Hence rapidly deployable networks and other communication services need to be employed for disaster relief operations in these countries.
To cope with the climate stress, communities – especially most vulnerable to developing countries should be well aware in advance of the climate adversities by making use of the appropriate and latest technologies to build their resilience. Monitoring networks can be useful in informing habitat location (to provide information to shift communities away from a flood or landslide in sensitive areas), better agriculture (based on information obtained from monitoring networks on climate or water allocation) and provide early signals and warnings [2].

II. Impacts Of Weather Change

Climatic impacts especially has a greater affect on people who live in areas that are more prone to coastal storms, sea level rise, drought or people who are poor. Likewise, people of some types of professions and industries may face considerable risks from climate change [1]. Occupations that are closely related to weather and climate, like agriculture and outdoor tourism, will be extremely affected. The amount of money spent on weather related insurance losses is shown in figure 1.

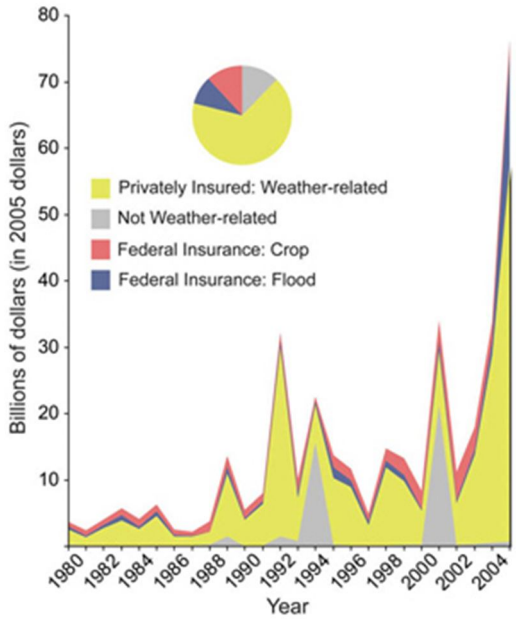

Figure 1 Dollars spent on Weather related Insurance Losses

Weather affects the visibility impairments, precipitation, high winds, and extremes of temperature which may affect driver capabilities, performance of vehicles , pavement friction, roadway infrastructure, crash risk, traffic flow, and agency productivity.
More than 6,301,000 vehicle crashes occur every year approximately. Of these about 24% are weather related crashes which is approximately 1,15,000 [3]. Weather related crashes are those which happen due to weather extremes or adversities. The average numbers of people who are killed due to these crashes every year are 7,130 and those injured are over 629,000.Of these crashes 75% are known to occur on wet pavements, 47% during rainfall [3]. About 15% crashes happen during snow, 13% on icy pavement and 11% take place on slushy pavements. And about 3 % happen in the presence of fog.

TABLE I. STATISTICS OF WEATHER RELATED CRASHES

Table: Statistics of Weather –Related crashes. (Annual Averages)			
Road and Weather Conditions	Crash Statistics		
	Annual Approximate Rates.	Percentage	
Wet Pavement	1,128,000 crashes	18% of vehicle crashes	75% of weather-related crashes
	507,900 people injured	17% of crash injuries	81% of weather-related crash injuries
	5,500 people killed	13% of crash fatalities	77% of weather-related crash fatalities
Rain	707,000 crashes	11% of vehicle crashes	47% of weather-related crashes
	330,200 persons injured	11% of crash injuries	52% of weather-related crash injuries
	3,300 persons killed	8% of crash fatalities	46% of weather-related crash fatalities
Snow/Sleet	225,000 crashes	4% of vehicle crashes	15% of weather-related crashes
	70,900 persons injured	2% of crash injuries	11% of weather-related crash injuries
	870 persons killed	2% of crash fatalities	12% of weather-related crash fatalities
Icy Pavement	190,100 crashes	3% of vehicle crashes	13% of weather-related crashes
	62,700 persons injured	2% of crash injuries	10% of weather-related crash injuries
	680 persons killed	2% of crash fatalities	10% of weather-related crash fatalities
Snow/Slushy Pavement	168,300 crashes	3% of vehicle crashes	11% of weather-related crashes
	47,700 persons injured	2% of crash injuries	8% of weather-related crash injuries
	620 persons killed	1% of crash fatalities	9% of weather-related crash fatalities
Fog	38,000 crashes	1% of vehicle crashes	3% of weather-related crashes
	15,600 persons injured	1% of crash injuries	2% of weather-related crash injuries
	600 persons killed	1% of crash fatalities	8% of weather-related crash fatalities
Weather-Related *	1,511,200 crashes	24% of vehicle crashes	
	629,300 persons injured	21% of crash injuries	
	7,130 persons killed	17% of crash fatalities	

Communities that produce different agricultural crops, such as wheat, corn or cotton, are highly dependent on the climate to support their way of life. Climate change may cause the ideal climate for these crops to shift

towards North. Climate changes are likely to affect the tourism industry as well. Also the recreational activities will be affected [4]. Increased number of wildfires could affect hiking activity. Sea shores could suffer erosion due to sea level rise and storm surge. Islands may disappear due to sea level rise. Changes may also have negative impact on fishing and hunting [4] .Communities that supports themselves through these recreational activities would feel economic impacts as tourism patterns begin to change. Climate change makes it difficult and expensive for many people to insure their homes, business or other valuable assets in risk prone regions.

III. CLIMATE CHANGE IMPACTS

Monitoring of weather events becomes a very important factor in developing countries. Several technologies such as satellite systems, Wireless broadband technologies, wireless sensor networks, mobile phones and hand held devices are used for monitoring weather and climate related adversities [1].

Rainfall and Landslide Monitoring

Countries in temperate and tropical zones are likely to experience increased and increasingly variable rainfall and exposure to extreme landslide events due to global warming. Typical examples of existing landslide solutions involve a trip wire and alarm installed along landslideprone areas, triggered by falling rocks, but these are unreliable due to their margin for error. In order to monitor rainfall and detect landslides a number of WSN initiatives have been deployed in developing countries. A landslide detection system using a WSN has been deployed in Munnar, Idukki and Kerala in India; areas which are highly prone to landslides. SenSlide can also be used for detecting landslides. SenSlide makes use of WSN and strain gauges and provides data to a network.

Fire Monitoring

With global temperatures expected to rise, a major concern is the increased frequency of forest fires, which contribute to 25 to 30 percent of carbon emissions. Typical approaches to fire detection involve human spotters in towers or aircraft searching for smoke. These are costly: for instance, in Portugal a network of over 200 surveillance towers observes fire sensitive areas. But they are also relatively ineffective given the difficulties of providing total coverage and accurate location. Wireless sensors or wireless broad band supported video surveillance with automatic detection of smoke or heat sources can be used to monitor fires. These approaches can still require human interaction for confirmation, however they greatly enhance the efficiency of monitoring networks by reducing costs (only centrally located operators would be required), provide more accurate location data, effective management of false alarms and 24/7 operation. Technologies such as fixed broadband, mobile and radio links (e.g. ADSL or 3G/UMTS, GSM, GPRS) are not typically available in remote forests or cannot provide the bandwidth required for more automated fire detection. Wireless broadband technologies can fill this gap by providing connectivity to remote sensors and monitoring systems, capable of effectively providing early detection of fire in an efficient and cost effective manner.

Flood Monitoring

Climate change is predicted to increase flooding frequency causing significant problems for vulnerable communities in developing countries

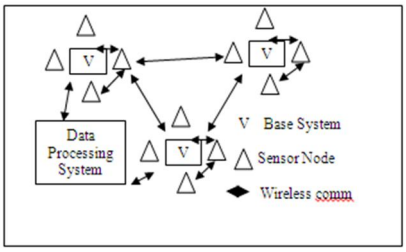

Figure 2. Flood Monitoring WSN

The normal practice of flood monitoring typically involves taking readings from painted markers at certain points or water gauges. There is a great deal of potential for WSNs to be deployed for flood and water level monitoring systems. A graphical representation of a riverbank WSN for monitoring floods is shown in figure

2. In this example, sensors form clusters at certain points along a river bank to communicate with local base stations, which communicate with each other and the processing centre wirelessly.

Impacts of Agriculture

COMMON-Sense Net, a WSN-based agriculture management system was deployed in India to support rain-fed agriculture which provides environmental data to the farmers. In geographical clusters wireless sensors were deployed, each with one base-station which is connected to a local server via a Wi-Fi link. These were organized into groups, each group corresponding to a specific application, such as water conservation measures, crop modelling or deficit irrigation management.

IV. DISASTER MANAGEMENT AND CLIMATE CHANGE ADAPTION

More often, the available communication system will be destroyed by extremes of weather. This gives rise to a need for the development of rapidly deployable network and communication services to be employed for disaster relief operations.

- Emergency Communication Systems- This deploys an Integrated Information and Communication System which uses satellite, wireless broadband, mobile phones and community radio services strengthening communication links between rescue and relief units and Emergency Operation Centers (EOC) [5].
- Social Networking-In 2009 During Typhoon Ondoy in the Philippines, local volunteers organized and shared information online through websites such as Twitter and Facebook [6]. Organizations and people affected made use of these sites for timely reports concerning the damage extent, and to provide information on the required resources and to provide those relief resources.
- GIS & Other Information Systems- Visualize high risk zones; shelters, evacuation routes and the catalogue of available resource and their proximity
- Early Warning Systems- mobile phones, satellite radio cell broadcasting system, the web, WSNs, and CAP (common alerting protocol) can be coupled with climate data for immediate and short/medium/long-term warnings to minimize harm to vulnerable communities [7].

ACKNOWLEDGMENT

Several impacts of weather changes on society are discussed. Also the adverse impacts of climate extremes on roads and the fatal accidents and injuries it causes and their statistics are given. The importance and the uses of several ICTs in monitoring of climate changes and tracking climate adversities like flood monitoring, fire monitoring, rainfall and landslide monitoring are described. The benefits of these technologies and functioning of several monitoring systems are briefly discussed. The areas like disaster management and early warning systems are gaining great importance and have a wide scope for development in the future as well. Research on new emerging ICTs are slowly beginning to take shape in developing countries but still most of them are in the embryonic stage and hence it is difficult to analyze their benefits completely. It is very important to provide more funds to the committees that are dedicated to the study and development of new ICTs.

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