

# Statistical Comparison of floods in Pakistan & Flood prevention through DDM with sensor based Disaster Database Systems.

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**Abstract**—From the time of its creation, Pakistan is suffering from natural disasters like earth quacks, cyclones and particularly floods. In last few decades World's climate has drastically changed that is a major cause of water disorder. Pakistan is bearing a huge damage in terms of economy, agriculture, infrastructure, livestock and specially the human lives due to floods every year. After worst flood of 2010, Government of Pakistan has taken serious steps towards flood management but unfortunately couldn't get substantial results. Here in this paper we have analyzed the flood statistics of damages and prevention measures from last four years 2010 to 2014. Depending on the results we have proposed dynamic digital map DDM for all districts of country liked with a central disaster database. This DDM is directly connected with wireless water sensors deployed on water reserves. This dynamic digital map DDM will bring a vital change in flood management by minimizing communication gap between the concerned departments and public before and during flood. The accurate information from water sensor shown my DDM can help authorities to learn situation quickly and to take better decisions. With the help of this ICT solution as a resultant economical losses can be minimized, agriculture and livestock's damages can be reduced and most importantly precious human lives can be saved.

**Keywords**—floods; Pakistan; Disaster; prevention; ICT solutions; Disaster Database

## I. INTRODUCTION

Due to the extensive usage of fossil based fuels and industrial growth by the developing countries, World's climate has been changed by greenhouse gases accumulated in atmosphere. As its outcome temperature of the globe is increasing. Pakistan is also affected by this global change. According to technical report based on 70 years of climatic data compiled by Pakistan Meteorological Department, Average temperature in Pakistan has been increased from 0.6 to 1.0 degree centigrade [1]. Due to this increase in temperature glaciers are melting quickly. In the result, country is facing flood and heavy monsoon season. In just last five years from 2010 to 2014, due to heavy floods loss of billions of dollars is

reported in terms of infrastructure, agriculture, livestock and industry.

There are many flood management institutions in Pakistan that are working under federal and provincial governments to manage floods. These institutions are operating under huge amount of budget but their performance is not satisfactory. Here in this paper we have clearly examined the last five years of flood statistics in Pakistan. From 2010 to 2014, despite working of flood management agencies floods damage rate is still high and country is bearing huge lose by floods every years. Flood statistics of said years are highlighted in the form of graph for better understanding recent flood trends and performance of flood management institutions. This five years comparison will help us to examine the core problems and for better design of an effective flood management system.

Major issues in current system includes communication Gap between institutions that is one of the major reason of poor flood management. Before and during floods, flood management departments have no proper synchronization and coordination among them. Relying on legacy system instead of modern digital systems is another key factor in flood mismanagement in Pakistan. Pakistan is still relying on old legacy manual systems for water management. Manual scaling systems are being used to read water level as well as the speed and flow of water. Another vital factor in this regard is poor education and training for citizens as well as for officials. People are not aware how to react under specific circumstances. Even rescue teams are also facing same deficiency.

In our research, we have proposed modern ICT based solution for Pakistan for better floods and water management. In our proposed system manual scaling system has been replaced by the modern sensor technology. Water sensors capable to read water level, speed, depth, and quantity can be deployed in rivers and other flood sources. This system is connected with dynamic digital Map installed in nearest district office. Dynamic digital Map DDM is capable to show water flow in concerned water source and highlight water characteristics transmitted by water sensors. A main centralized

disaster database is proposed connected with all district offices to collect updated information related flood main disaster control room. Main disaster database will be able to update recent flood related information on a web based portal and mobile application for common citizens. Many developed countries like Japan are also using Disaster distributed database systems for disaster management. These databases collect data from satellites in affected areas and process the information for better counter mechanism [2].

Our research aimed bellow mentioned aims

- Identify the problems in current flood management system in Pakistan and analyze the flood statistics of last five years from 2010 to 2014 floods.
- To propose IT based solution for better flood management across the country.
- To propose such system that can integrate current flood management bodies and can remove communication gap between them. Such system that enables an individual to quick access updated flood information for better planning and prevention activities.

## II. EXISTING SYSTEM AND SCOPE OF PROBLEM

Living in 2016, World has moved to upgraded digital systems like satellite navigation and Image processing for disaster management which are capable of high efficiency. Modern Information systems are deployed in developed countries to easy and quick access of flood updates among concerned authorities. Pakistan a under developed country, unfortunately has no such modern digital system to manage floods. We are still relying on manual scaling system in which water statistics like water level, water speed, water depth and quantity is measured manually. Manual scales are deployed on water resources and data is observed and communicated manually. For example, let us consider a flood occurred somewhere in Pakistan the officials of irrigation department will observed water statistics and will communicate it to authorities by telephone for further counter measures. Through this process following problems and difficulties can be faced

- Authenticity of data
- Slow communication
- Errors in data
- Information Sharing
- Storage and Backup

Decisions are made on wrong statistics and ultimately result is poor management. Public and private rescue departments have their own strategies based on their information. Similarly communication gap also exist between flood victims and government agencies. People are not aware of proper instructions and precautions and in the result human casualties and damage increases. Such practices turn the country in huge lose in case of both financially and human lose in last five years of worst floods in country. In 2010 after heavy rain fall in monsoon, 20% of total geographical area was under flood

water due to poor management. Following tables are showing overall damages of floods in last five years from 2010 to 2014 based on National Disaster Management Authority (NDMA) flood reports [3] [5] [6] [7] [8].

TABLE 1. Damage in 2010 Flood

Provinces	Sindh	Punjab	KPK	Baluchistan	AJ & K	Total
Houses	879,978	375,773	257,294	79,720	6843	159,9608
Health	151	57	190	45	39	482
Education	5655	2821	886	557	194	10113
Govt Buildings	331	127	880	27	8	1373
Transport & Com (KM)	8467	2819	6511	2077	3575	23449
WSS (Affected)	1018	1193	3923	146	337	6617
Cropped Area (thousand)	1043.5	746.9	121.5	132.5	33.1	2077.5
Animals a. Large	93.7	2.3	72.4	139.6	0.3	308.7
b. Small (goats etc) (Thousand d)	81.9	2.5	67.8	1036.7	0.3	1889.2
Industries	16	41	89	-	-	146
Hotel / Shops (approx)	54000	40000	17700	6500	500	118700

Similarly in 2011 flood only in Sindh 497 people were died and 9,275,568 were affected. 1596807 houses were damaged. 2184951 acres of agricultural land was affected, 116529 animals were also died that is a huge loss in livestock [4].

TABLE 2. Damage in 2012 Flood

Province	Persons Affected	Area Affected (Acres)	Crops Affected (Acres)	Cattle Head Perished
KP	0	0	0	0
Punjab	887245	1490827	473998	898
GB	0	0	0	0
AJ & K	0	0	0	0
Islamabad	0	0	0	0
Sindh	3174716	274556	245459	2029
Baluchistan	787780	0	452588	9194
Total	4849841	1765383	1172045	12121

TABLE 3. Damage in 2013 Flood

Province	Persons Affected	Villages Affected	Crops Affected (Acres)	Cattle Head Perished
Punjab	795857	2946	745655	81

<b>KP</b>	584	2	5351	80
<b>Sindh</b>	524833	3068	246590	88
<b>Baluchistan (Final)</b>	167789	2281	114463	13160
<b>FATA</b>	0	0	17	14
<b>AJ &amp; K</b>	0	0	0	81
<b>Total</b>	1489063	8297	1107260	13504

TABLE 4. Damages in 2014 Flood

Province	Persons Affected	Villages Affected	Crops Affected (Acres)	Cattle Head Perished
<b>KP</b>	0	0	0	0
<b>Punjab</b>	2.47M	3484	241	1733
<b>AJ &amp; K</b>	46979	187	0	2620
<b>Gilgit Baltistan</b>	13266	127	1513	5369
<b>Sindh (Final)</b>	0	267	0	0
<b>Total</b>	2.53M	4065	2412	9722

Above mentioned loss could be minimized by using better management systems and better strategies.

#### A. STATISTICAL VIEW

In Pakistan flood season normally starts from July 1st and ends on September 30 every year. However all rescue departments and flood management & forecasting agencies start their work early from 15th of June every year. These data collection analyses and forecasting activities are continued till the end of October. During this period of time, it is tried to maintain good communication and interaction between all flood management agencies whether provincial or federal in order to response any eventuality due to flood. However this system is not going to work effectively anymore. Flood commission 2010 in their report “Annual flood report 2010” has clearly indicated some flaws in current flood management system and suggested some actions in this regard. The earlier weaknesses in exiting system called for some remedial actions given bellow

- Existing Police communication system for flood forecasting/ warnings should be replaced by an advanced digital and automated information system.
- Dissemination of early warnings should be communicated to every important recipient by the flood forecasting Centre.
- There should be a proper mechanism that can ensure the proper coordination between all agencies and departments involved in flood management activities.

After this report by flood commission, Government has raised some steps for the betterment of existing system by

- Flood Management training has been made essential for all the people of irrigation and WAPDA.
- Flood forecasting Centre has been redesigned as flood forecasting Division FFD.

Considerable improvements has been made but still improvements are needed as after 2010 still country is bearing loss every year by floods. If we analyze the data of damages

during flood by comparing last five years from 2010 to 2014, we can clearly draw results that 2010 was the worst year. According to flood report 2010, area of agricultural land damaged in flood was more than 2000000 acres across the country. In 2011, flood hit Sindh and rest of the country did not come under the risk. In next two years again this values increase and more than 1000000 acres of agricultural land destroyed. This is happening every year and has worst effects on country’s economy. Below is the picture that describes trend of land damaged in last four years.

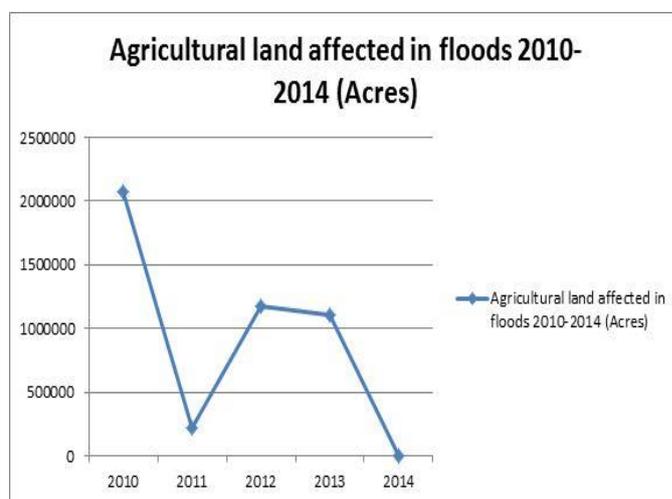


Fig.1. Agricultural land affected in floods 2010-2014

Similarly if we see total number of population affected, livestock loses as well as the total number of villages destroyed in during these years, a relation can be b we get following relations presented in figures given bellow as

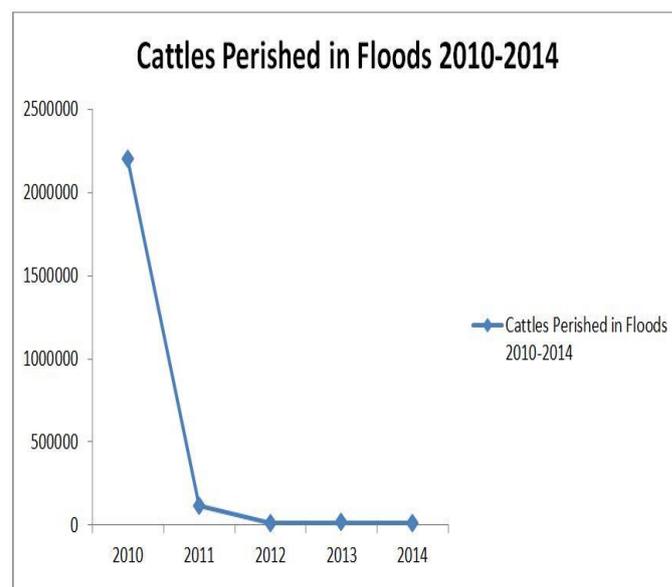


Fig.2. Animals perished during floods 2010-2014

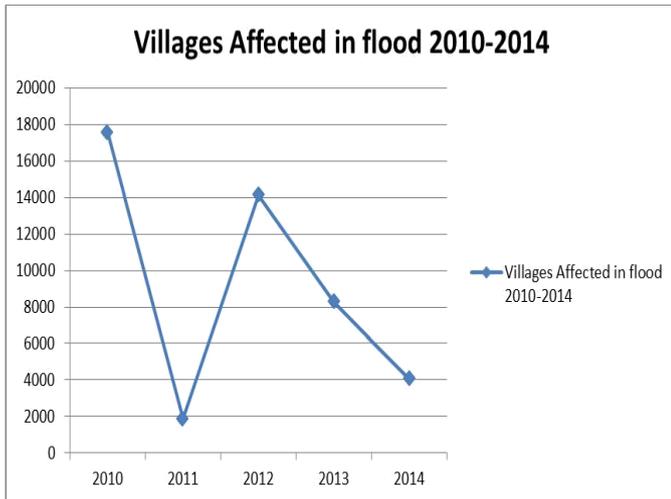


Fig.3. Villages affected during floods 2010-2014

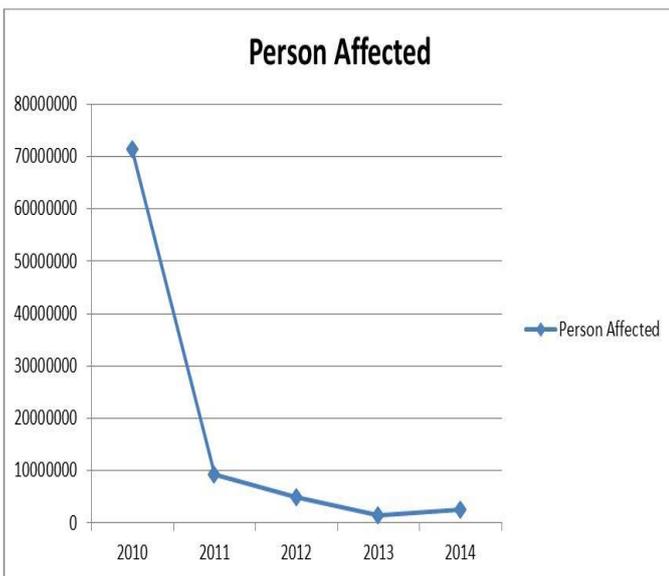


Fig.4. Population affected during floods 2010-2014

### III. PROPOSED SOLUTION

Keeping in mind the above statistics of floods in Pakistan, here in this research we have proposed an ICT based solution in which water sensors using wireless technology will be implanted on riverine and other large resources of water. These water sensors will be capable to get the following readings continuously

- Water Speed
- Water Level
- Water inflow and outflow

After fetching these readings, water sensors will transmit the data to nearest district disaster management office. In every district a digital wall screen called Dynamic Digital Map is placed that shows map of water routs with current data. This

DDM system receives the data of water sensors and show that data on the Map as well as store this information in database. District government officials can watch latest information and take decision easily in any flood emergency. These district disaster management offices are directly linked with Central database in Disaster headquarters. All the information gathered from water sensors will transmit to district office first and then shared with central disaster headquarter where a central database is linked with all districts. In central Disaster headquarter Information is analyzed and if any district information found critical authorities can take abrupt actions in counter measures. This system not only helps officials but also keep the public up to date. For the public to be aware of situation, this system has following channels to make people up to date.

- Web based portal for internet users
- SMS service for common people
- Mobile Application.

If any district information found critical on DDM then official can share the precautions and related information on Web based disaster portal as well as on Mobile application and an SMS will be generated to all those people living in concerned districts.

We can also use this system to detect water stolen activities in canals. If water sensors deployed on one point of a canal shows a specific reading on dynamic digital map and water sensors placed on another end shows different reading then it is understood that some amount of water is being stolen or used between these two ends. If the difference between these two ends meets a specific criteria stored in system, this DDM can generate beep and can highlight these specific location on the map. Pakistan is an agricultural country and has largest canal system in the World. This is a need of time to use such a system that can help us to manage water resources properly and to help the government agencies in any flood related situation. Following picture is showing the complete process of this system.

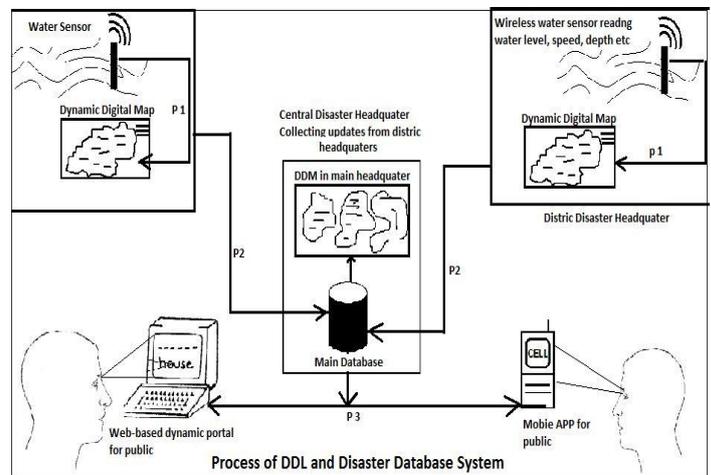


Fig.5. Working of system

#### IV. SYSTEM DESIGN

Dynamic Digital Map and Disaster database systems as proposed systems will use present dataset and will work out to make existing system towards highly efficient flood management system. This system breaches communication gaps between the flood management institutions and enables them to observe and control the system more efficiently. Our proposed system takes live stream if data as an input with the help of water sensors. System working in district offices and main disaster headquarter are responsible to process the data and to display the information on dynamic digital map. System generates real time alerts in case of emergency and enables officials to send relative information to general public by SMS; web based portal and mobile application with the help of a single click. Control flow of system is shown in figure given below as

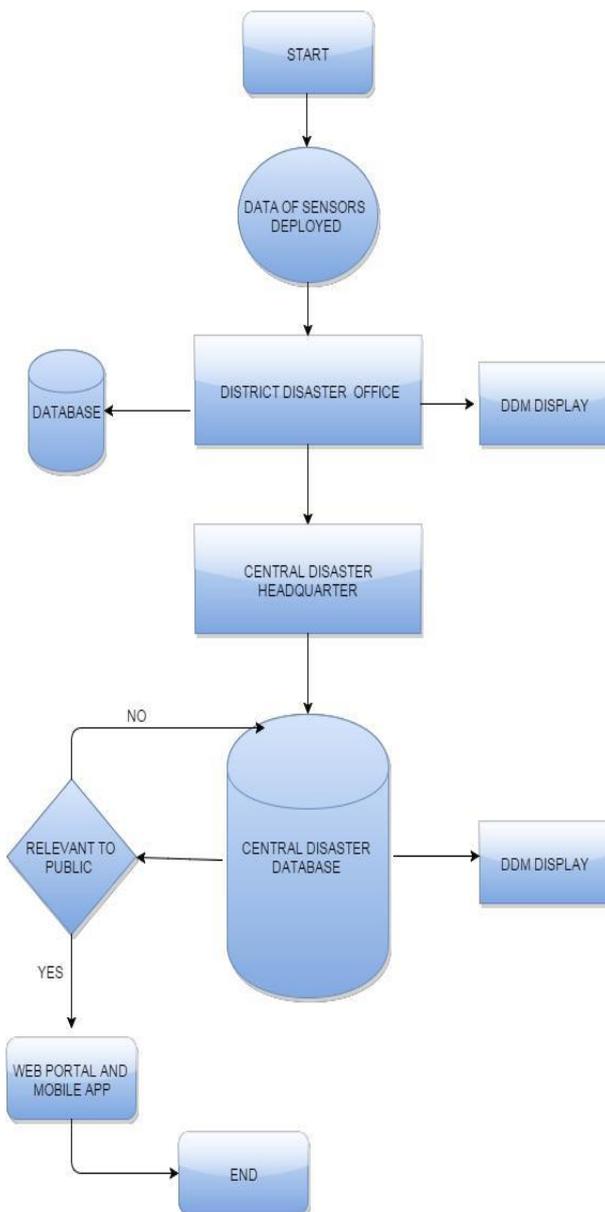


Fig.6. Control flow of the system

#### V. RELATED WORK

As for as the disaster management in Pakistan is concerned, a lot of researches have been done in this regard. Mubushar Hussain with his fellows has worked on remote sensing and geographical information systems. In his paper named as “Emerging Geo-Information Technologies (GIT) for Natural Disaster Management in Pakistan” he has briefly describe the role of Geographical information systems in disasters particularly in Pakistan’s context. He compared flood statistic and usage of geographical information systems to overcome the natural disasters in Pakistan in pre disaster, disaster and post disaster activities. He concluded that with the help of high resolution satellite data it has become very easy to develop the high efficient disaster information systems in Pakistan [9].

Wenling XUAN and Gang ZHAO from China in their paper “Early Warning Monitoring and Management of Disasters” highlighted the major issues being faced by disaster management authorities in china in disasters early warning system. In their research they suggested a model for effective early disaster warning and monitoring system [10]. Muhammad Hussain Mughal, Zubair Ahmed Shaikh wrote a paper on A Wireless Sensor Grid for Water Management, their study brings a complete road map to manage and control the usage of water resources with the help of wireless sensor network. They proposed a complete digital solution to remotely control all water sources with the help of wireless sensors. According to this research wireless sensors can be placed to control the flow and equal distribution of water to all stockholders. Even physical machinery like gates of the barrages can be opened remotely with the help of the technology they suggested [11].

George S. Percivall has introduced a new concept in his research to handle the natural disasters like floods and earthquakes. According to this research Earth observations can play a vital role in disaster management. In his paper he describes how GEO and CEOS Group on earth observation and Committee on Earth observation satellites respectively are making the ability of agencies stronger enough for agencies to manage the disasters lifecycle. The Architecture Implementation Pilot of group on earth observation committee has, through an agile development process, places and tested advanced information systems for Earth Observations based on ability of exchange and use information arrangements [12]. Stefan Voigt and Thomas Kemper briefly described the role of Satellite Image Analysis for Disaster management. From last one decade, satellites are extensively being used by many advanced countries for civil projects also. Satellite Images before and after disasters like flood can help us to analyze the scope and type of destruction. For example in Pakistan, in 2005 earthquake there were many areas which were totally cutoff from other side of country. In such cases Image analyses through satellites can help us to understand the magnitude of disaster [13].

In 2012 Tomoyuki Ishida and Akira Sakuraba from Japan with their fellows worked on Disaster prevention through Geographical Information System based tiled display environment. Their research is based on a high definition digital wall just like DDM to show information and Maps from information systems. This tiled display works with integrated

Information Systems, collects data and display it in an efficient manner for better understanding [14].

## VI. CONCLUSION AND FUTRE WORK

Natural From 1947 to present in 2015, Pakistan is suffering natural disasters like floods, earthquake, cyclones and specially floods. Total loss is estimated billions of dollars. Thousands of people died and many villages have been eliminated from map. From last decade due to global change in climate, Pakistan is facing worst floods every year. In our paper we have analyzed the flood statistics of last five years from 2010 to 2014 and show damage results in the form of graphs. On the basics of these results we have briefly described the existing flood management system functioning in country and proposed a well-organized and efficient system to handle the gaps and loopholes in existing system. In our proposed system we have suggested wireless sensors for water which get water readings and sends to nearest district. These districts are connected with main database system where all data stores. It will become very easy for government officials to react in critical situations like floods with the help our system.

In future we can use this system to integrate all Government agencies, hospitals, rescue departments together to counter reaction for disaster. We can connect control of our water resources barrages and heads with this system. With the help of single click form the remote distance we can open and close door of heads / barrages and also can manage water distribution in all canals from a single office. This system can also be expanded for crime prevention. Water stolen activities from canals can be prevented with the help of this system.

## REFERENCES

- [1] Chaudhry Q. Z., A. Mahmood, G. Rasul and M. Afzaal, 2009:Climate Change Indicators of Pakistan, Pakistan Meteorological Department, Technical Report No. PMD 22/2009
- [2] Hiroyuki Echigo, Hiroaki Yuze, Tsuyoshi Hoshikawa, Kazuo Takahata, Yoshitaka Shibata, "Large Scale Distributed Database System for Safety Information by Dynamic Reconstruction Method over Japan Gigabit Network", accepted, to appear in Proc. of The International Symposium on Management Systems for Disaster Prevention(ISMD2006), Mar.2006.
- [3] National Disaster Management Authority Pakistan NDMA, damages /losses–flood–2010, Flood report 2010.
- [4] National Disaster Management Authority Pakistan NDMA, damages losses–flood –2011, Flood report 2011.
- [5] National Disaster Management Authority ,damages / losses–flood – 2012, Flood report 2012.
- [6] National Disaster Management Authority Pakistan NDMA, damages losses–flood–2013, Flood report 2013.
- [7] National Disaster Management Authority Pakistan NDMA, damages / losses–flood–2014, Flood report 2014.
- [8] Federa flood comission Pakistan, Flood report, Annual flood report 2010
- [9] Mubushar Hussain, Mudassar Hassan Arsalan, Emerging Geo-Information Technologies (GIT) for Natural Disaster Management in Pakistan An Overview, 0-7803-8977-8/05/520.00 02005 IEEE
- [10] Wenling XUAN and Gang ZHAO, Early Warning Monitoring and Management of Disaster, 1-4244-1212-9/07/\$25.00©2007 IEEE
- [11] Muhammad Hussain Mughal, Zubair Ahmed Shaikh, WaterGrid: A Wireless Sensor Grid for Riverine Water Management, ISBN: 978-1-4799-5754-5/14/\$26.00 ©2014 IEEE
- [12] George S. Percivall, III, Senior Member, Improving Disaster Management Using Earth Observations GEOS and CEOS Activities, 1939-1404/\$31.00 © 2013 IEEE
- [13] Stefan Voigt, Thomas Kemper, Torsten Riedlinger, Satellite Image Analysis for Disaster and Crisis-Management Support, 0196-2892/\$25.00 © 2007 IEEE
- [14] Tomoyuki Ishida and Akira Sakuraba, A Unified Large Scale Disaster Information Presentation System Using Ultra GIS based Tiled Display Environment, 978-0-7695-4779-4/12 \$26.00 © 2012 IEEE DOI 10.1109/NBiS.2012.115