

Capacity Development for Managing Disaster Risks of Flash Floods in Sudan

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This paper discusses the deliverables and achievements made in Sudan within the UNESCO-Japanese project on Urgent Capacity Development for Managing Disaster Risks of Flash Floods in selected four Arab countries. The Sudan is often subjected to deadly flash floods in Wadi systems resulting from intense rainfall of a relatively short duration. Flash floods have increased in frequency and magnitude over the last 50 years as a result of global climate change creating severe socioeconomic and environmental destruction in many regions of the country, in addition to casualties, psychological and sociopolitical impacts. Integrated flash flood management (IFFM) in Wadi systems in Sudan is faced with many technical, institutional and socio-economic challenges that call for urgent need for capacity development. The present project has contributed to capacity development in IFFM in Sudan through studies and training activities in flood forecasting and early warning, flood hazard and risk mapping, development of guidelines and resources manual for effective flash flood remedial measures and development of programs for community awareness to reduce risks and vulnerability before, during and after flash floods. The Gash River in Eastern Sudan was selected as a case study area which is a trans-boundary seasonal Wadi that originates in the Ethiopian and Eritrean highlands and flows to the eastern parts of the Sudan towards Kassala town, and often causes serious flood hazard to the town. The paper discusses the progress in developing a flood early warning system for Gash using various modeling systems such as HEC-HMS, IFAS and RRI. The activities for the development of flood hazard and risk maps for the case study area will be outlined and the developed maps with flash floods of various return periods {25yr, 50yr, and 100yr} will be discussed, together with identification of risk areas and zones for future planning. The manual developed within this study for flash flood remedial measures as well as the activities conducted for promoting community awareness and strengthening community resilience will also be discussed. The paper concludes with some recommendations for integrated flash flood management in the study area as well as recommendations for innovative approaches for maximizing the benefits from flood waters.

Capacity Development for Managing Disaster Risks of Flash Floods in Sudan : Case of Gash Wadi, Eastern Sudan

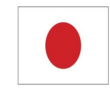
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Second International Symposium on Flash Floods in Wadi Systems,
25-27 October 2016, El Gouna-Hurghada Egypt.



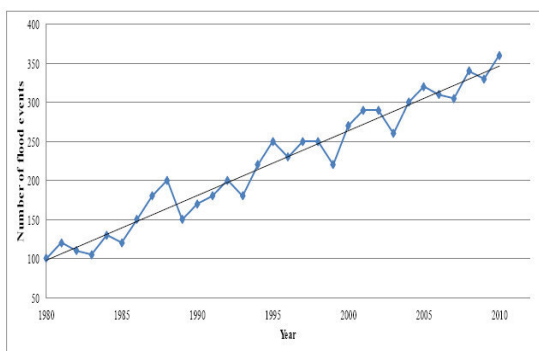
Acknowledgment



From
the People of Japan

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Growth of Flood Events Worldwide (Munch Re, 2011 modified)



Floods in Sudan

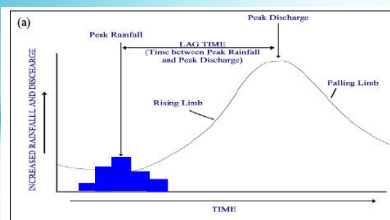
River Nile floods

Slow Rising Floods with sufficient lead time

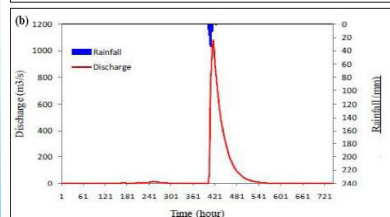
Flash floods (Wadis)

Flash floods of very short lead time due to heavy rain in short duration

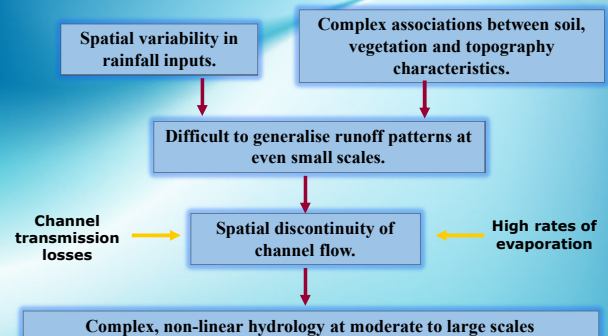
Hydrograph of a typical slow rising flood (Nile)



Hydrographs of a typical flash flood (Wadi System)



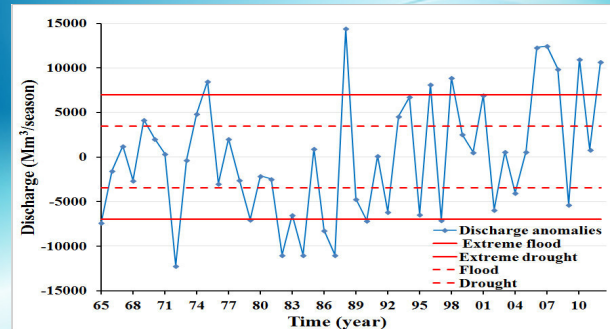
Challenges of Wadi Hydrological Characteristics



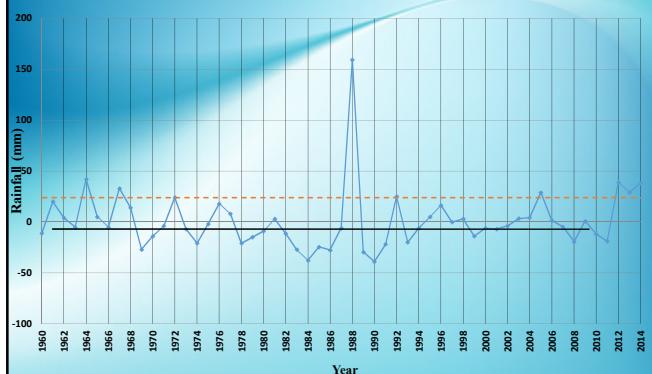
Challenges of Climate change

- Climate change has been identified as main factors causing extreme events such as floods.
- Drought is also one of the most serious natural disasters as a result of climate change.
- Sudan has been subjected to extreme events of floods and droughts in recent years with increased frequency.

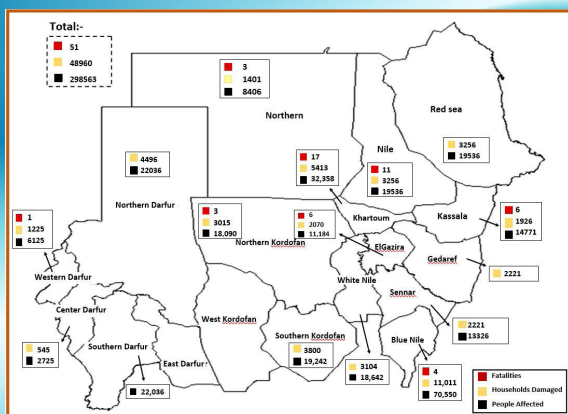
Blue Nile: Example of increased flood and droughts



Example of extreme rainfall events Khartoum Max. Daily Rainfall



Impact of 2014 Flash Floods on Sudanese States (UNOCHA, 2014 modified)



National Institutions Participated in the Project in Sudan

- Water Research Centre, University of Khartoum
- Ministry of Water Resources, Irrigation and Electricity
- Sudan Civil Defense
- Universities (Kassala, Omdurman and Medical Science and Technology)
- Sudan red Crescent
- Local authorities in the project area

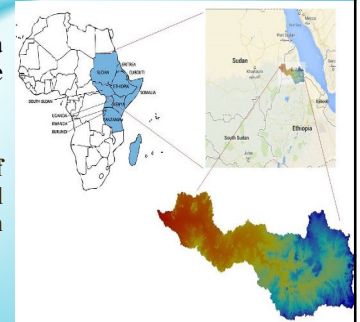
Sudan hotspot/pilot area

• The Gash is a transboundary river between Sudan, Ethiopia, and Eritrea

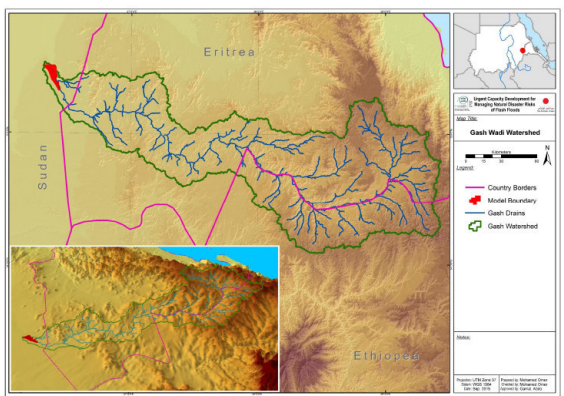
The Gash River Basin

• Total catchment area 21,000 km² with average annual discharge of 700 M m³

• It is the only source of potable water and recharges to the Gash Groundwater Basin.



Gash Catchment Area



Basin Characteristics

- Gash river catastrophic flooding is increasing steadily.
- A frequency of 1 severe flood in 5 years of flood is estimated.
- The flood damages are severe in Kassala town
- Watershed degradation due to human activities in the upper catchment coupled with high intensity short duration lead to a flash flood flow
- The river often reshapes and changes its course.
- It has a unique nature that it ends in an open land (Delta)

Project Activities and Achievements

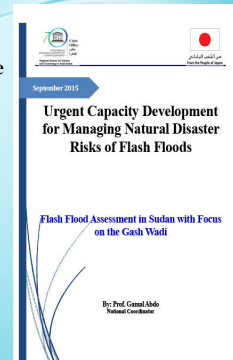
- Flash Flood Assessment in the Gash
- Development of hazard and risk maps
- Development of guidelines for remedial measures
- Community Awareness
- Training Activities
- Other relevant ongoing activities

Flash Flood Assessment in the Gash

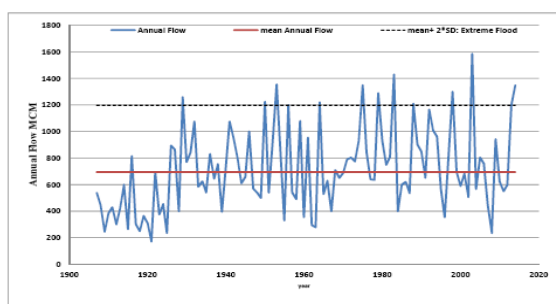
1. Flash floods in the Gash and their impacts on various sectors.
2. Flash flood management challenges in the Gash.
3. Needs assessment and Recommendations for IFM.

Methodology Adopted

- Review of available Literature
- Field visit and direct observations
- Questionnaire
- Meetings with flood management actors
- Focus group discussion and
- Stakeholders observations



Annual Flow of Gash for the Period (1907-2014)



Frequency of occurrence of flash floods in the Gash

Period	Number of flash flood events	Frequency of occurrence
Before 1920	0	
1921 to 1950	2	Once every 15 years
1951 to 1980	4	Once every 8 years
1981 to 2014	6	Once every 5 years



2007 Flood in Gash River (Photo Credit: Mohamed Nureldin Abdallah/REUTERS)



Plate 9: View of the Gash Protection embankment

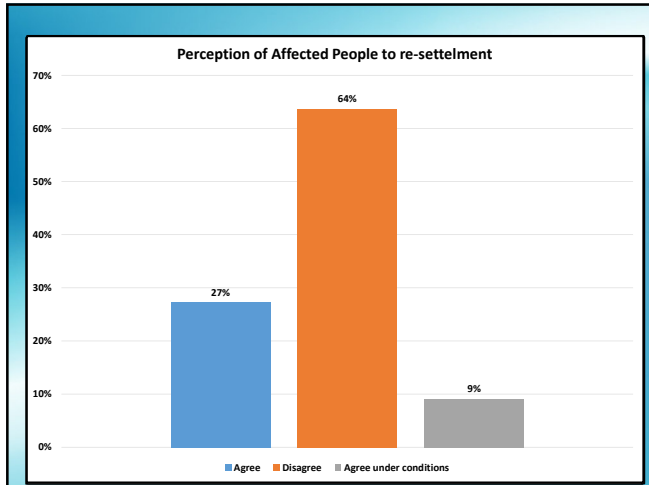
to reduction in cross section at the old bridge)

69 | P a g e
63 | P a g e



Plate 3: Meeting at Gash Wadi Training Unit

Results of Questionnaire



Major Needs Identified for the Gash river

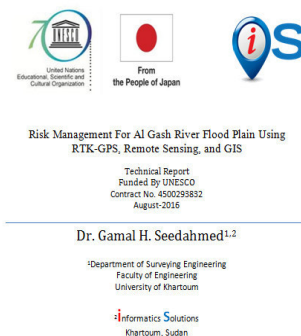
1. Development of real time flood forecasting and early warning system and mechanism for issuing flood warning to the people.
2. Development of flood risk/Hazard maps.
3. Development of an integrated flood Management plan including preparedness and emergency
4. community awareness and capacity building a programs
5. Enhancing institutional capacities and coordination
6. Improving data resources , knowledge sharing and regional cooperation and coordination.
7. Training and Capacity Building in Flood Management
8. Financial Resources

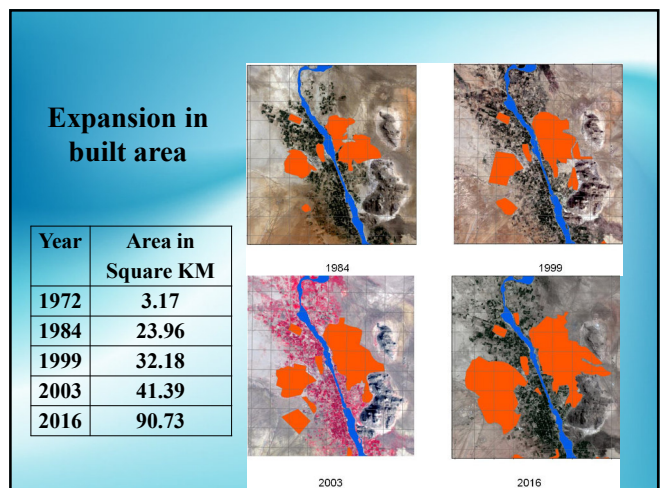
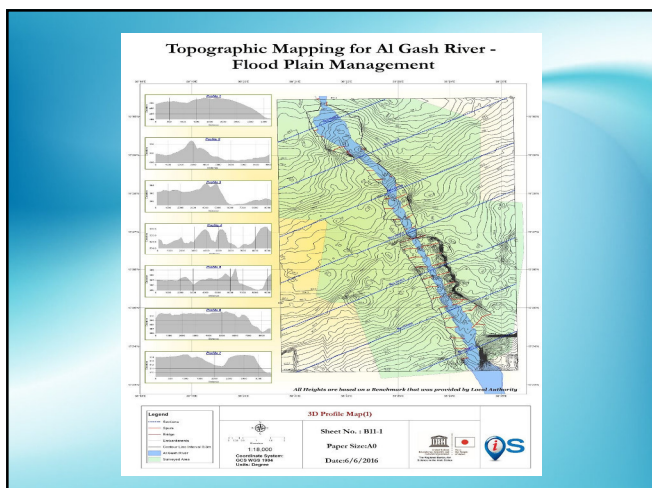
Development of Flood Risk Maps

Deliverables

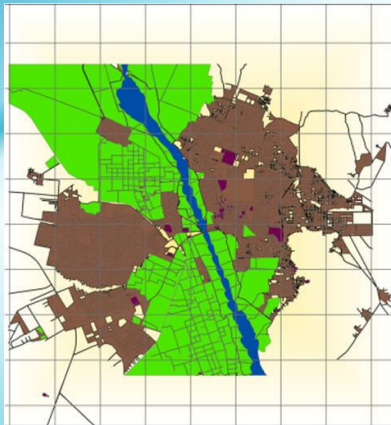
1. RTK Survey conducted for the longitudinal section of the Gash River {27 KM) at 20 cross-sections
2. Development of contour map for the flash flood affected areas in Kassala city about {70 km2) with a cross-section every 1 km interval
3. Development of GIS Maps using Sattlite data
4. Frequency analysis of historical water levels at the main station (Bridge station) and Geira station was conducted

5. Development of flood hazard maps for various return periods {25yr, 50yr, and 100yr).
6. Assessment of affected population (current status), identify risk areas and zones for future planning
7. Suggested remedial measures for flash flood risk mitigation in Kassala
8. A technical report documenting and outlining the main activities of the development of Flash Flood Hazard and Risk Maps for the Gash River (with atlas of maps)

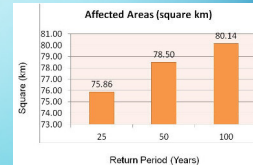
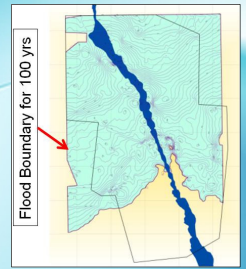
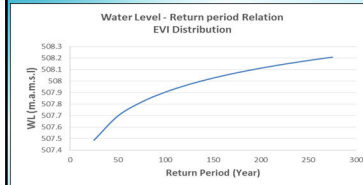




Categories of Land Use in Kassala



Station : Bridge Station	Parameter
Mean	506.3
Standard Deviation	0.279
Coeff of Variation	0.0006
Skewness	0.6
Maximum Daily level in Record	507.4



Return Period (Yrs)	Area (km ²)	Green Area(km ²)	Built-Up Area (km ²)	Open Space (km ²)	Streets Length (km)
25	75.86	26.85	33.53	15.49	1019.32
50	78.50	27.98	34.28	16.23	1040.91
100	80.14	28.77	34.75	16.62	1051.99

Development of Guidelines for Remedial Measures



The guidelines contain five parts.

Part 1 : Geographical, geological, hydrological and geomorphological settings of the study area

Part 2 : was devoted to introduce disasters and their management along with their basic concepts, classifications and types. are natural and manmade causes of Kassala flooding in addition to climate change.

Part 3 : analysis of the mitigation measures performed to reduce 2003 flood damages was done.

part 4 : the mitigation measures that must be followed to reduce flood damages at its different stages was discussed with special focus on Kassala protection.

Part5 : conclusion and recommendations.

Annex: Training program on remedial measures

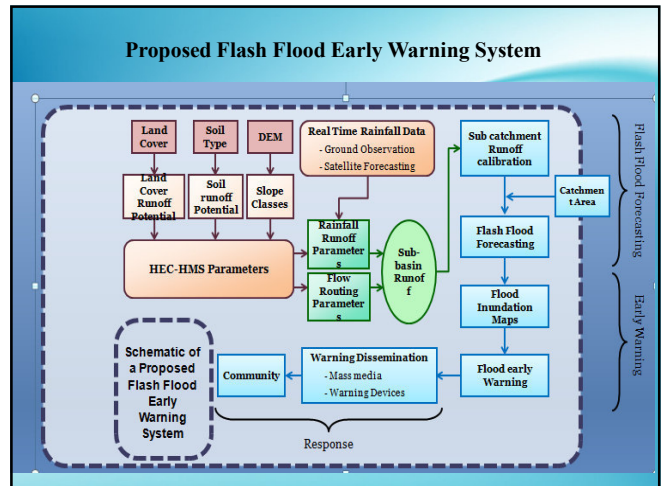
Community Awareness

- Preparation of awareness material (posters, books, flyers, film)
- Awareness workshops for all stakeholders
- Awareness at schools (primary and secondary)
- Awareness should explain flash flood risks, impacts, actions to be taken, safety procedure, first aid introduction, etc

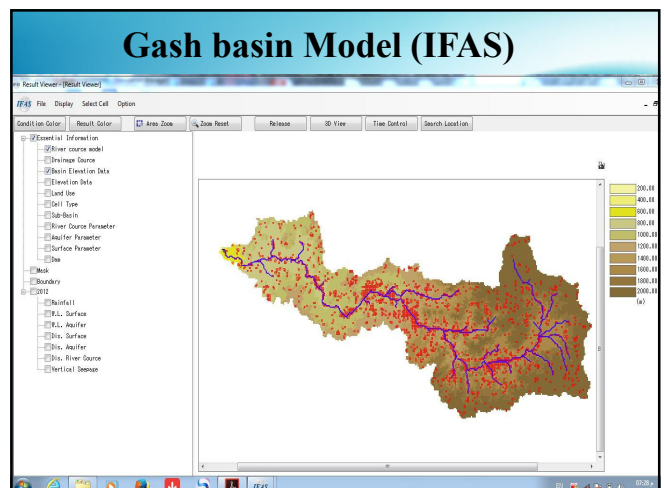


Training and Capacity Building

- Training of five young professionals on Flash Flood Early Warning , RS/GID, Development of Hazard and Risk Mapping , Cairo, 14-20 Dec, 2015.
- Training five young professionals on Flash Flood Remedial measures, Amman, Jordan, 17-20 May 2016.
- Training on Numerical Modelling of Flash Floods, El Gouna, 24th Oct, 2016.



- Models used : IFAS & HEC_HMS .
- Rainfall : Satellite Rainfall Estimates from (Jaxa-Japan Aerospace Exploration Agency GSMaP-NRT) & TRMM (NASA_3B42RT).
- Observed Discharge Data



Most effective IFAS Parameters

Two layer tank model

Surface tank (SNF, surface roughness - Surface flow; SKF, hydraulic conductivity – infiltration, HFMXD Evaporation)

Aquifer tank (AUD, runoff coefficient for overland flow; AGD, runoff coefficient subsurface flow; HCGD, Storage height)

River source (RRID, meander coefficient)

Methods and Parameters used in HEC_HMS

Loss

Transform

Base flow

Routing method

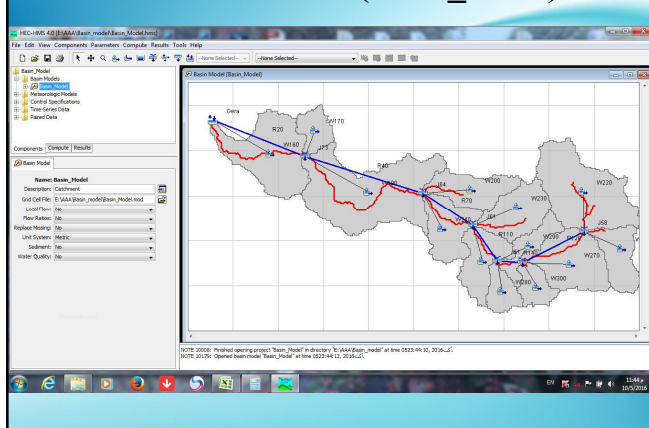
Initial and constant rate

Snyder unit hydrograph

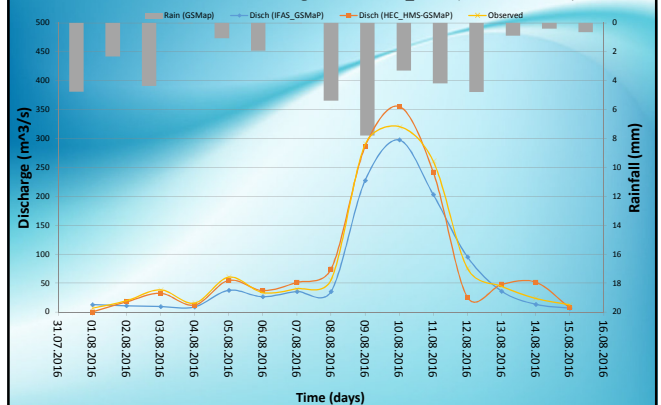
Recession

Muskingum

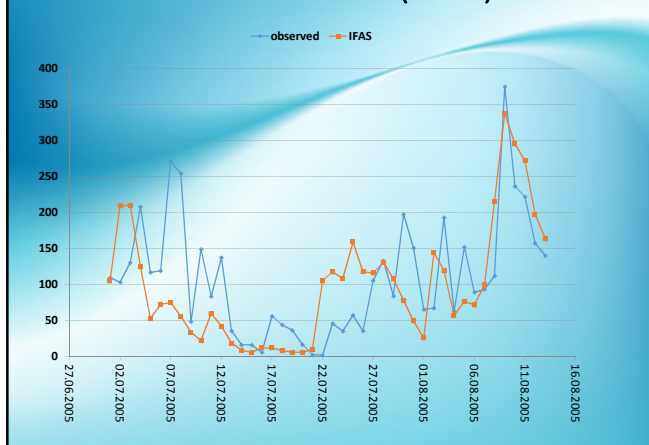
Gash basin Model (HEC_HMS)



Gash Wadi Flow Forecast Using IFAS & HEC_HMS (3B42RT rainfall)



Calibration of IFAS (2005)



Msc in Identification of suitable sites for flood water harvesting and artificial Groundwater Recharge using (RS/GIS)



**THANK
YOU**