Flood Risk Assessment Using Potential Inundation Level and ALOS Images: A Case Study In Kabul River, Pakistan

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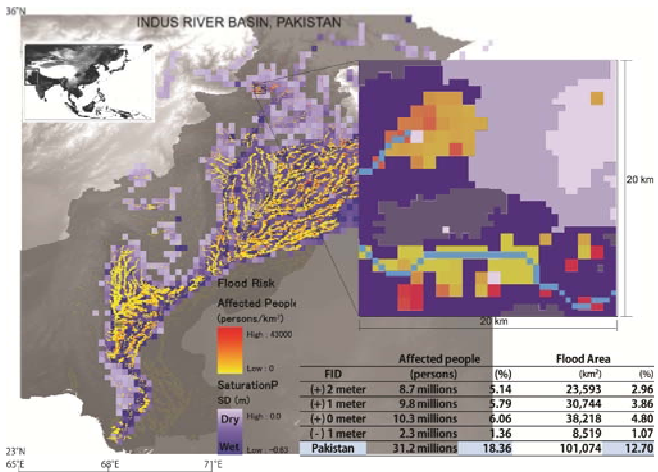
1. Introduction

Large-scale water-related disasters have been more frequent in Asia than the region's annual average because of extreme meteorological events. In complex areas such as large basins there are many factors having negative influence on flooding. Therefore, risk assessment should take into account possible flood scenarios as well as the spatial distribution of potential casualties and damage within areas that might be affected.

2. Study area

The prime research focus area is Kabul river in the Indus River basin, Pakistan



FID	Affected people (persons)	(%)	Flood Area (km²)	(%)
(+)2 meter	8.7 millions	5.14	23,593	2.96
(+)1 meter	9.8 millions	5.79	30,744	3.86
(+)0 meter	10.3 millions	6.06	38,218	4.80
(-)1 meter	2.3 millions	1.36	8,519	1.07
Pakistan	31.2 millions	18.36	101,074	12.70

Length is about 2,900 km, its area is 1,165,500 km²

Latitude : 23°45′N to 36°50′N , Longitude: 60°55′E to 75°30′E

over 20 millions were affected in the Pakistan flood **from late July to early August in 2010**

Research Plan

RISK = HAZARD × Exposure × Social Susceptibility

Vulnerability

- HAZARD: Indicator of extreme statistics of hazard type
- Exposure: Affected by particular event (e.g. people and property)
- Social Susceptibility: A potential social factor which causes exacerbation of the damage

Global Flood Disaster Risk: Indicator of expected disaster damage per capita or area (maximum loss of property and persons affected)

Purpose

✓ To estimate the number of the population and damage potentially affected or caused by flooding with each additional meter of flood inundation level (FIL) H.W.L.

✓ To predict the flood extent of current and future risks based on the huge and severe flood caused by the abnormally heavy rainfall from late July to early August 2010 in Pakistan.

3. Risk analysis methodology

Flood hazard which was composed of extreme discharge in climate change scenarios, saturation deficit (SD) derived from the extreme discharge, and flood inundation area.

$$Hazard_{flood} = f\,(Q_{extreme}, SD, FIL)$$

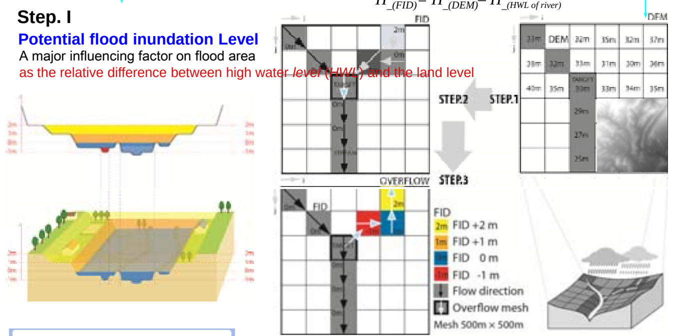
The relative difference between high water *level* (*HWL*) and the land level

$$H_{(FID)} = H_{(DEM)} - H_{(HWL\ of\ river)}$$

Step. I

Potential flood inundation Level

A major influencing factor on flood area as the relative difference between high water *level* (*HWL*) and the land level



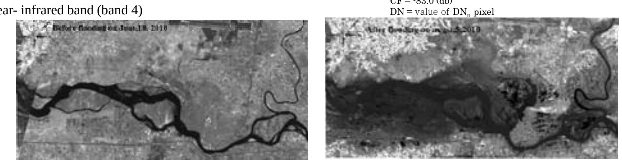
Step. II

Integrated analysis using FID data and ALOS(Advanced Land Observing Satellite) AVNIR2 and PALSAR images

$$\sigma = 10 \times \log_{10} \langle DN^2 \rangle + CF$$

CF = -83.0 (db)
DN = value of DN_n pixel

Near- infrared band (band 4)



ALOS Specification	AVNIR2 1B2	PALSAR HH 100	HydroSHEDs SRTM DEM data.
Observation	June,18.2010 (flood before) August,5.2010 (flood after)		Feb. 2000
Resolution	30m	100m	500m
Transform	WGS84 EGM96		

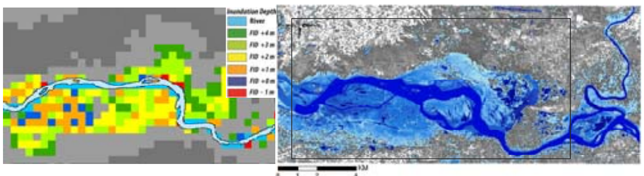
The Advanced Visible and Near Infrared Radiometer type 2 (AVNIR-2)
Phased-Array L-Band Synthetic Aperture Radar (PALSAR)

4. Result

The analysis focused on flood hazard risk, especially expected disaster damage caused by hazard in a given area considering the occurrence probability of the hazard and the vulnerability.

Relationship of potential hazard between flood extent area and inundation level

Potential flood inundation level H(m)	Extent width B(m)	Overflow discharge Q(m/s²)	Observed from a gauge station	
1	831.87	286.66		
2	1122.88	1228.48		
3	1413.89	3040.43	3398	2010.8.5 over flow
4	1904.90	6616.41	6600	PEAK



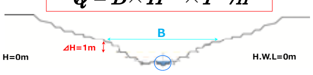
$Q = AV$ Kinematic eq.

$V = 1/n \times R^{2/3} \times I^{1/2}$

$n = 0.04$

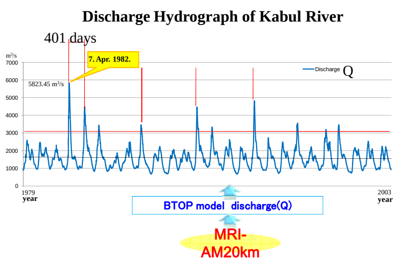
$I = 0.00019$ [5/26281(m)]

$$Q = B \times H^{5/3} \times I^{1/2} / n$$

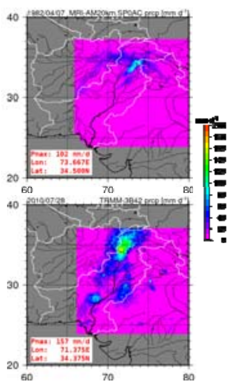


Verification

To estimate extreme discharges based on present



- Simulation Period : 1979 - 2003 (24 years) Present
- Time step : Daily
- Spatial Resolution : 10' = 20km
- Precipitation Products : MRI-AM20km
- Hydrological Model : IFAS-BTOP Stream-flow engine



5. CONCLUSION

Integrated risk analysis was possible to identify inundation areas and predict flood disaster damage caused by a hazard in a given area considering the occurrence probability of the hazard and the vulnerability of the area.

To consider **regional flood risk assessment**, the authors improved accuracy in identification of flood-vulnerable areas and eliminated disparity of flood risk assessment using integrated risk parameters.

Although heavy rain events and typhoons may behave highly unpredictable due to ongoing climate change, this developed approach can be a very useful tool in **emergency response efforts since it can conduct extreme value analysis and predict when and in what size a flooding event may occur**

To improve the proposed assessment to be applicable on a global, as well as national, level.

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