

Space-based Information for Assessing the Community Vulnerability to Flood Disasters in Mountainous Himalayas



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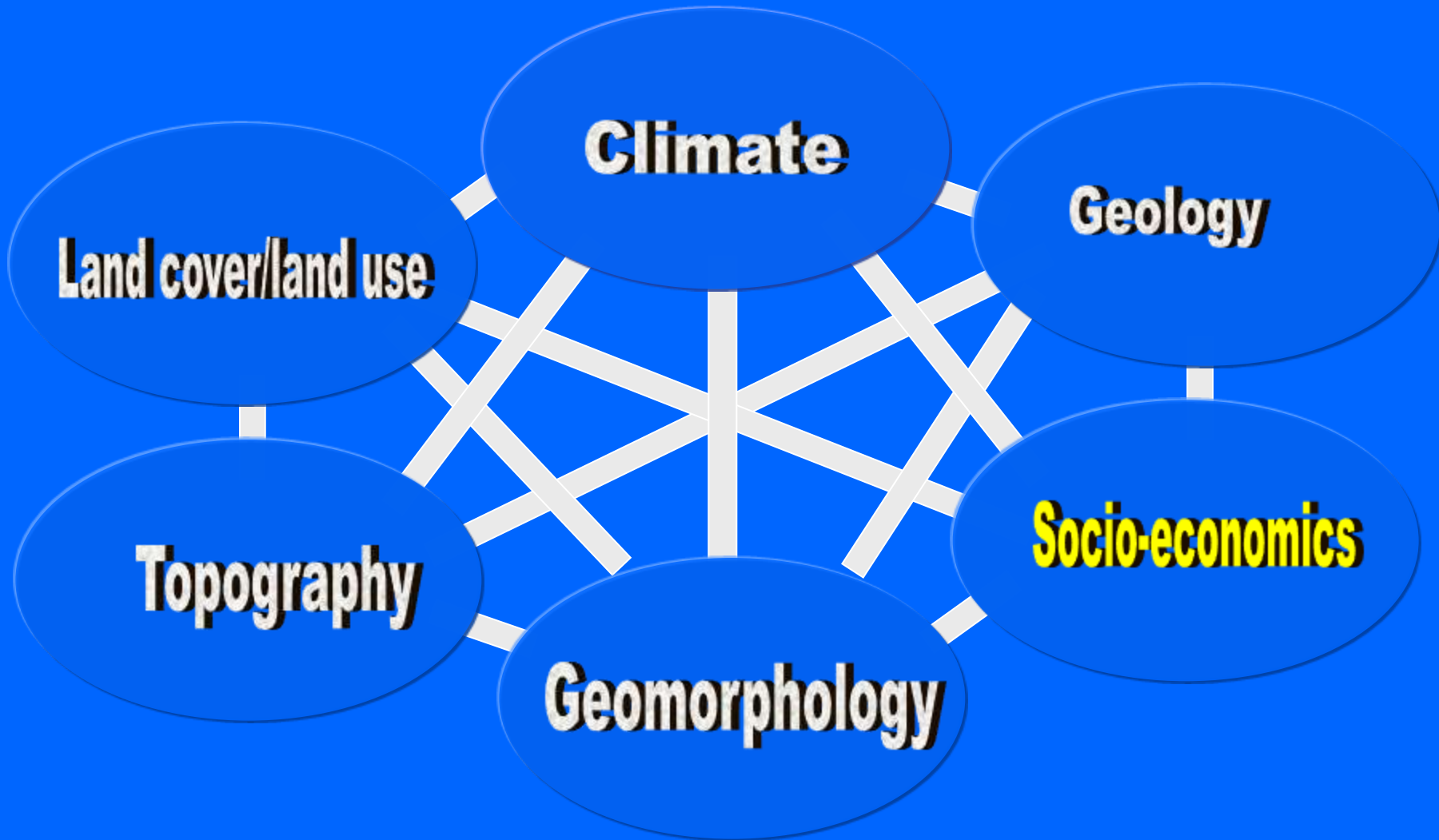
Outline of my Presentation

- ➡ **Introduction**
- ➡ **Flooding: an integrated approach**
- ➡ **Study Area**
- ➡ **Methodology**
- ➡ **Physical Vulnerability analysis**
- ➡ **Social Vulnerability analysis**
- ➡ **CB Flood Disaster Vulnerability Assessment**
- ➡ **Conclusions**

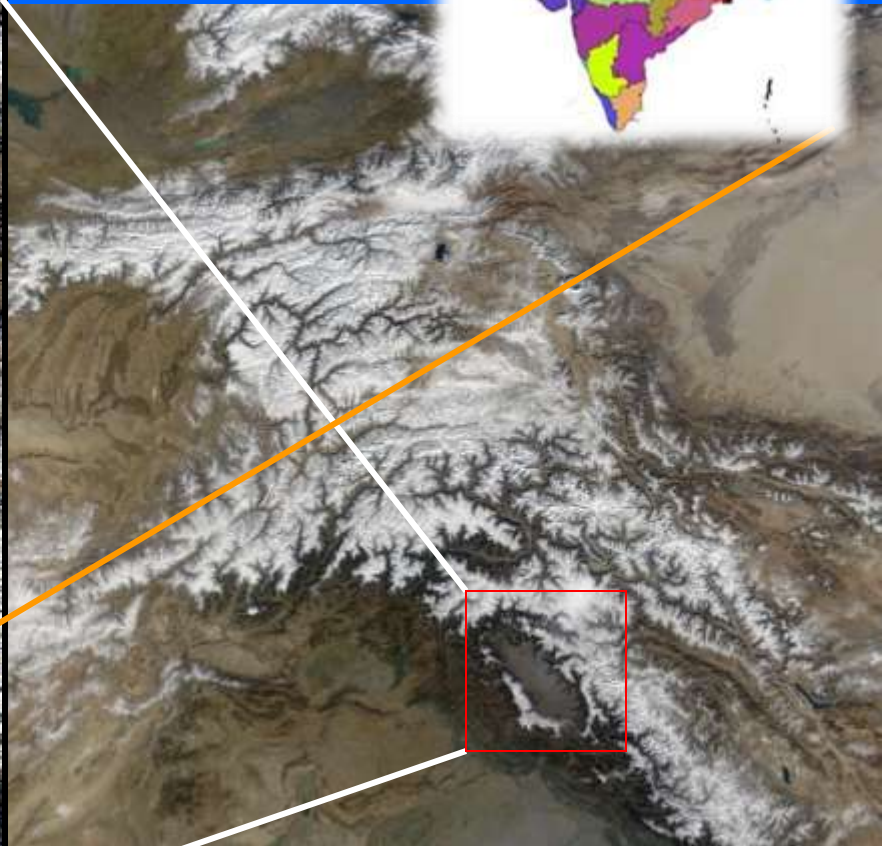
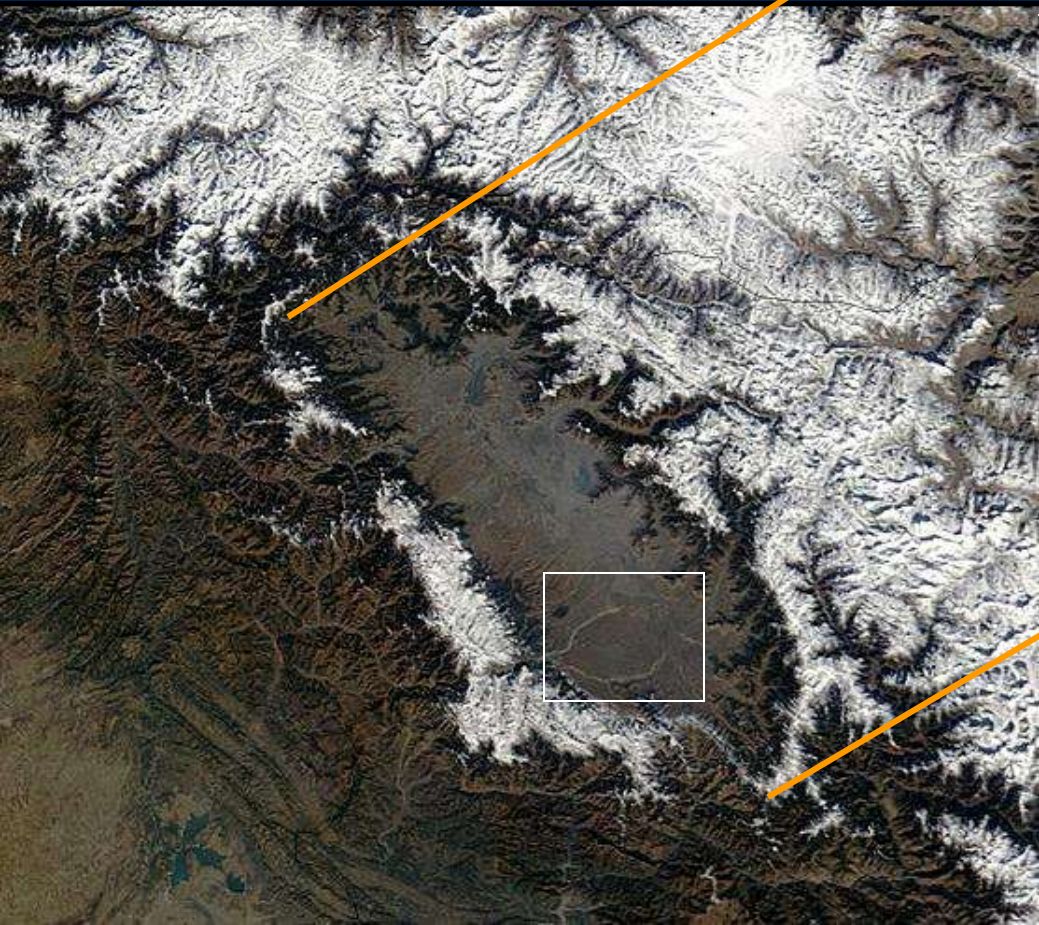
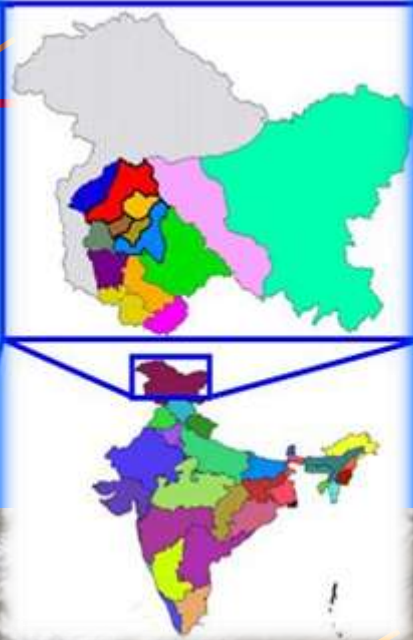
INTRODUCTION

- The consequences of failure to effectively manage the disasters will increase significantly during the 21st century. The entire HKH falls under high disaster risk zone with some disasters occurring more frequently than others with very high environmental, social and economic costs. Floods are the most common and widespread of all natural disasters
- A better understanding of the all the contributing influences is imperative to get a better idea of the mechanisms that contribute to enhanced disaster risk and facilitate DMP for every hazard in the region . Application of Geoinformatics
- CB flood vulnerability assessment has a potential to provide the desired information to bear on the needs of policy makers, particularly at village level for taking effective DRR measures .

FLOOD Disaster Linkages



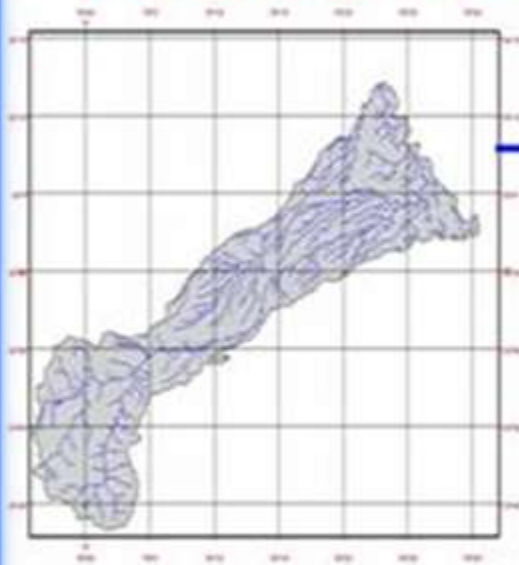
Study Area: Kashmir Himalayas



STUDY AREA

Jhelum Basin (UI Basin), J &K, India

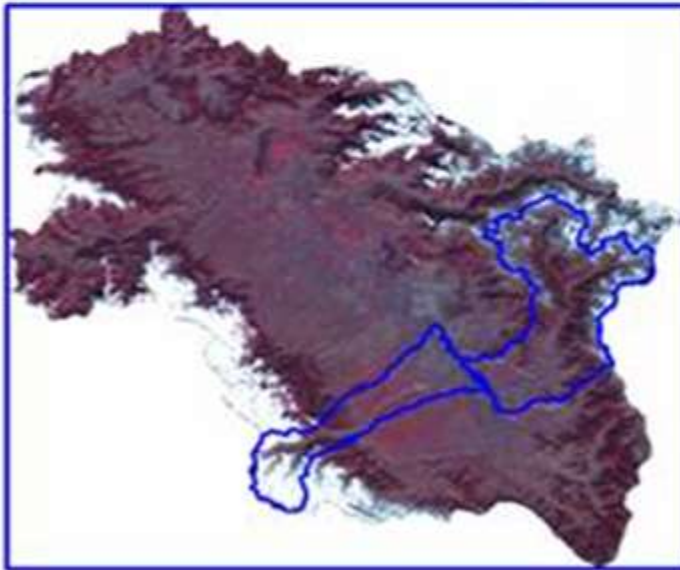
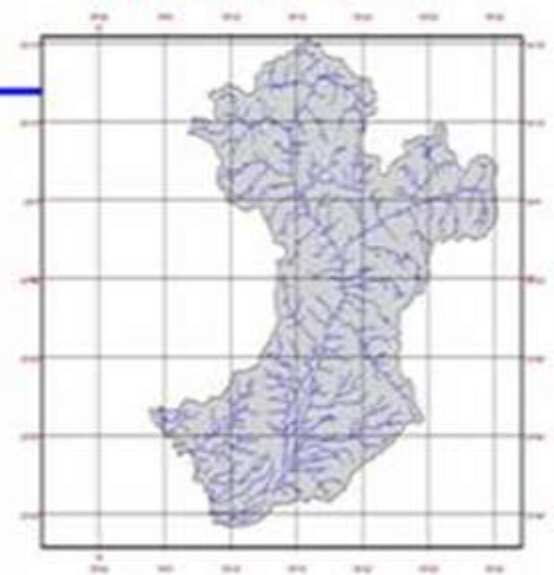
REMBIARA CATCHMENT



JHELUM BASIN



LIDDER CATCHMENT



Methodology : Flood Vulnerability Analyses

Digital Elevation Model

Satellite Data

Socio-economic Data

**Surface
Analyses**

**Fluvio-
Geomorphological,
Wetlands**

**Land use/Land cover
Mapping**

**Topographical
Attributes**

**Multi-criteria
analysis**

**Flood Simulation
Modelling (MoDWatFlo)**

**Hydro-met &
Field Observation**

**Physical Flood
Vulnerability**

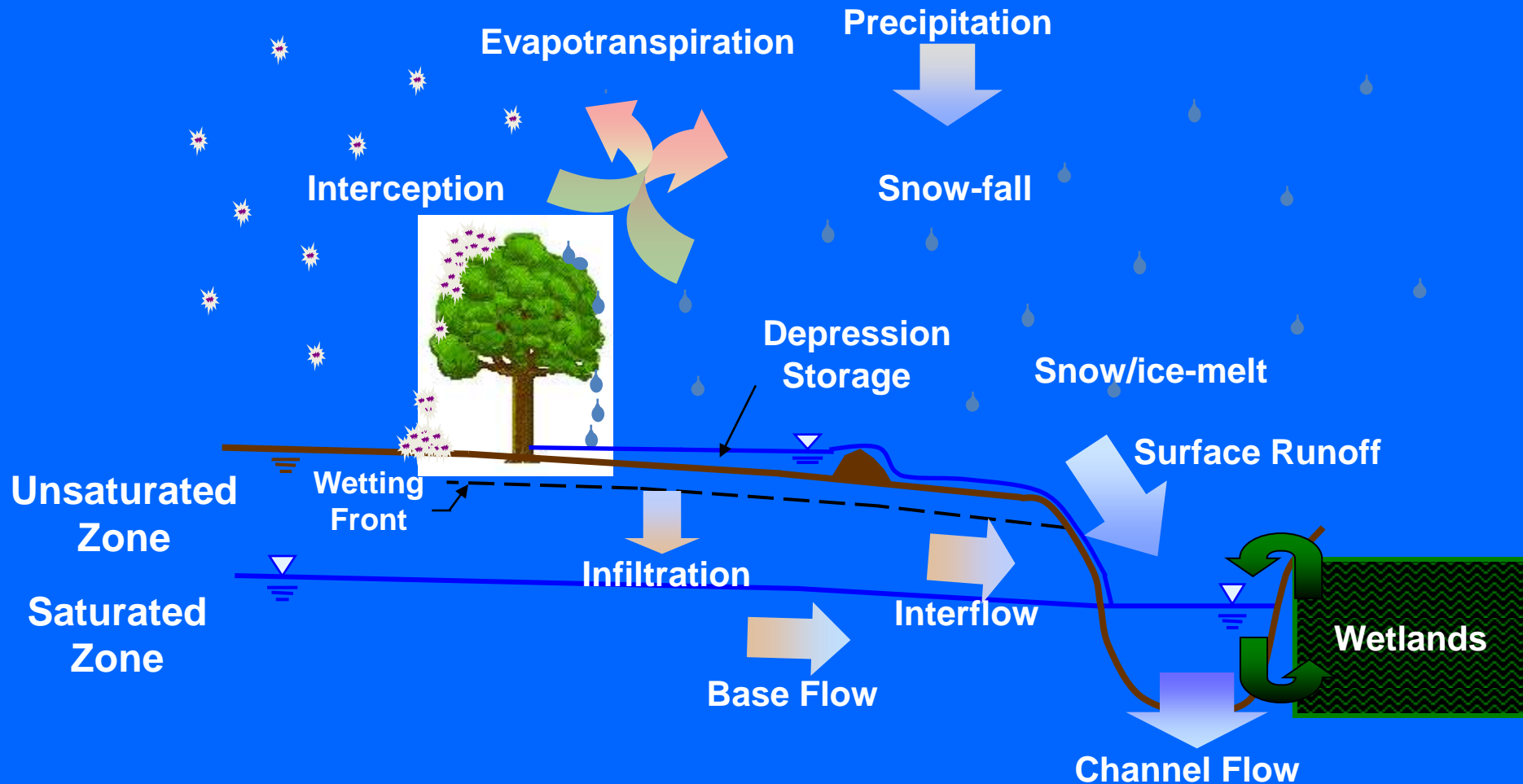
Geospatial Analysis

**Social
Vulnerability**

Flood hazard Zonation

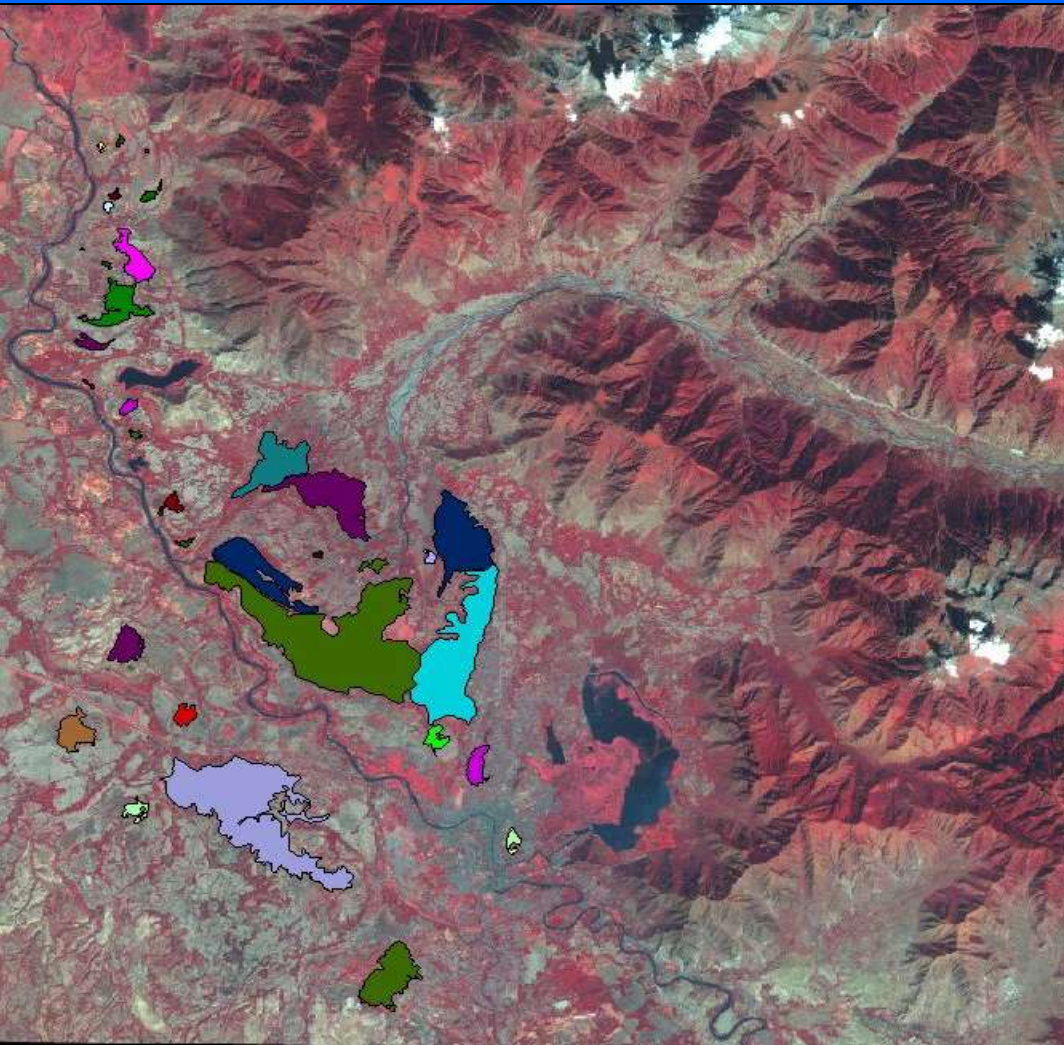
Hydrological Model (ModWatFlo)

Other than very common Runoff Routing and Channel Routing, the Flood simulation Model has Wetland Routing and Snow/Ice melt Runoff Routing as well



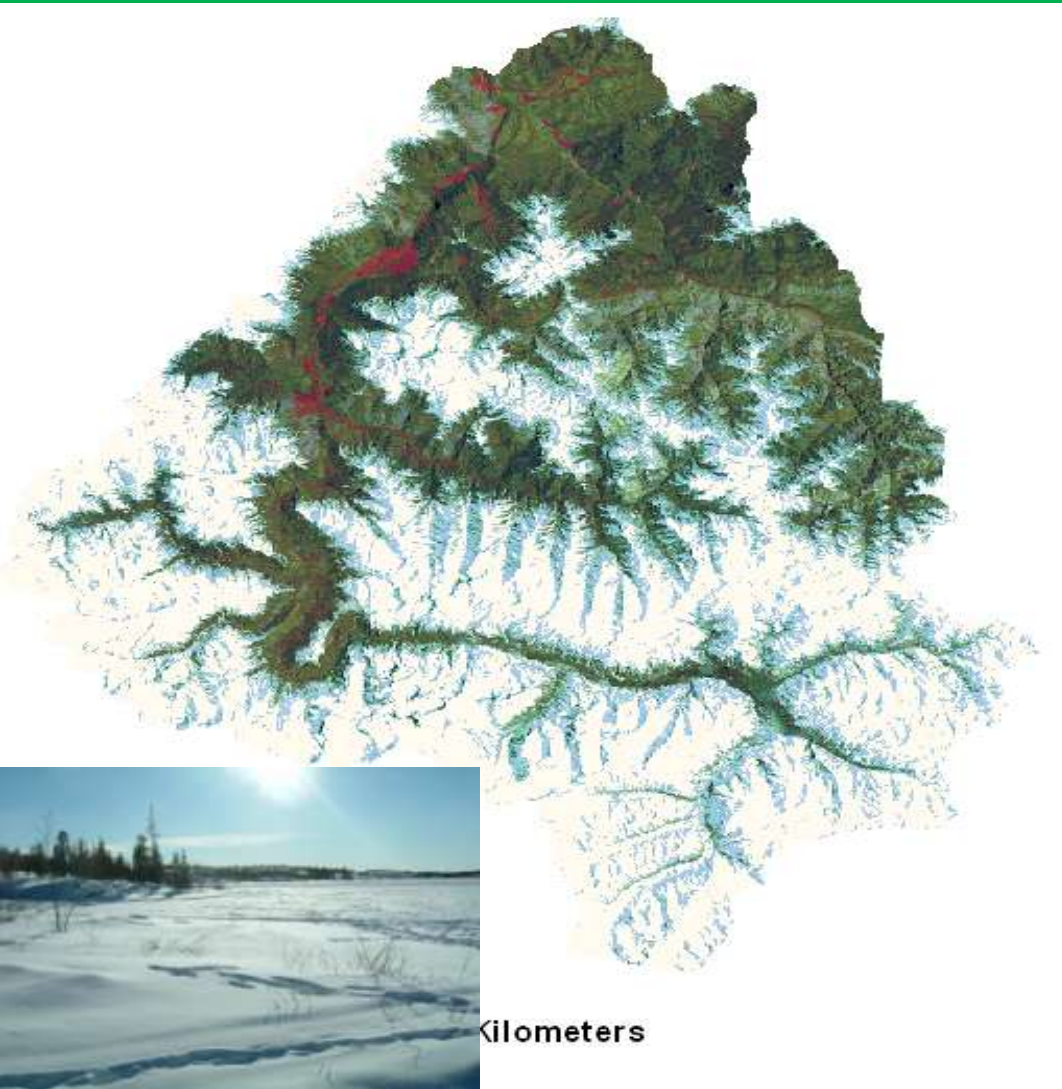
Appropriate Model For Flood Simulatin

There are >6000 wetlands/water bodies in the J&K State & for accurate wetland simulation, Wetland Routing has to be included in the Model

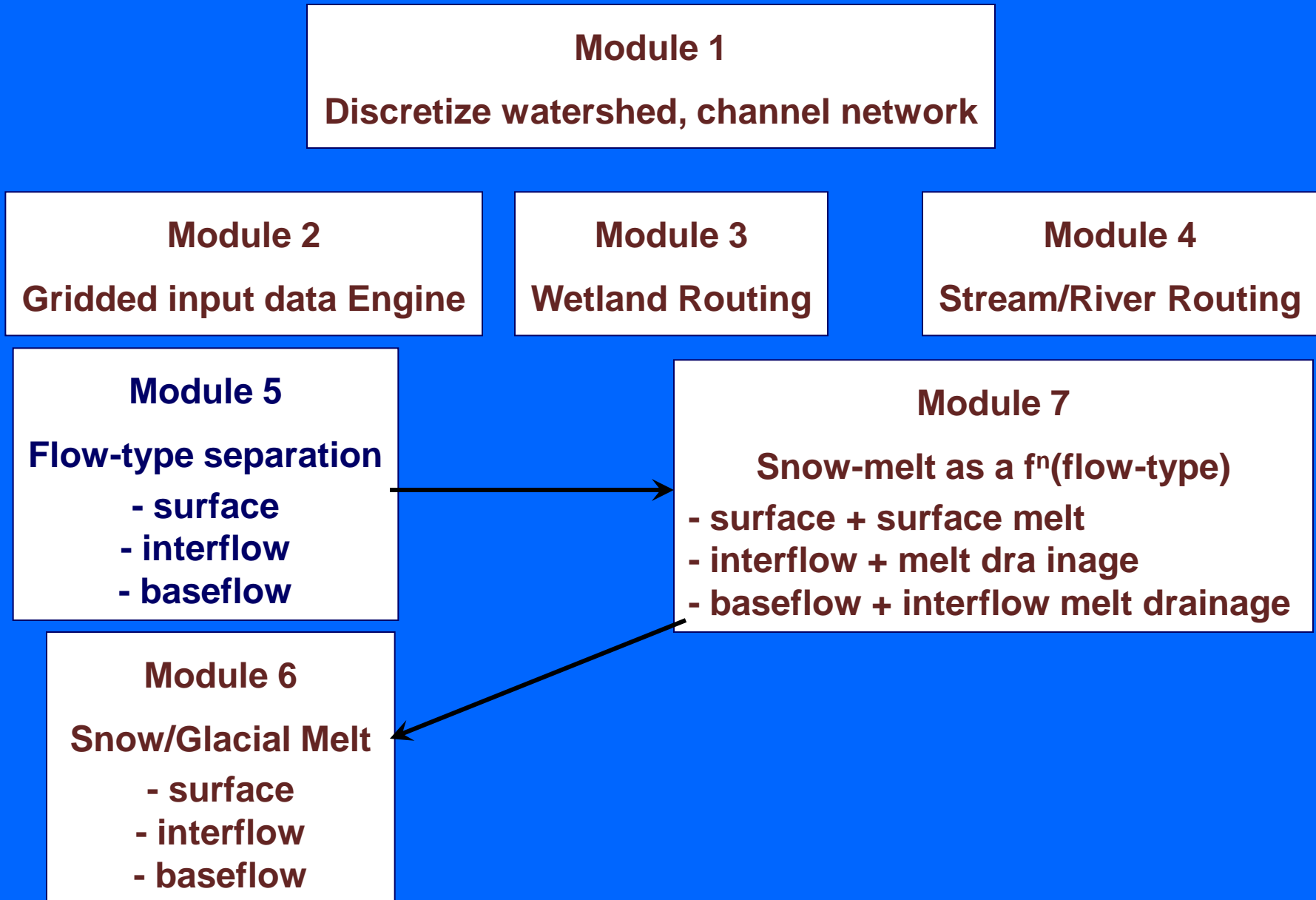


Importance of Snow & Glaciers in Flooding

The study area receives snow during winter and the snow and ice melt forms an appreciable proportion of the surface runoff all over the year



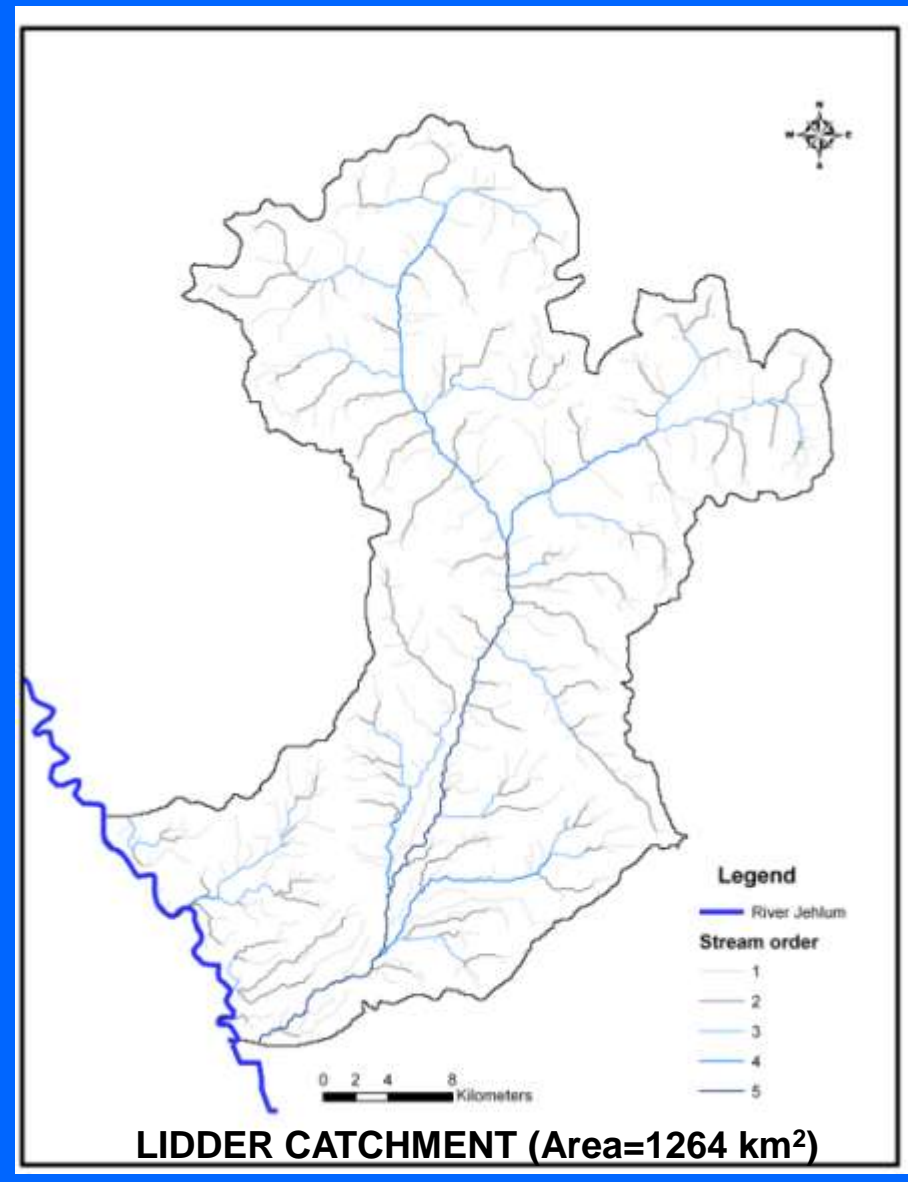
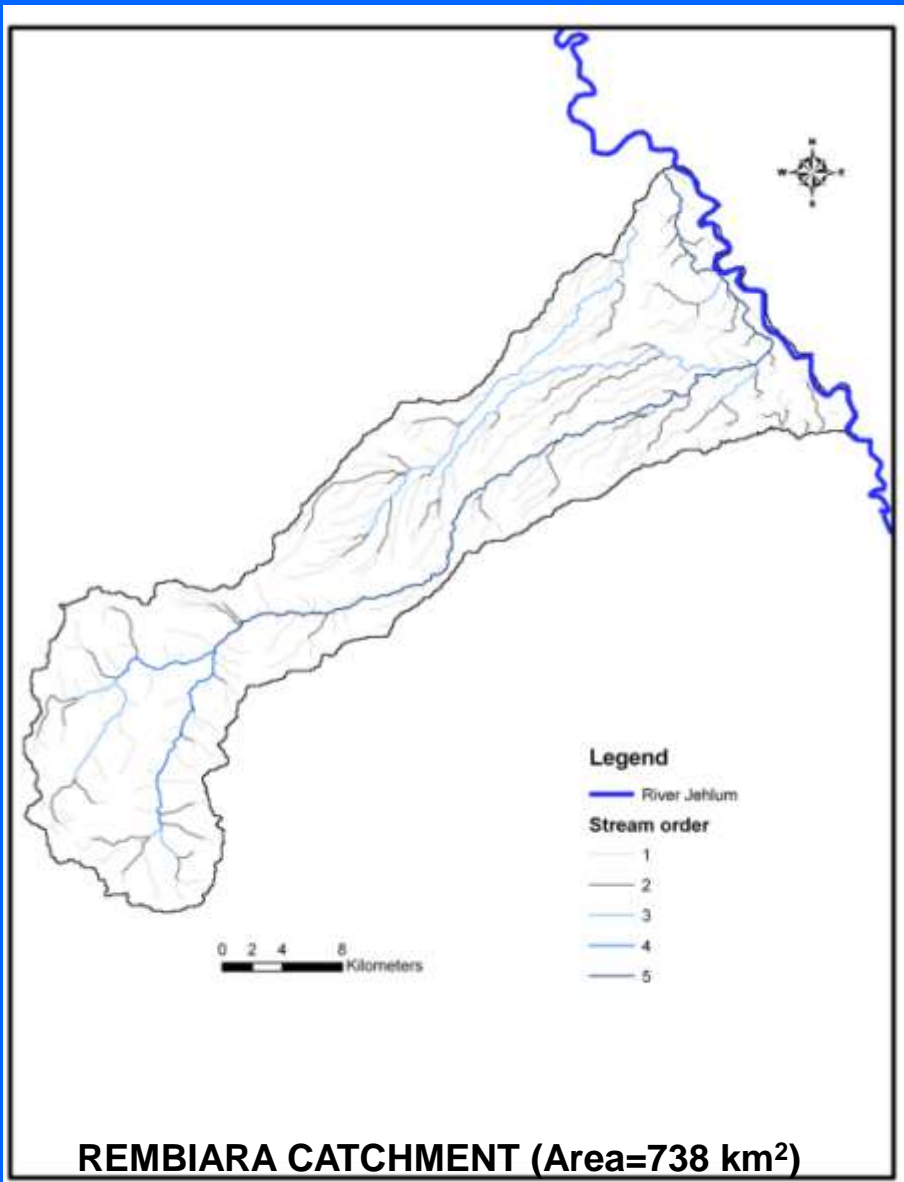
Module Components



Ground Truth/Field Studies

Most of the Study area is inaccessible & topographically precipitous

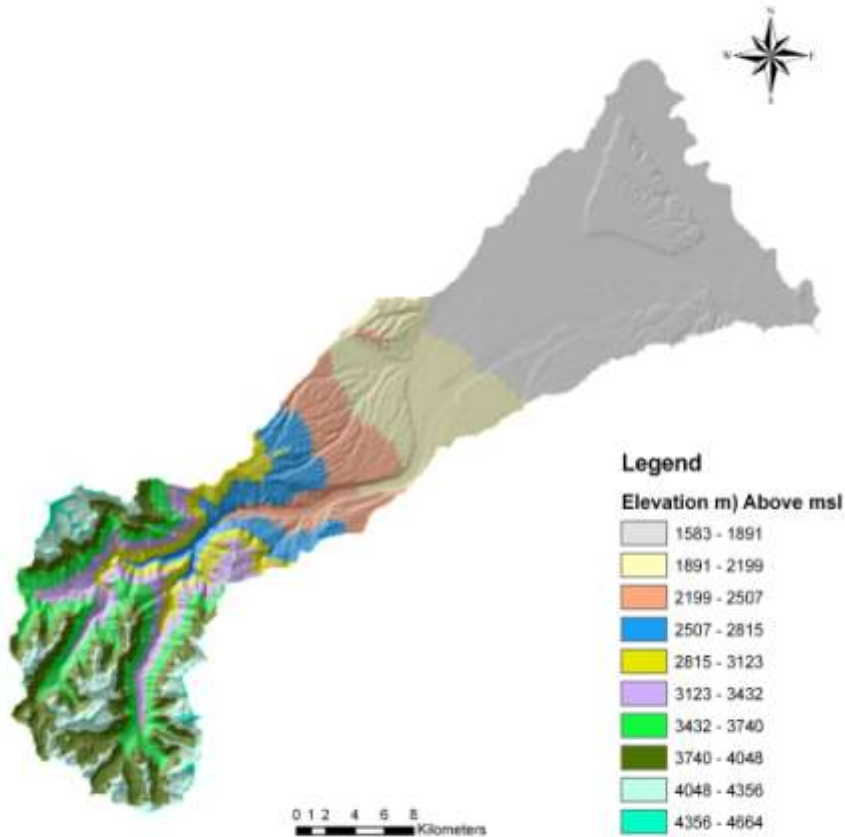




Drainage maps of Rembiara and Lidder catchments with stream ordering

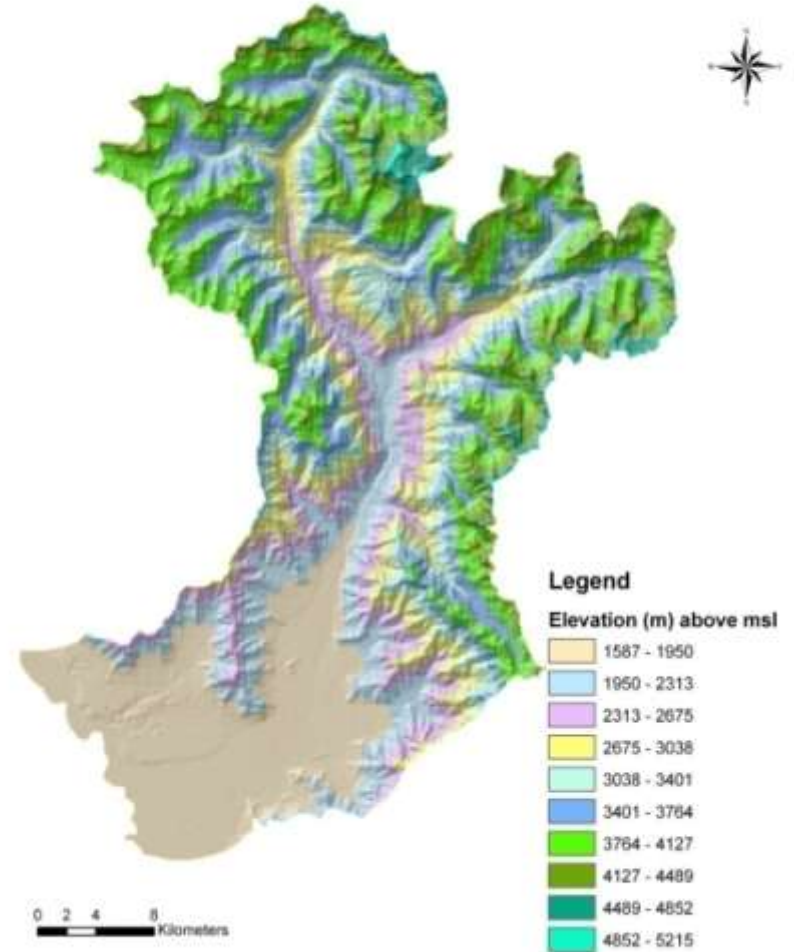
Topographic Data

Elevation Map



REMBIARA CATCHMENT

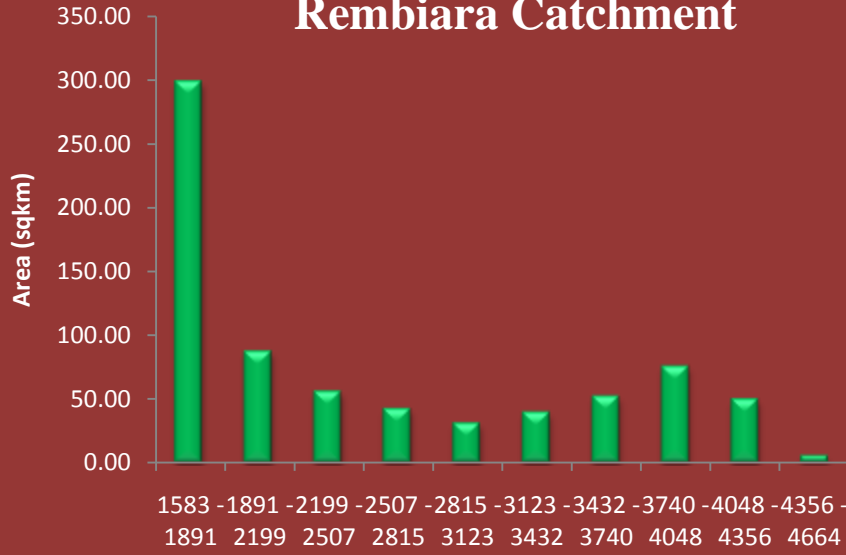
Elevation Map



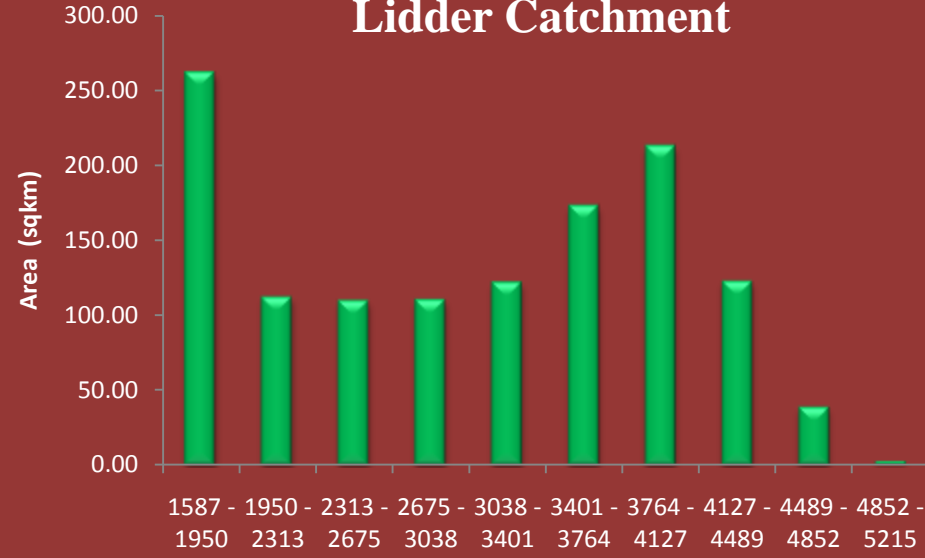
LIDDER CATCHMENT

Area Elevation Comparison

Rembiara Catchment



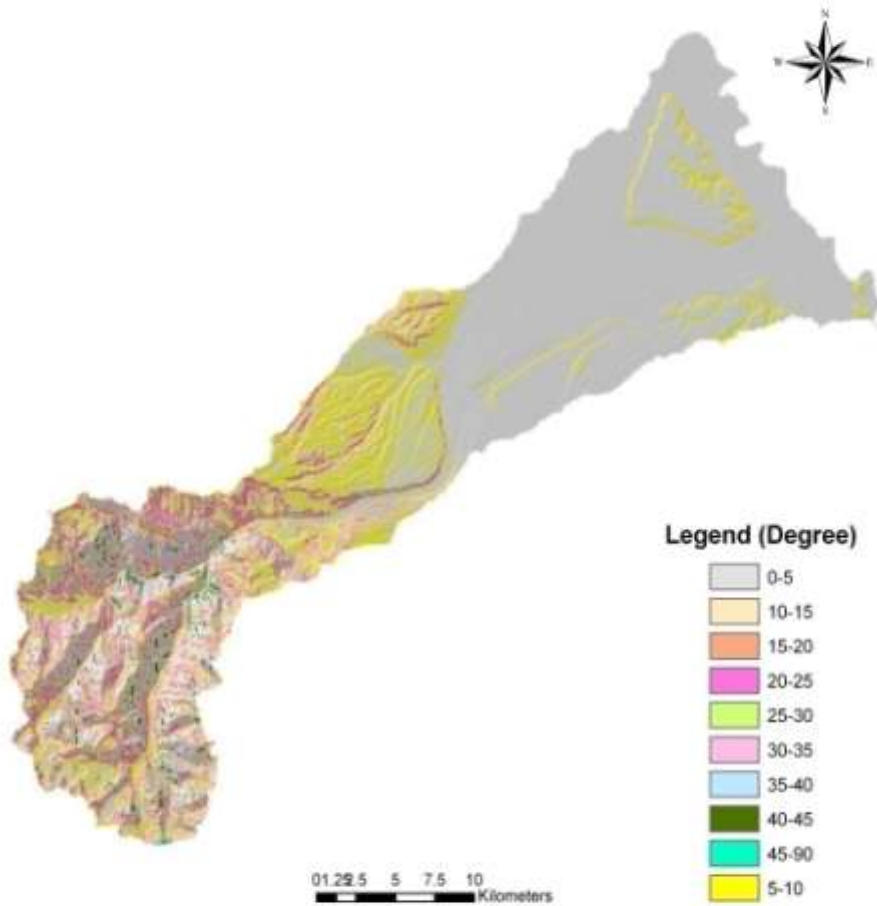
Lidder Catchment



Elevation (m) Rembiara Catchment	Area (km ²)	Elevation (m) Lidder Catchment	Area (km ²)
1583 - 1891	298.59	1587 - 1950	261.30
1891 - 2199	87.42	1950 - 2313	112.01
2199 - 2507	55.87	2313 - 2675	109.52
2507 - 2815	42.53	2675 - 3038	110.24
2815 - 3123	31.20	3038 - 3401	121.81
3123 - 3432	39.67	3401 - 3764	172.70
3432 - 3740	52.27	3764 - 4127	212.44
3740 - 4048	75.53	4127 - 4489	122.51
4048 - 4356	49.91	4489 - 4852	38.87
4356 - 4664	5.46	4852 - 5215	2.60

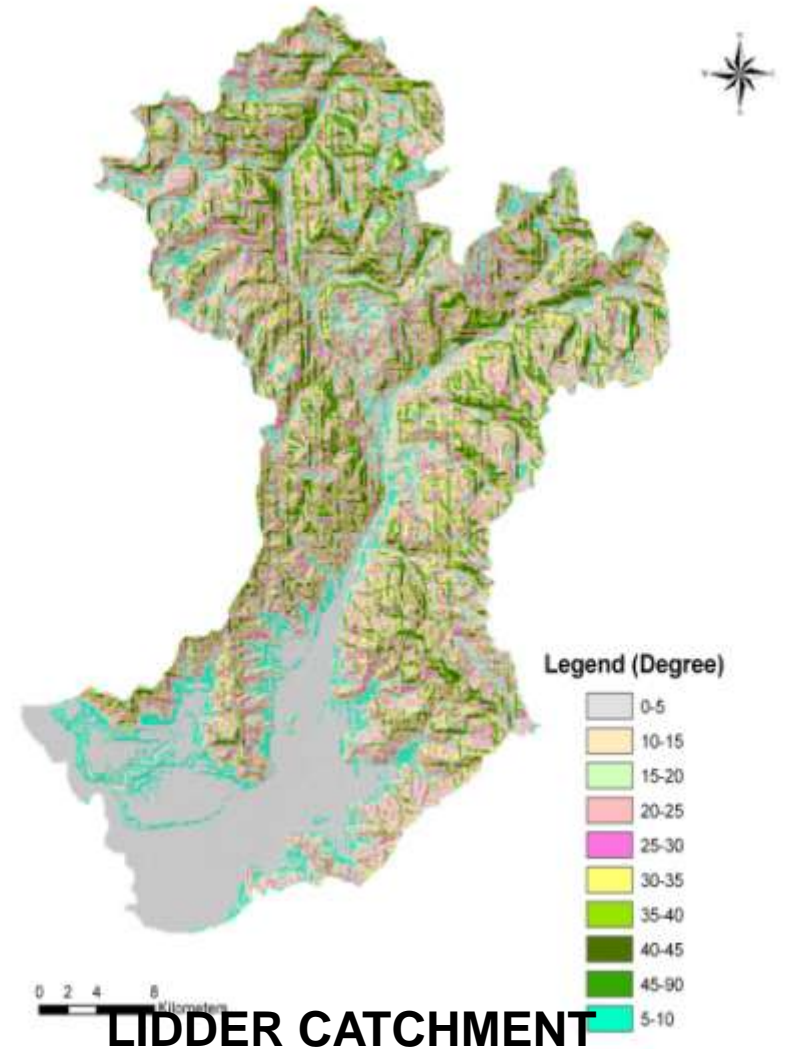
Slope Analysis

Slope Map



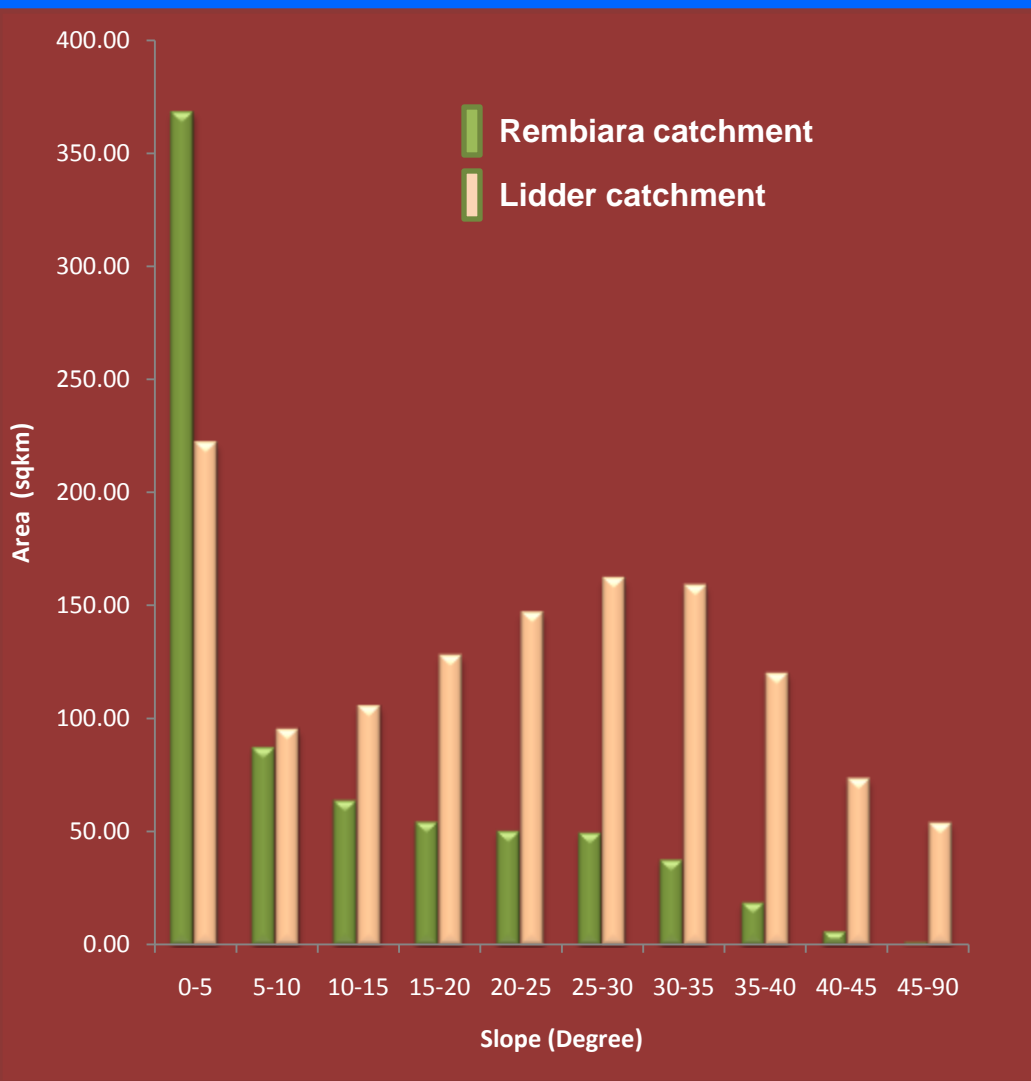
REMBIARA CATCHMENT

Slope Map



LIDDER CATCHMENT

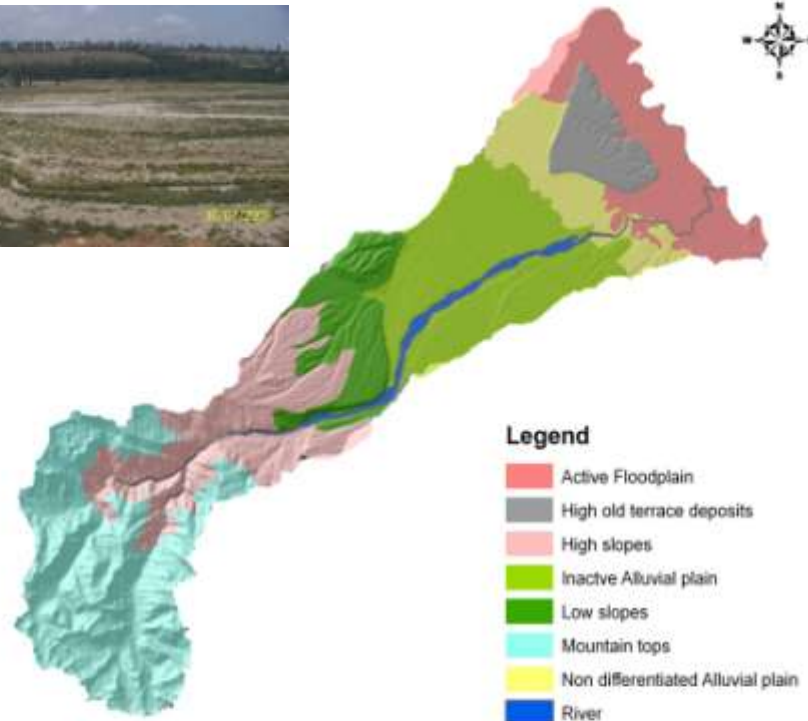
Slope Area Comparison



Slope (Degree)	Area (km ²) Rembiara	Area (km ²) Lidder
0-5	368.23	221.45
5-10	87.50	95.09
10-15	63.97	105.48
15-20	54.55	127.69
20-25	50.46	146.60
25-30	49.72	161.82
30-35	37.83	158.62
35-40	18.82	119.81
40-45	6.13	73.48
45-90	1.25	53.96

Geomorphological Maps

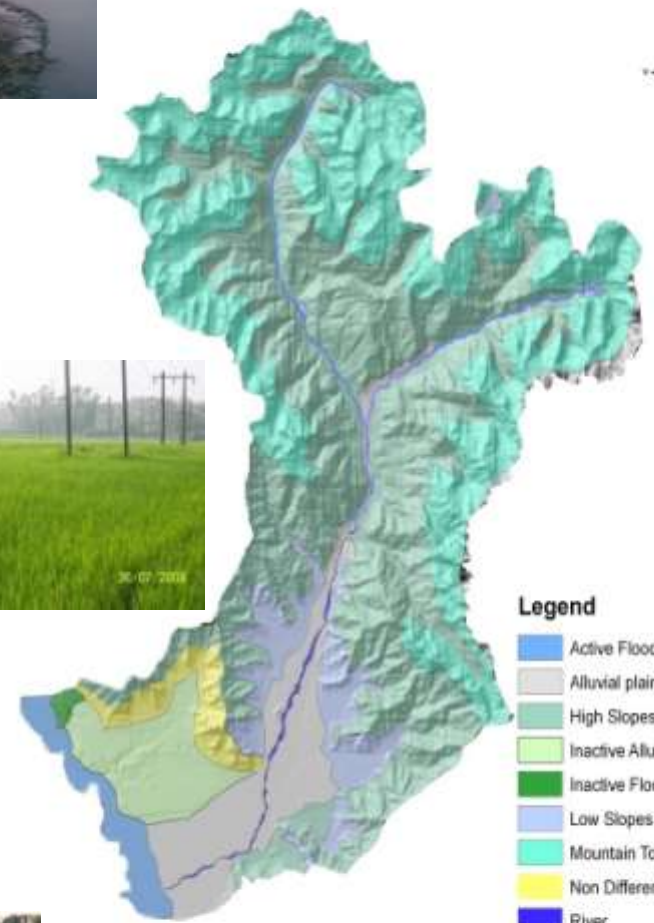
Rembiara Catchment



0 1 2 4 8 8 Kilometers



Lidder Catchment



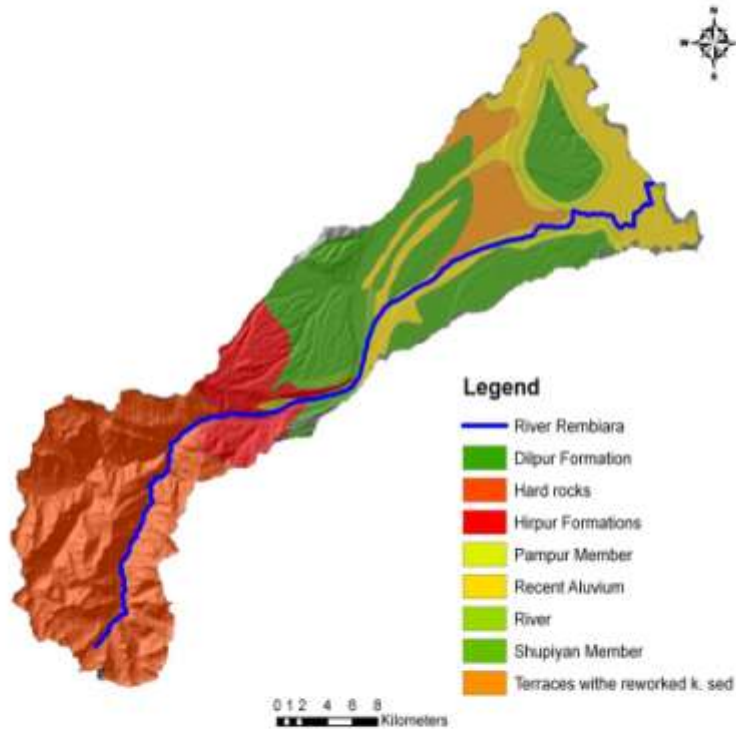
0 2 4 8 Kilometers

Fluvial – Geomorphological Units

Rembiara Catchment		Lidder Catchment	
Geomorphic Units	Area%	Geomorphic Units	Area%
Inactive Alluvial plain	19.69	Inactive Alluvium Plain	13.59
Low slopes	8.68	Low Slopes	7.16
Non differentiated Alluvial plain	6.79	Non differentiated Uplands	2.87
Mountain tops	26.91	Mountain Tops	31.83
High slopes	16.85	High Slopes	41.42
Active Floodplain	12.75	Active Flood Plain	2.43
River	2.23	River/ Water body	0.42
High old terrace deposits	6.10	Inactive Flood Plain	0.28

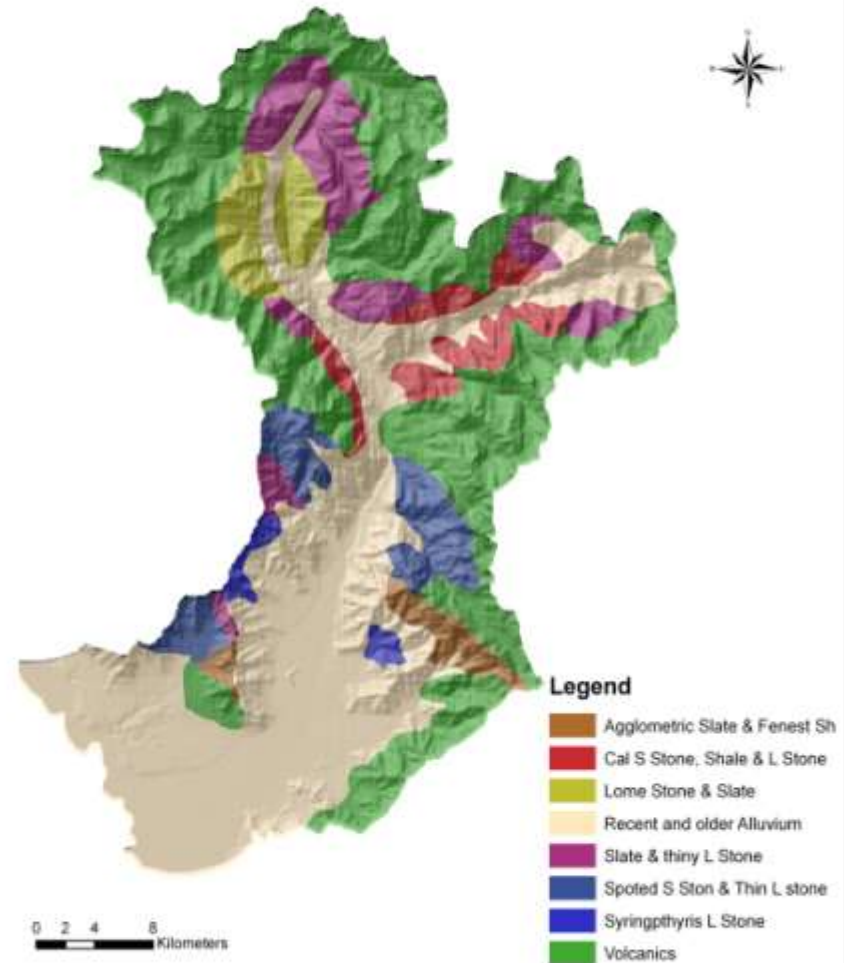
Geological Maps

Rembiara Catchment



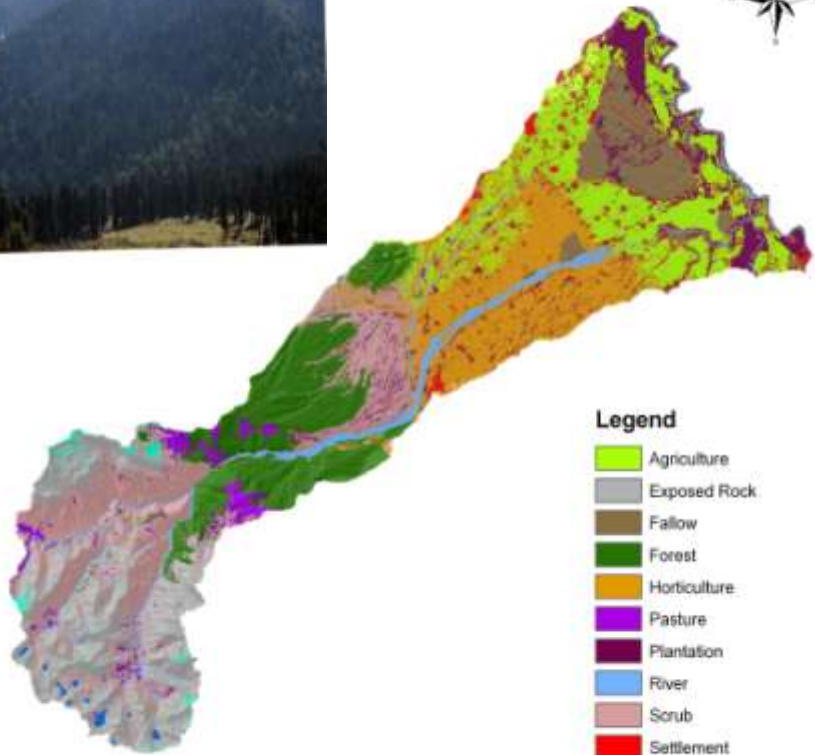
Modified After D K Bhat

Lidder Catchment



Modified after V. J. Gupta

Rembiara Catchment



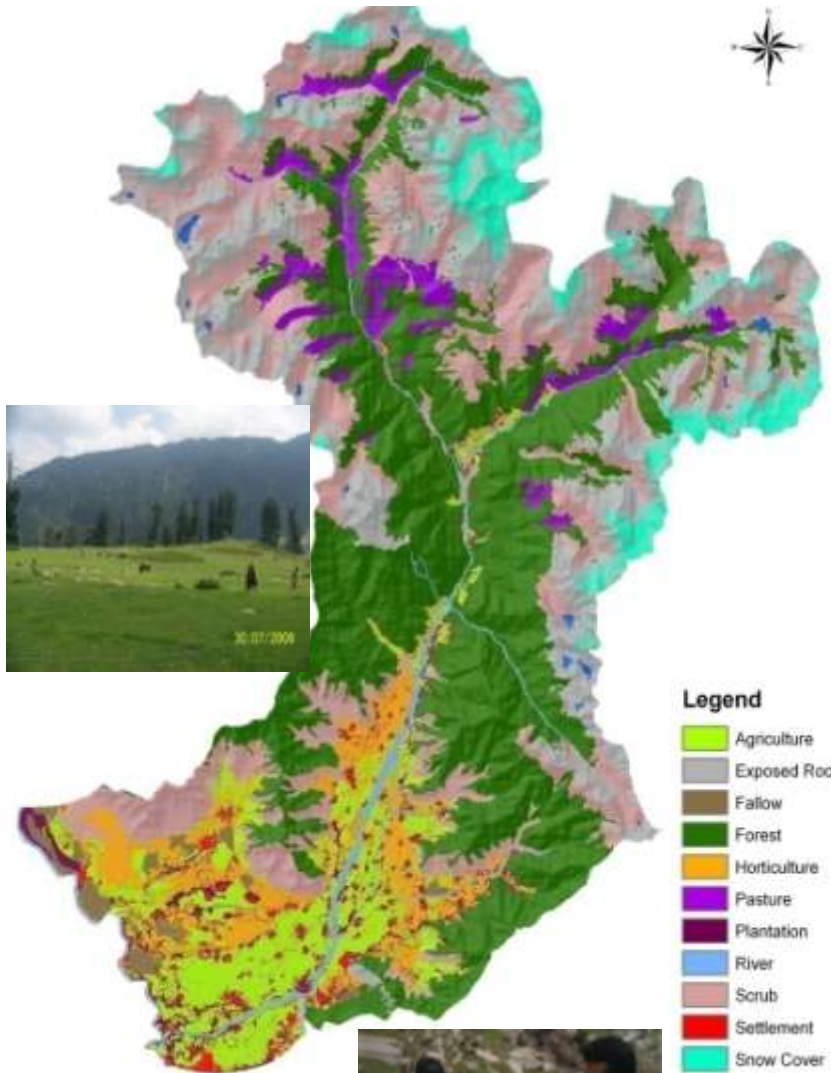
Legend

- Agriculture
- Exposed Rock
- Fallow
- Forest
- Horticulture
- Pasture
- Plantation
- River
- Scrub
- Settlement
- Snow Cover
- Water Body

0 1 2 4 6 8 Kilometers



Lidder Catchment



Legend

- Agriculture
- Exposed Rock
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0 2 4 8 Kilometers

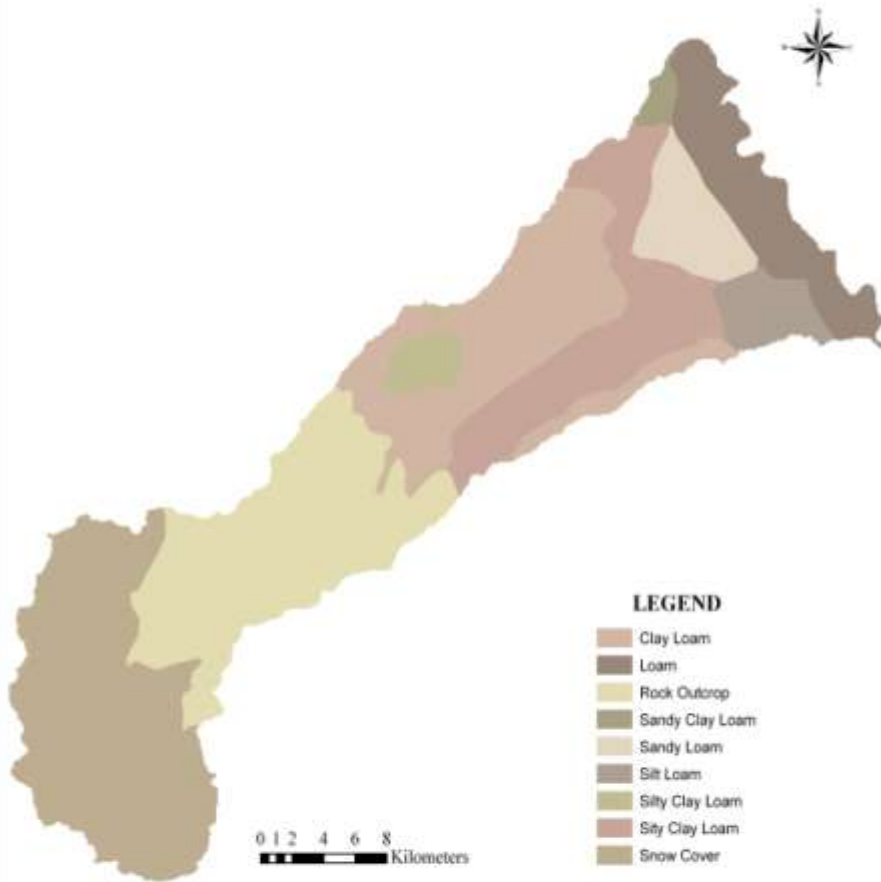


LAND USE / LAND COVER DISTRIBUTION

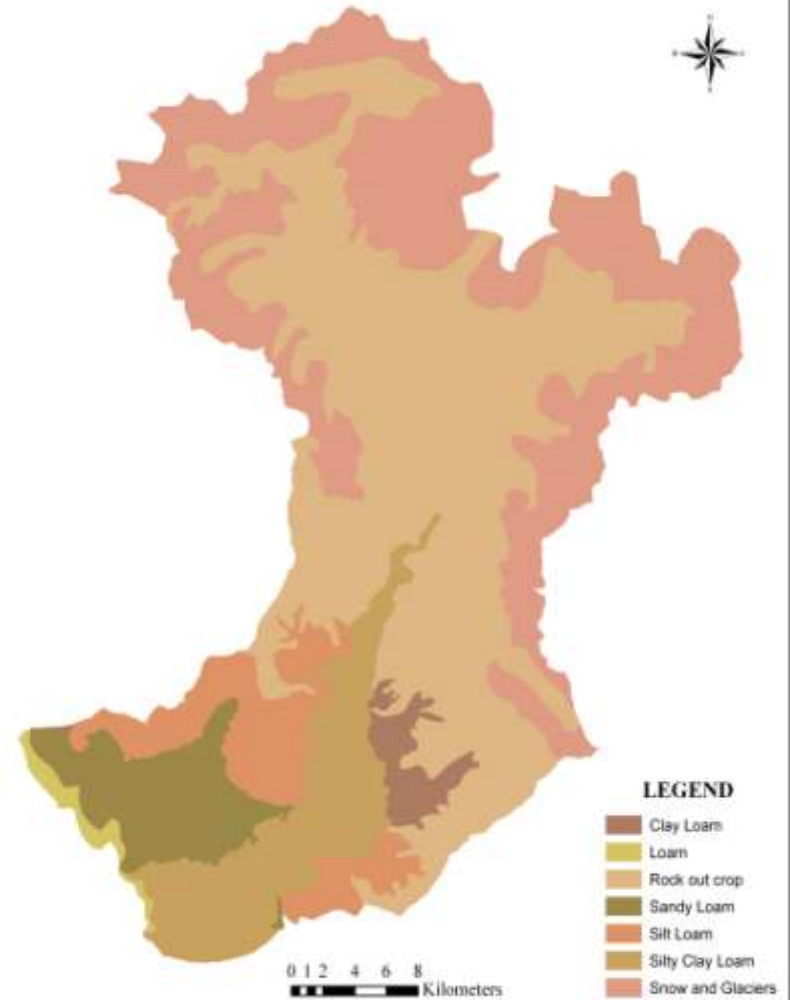
LIDDER CATCHMENT			REMBIARA CATCHMENT	
CLASS	AREA (km ²)	AREA %	AREA(km ²)	AREA %
Exposed Rock	223.55	17.69	123.35	16.71
Water Body	3.88	0.31	1.90	0.26
Settlement	7.20	0.57	7.93	1.07
Horticulture	76.49	6.05	121.45	16.46
Agriculture	96.72	7.65	102.11	13.84
Scrub	259.82	20.56	120.00	16.26
Pasture	41.44	3.28	15.24	2.07
River	20.23	1.60	28.83	3.91
Fallow	14.54	1.15	43.38	5.88
Plantation	37.48	2.97	63.89	8.66
Snow Cover	55.98	4.43	4.23	0.57
Forest	426.77	33.76	105.69	14.32

SOIL MAPS

Rembiara Catchment

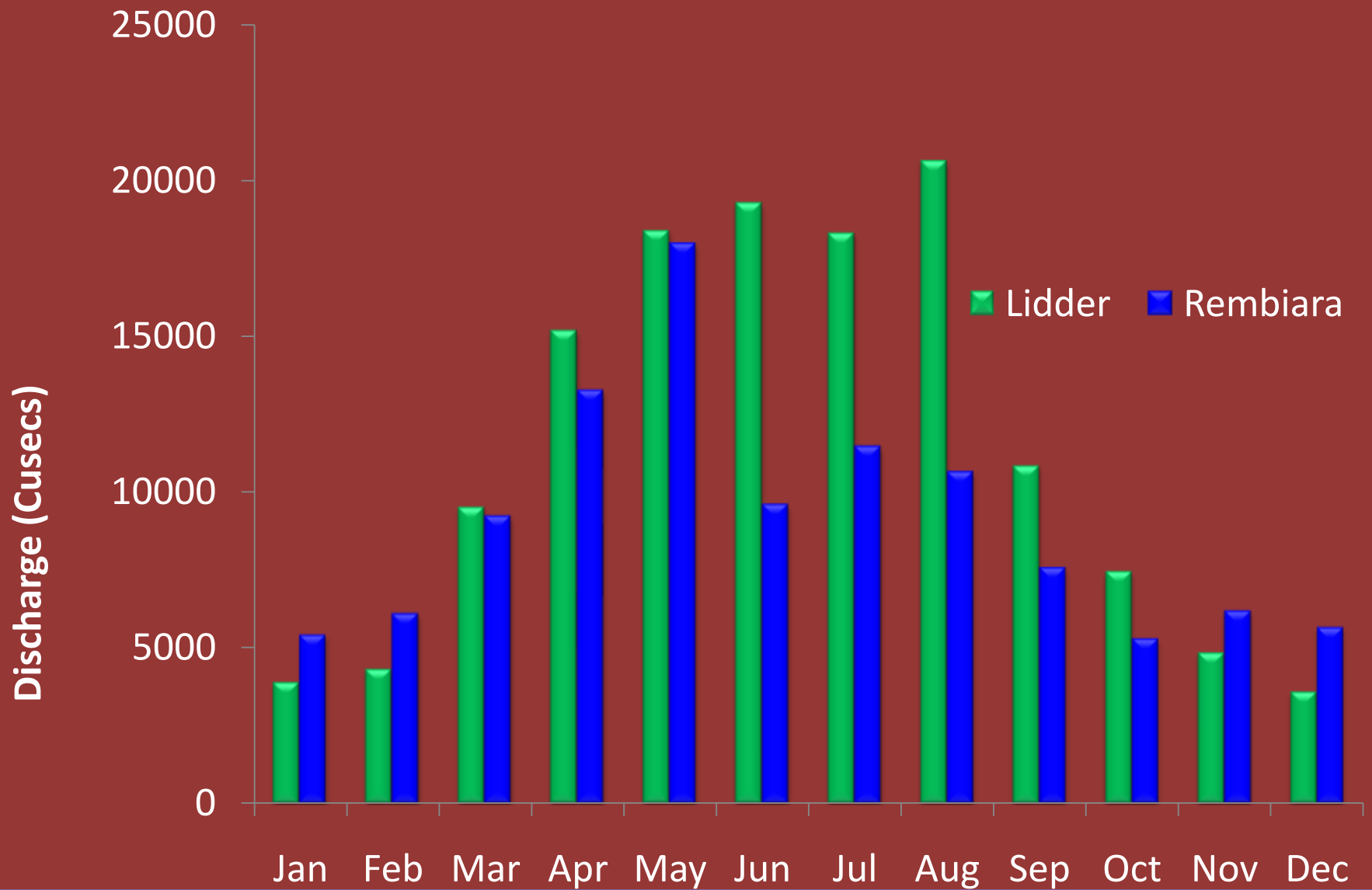


Lidder Catchment

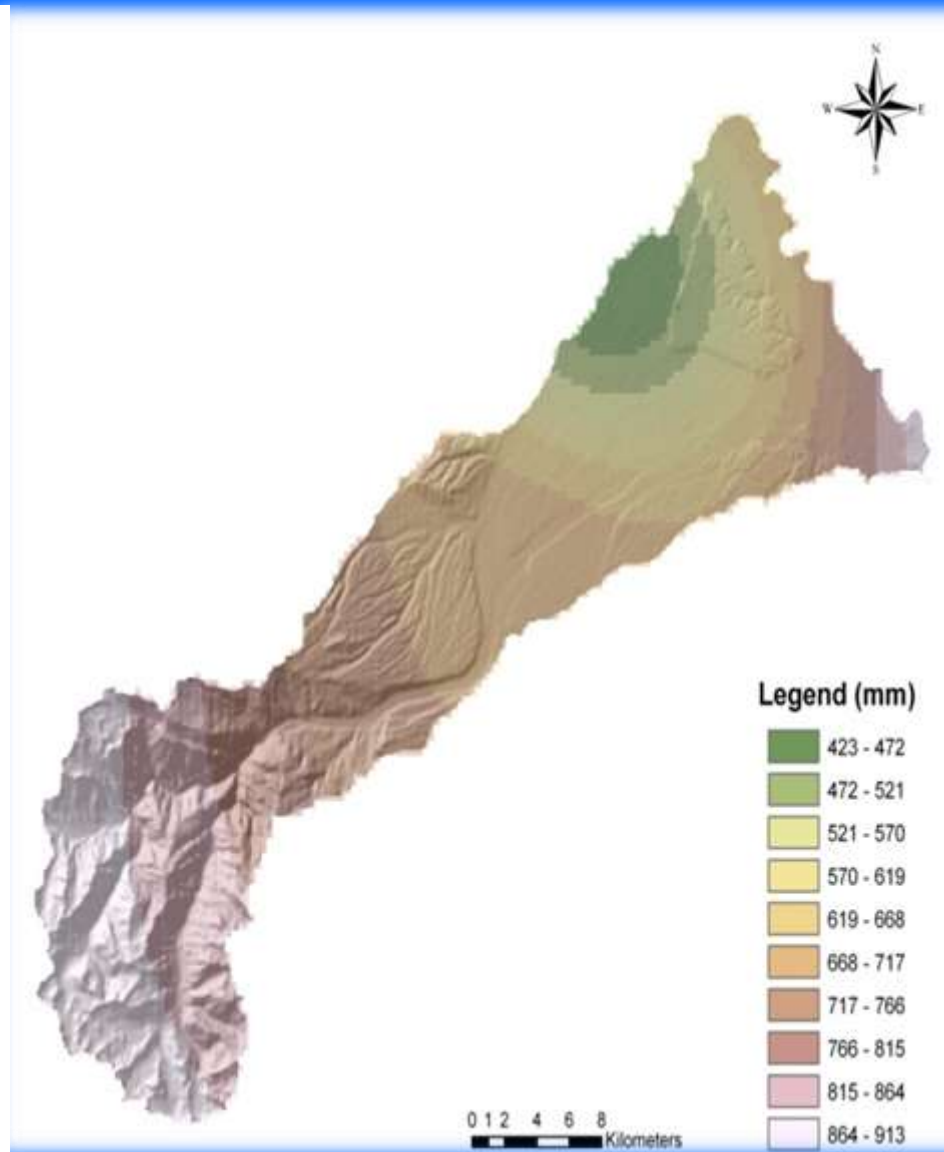
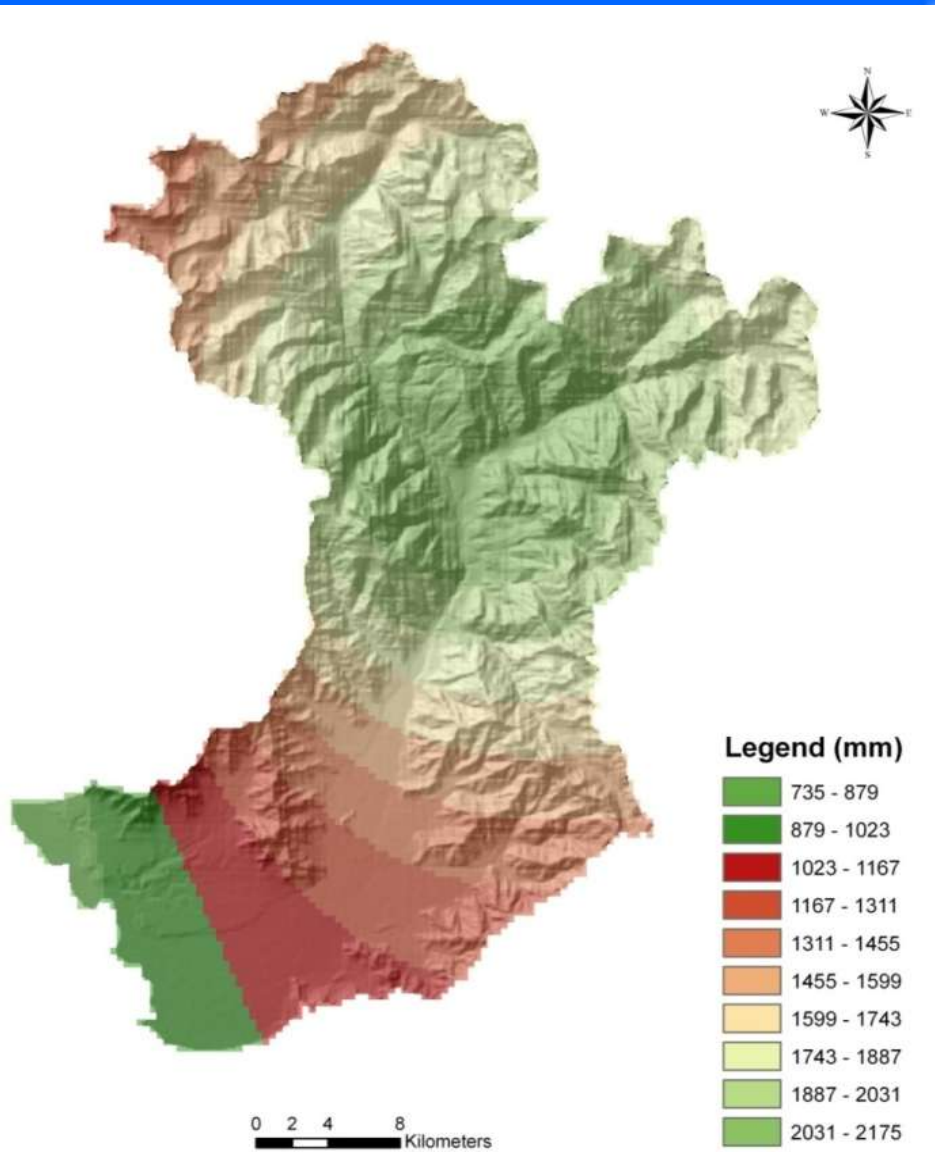


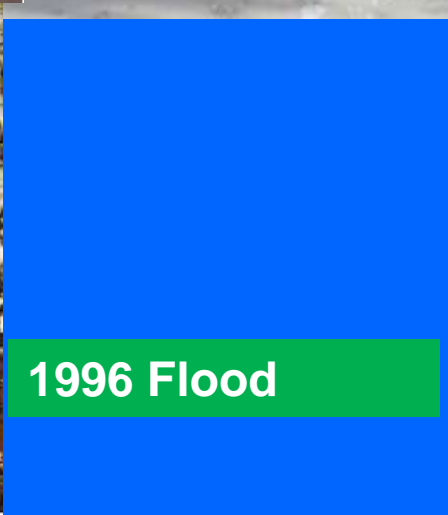
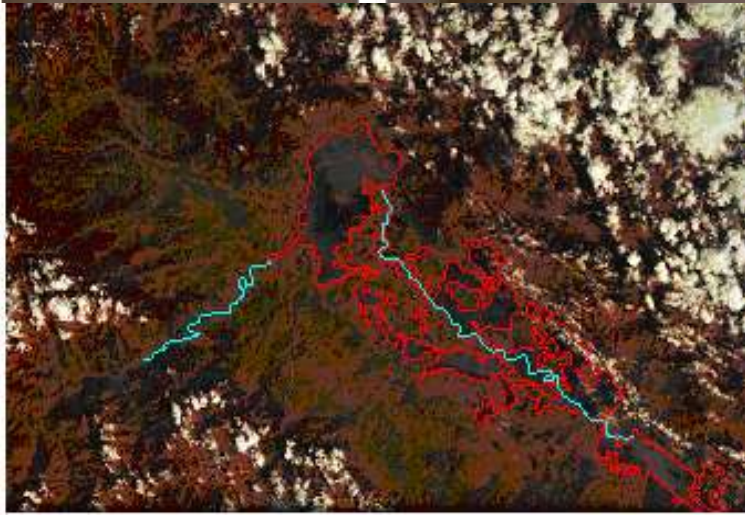
Rembiara catchment			Lidder catchment		
<i>Soil type</i>	<i>Area (km²)</i>	<i>% Area</i>	<i>Soil type</i>	<i>Area (km²)</i>	<i>% Area</i>
Clay Loam	137.10	18.58	Clay Loam	26.26	2.08
Silty Clay Loam	113.36	15.36	Silty Clay Loam	125.01	9.89
Sandy Clay Loam	6.47	0.88	Sandy Loam	78.87	6.24
Sandy Loam	37.01	5.01	Silt Loam	94.47	7.47
Silt Loam	24.77	3.36	Loam	11.72	0.93
Loam	68.67	9.30	Rock outcrop	542.07	42.89
Rock Outcrop	164.49	22.29	Snow and glaciers	385.60	30.51
Snow and glaciers	186.13	25.22			

Average Monthly Discharge of Lidder and Rembiara Catchments at Odure and Nayun guage stations respectively (1979-1999)

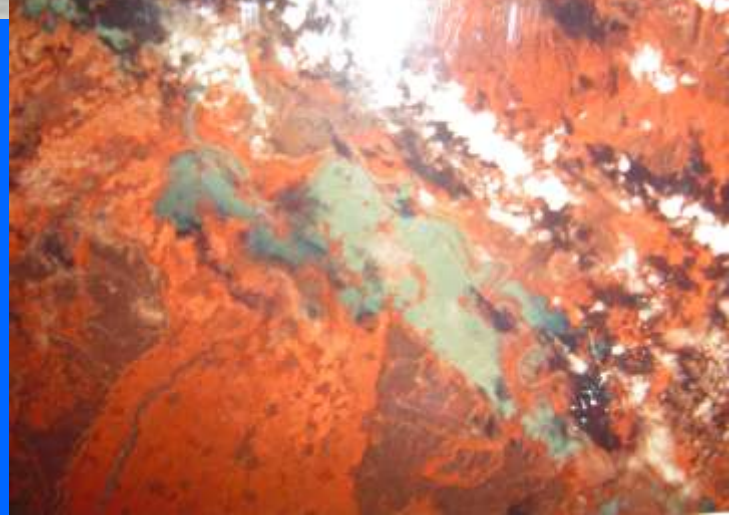


Precipitation Maps



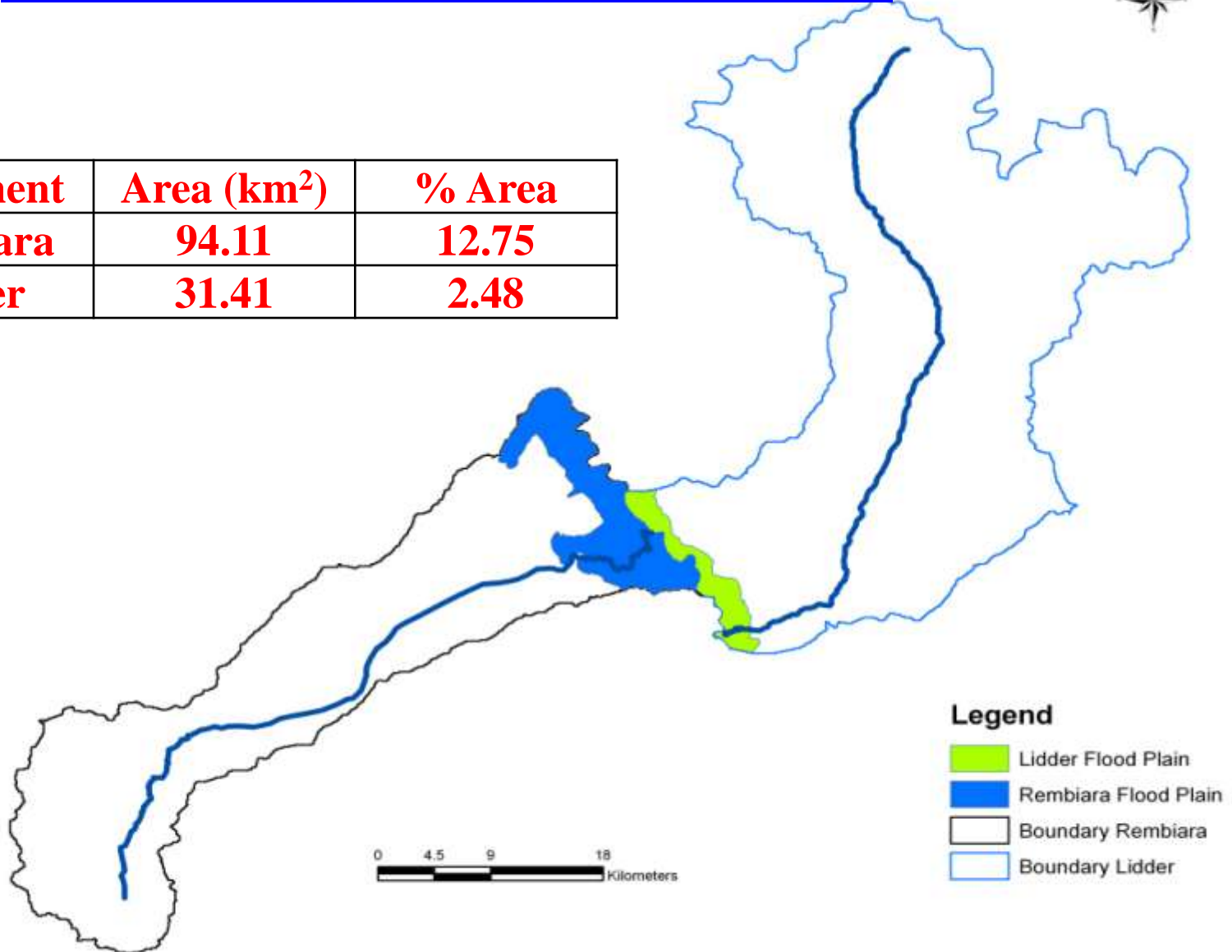


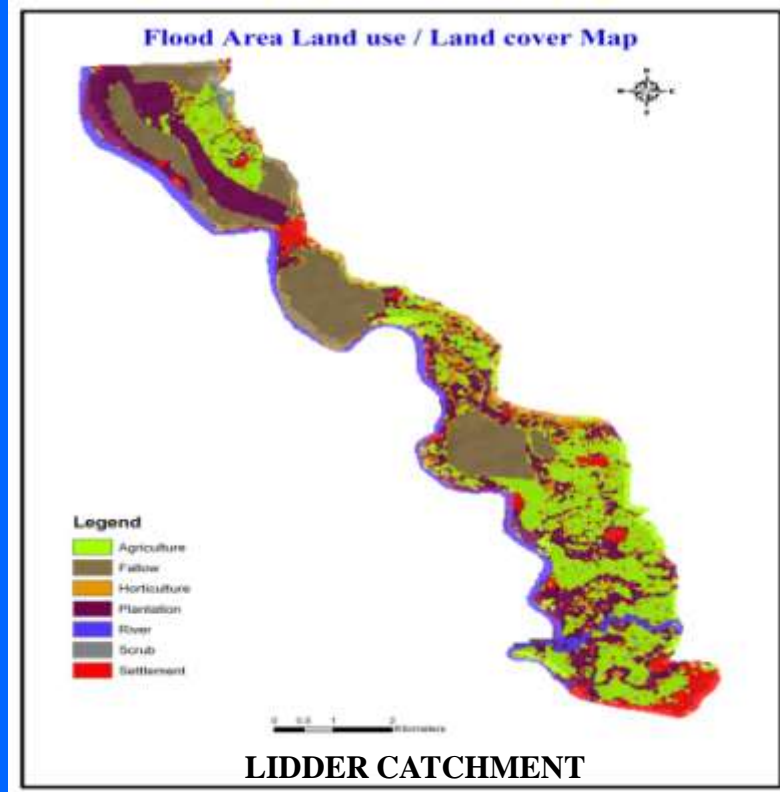
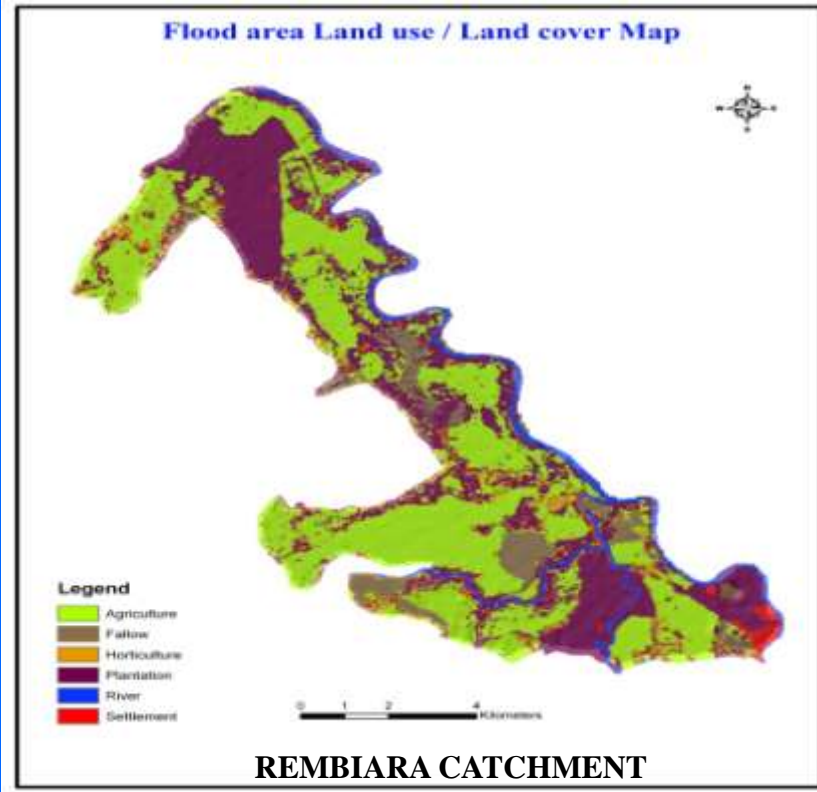
1996 Flood



Flood Inundated Areas

Catchment	Area (km ²)	% Area
Rembiara	94.11	12.75
Lidder	31.41	2.48

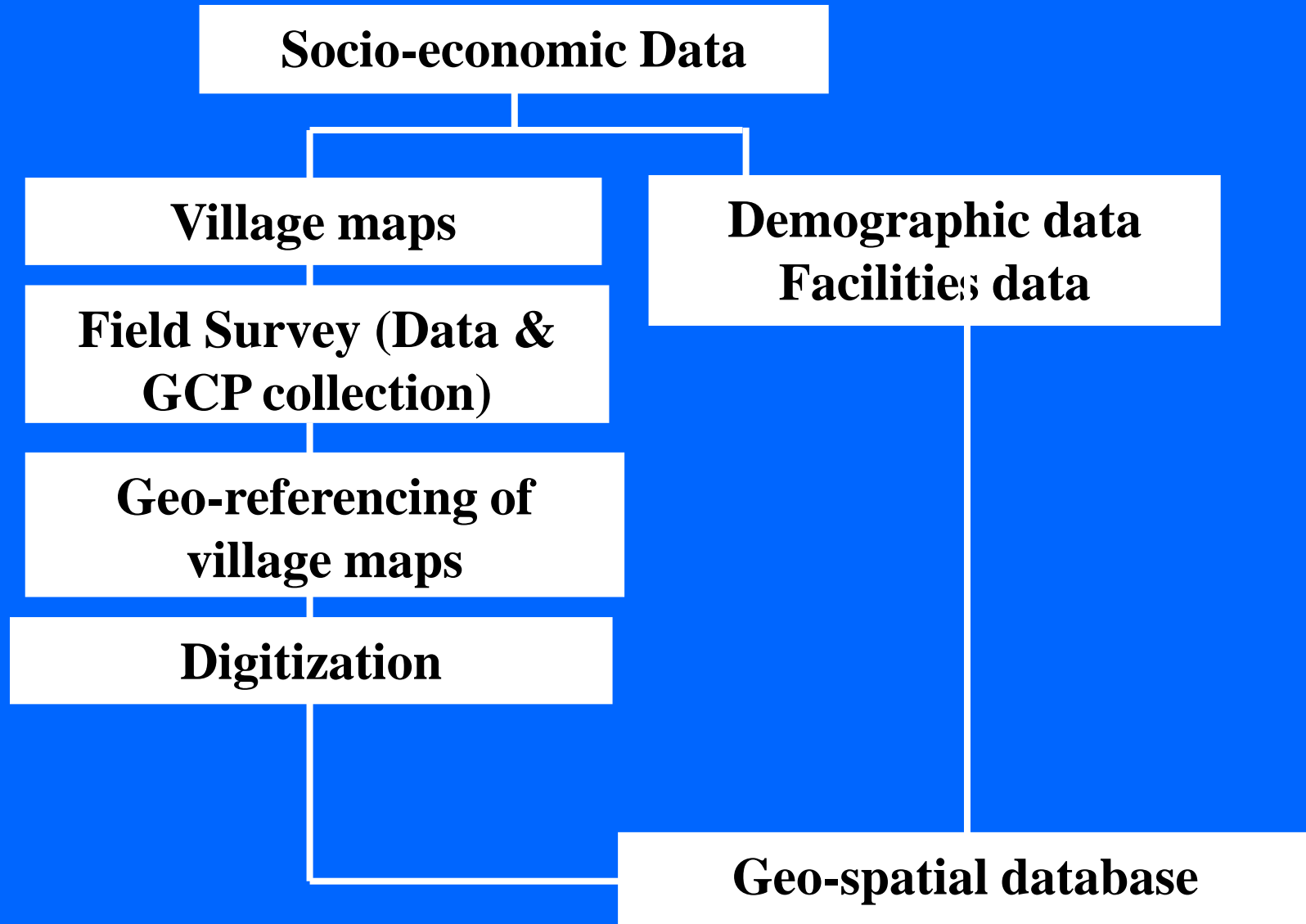




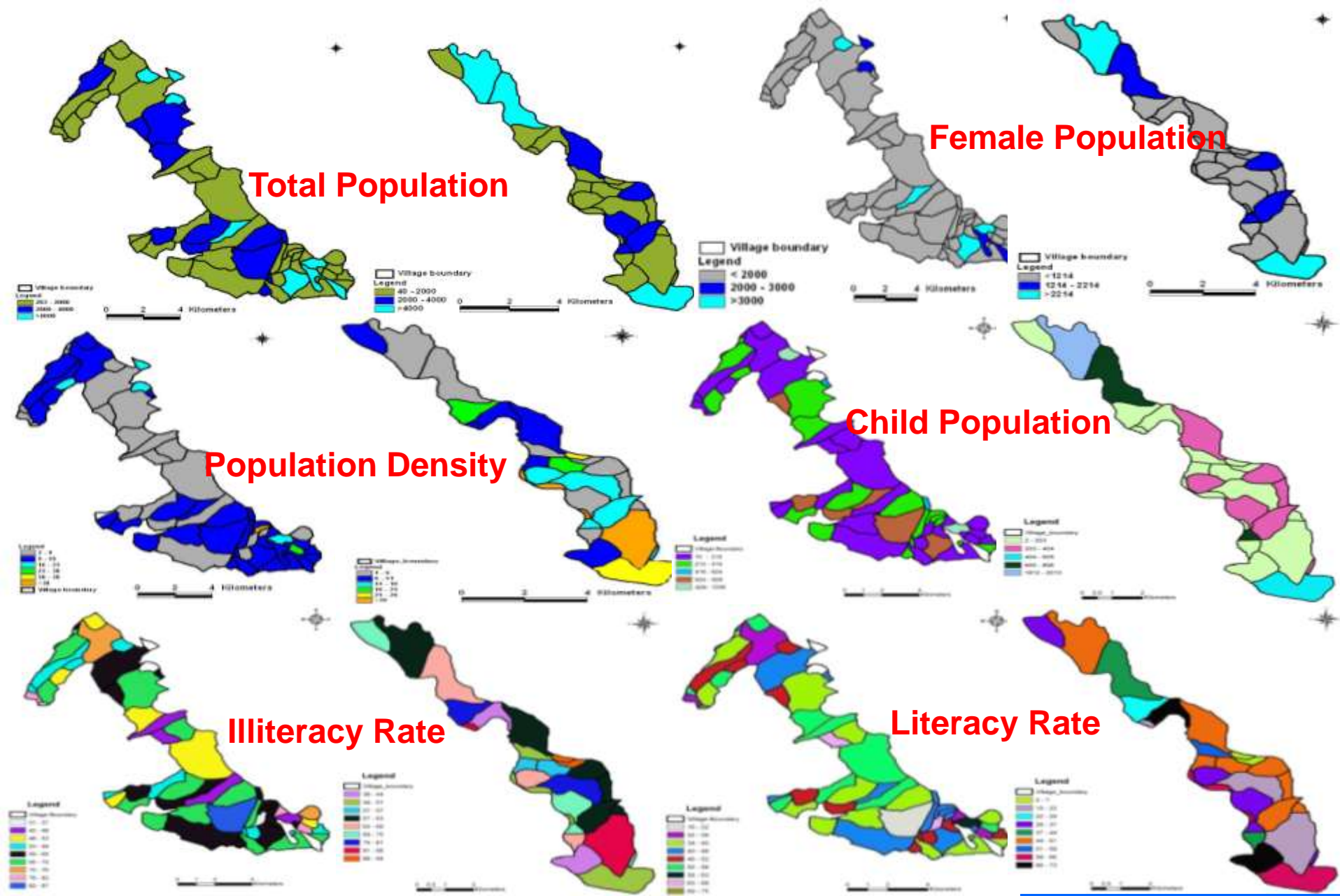
Class	Rembiara Flood Area	Lidder Flood Area
	Area (km ²)	Area (km ²)
Settlement	2.90	1.89
Horticulture	4.77	3.07
Agriculture	42.79	9.44
River/water bodies	4.24	2.41
Fallow	5.92	6.99
Plantation	33.49	7.61

SOCIAL FLOOD VULNERABILITY

GENERATION OF GEO-SPATIAL DATA BASE AT VILLAGE LEVEL



Spatial Distribution of Socio-economic Data



SOCAIL VULNERABILITY ANALYSES

Spatial data base at village level

**Population
density**

**Female
population**

**Children
Population**

**Illiteracy
rate**

**Literacy
rate**

**Facility
Index**

Reclassification

Weightage analysis

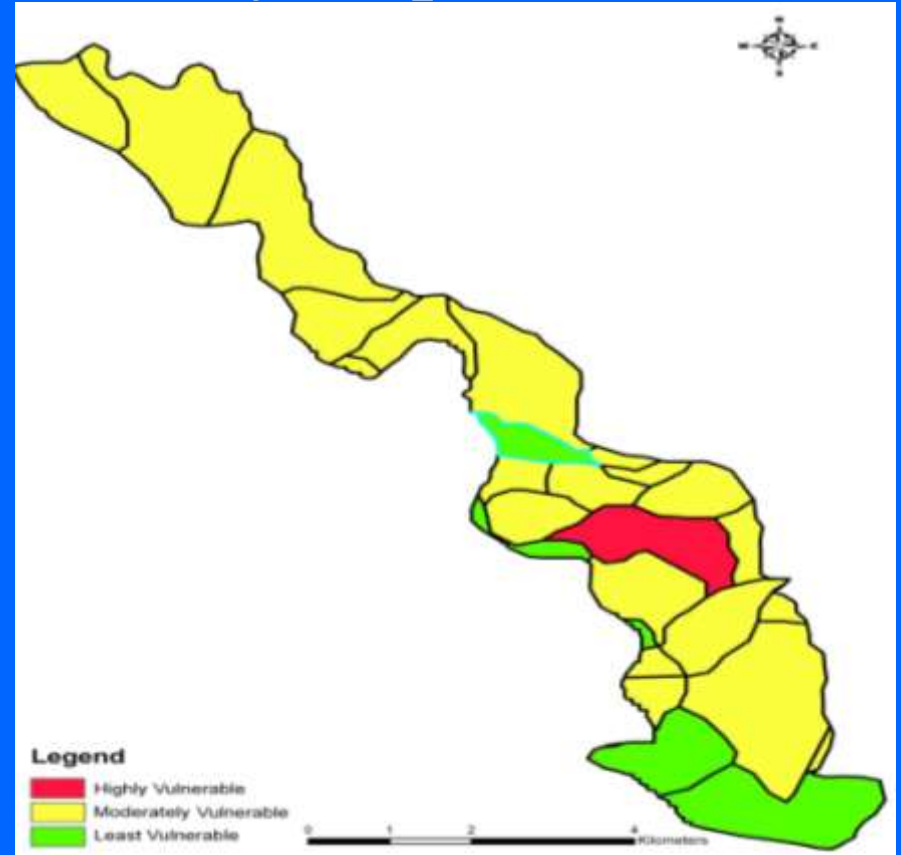
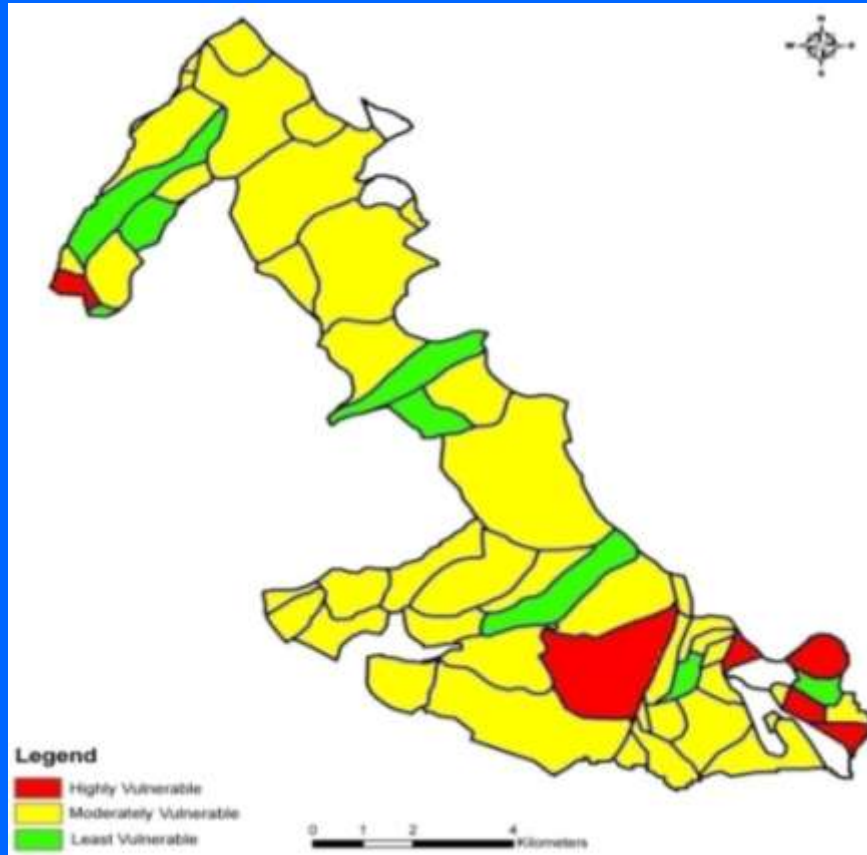
Overlay analysis

Social vulnerability

Social Vulnerability Analyses Criteria

S.No	Parameters	Reclassification	Weightage	Assigned Class	O V E R L A Y A N A L Y S E S	Vulnerability classes	
01	Population Density	High	20	1		High	
		Moderate		2			
		Low		3			
02	Female Population	High	20	1			Moderate
		Moderate		2			
		Low		3			
03	Child Population	High	20	1		Low	
		Moderate		2			
		Low		3			
04	Illiteracy Rate	High	15	1			
		Moderate		2			
		Low		3			
05	Literacy Rate	High		3		Low	
		Moderate		2			
		Low		1			
06	Facility Index	High	25	3			
		Moderate		2			
		Low		1			

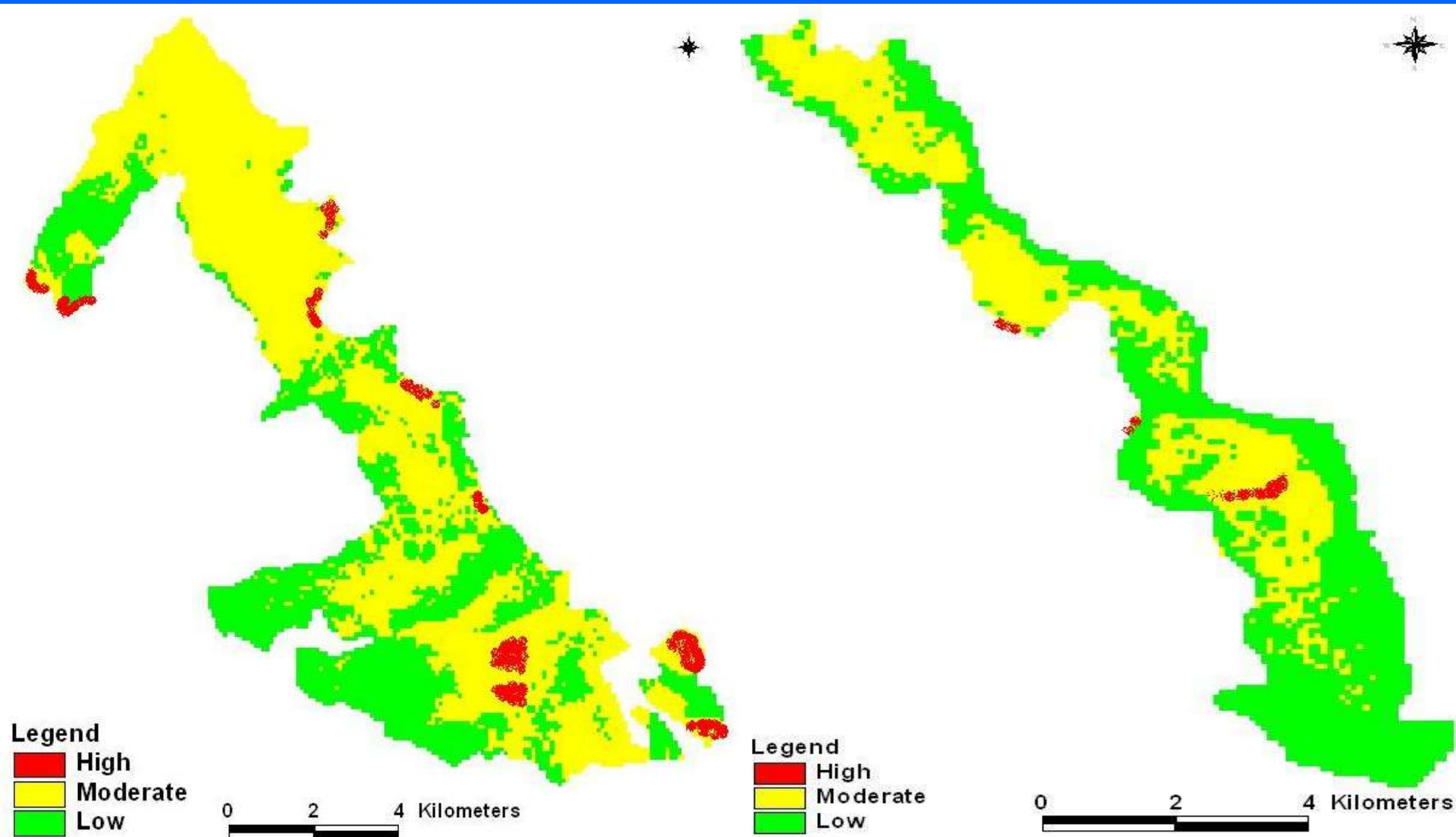
Social Flood Vulnerability Maps



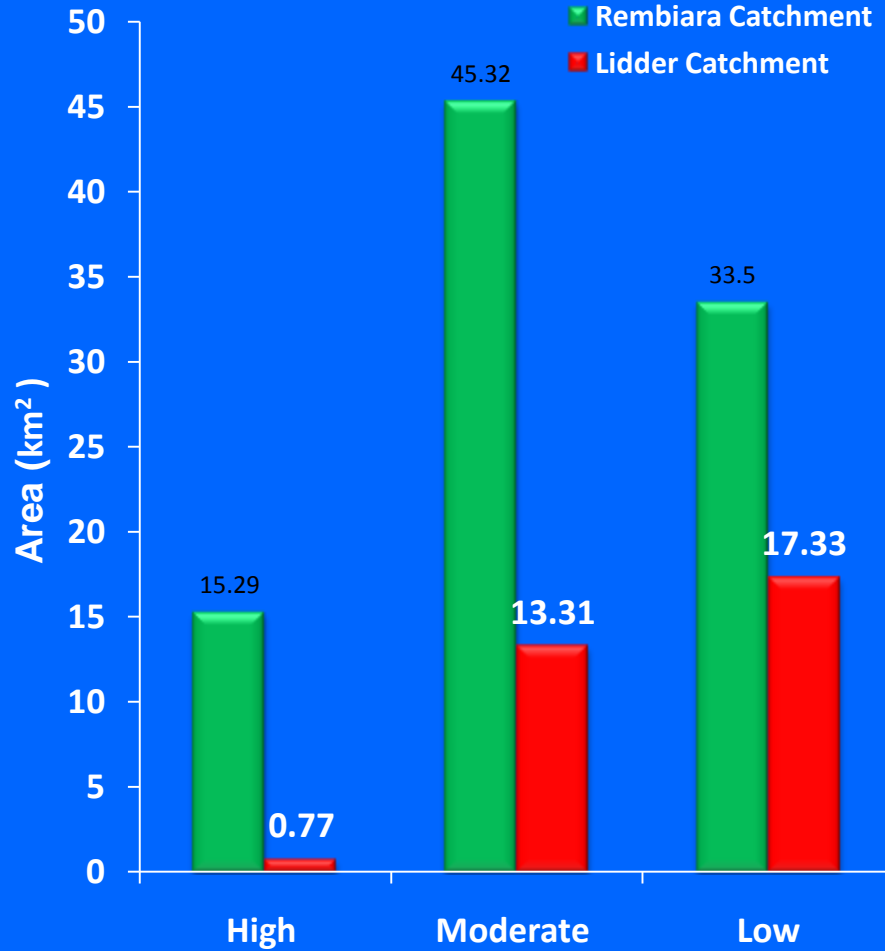
Data not available

Vulnerability	Rembiara Catchment			Lidder Catchment		
	No. of villages	Area (km ²)	% Area	No. of villages	Area (km ²)	% Area
Highly Vulnerable	6	7.36	7.82	1	0.22	0.70
Moderately Vulnerable	46	73.48	78.08	21	30.01	95.54
Least Vulnerable	8	13.27	14.10	4	1.18	3.76

CB Flood Vulnerability Analysis (Integration of Physical and Social)



Hazard Zones	Rembiara Catchment		Lidder Catchment	
	Area (km²)	% Area	Area (km²)	% Area
High	15.29	16.25	0.77	2.45
Moderate	45.32	48.16	13.31	42.38
Low	33.50	35.60	17.33	55.17



Conclusions

- Because of different Geomorphological and Geological settings Rembiara catchment is more prone to flooding than Lidder catchment.
- In this study, we have successfully linked the physical and Social Vulnerabilities and identified the vulnerability of the places and people to flooding in the area.
- The research methodology established in this research should help “socialization” of the science and technology benefits for the flood disaster prone communities by developing robust strategies for reducing their vulnerability and risk to disasters through appropriate development planning.

**THANKS
FOR YOUR
ATTENTION**