International Institute for Applied Systems Analysis

IIASA

**IV International Conference on El Niño Southern Oscillation:**
**ENSO in a warmer Climate**
**16-18 October 2018. Guayaquil - Ecuador**


**Presenter**

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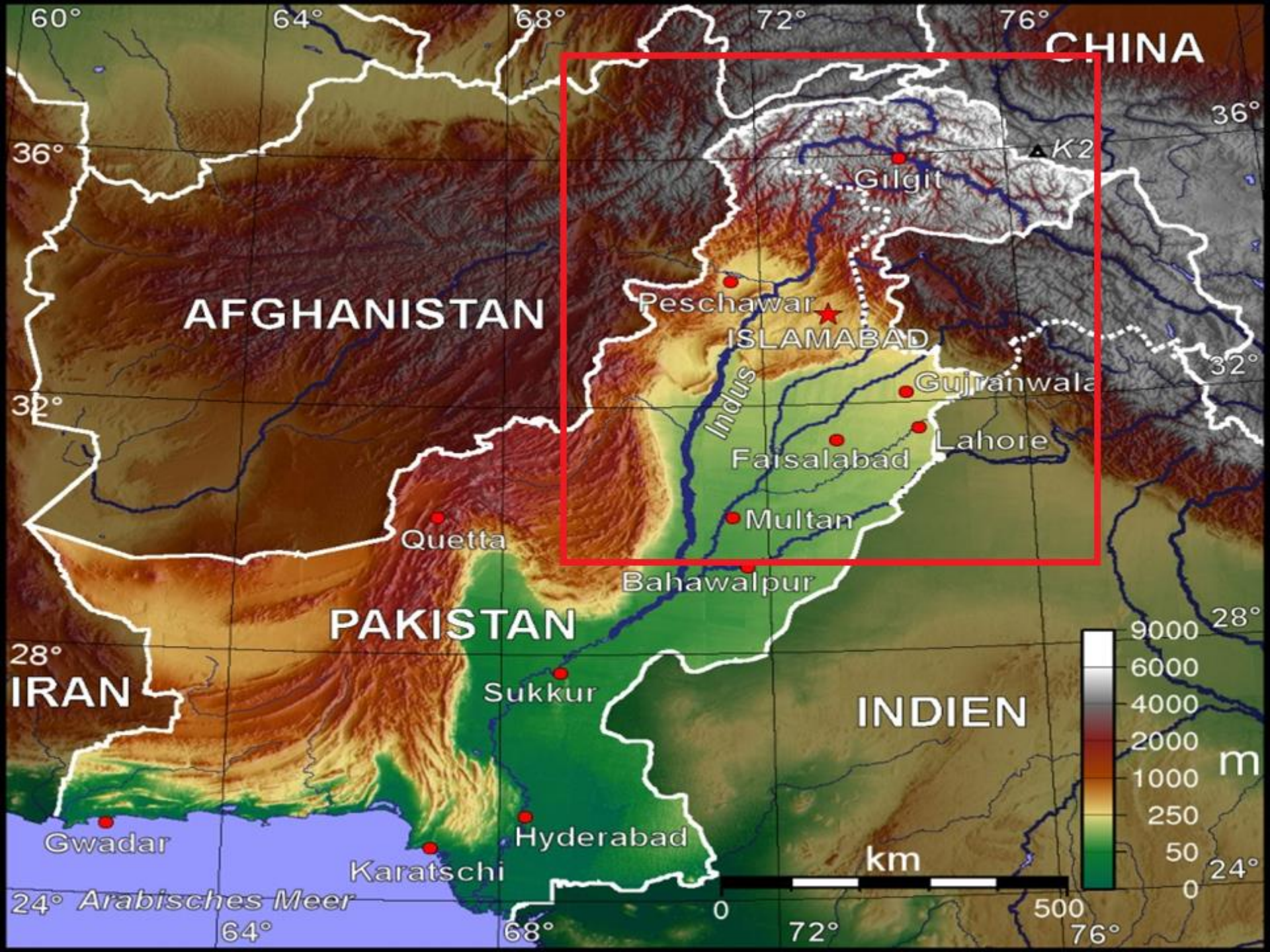
# Riverine flood assessment in connection with La Nina and summer monsoon rainfall over Upper Indus Basin Region of Pakistan

Khalid B et al., (2018) Riverine flood assessment in Jhang district in connection with ENSO and summer monsoon rainfall over Upper Indus Basin for 2010. Natural Hazards. DOI: 10.1007/s11069-018-3234-y

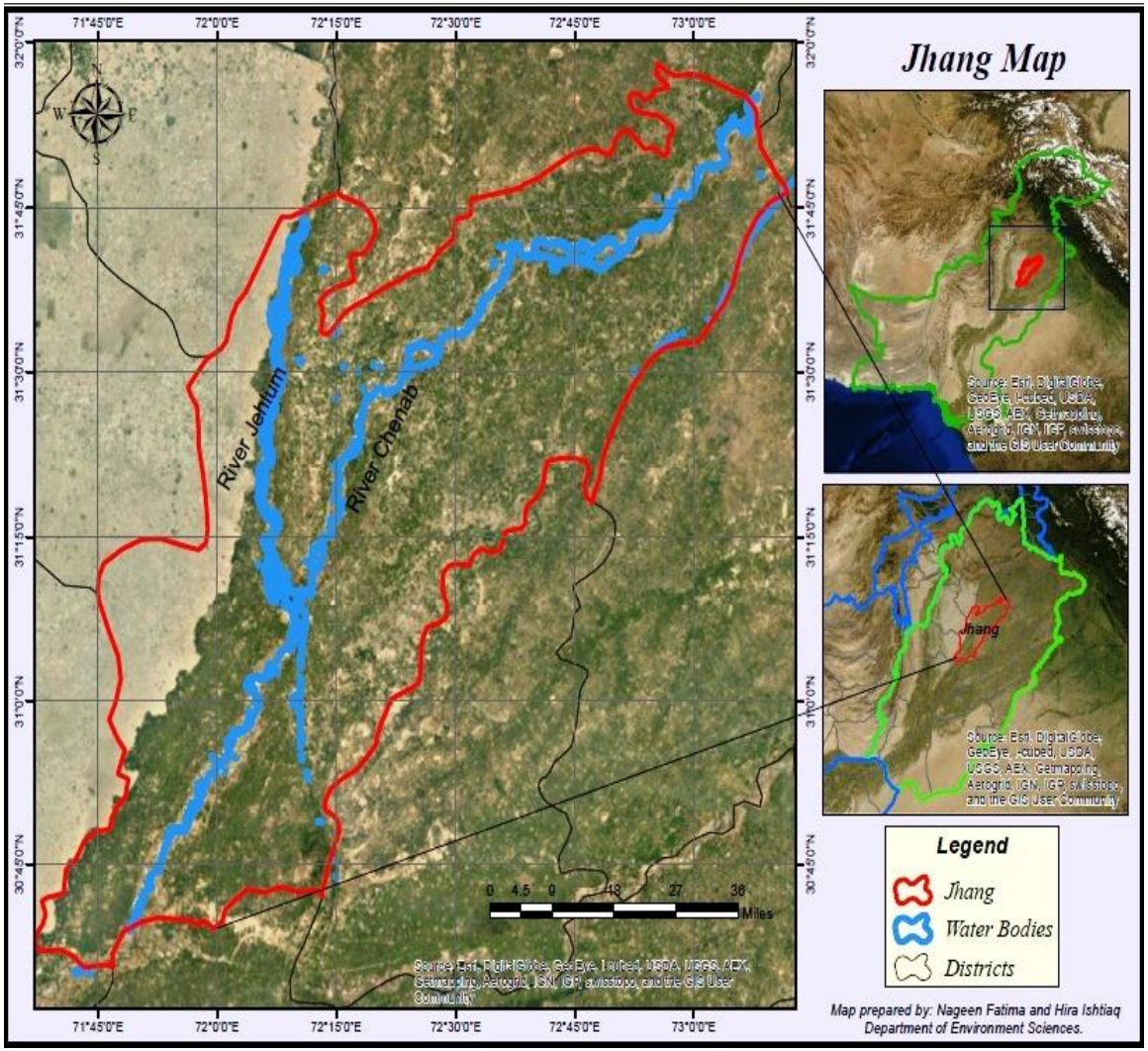
- Riverine flooding in the Jhelum and Chenab rivers joining point (Trimmu headworks), where the nearby district Jhang was severely flood affected

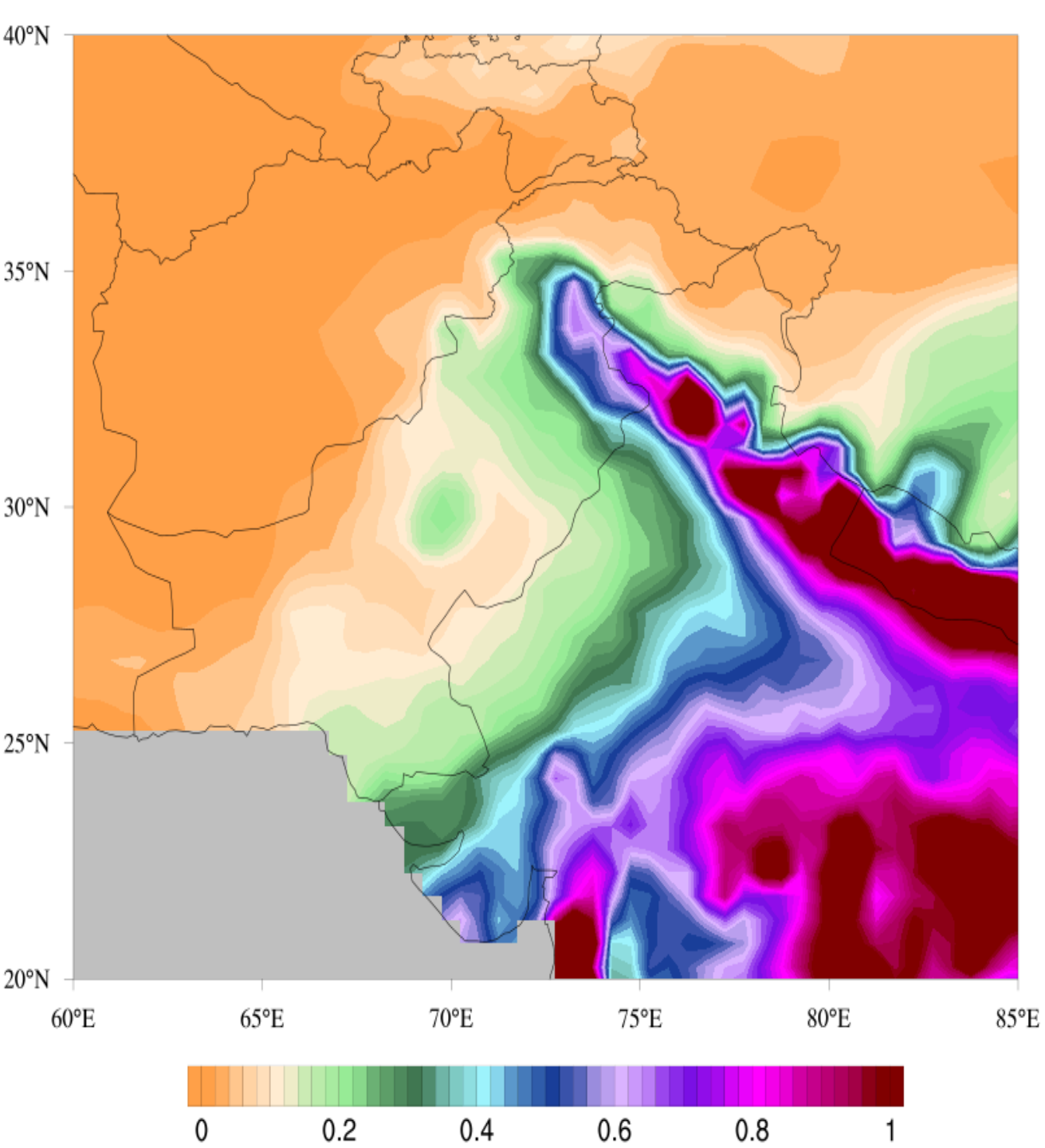
- Summer monsoon rainfall patterns and anomalies over Upper Indus Basin (UIB) region of Pakistan considering the case of 2010 flood.

- Pakistan is highly vulnerable to hydro-meteorological events and has experienced recurring cycles of riverine flooding over the past several years.
- The flooding in Pakistan during the summer monsoon months of July-September 2010 was 7.5 on scale of intensity.
- The 2010 flood affected approximately one-fifth of Pakistan's total land area
- and displaced ~20,000,000 inhabitants with 2000 fatalities across the country (Brakenridge 2012; Chorynski et al. 2012).
- Flooding in the Jhelum & Chenab Rivers started in late July and sustained by the end of 2010 due to abnormally intensified summer monsoon rainfall in UIB (Syvitski and Brakenridge 2013).


60°
64°
68°
72°
76°
CHINA
36°
K2
Gilgit
AFGHANISTAN
Peschawar
ISLAMABAD
32°
Gujranwala
Indus
Lahore
Faisalabad
Multan
Quetta
Bahawalpur
PAKISTAN
28°
IRAN
Sukkur
INDIEN
9000
6000
4000
2000
1000
250
50
0
m
Hyderabad
Gwadar
Karatschi
km
0
500
24°
Arabisches Meer

# Jhelum and Chenab Rivers meeting point

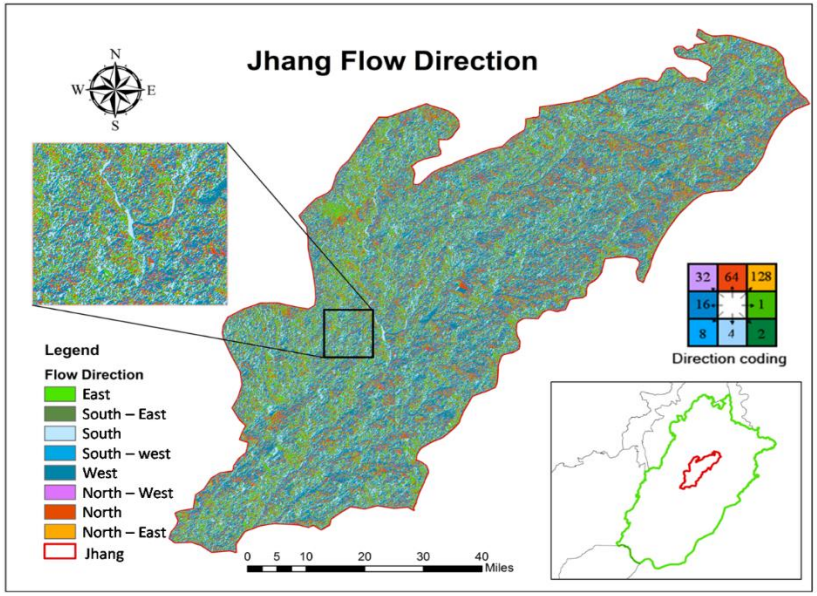


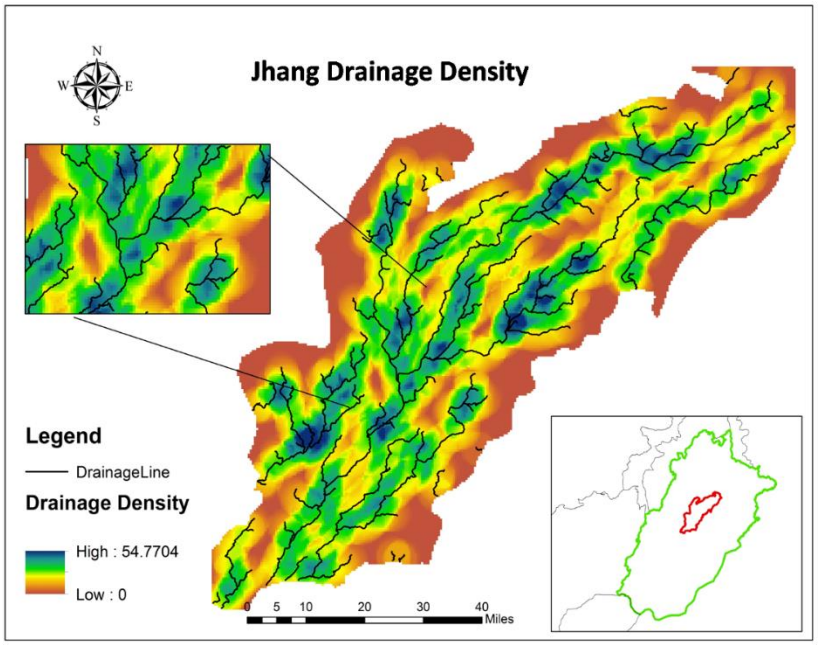


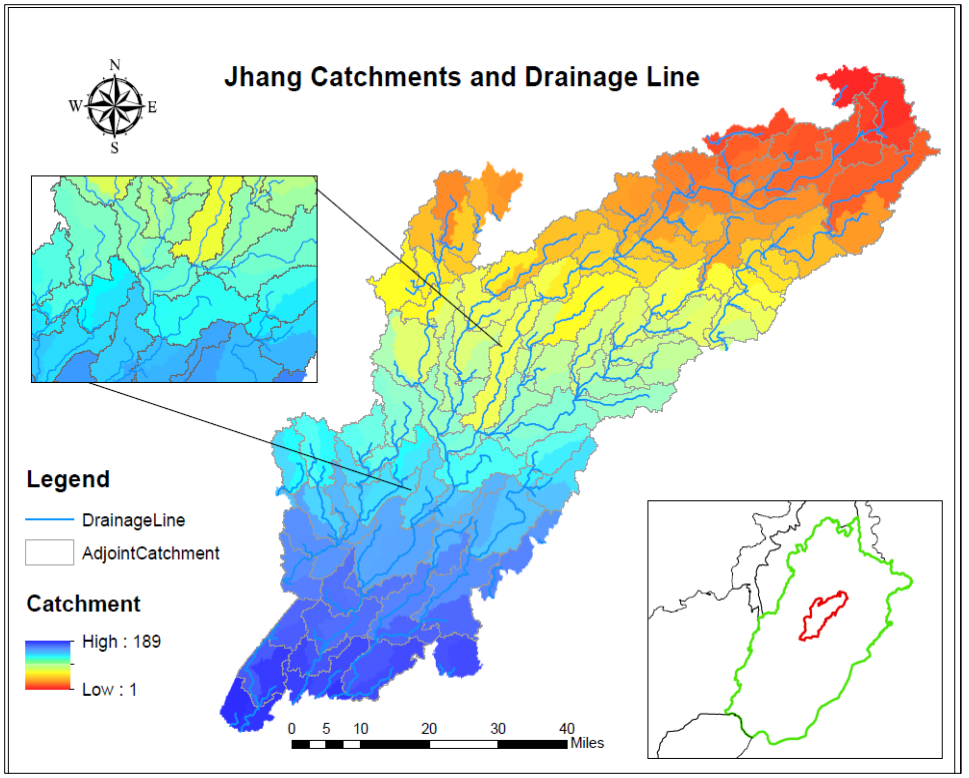

Climatology

Summer monsoon rainfall over Pakistan

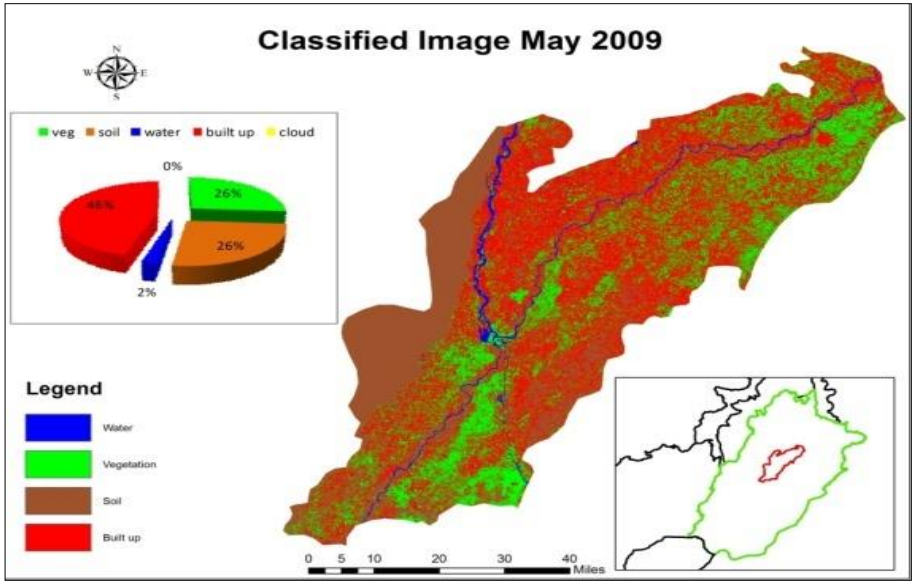
# SRTM 90m digital elevation model results

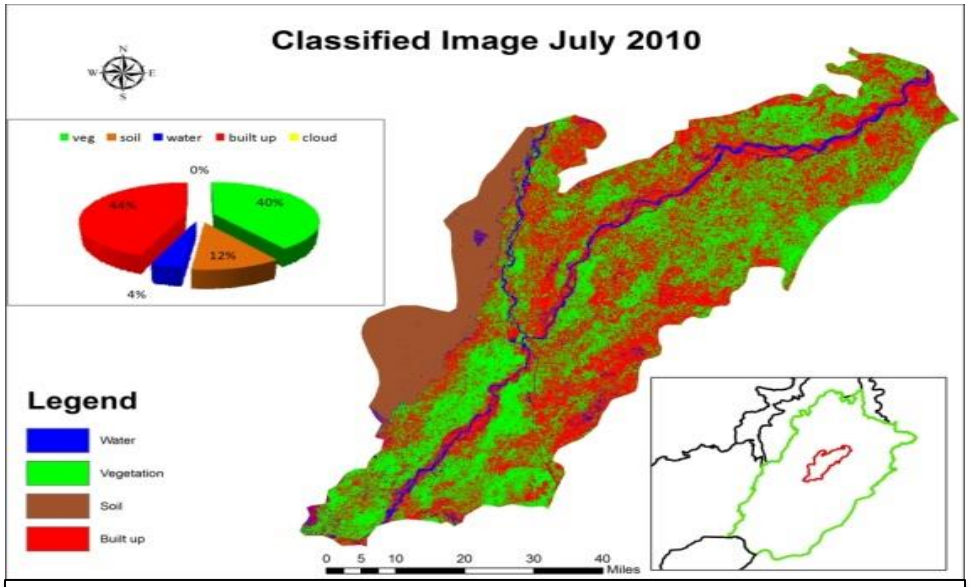


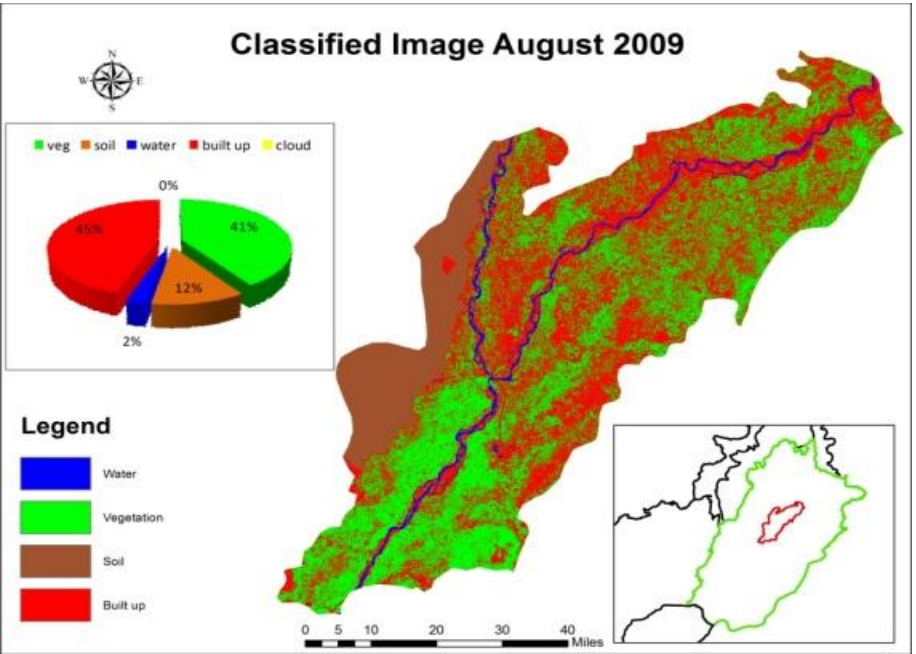



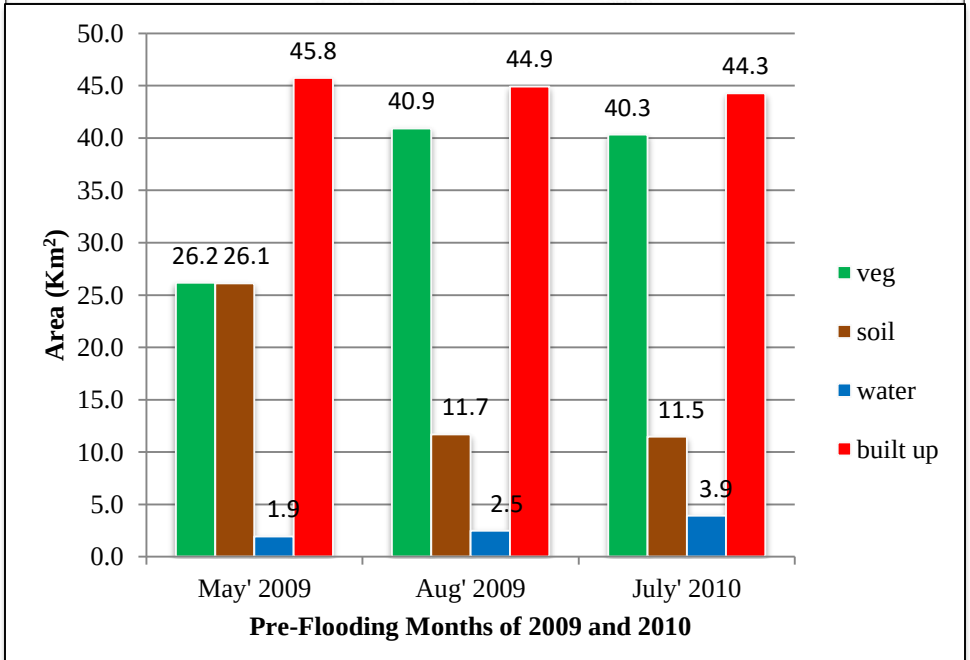



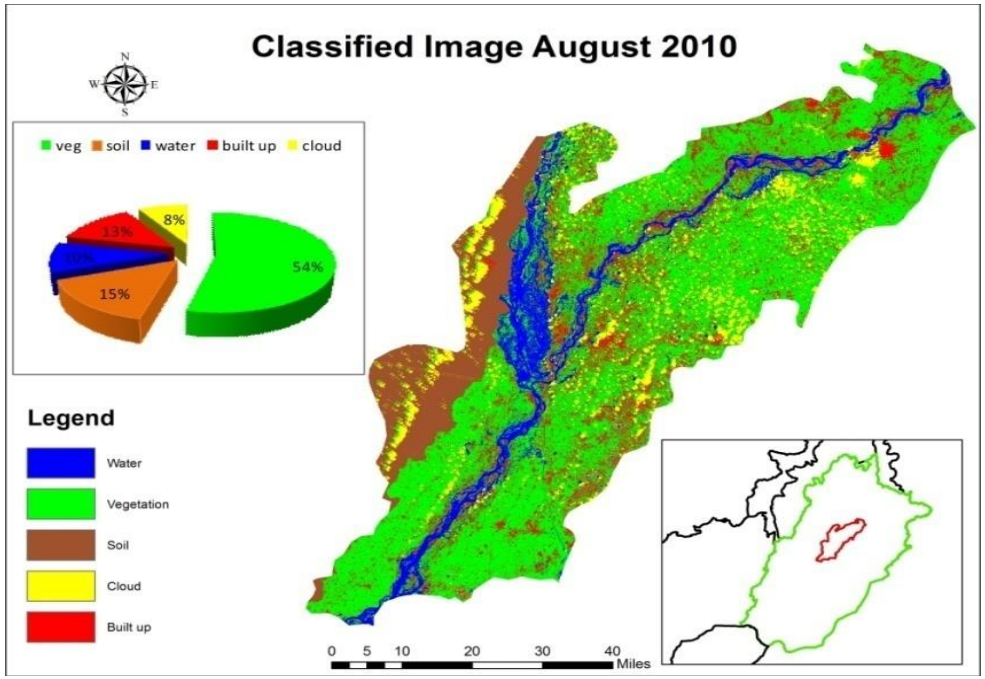
Supervised classification using maximum likelihood algorithm for pre-flooding instance. (Landsat TM 30m satellite imageries)



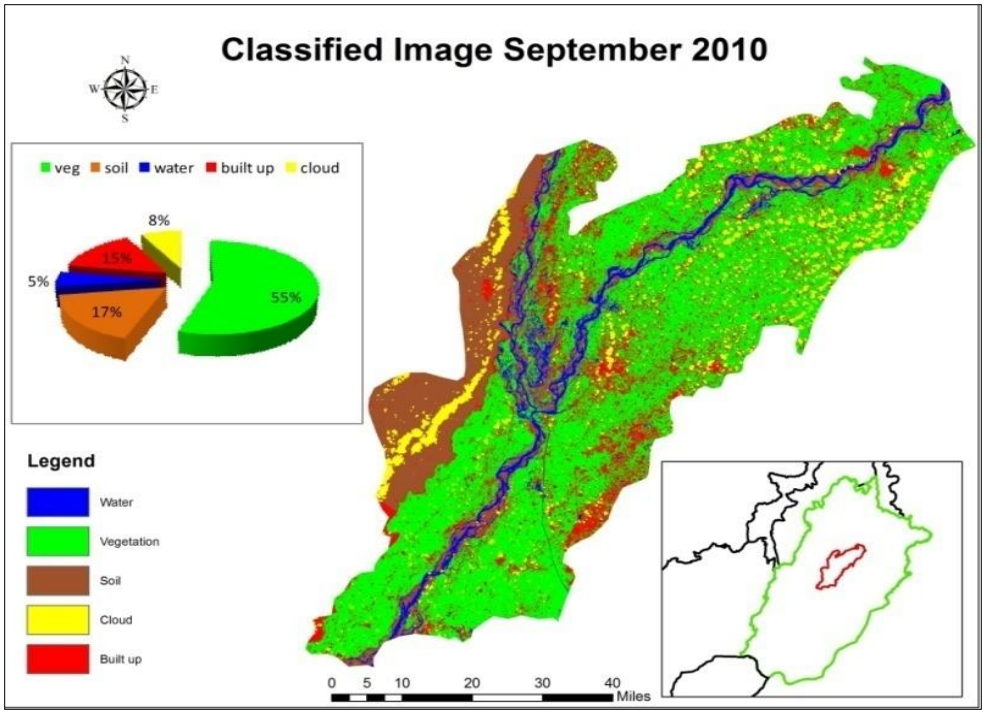



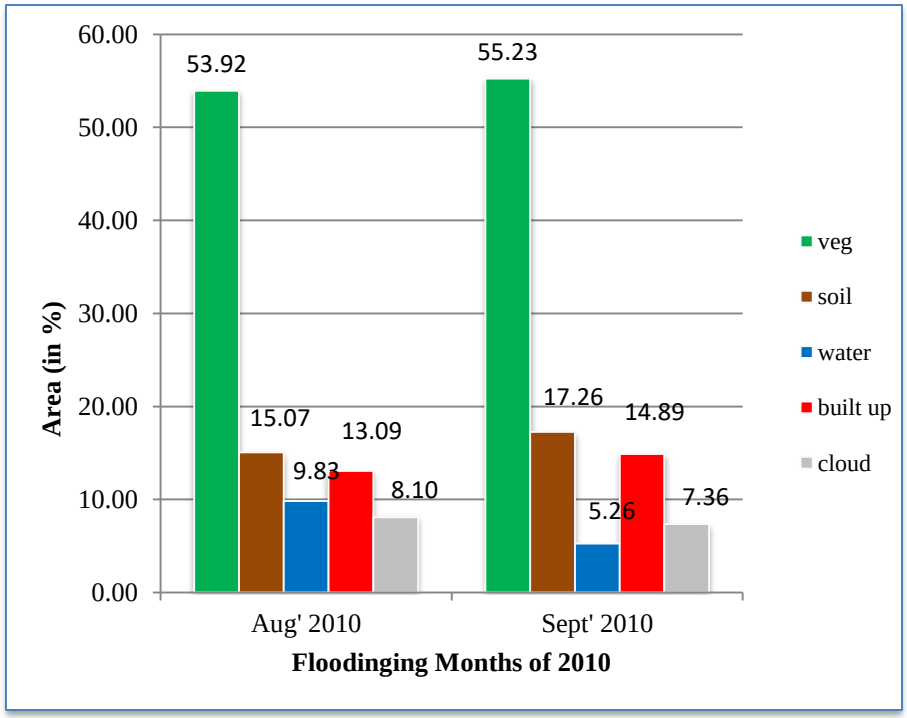



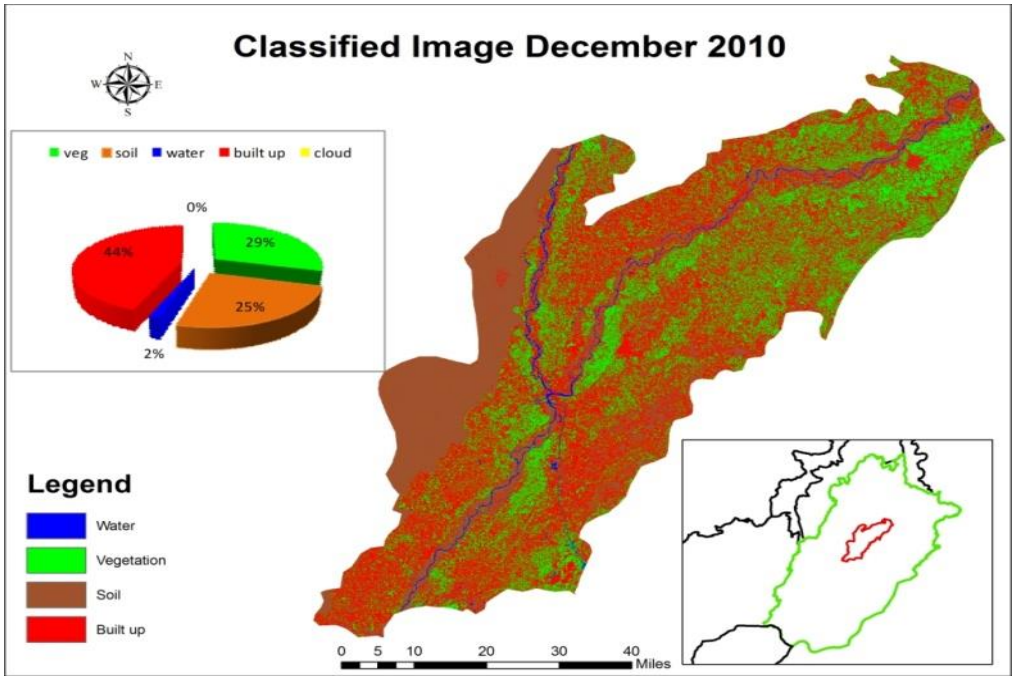



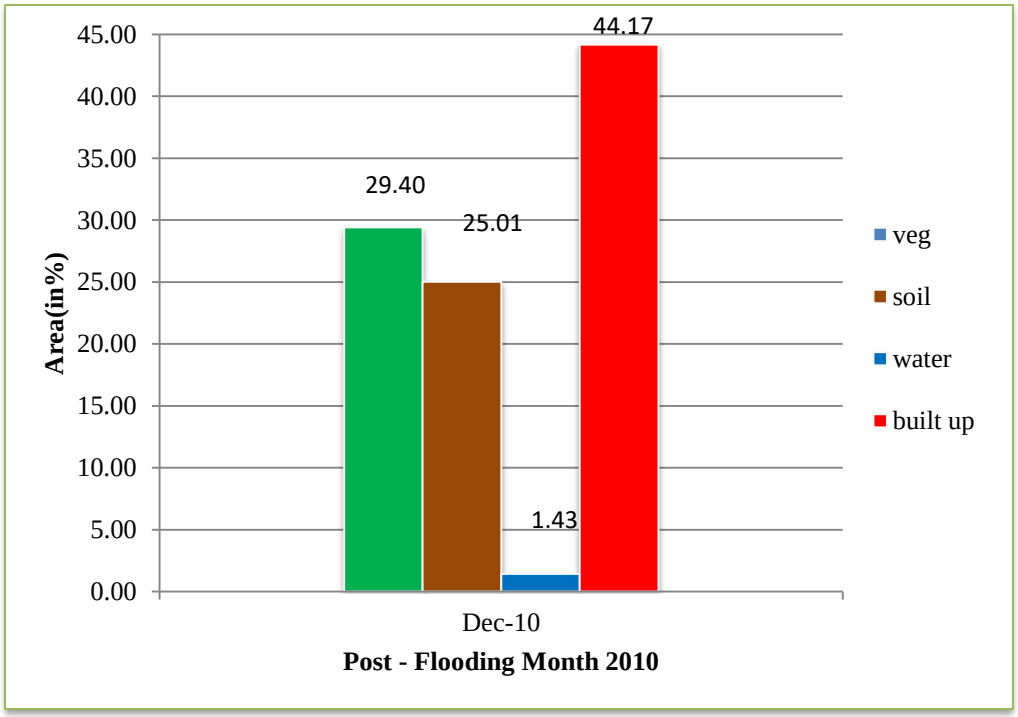



Supervised classification using maximum likelihood algorithm for flooding instance (Landsat TM 30m satellite imageries)



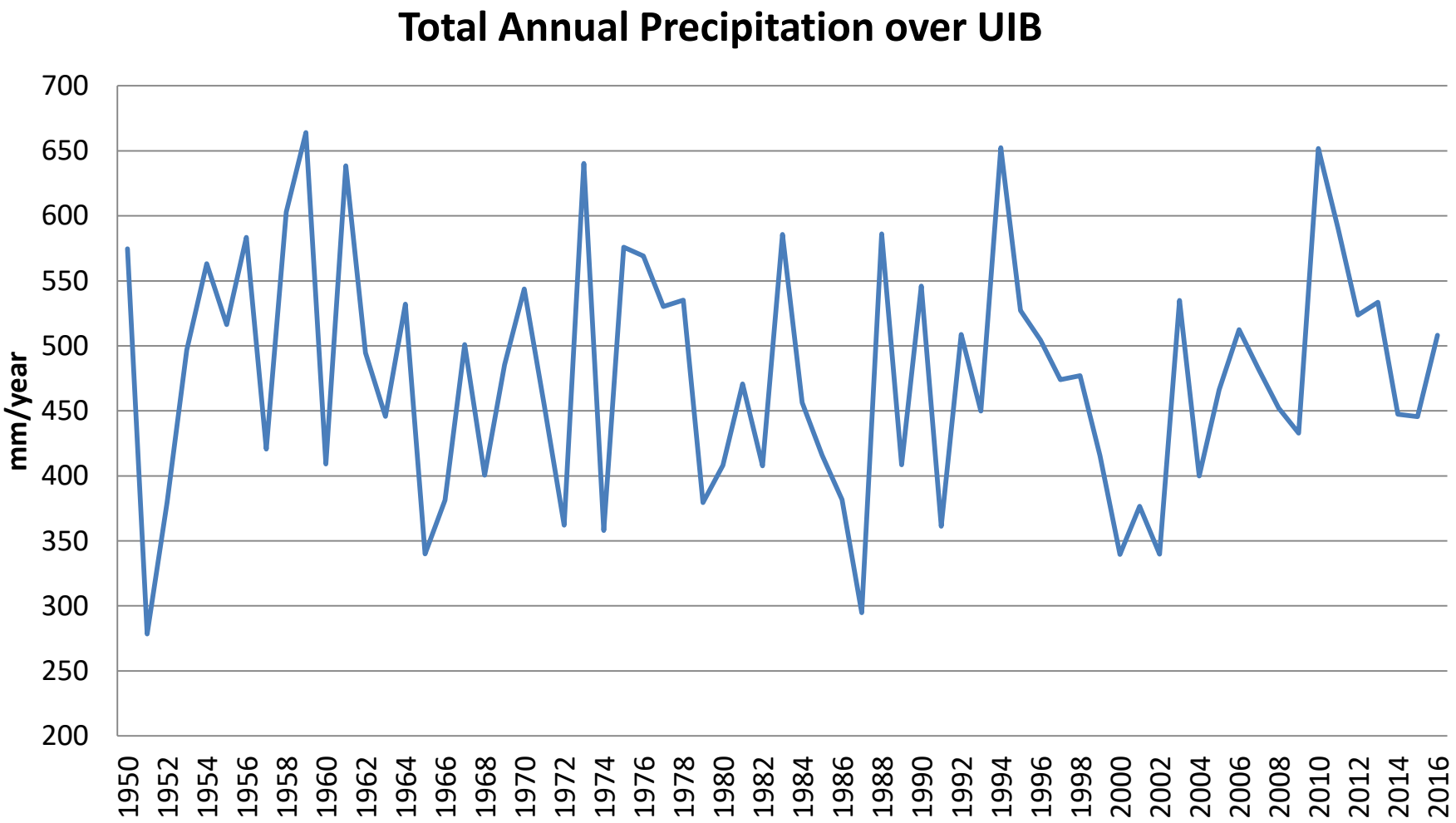


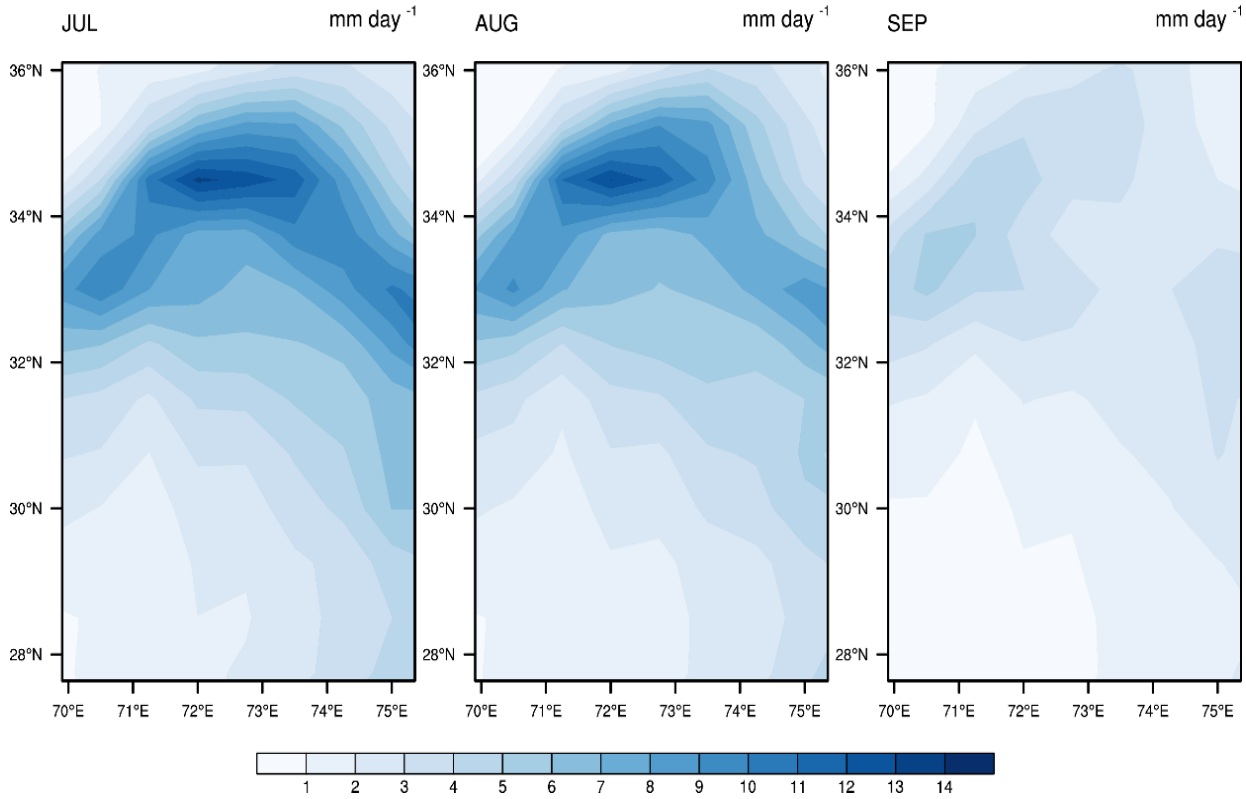




Supervised classification using maximum likelihood algorithm for post-flooding instance

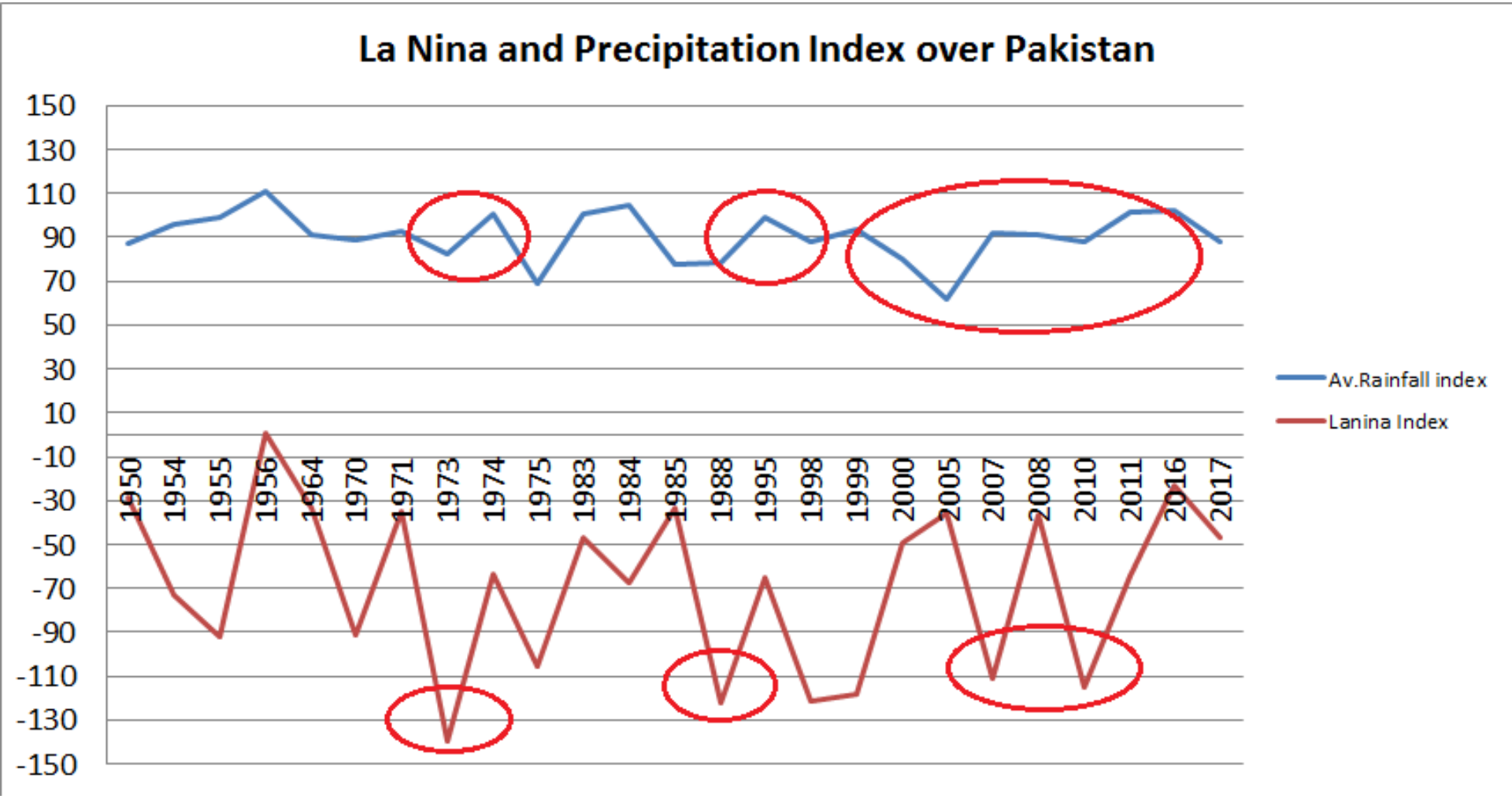
# Findings

- Comparison of pre & post flooding instances showed the significant decrease in built up area as compared to flooding instances i.e., from 44% to 13%.
- Water content is maximum in the rivers in August 2010.
- Vegetation has shown a peak in August-September 2009 and 2010 while in May 2009 and December 2010, vegetation has decreased and bare soil has increased.

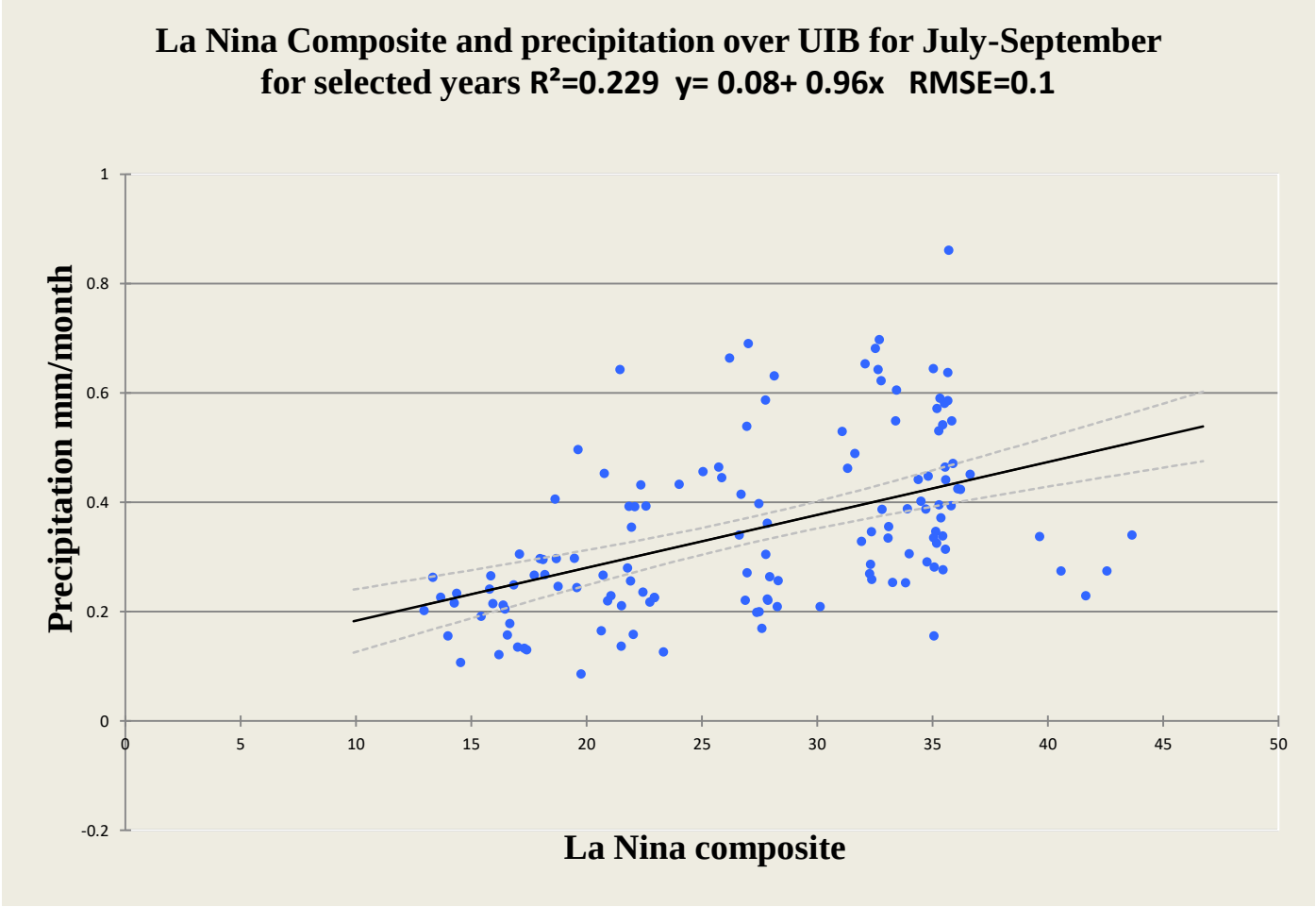

Total Annual Precipitation over UIB
mm/year
700
650
600
550
500
450
400
350
300
250
200
1950
1952
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016




Climatology (1979-2008) showing rainfall patterns for JAS over Upper Indus Basin (UIB) region


La Nina and Precipitation Index over Pakistan
150
130
110
90
70
50
30
10
-10
-30
-50
-70
-90
-110
-130
-150
1950
1954
1955
1956
1964
1970
1971
1973
1974
1975
1983
1984
1985
1988
1995
1998
1999
2000
2005
2007
2008
2010
2011
2016
2017
Av.Rainfall index
Lanina Index

# La Nina years in which Pakistan experienced flooding Pakistan received 50-80 % more than normal rainfall during these years from 1950-2016




**1954-55**

**1974-75**

**1983-84**

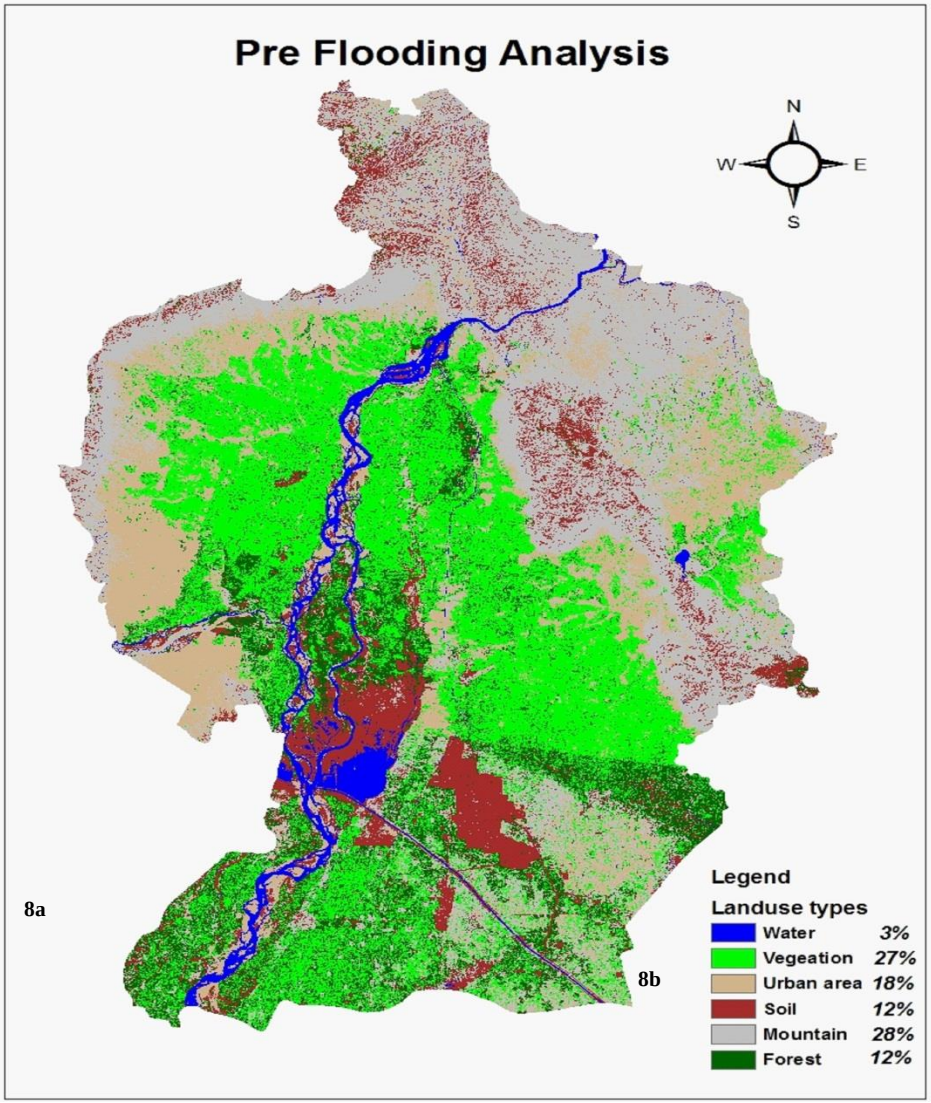
**1988-89**

**1994-95**

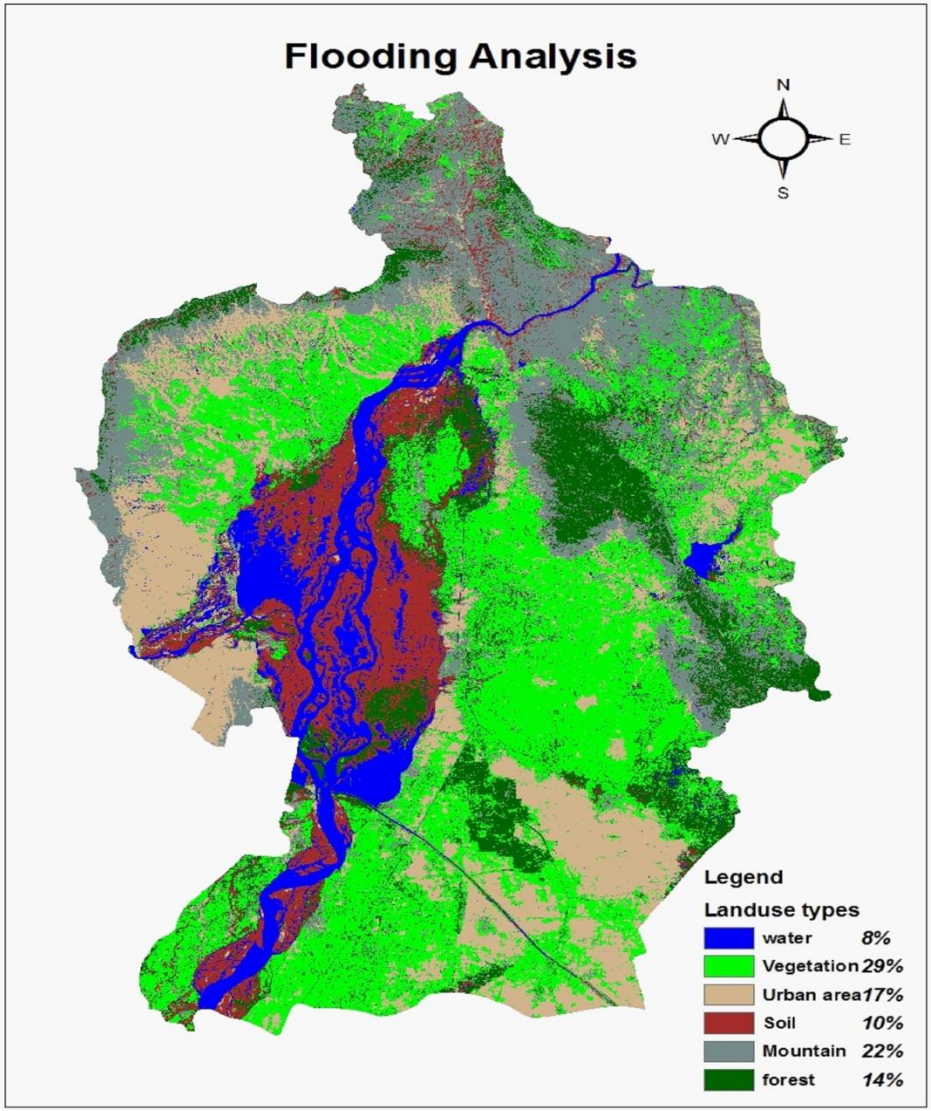
**2005-06**

**2007-08**

**2010-11**




8a




8b

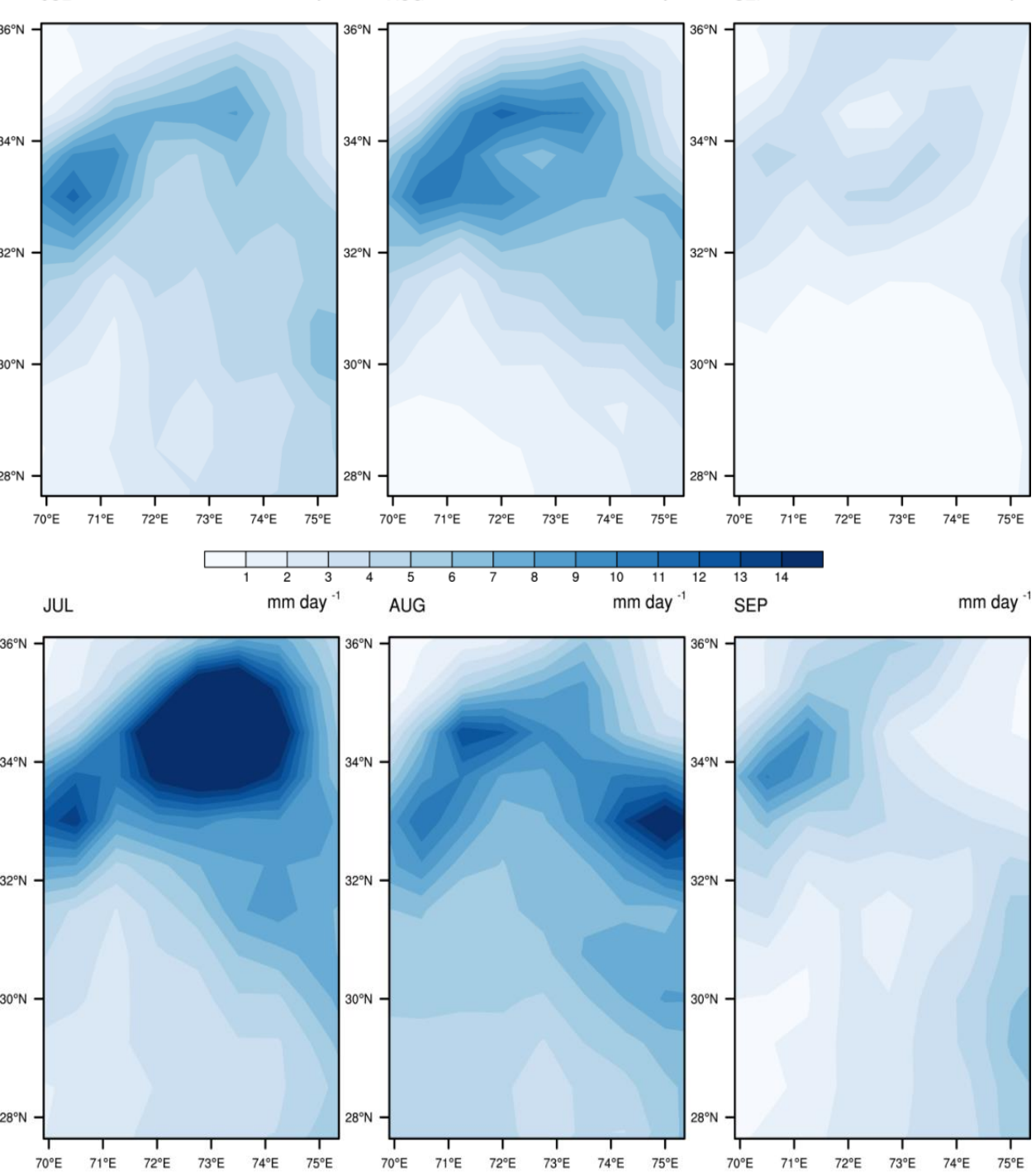
**Figure. Land Cover Classification during Pre-Flood Period in Central UIB and Land Cover Classification during Flood Period during 2005-06**

Summer monsoon season JAS are analyzed for the following years:

2009

2010

2011



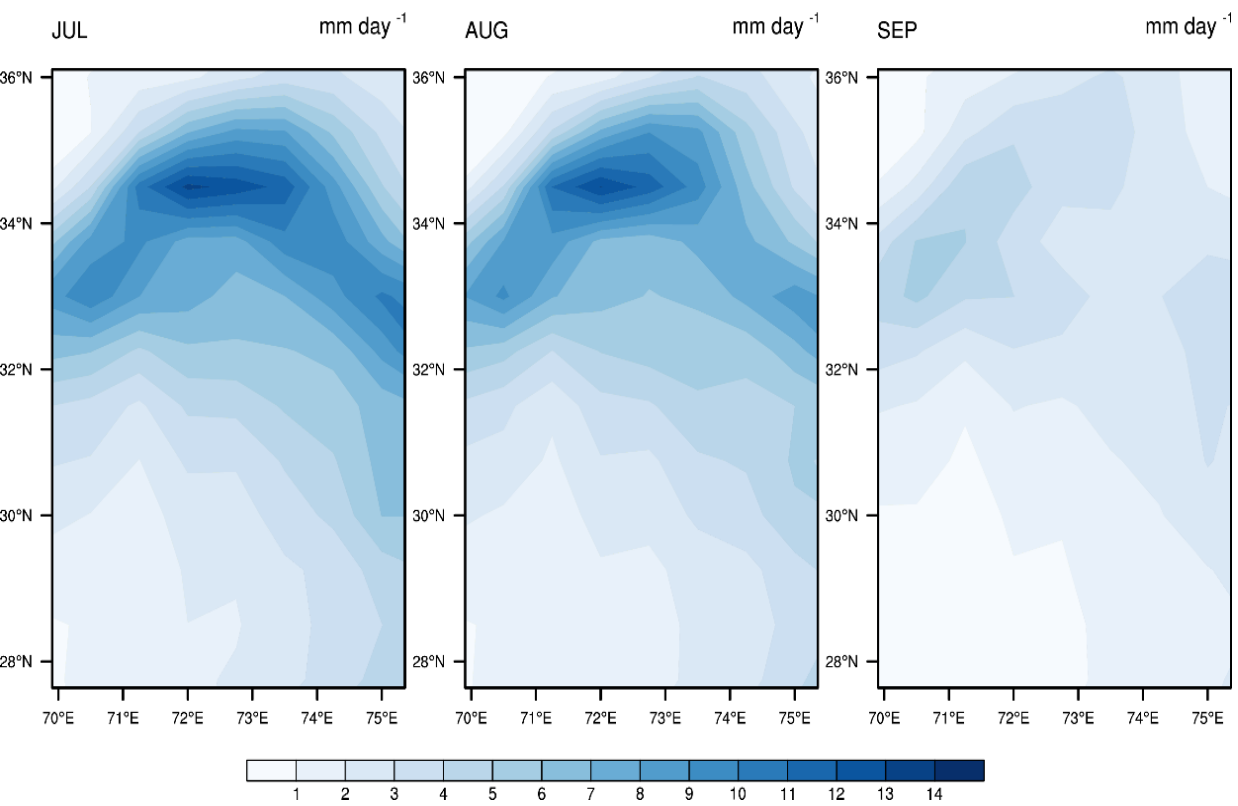

Era Interim 0.75x0.75 resolution

Summer monsoon rainfall for 2009 over UIB

Pre-flooding instance

Summer monsoon rainfall for 2010 over UIB

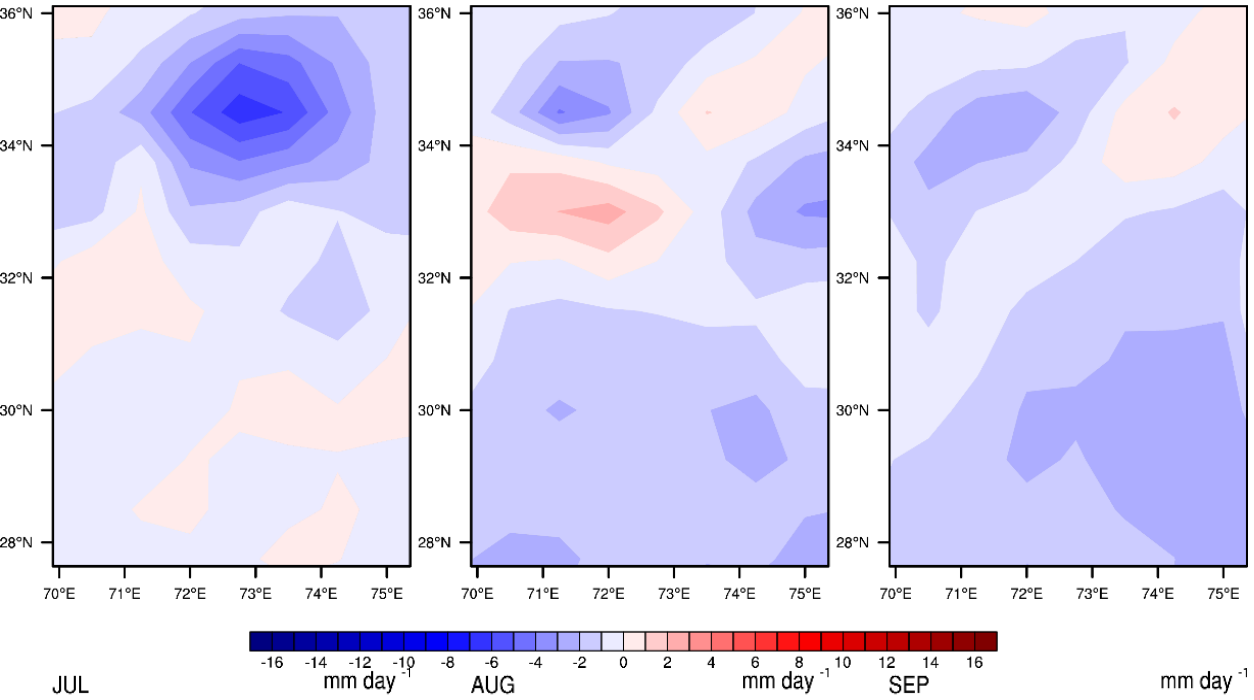
Flooding instance




# Summer monsoon rainfall for 2011 over UIB

## Post-flooding instance

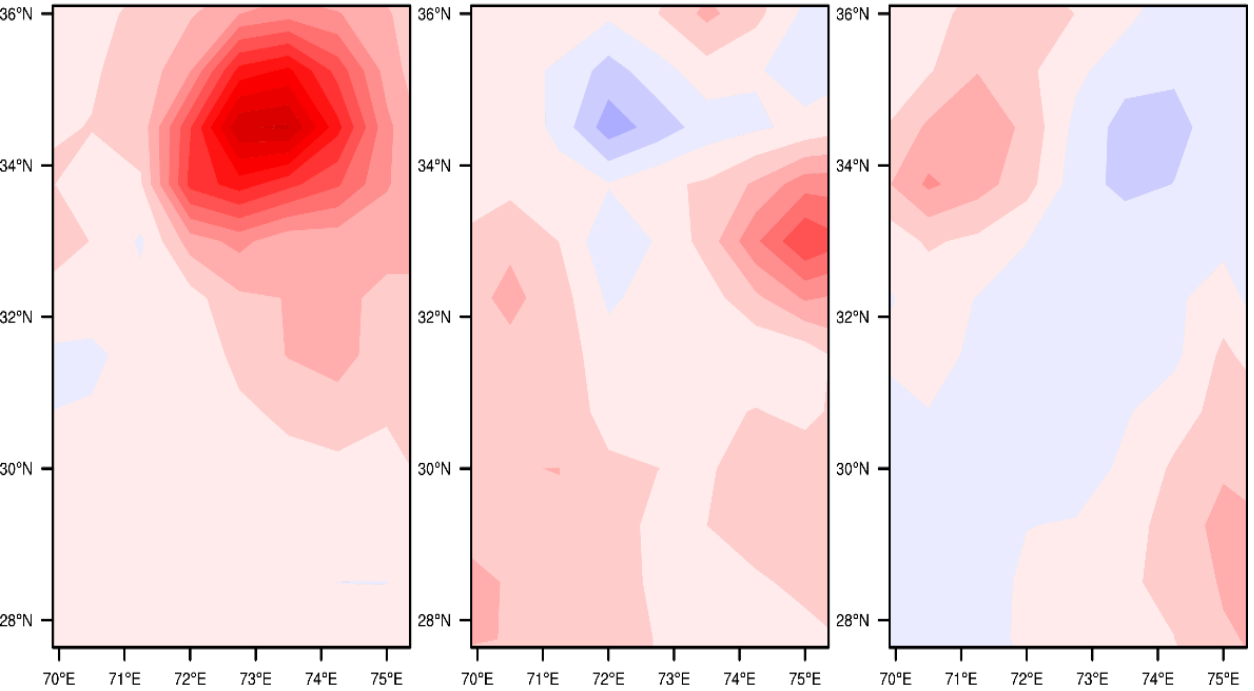
The intense rainfall pattern has been shown in UIB during JAS 2010 and August 2011. The summer monsoon rainfall had deviated pattern and intense anomalies prevailed in 2010.




Rainfall anomaly 2009

over Upper Indus Basin region of Pakistan

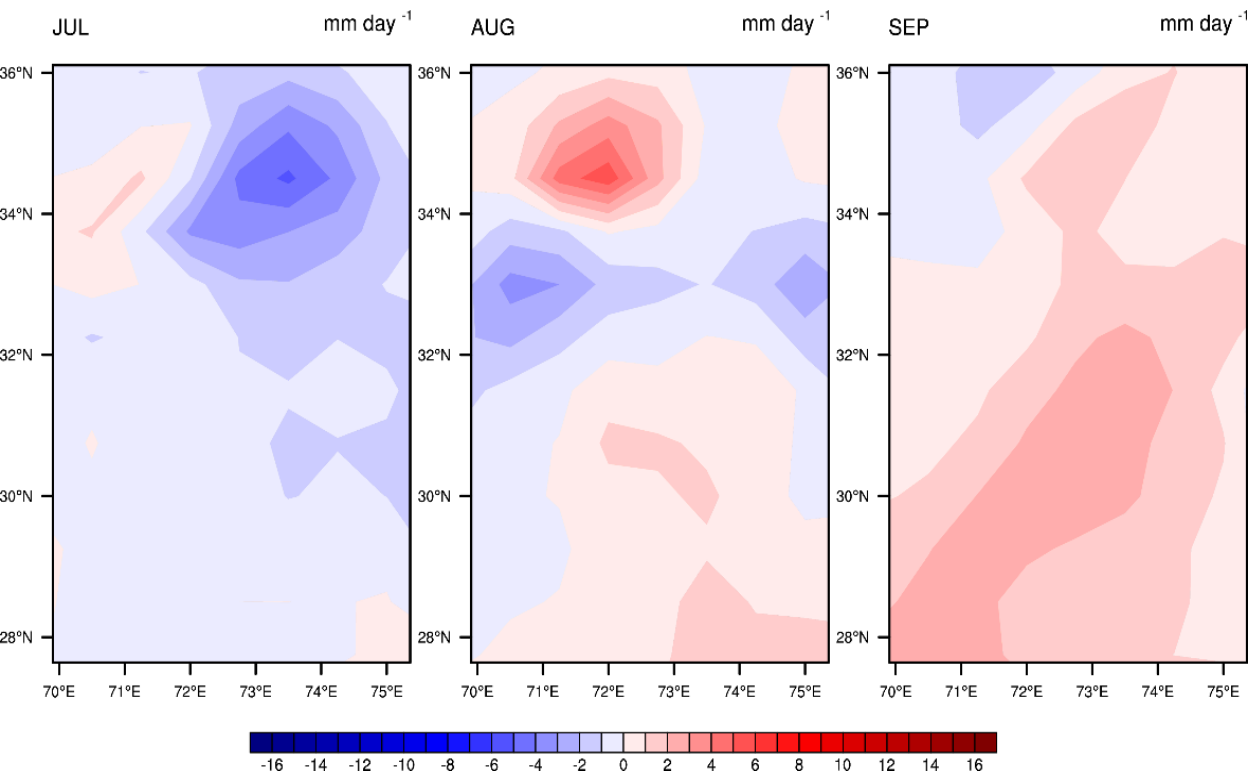
Pre-flooding instance




Rainfall anomaly 2010

over Upper Indus Basin region of Pakistan

Flooding instance




Rainfall anomaly 2011 over Upper Indus Basin region of Pakistan

Post-flooding instance

The abnormal rainfall patterns (anomalies) have been observed during 2010 and 2011 when compared to the normal conditions.

# Application

- An interactive automated application can be developed on the methodology which can serve the purpose of web-based flood delineation tool involving GIS and reanalysis model data sets.
- Studied sub-basins can be further used for flood risk mapping. This analysis can be used in planning for natural resource, flood management and mitigation plans.

Thankyou