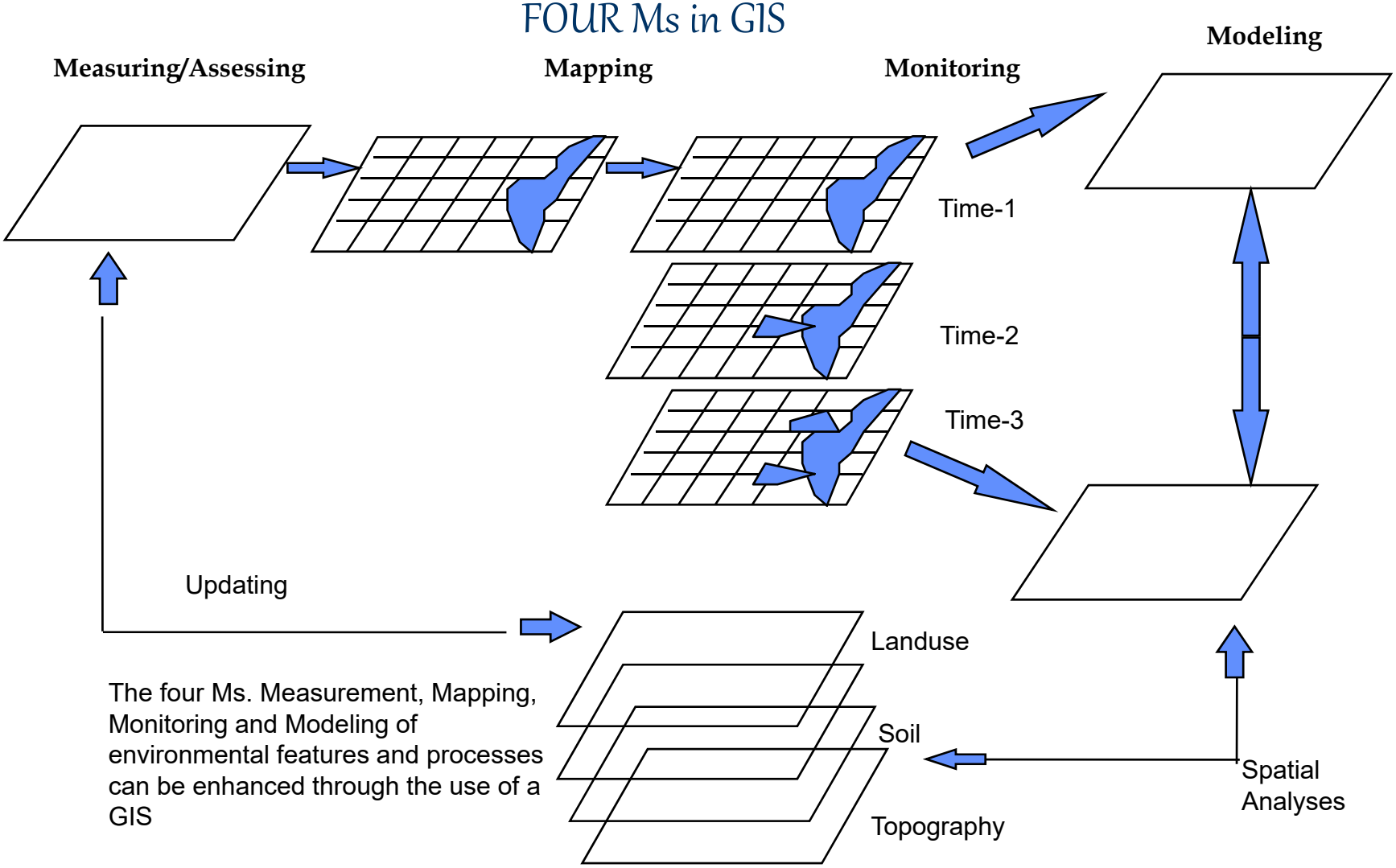
Applications of GIS

- Natural Resources' Applications
- Environmental Applications
- Socioeconomic Applications

Sample GIS Applications

- Land-use planning and management
- Mineral exploration
- Forestry and wildlife management
- Soil degradation studies
- Monitoring desertification
- Natural Hazard Mapping

FOUR Ms in GIS



The four Ms. Measurement, Mapping, Monitoring and Modeling of environmental features and processes can be enhanced through the use of a GIS

GEOGRAPHIC INFORMATION SYSTEM

Adapted from J.Stars and J.Estates

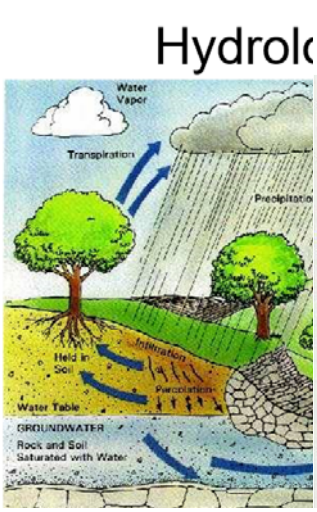
FLOOD RISK MODELING

- **How much water is there?**

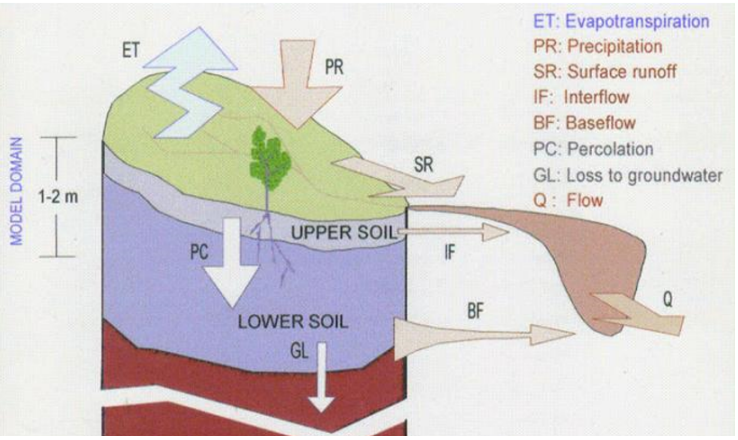
  Hydrologic Modeling:
  (precipitation-runoff modeling), determines for a given area, how much water will become **runoff.**

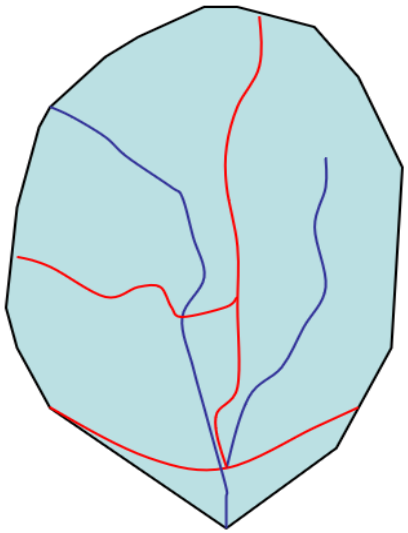
- **Where will it go?**

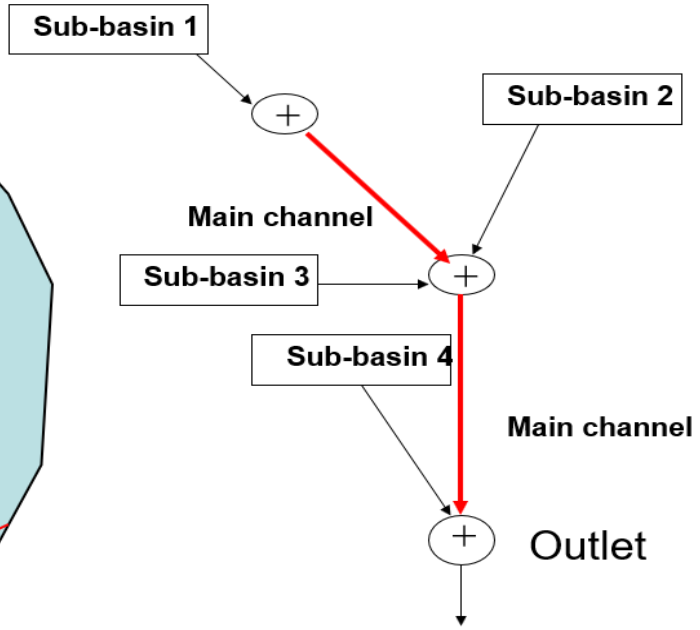
  Hydraulic modeling:
  takes the **quantity of water** and the **shape of the landscape** and stream channel and determines **how deep and fast** the water will be, and what area it will cover.



Hydrological Cycle







USGS science for a changing world

Flood Risk Assessment

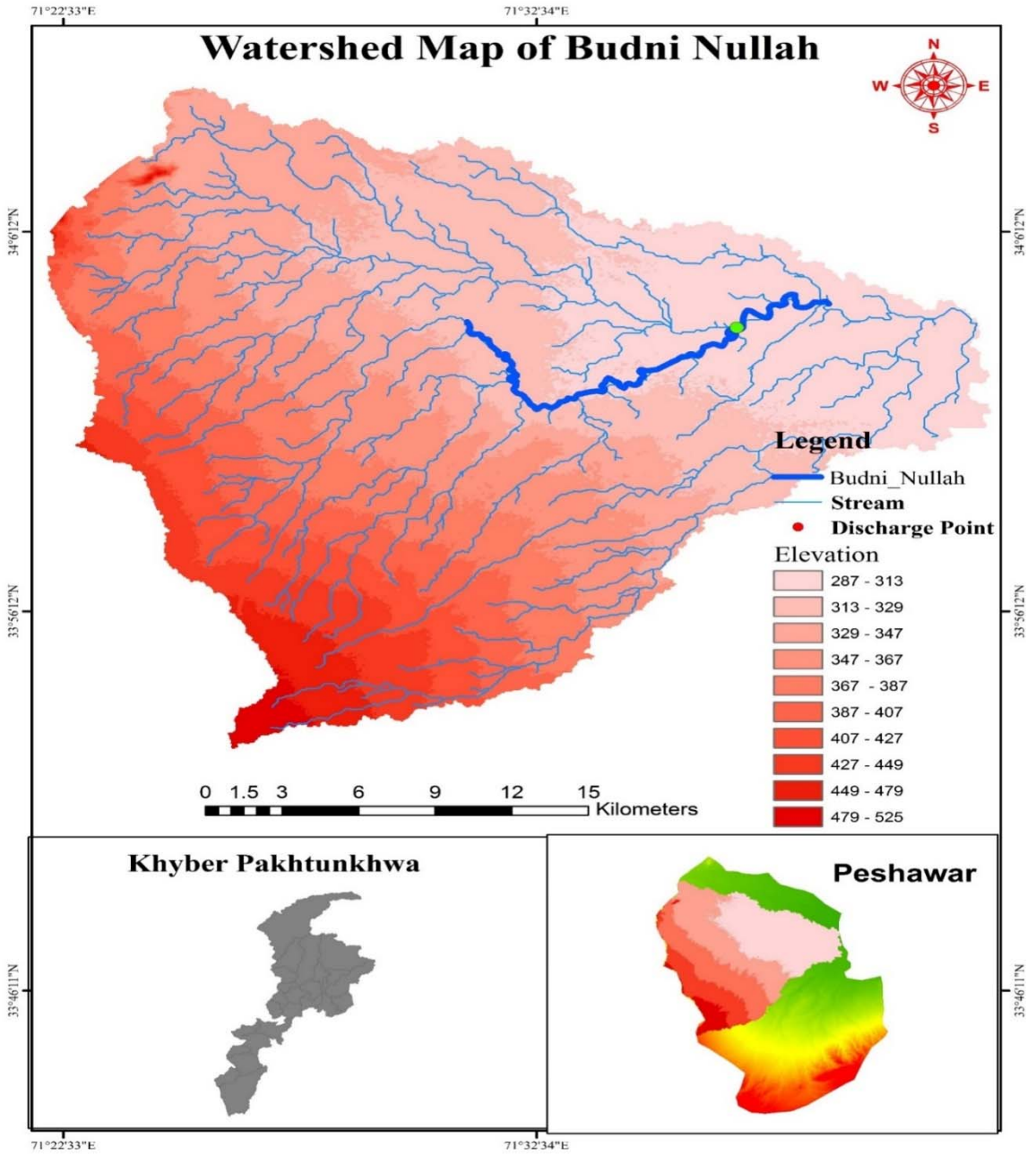
Risk = Hazard * Vulnerability * Exposure

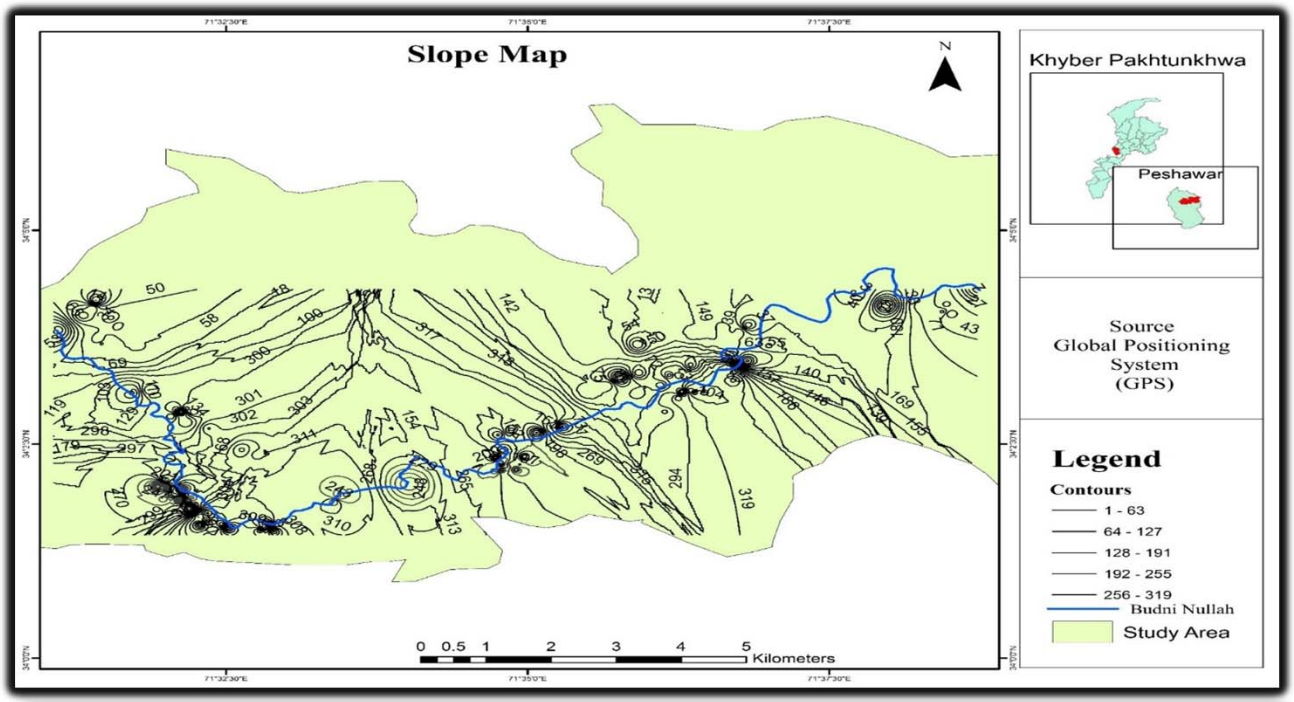
- Hazard accounts different characteristics of hazard like velocity, depth of water, Probability, Intensity, duration etc.
- Exposure takes into account the environmental conditions e.g. Proximity, susceptibility etc.
- Vulnerability is weaknesses of a person or a group to cope with, or resist and recover from floods.

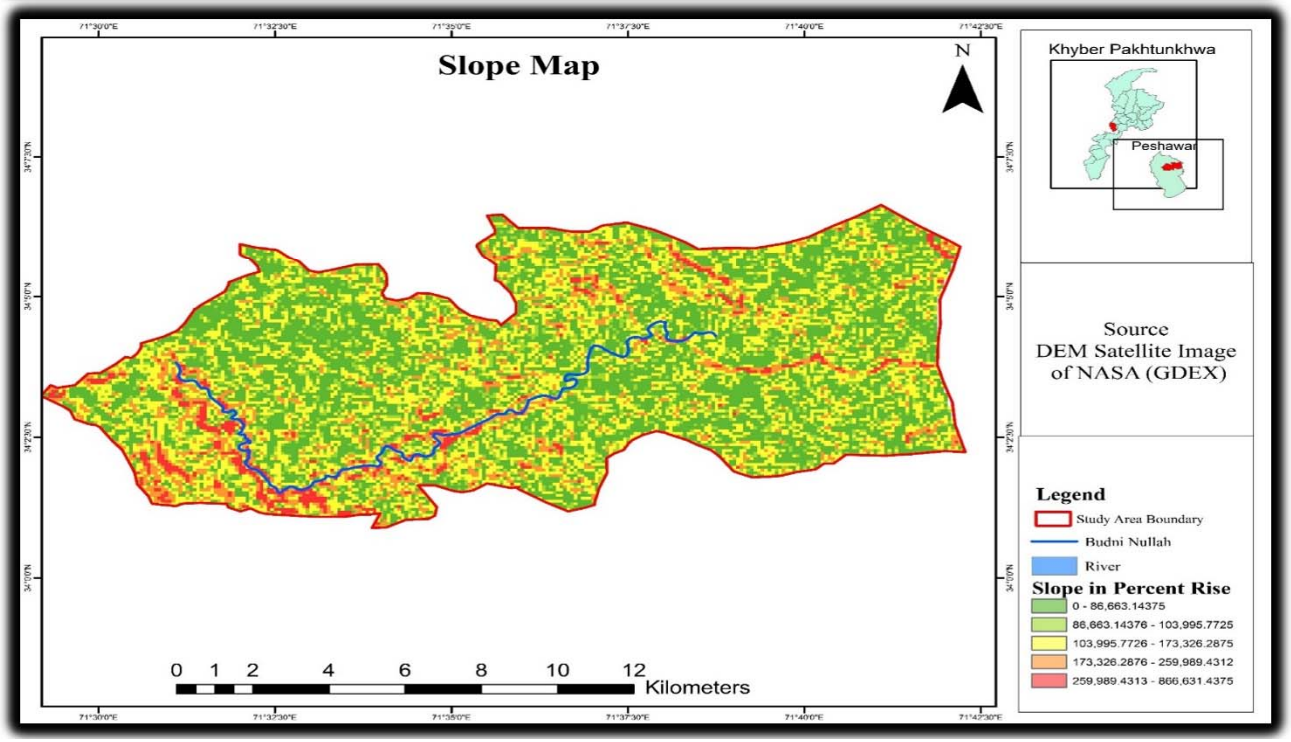
Example: Flood Risk Assessment for Budni Nullah (Peshawar)

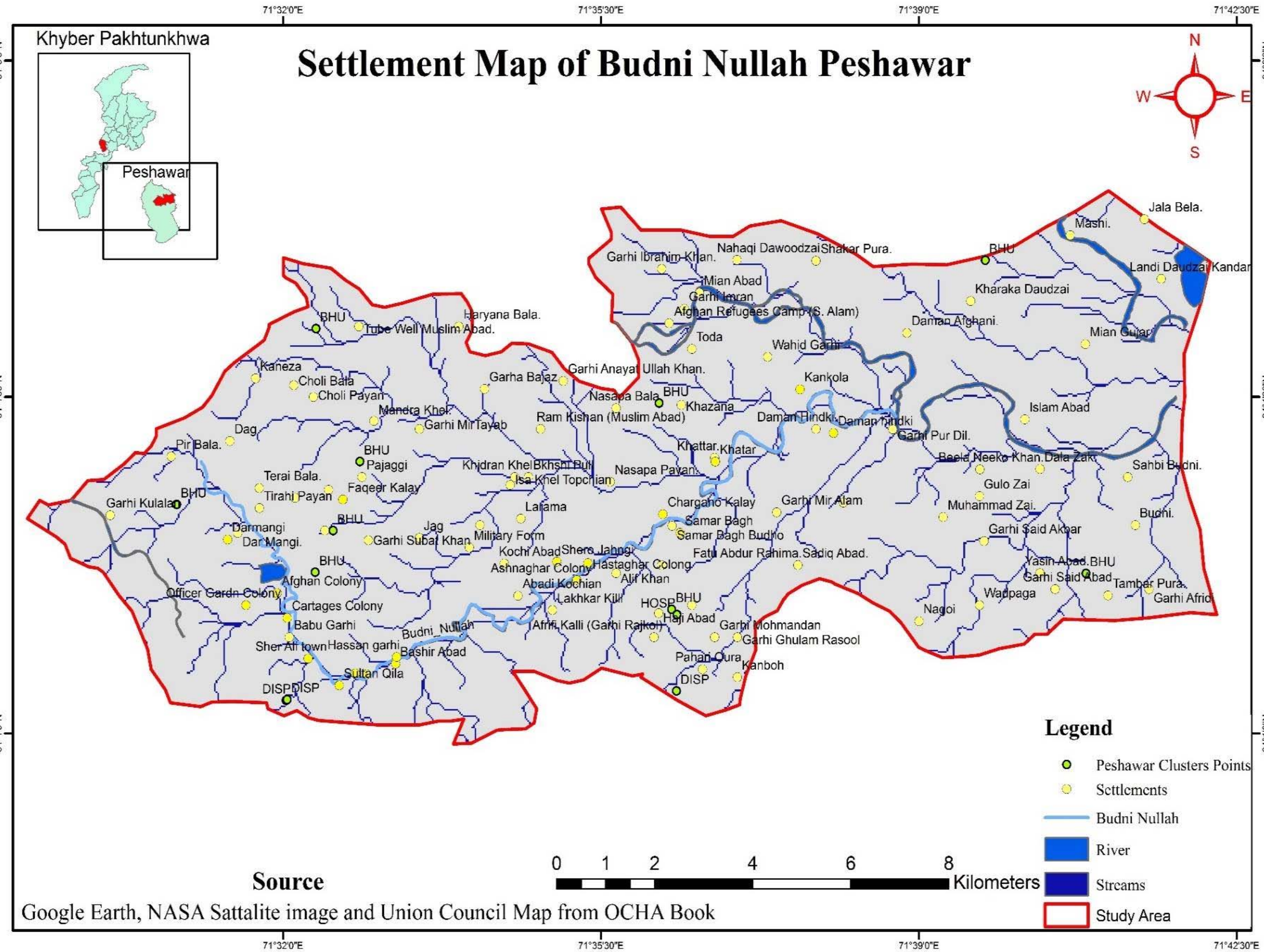
FLOOD HAZARD MAPING

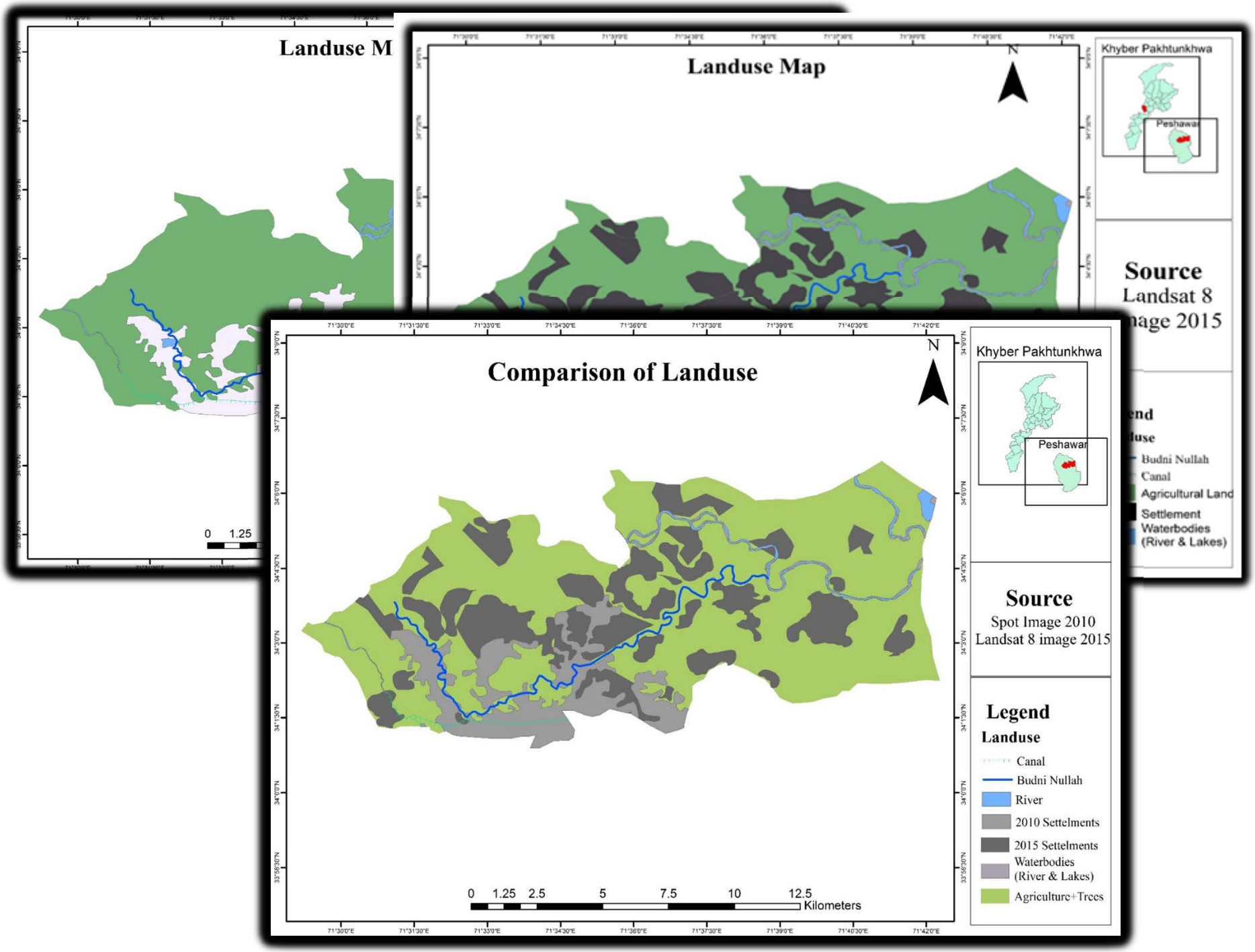
The degree of flood hazard in a certain area is determined by a combination of factors. These factors are provided in the form of maps like:

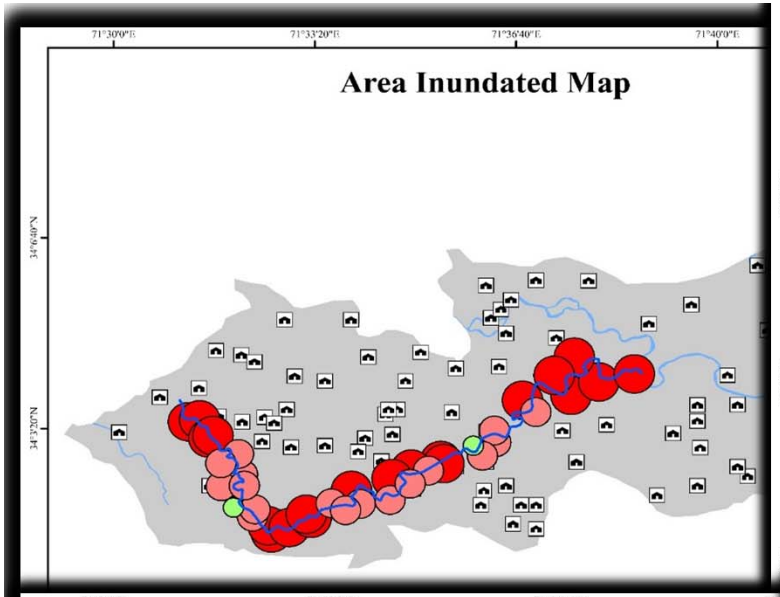


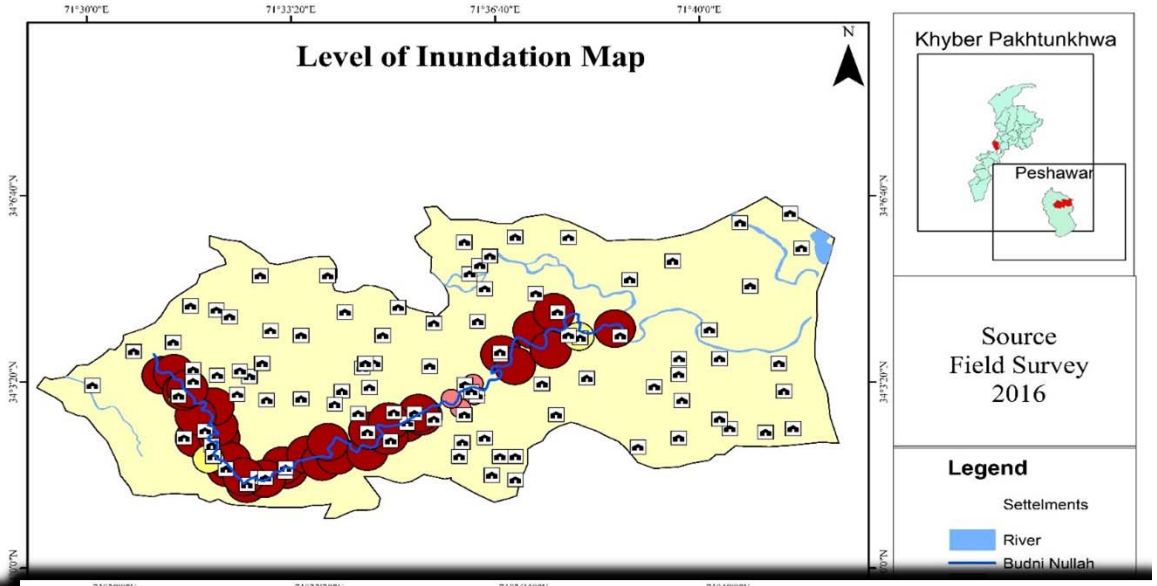

Slope Map
N
Khyber Pakhtunkhwa
Peshawar
Source
Global Positioning
System
(GPS)
Legend
Contours
1 - 63
64 - 127
128 - 191
192 - 255
256 - 319
Budni Nullah
Study Area
0 0.5 1 2 3 4 5
Kilometers

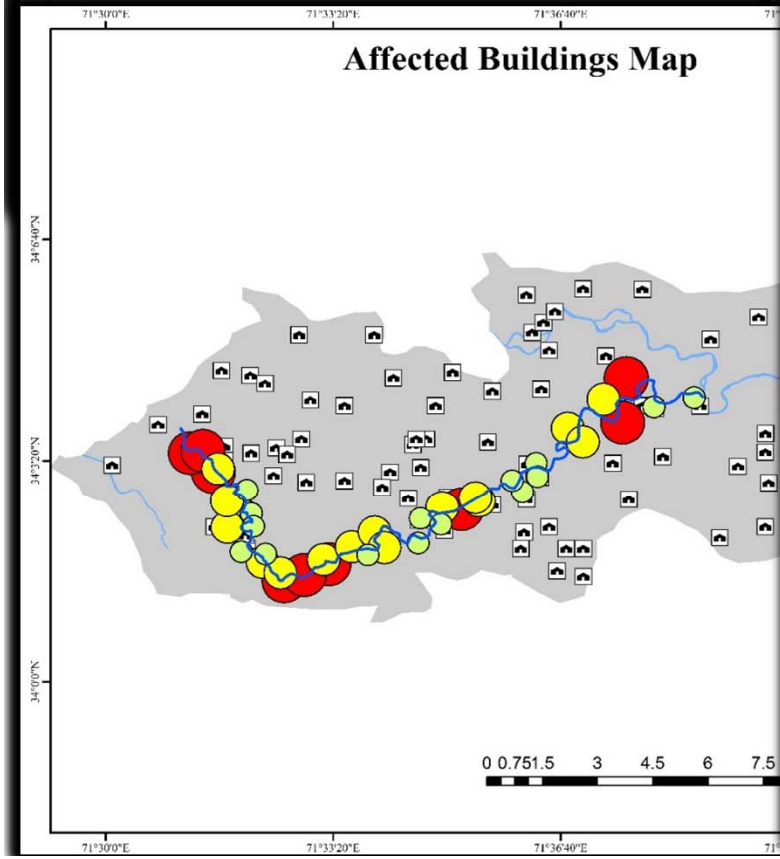

Slope Map
N
Khyber Pakhtunkhwa
Peshawar
Source
DEM Satellite Image
of NASA (GDEX)
Legend
Study Area Boundary
Budni Nullah
River
Slope in Percent Rise
0 - 86,663.14375
86,663.14376 - 103,995.7725
103,995.7726 - 173,326.2875
173,326.2876 - 259,989.4312
259,989.4313 - 866,631.4375
0 1 2 4 6 8 10 12
Kilometers

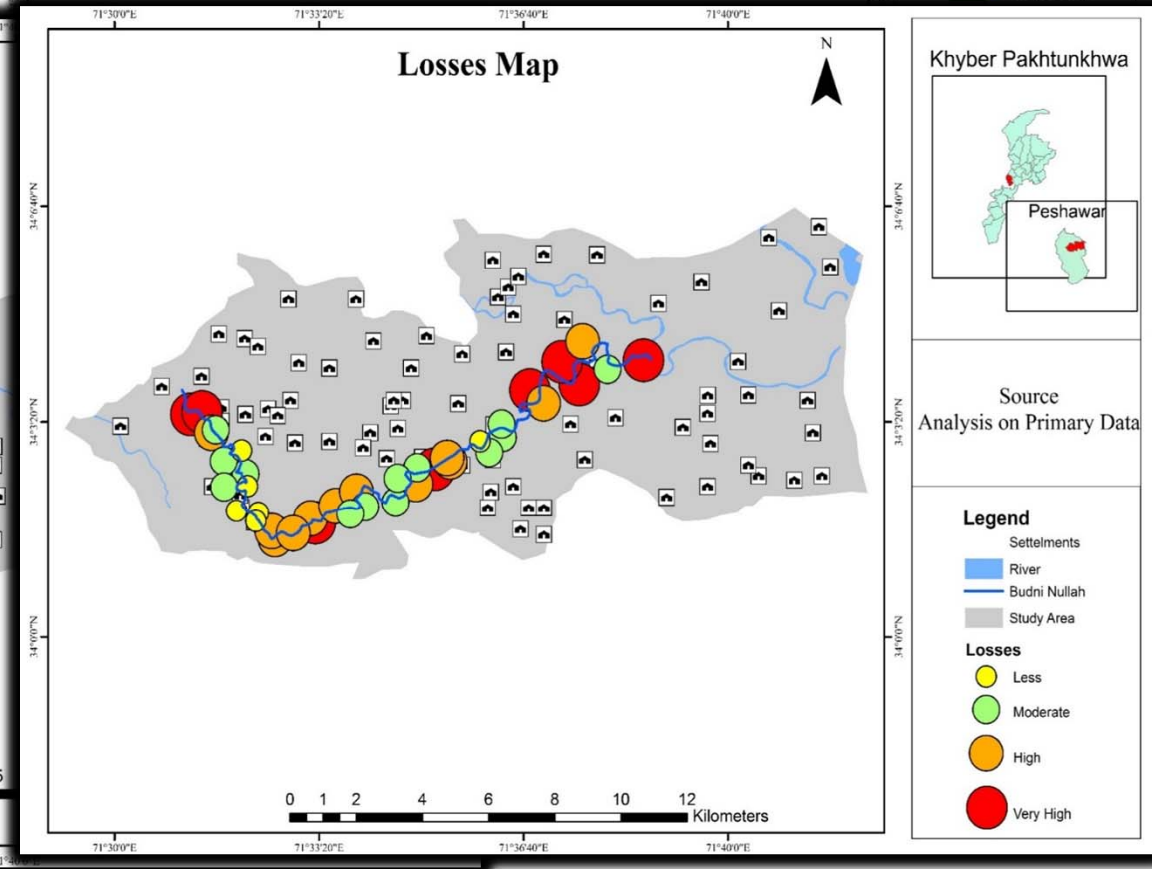

Settlement Map of Budni Nullah Peshawar
Khyber Pakhtunkhwa
Peshawar
N
S
E
W
71°32'0"E
71°35'30"E
71°39'0"E
71°42'30"E
34°8'0"N
34°4'30"N
34°1'0"N
Jala Bela.
Mashi.
BHU
Landi Daudzai Kandar
Kharaka Daudzai
Daman Afghani.
Mian Gujar
Garhi Ibrahim Khan.
Nahaqi Dawoodzai
Shakar Pura.
Mian Abad
Garhi Imran
Afghan Refugees Camp (S. Alam)
Toda
Wahid Garhi
Kankola
Haryana Bala.
Tube Well Muslim Abad.
Garha Bajaz
Garhi Anayat Ullah Khan.
Nasapa Bala
Khazana
Ram Kishan (Muslim Abad)
Daman Hindki
Garhi Pur Dil.
Islam Abad
Kaneza
Choli Bala
Choli Payan
Mandra Khel
Garhi Mir Tayab
Dag
Pir Bala.
Pajaggi
Khidran Khel
Isa Khel Topchian
Nasapa Payan
Khattar.
Khatar
Terai Bala.
Tirahi Payan
Faqeer Kalay
Garhi Kulala
Lalama
Chargano Kalay
Garhi Mir Alam
Samar Bagh
Samar Bagh Budho
Gulo Zai
Muhammad Zai.
Sahbi Budni.
Budni.
Garhi Said Akbar
Darmangi
Dar Mangi.
Jag
Garhi Subal Khan
Military Form
Kochi Abad
Shero Jahngi
Ashnaghar Colony
Hastaghar Colony
Fatu Abdur Rahima.
Sadiq Abad.
Ali Khan
Abadi Kochian
Afghan Colony
Officer Gardn Colony
Cartages Colony
Lakhkar Killi
HOSP
Haji Abad
Yasin Abad.
Garhi Said Abad
Tamber Pura.
Garhi Afridi
Wadpaga
Nagoi
Babu Garhi
Budni_Nullah
Afrin Kalli (Garhi Rajkol)
Garhi Mohmandan
Garhi Ghulam Rasool
Sher Ali town
Hassan garhi
Bashir Abad
Pahari Pura
Kanboh
Sultan Qila
DISP
Legend
Peshawar Clusters Points
Settlements
Budni Nullah
River
Streams
Study Area
0 1 2 4 6 8 Kilometers
Source
Google Earth, NASA Sattalite image and Union Council Map from OCHA Book

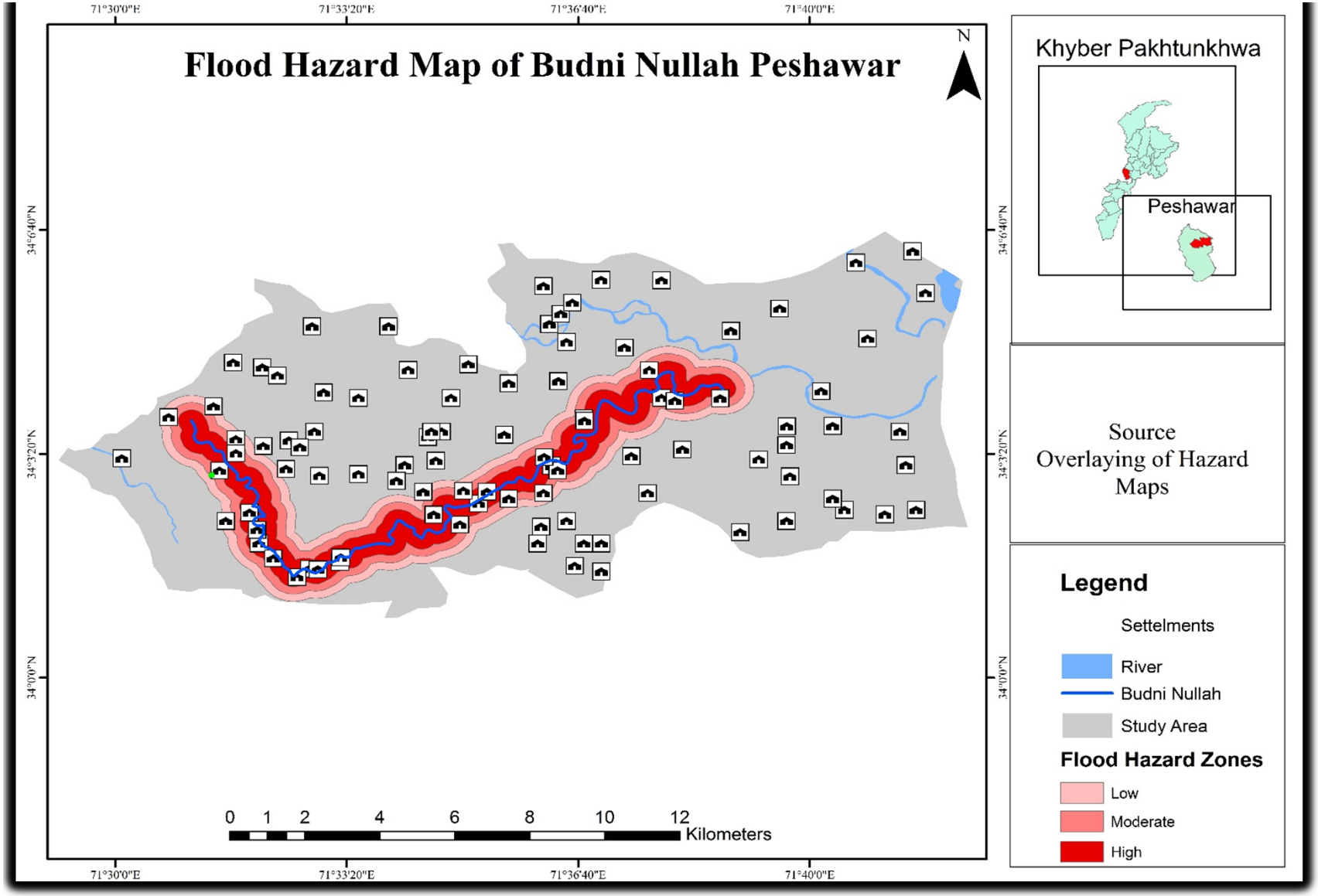

Landuse M
Landuse Map
Khyber Pakhtunkhwa
Peshawar
Source
Landsat 8
nage 2015
Budni Nullah
Canal
Agricultural Land
Settlement
Waterbodies
(River & Lakes)
0 1.25
Comparison of Landuse
N
Khyber Pakhtunkhwa
Peshawar
Source
Spot Image 2010
Landsat 8 image 2015
Legend
Landuse
Canal
Budni Nullah
River
2010 Settelments
2015 Settelments
Waterbodies
(River & Lakes)
Agriculture+Trees
0 1.25 2.5 5 7.5 10 12.5
Kilometers


Area Inundated Map
71°30'0"E
71°33'20"E
71°36'40"E
71°40'0"E


Level of Inundation Map
N
71°30'0"E
71°33'20"E
71°36'40"E
71°40'0"E
Khyber Pakhtunkhwa
Peshawar
Source
Field Survey
2016
Legend
Settelments
River
Budni Nullah


Affected Buildings Map
71°30'0"E
71°33'20"E
71°36'40"E
0 0.751.5 3 4.5 6 7.5


Losses Map
N
71°30'0"E
71°33'20"E
71°36'40"E
71°40'0"E
0 1 2 4 6 8 10 12
Kilometers
Khyber Pakhtunkhwa
Peshawar
Source
Analysis on Primary Data
Legend
Settelments
River
Budni Nullah
Study Area
Losses
Less
Moderate
High
Very High

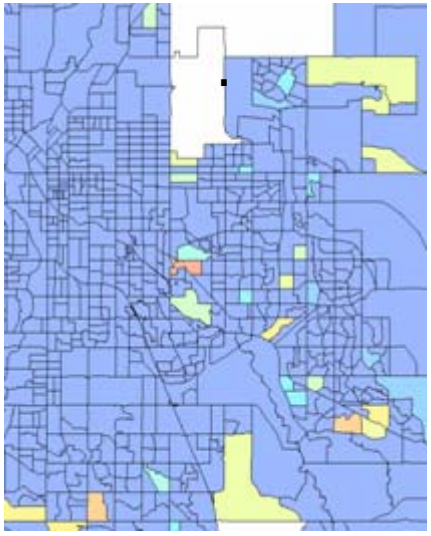

Flood Hazard Map of Budni Nullah Peshawar
N
71°30'0"E
71°33'20"E
71°36'40"E
71°40'0"E
34°6'40"N
34°3'20"N
34°0'0"N
0 1 2 4 6 8 10 12
Kilometers
Khyber Pakhtunkhwa
Peshawar
Source
Overlaying of Hazard Maps
Legend
Settelments
River
Budni Nullah
Study Area
Flood Hazard Zones
Low
Moderate
High

Vulnerability Assessment

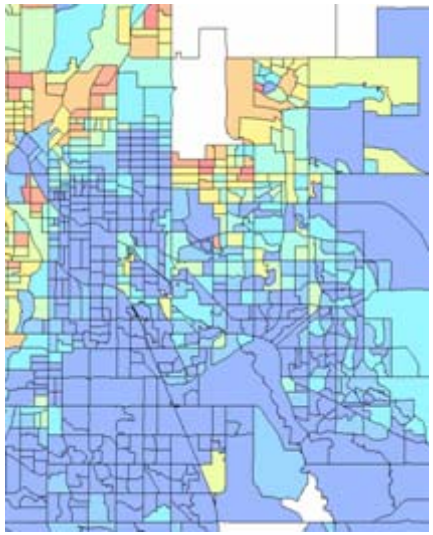
Physical Vulnerability

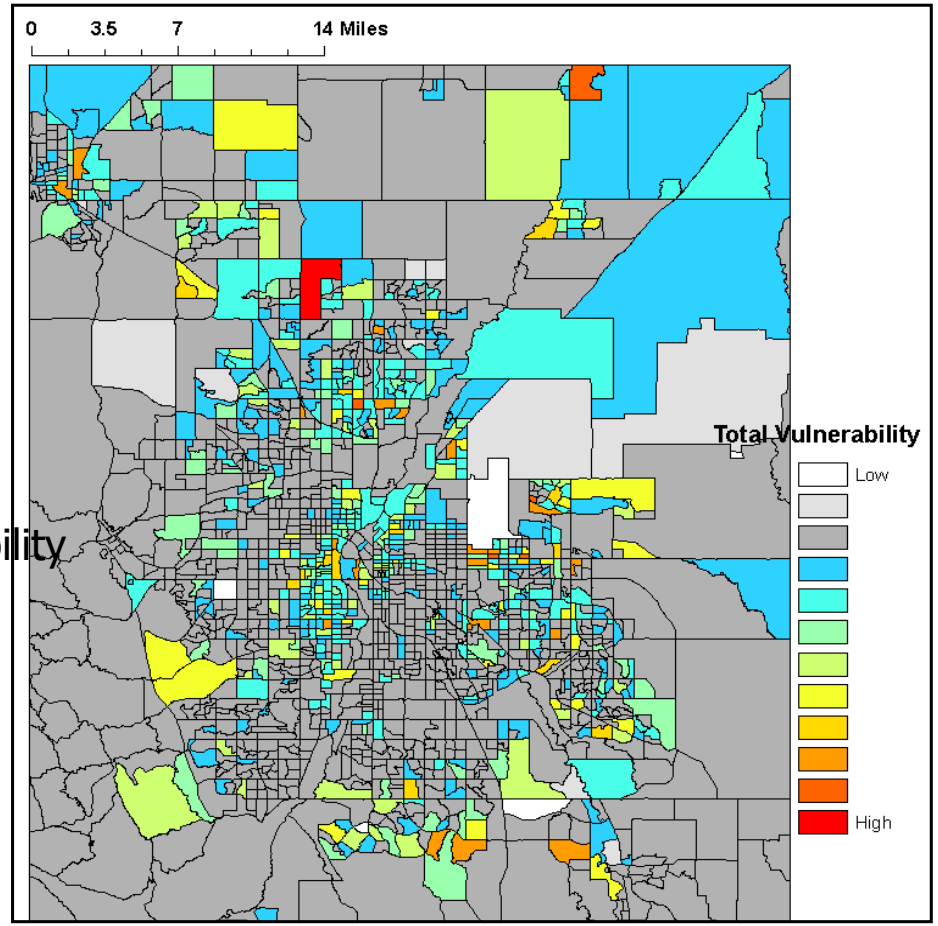
Economic Vulnerability

Social Vulnerability



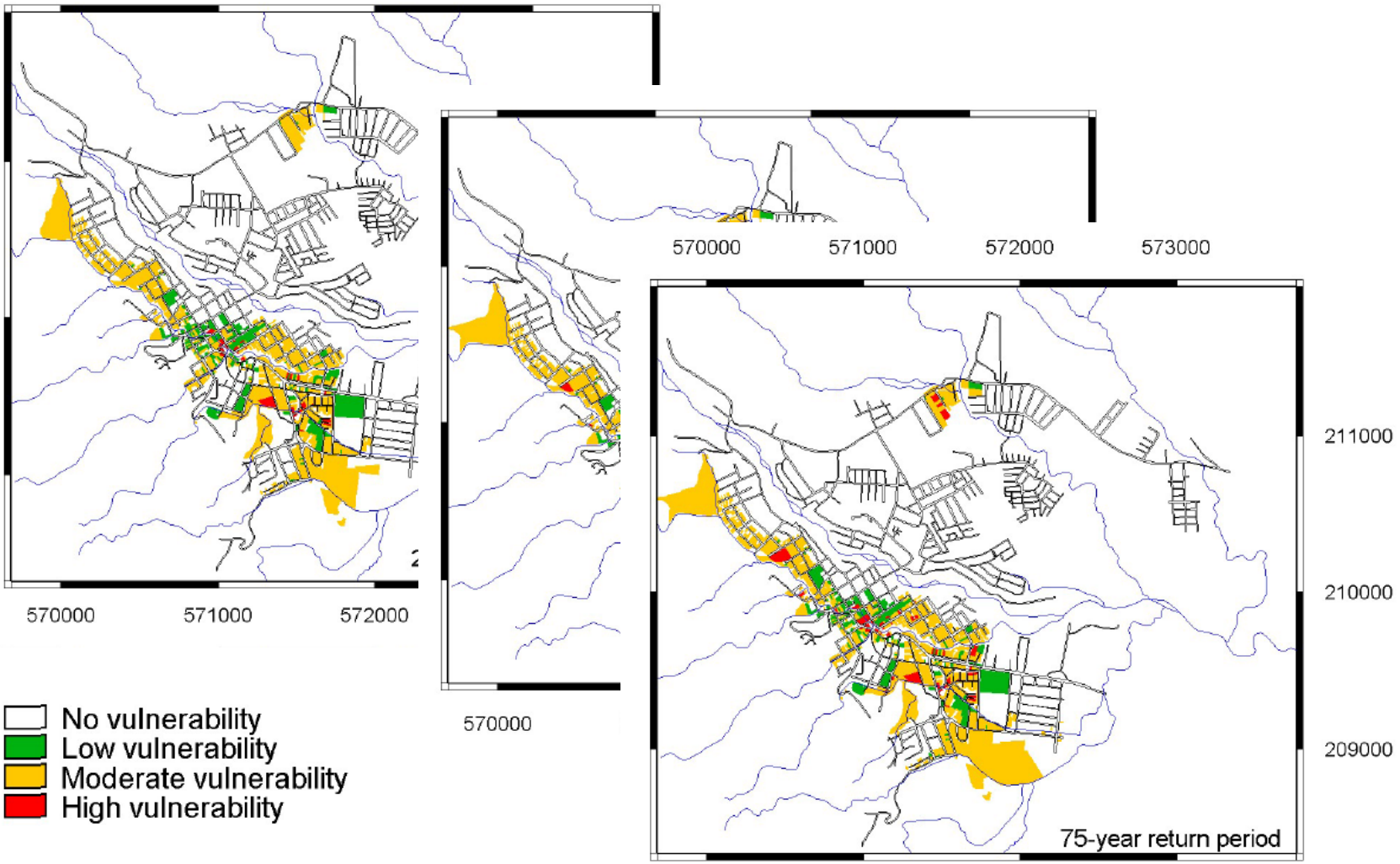
Environmental Vulnerability





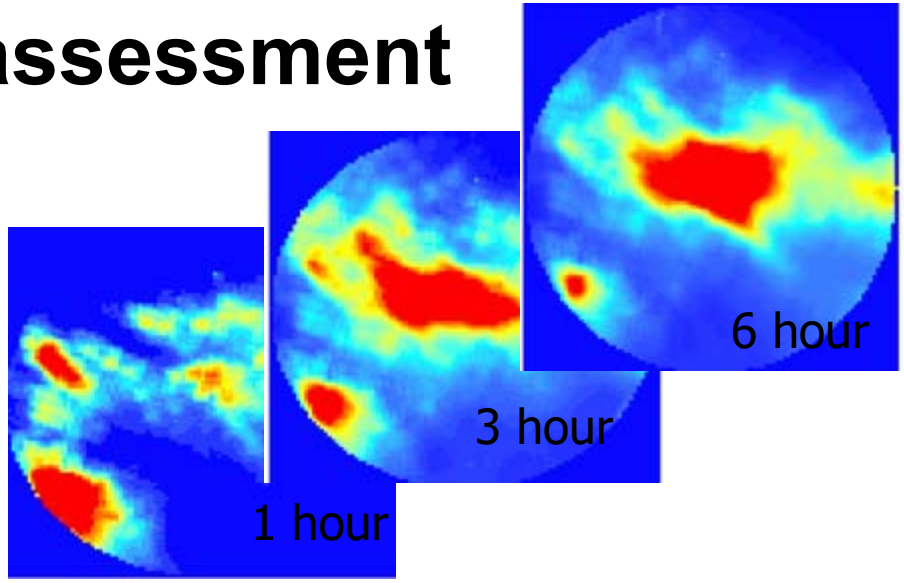
Total Vulnerability

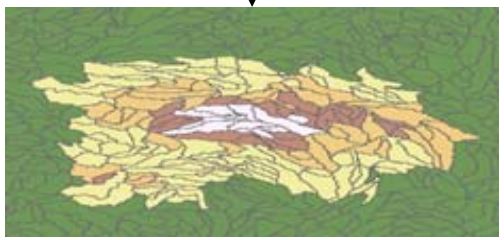
Vulnerability maps for different return period



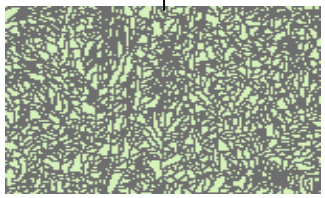
Exposure assessment

Radar rainfall

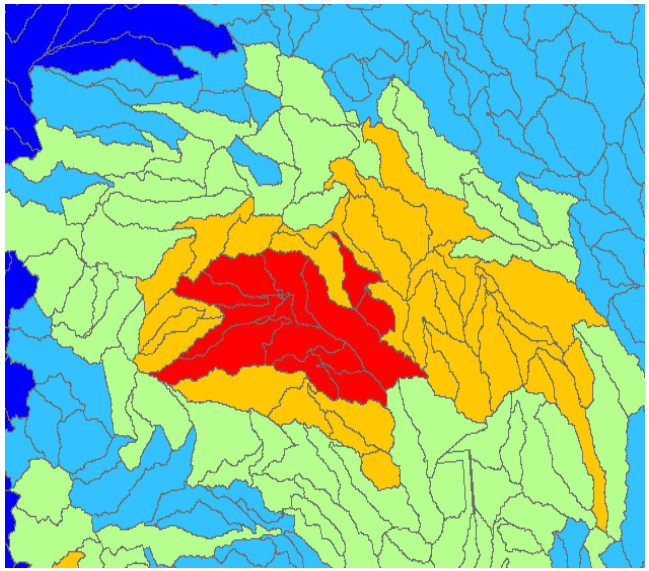




Basin average rainfall

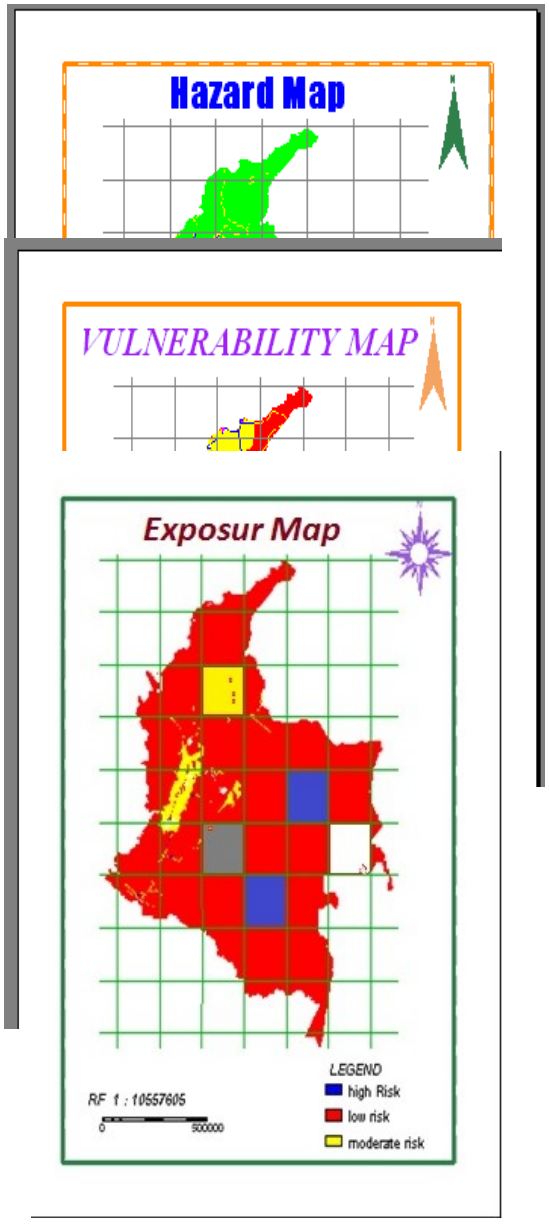


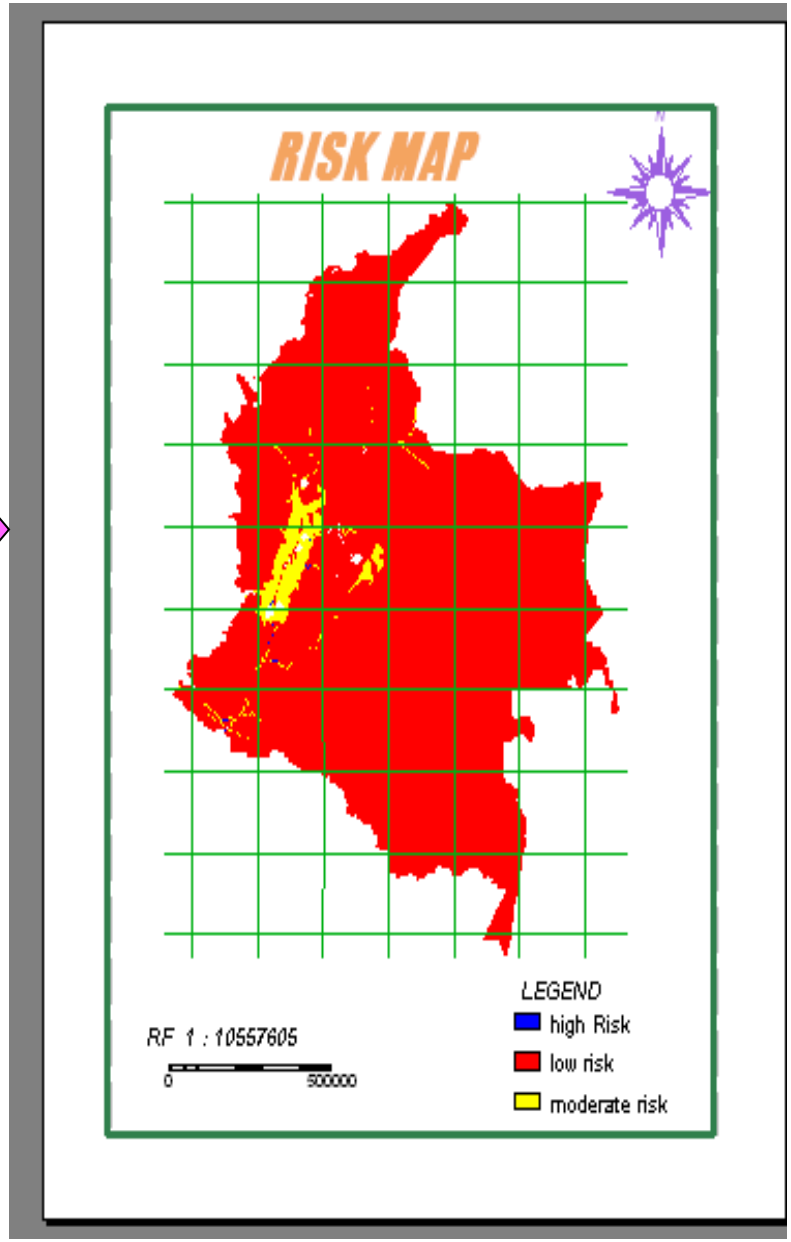
Watershed boundaries



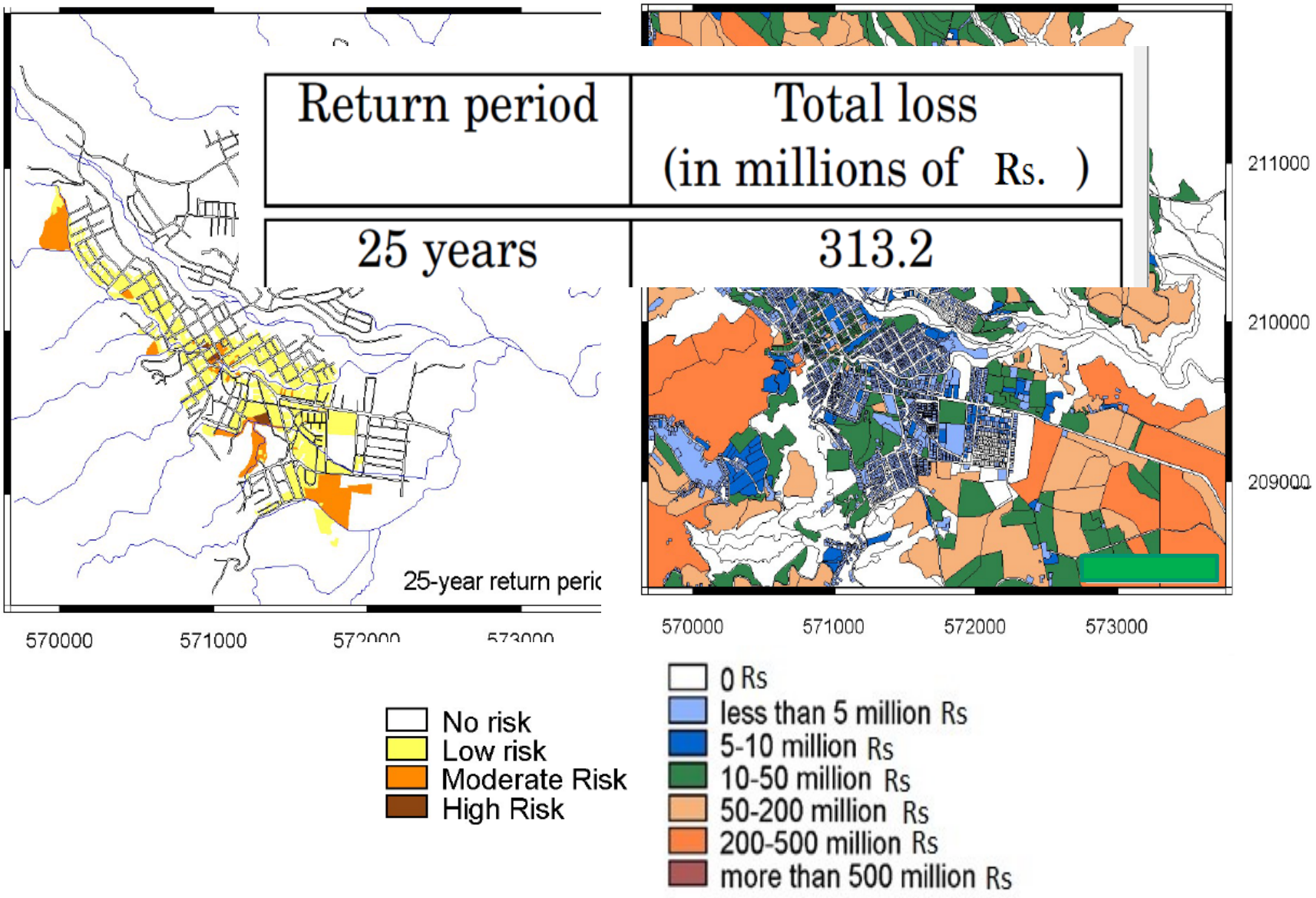
Exposure

RISK MAP AS A PRODUCT OF:
HAZARD, VULNERABILITY AND EXPOSURE MAPS

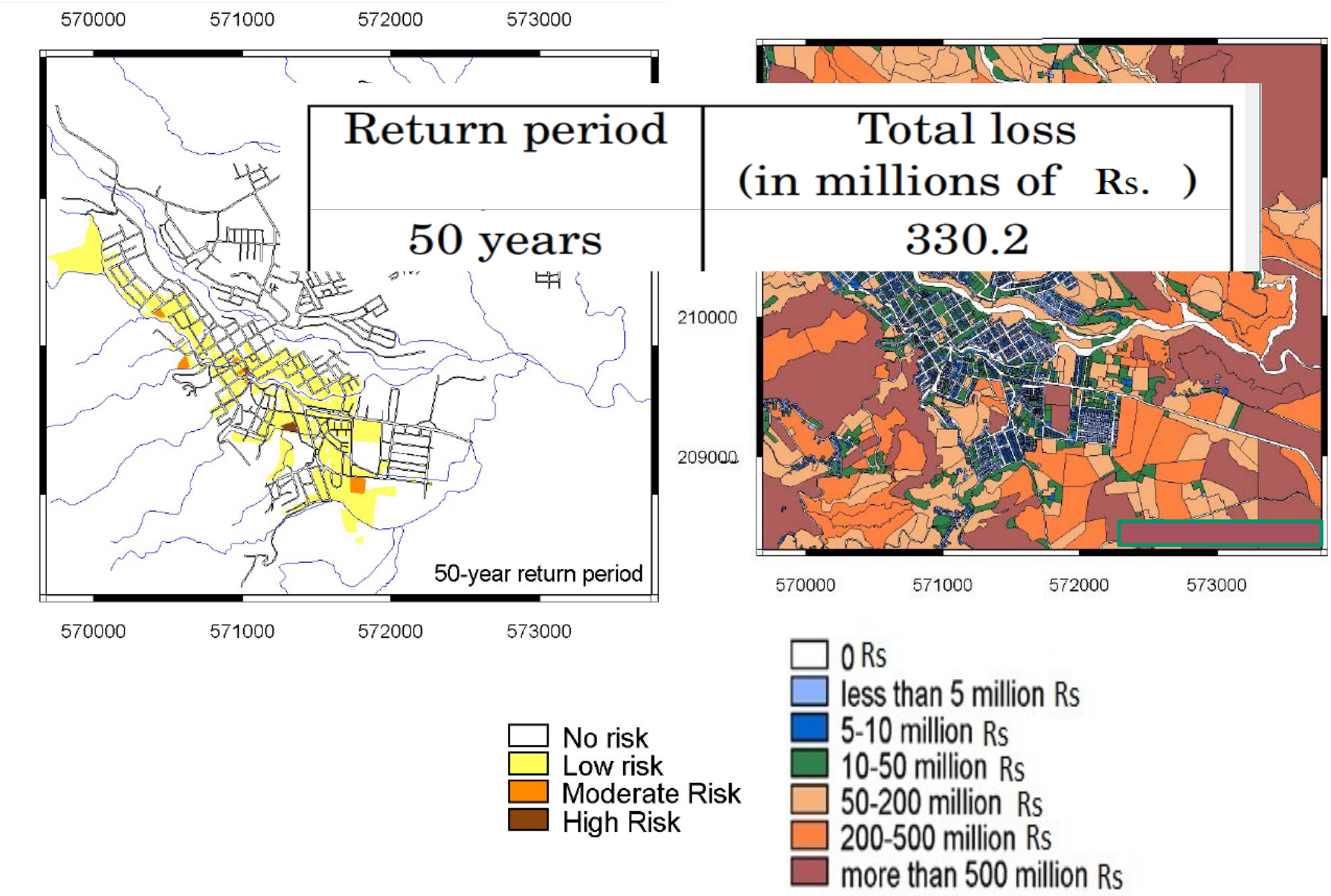




Final risk and cost maps for 25 year return period

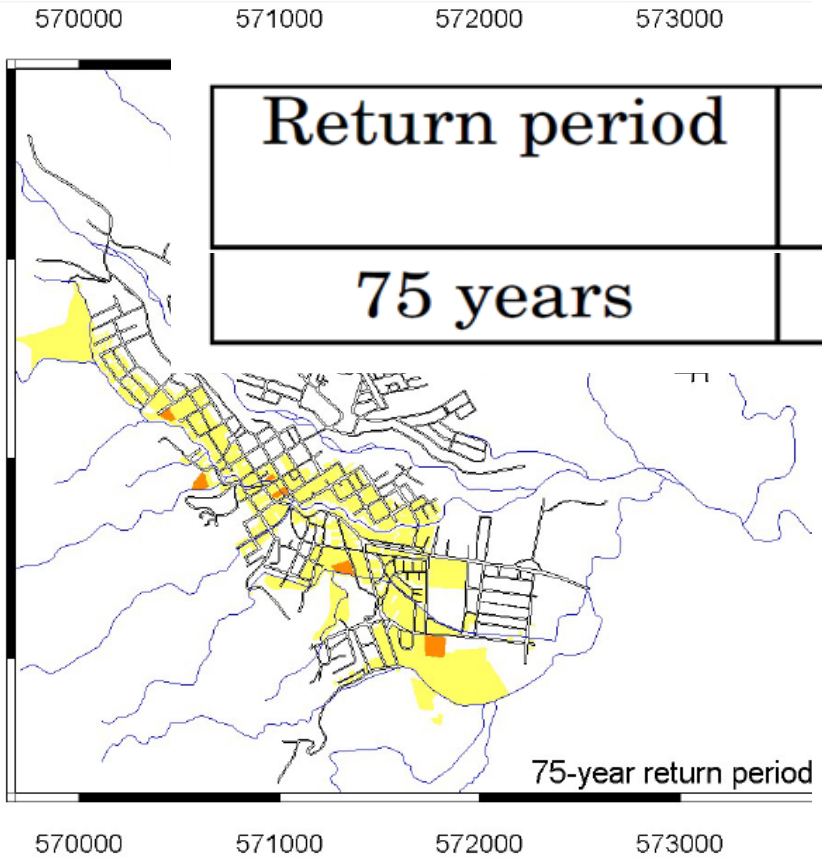


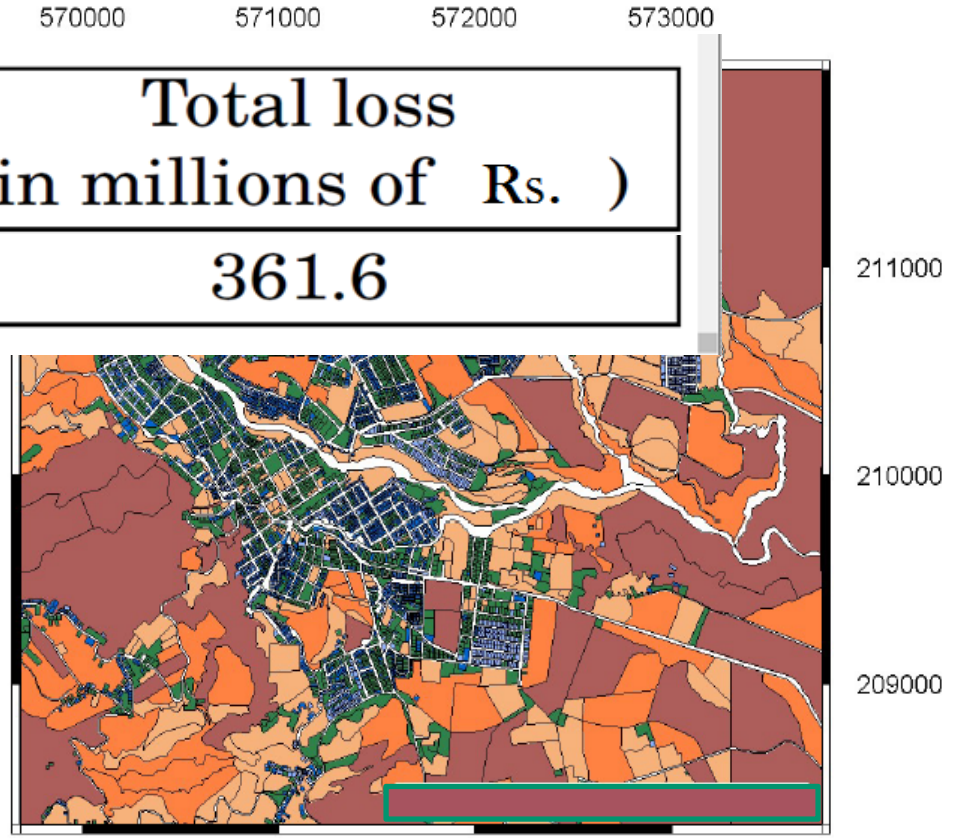
Final risk and cost maps for 50 year return period



Final risk and cost maps for 75 year return period

Return period	Total loss (in millions of Rs.)
75 years	361.6





No risk
Low risk
Moderate Risk
High Risk

0 Rs
less than 5 million Rs
5-10 million Rs
10-50 million Rs
50-200 million Rs
200-500 million Rs
more than 500 million Rs

No risk	$risk = 0$ Rs.
Low risk	$risk \leq 250000$ Rs.
Moderate risk	$risk$ 250000 Rs. – 1.0 million Rs.
High risk	$risk > 1.0$ million Rs.

Abbott (1996) stated:

"*Still, those who decide to build on a flood plain are gamblers. They may win their gamble for many years, but the river still rules the floodplain, and every so often it comes back to collect all bets".*

Thank you