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Understanding multiscale drivers of natural hazards, cascading failures, and risk management strategies within a multisector system

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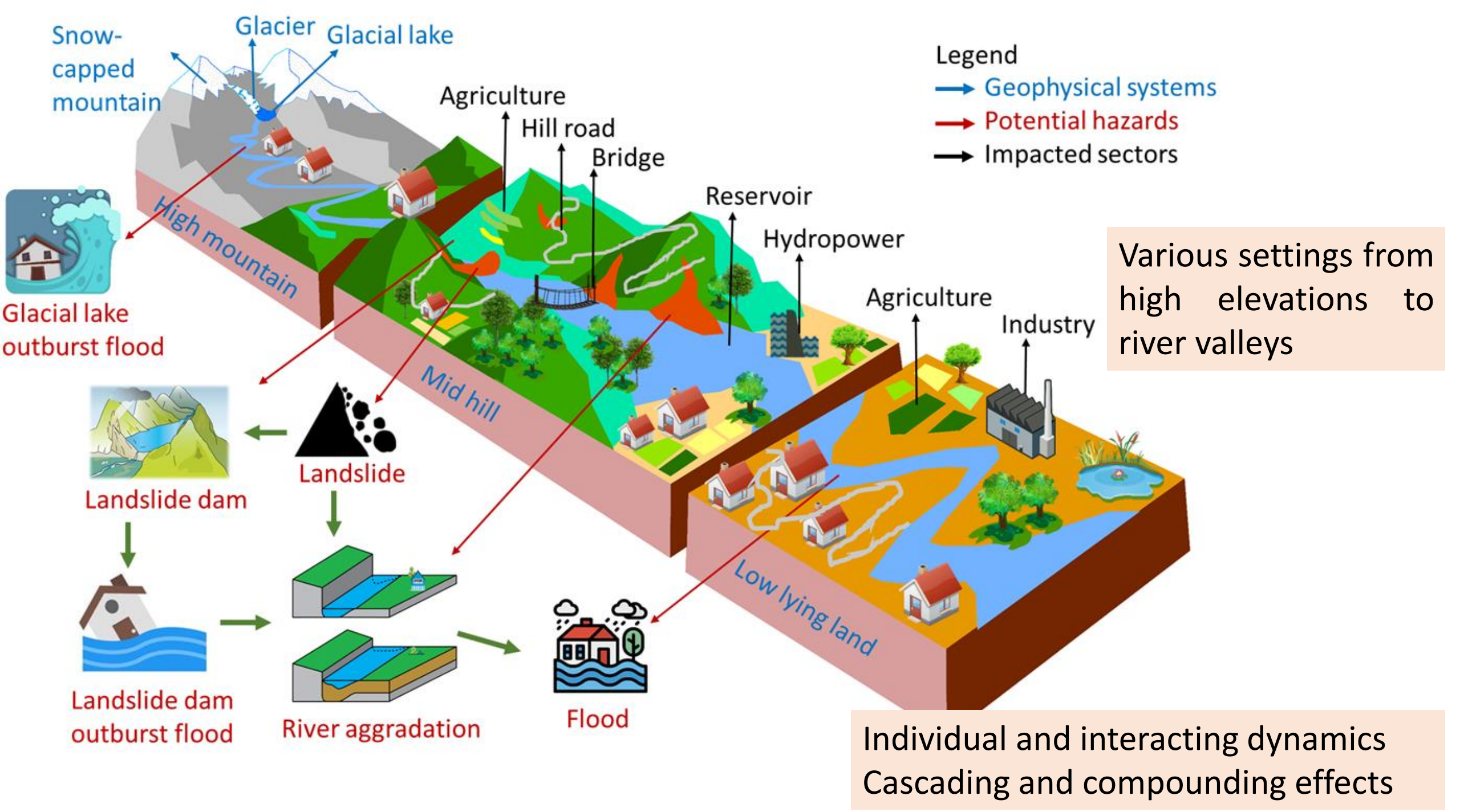
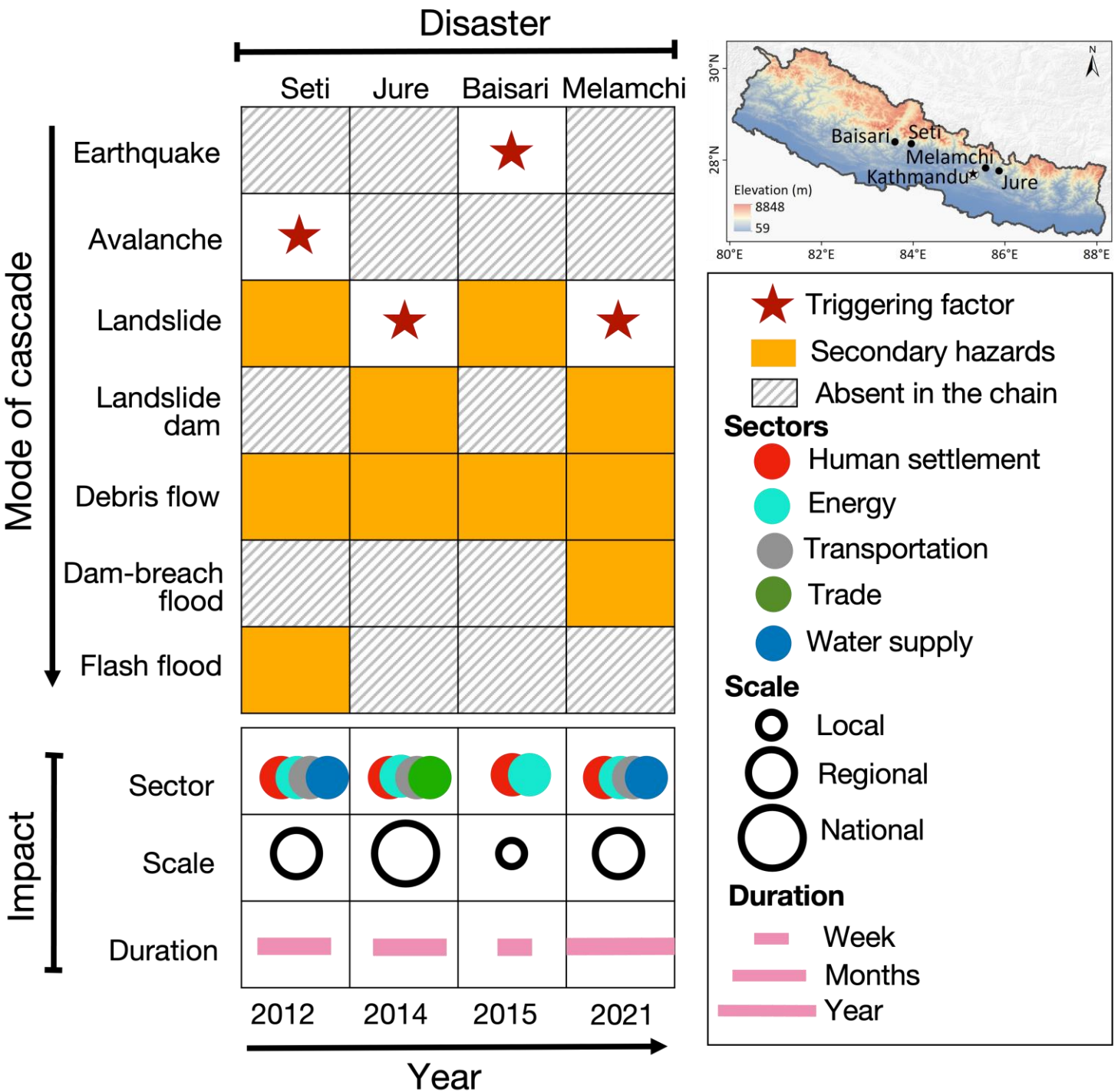
May 24, 2022



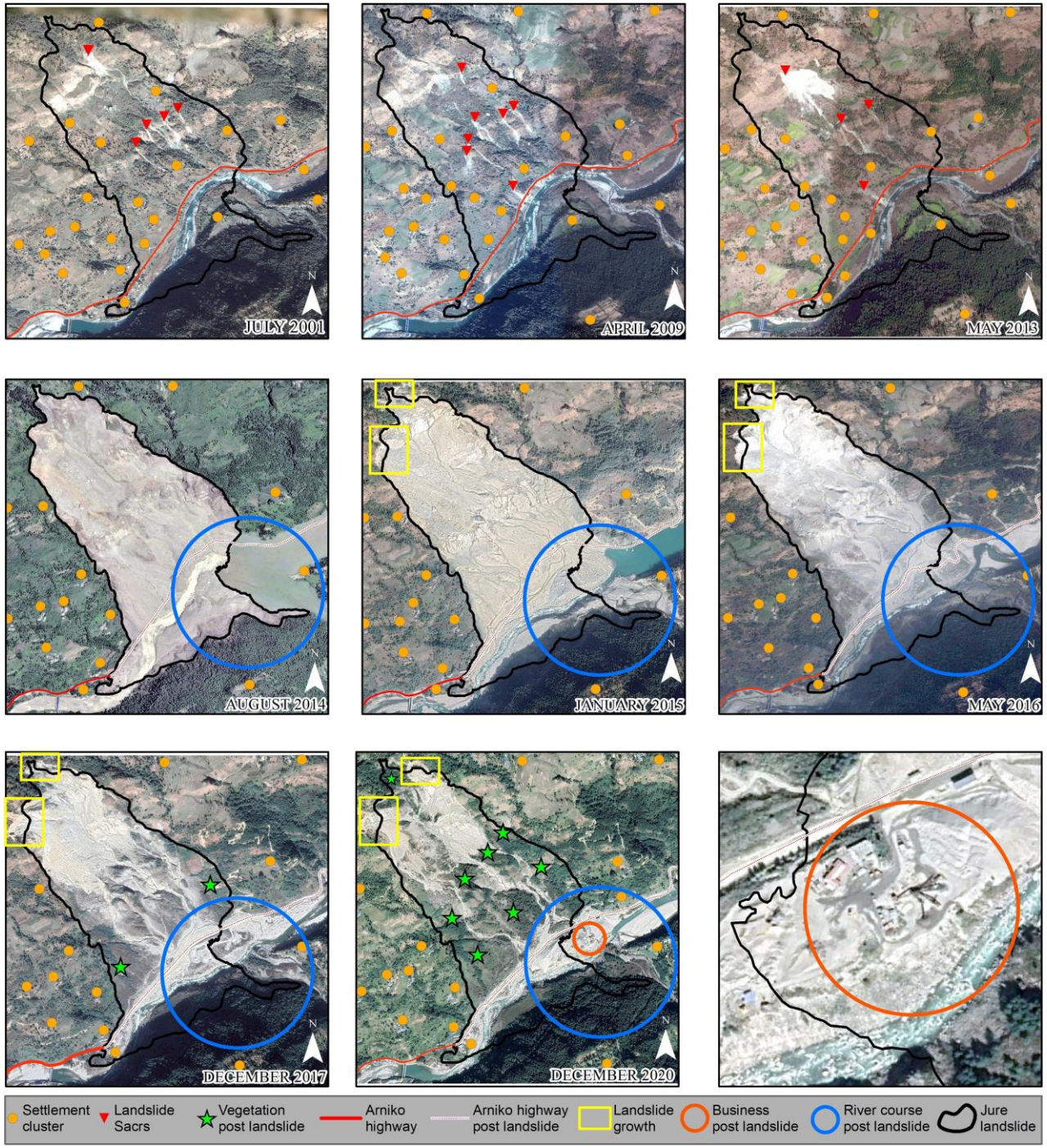
Various settings from high elevations to river valleys

Individual and interacting dynamics
Cascading and compounding effects

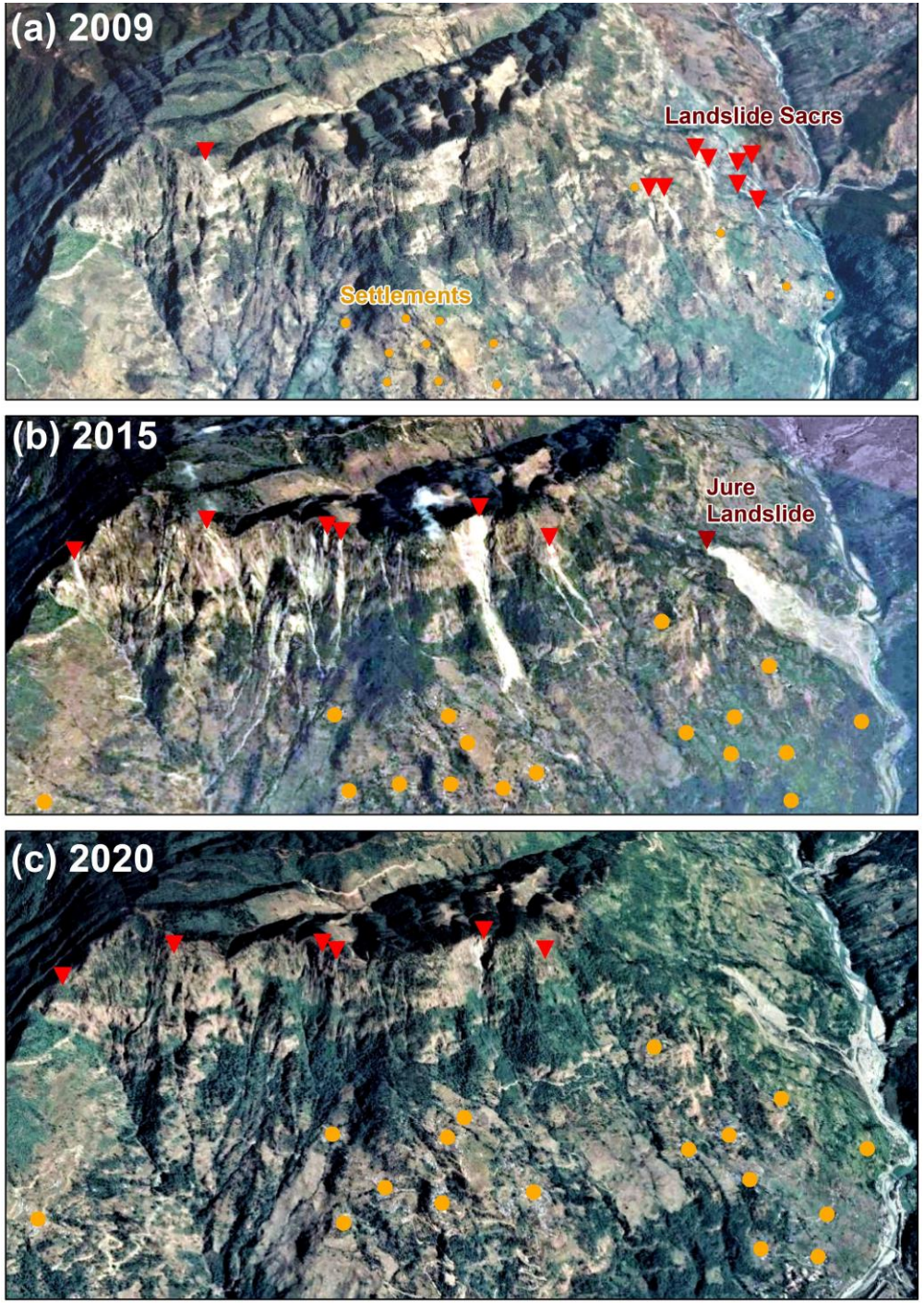

Disaster
Seti
Jure
Baisari
Melamchi
Earthquake
Avalanche
Landslide
Landslide dam
Debris flow
Dam-breach flood
Flash flood
Mode of cascade
Impact
Sector
Scale
Duration
2012
2014
2015
2021
Year

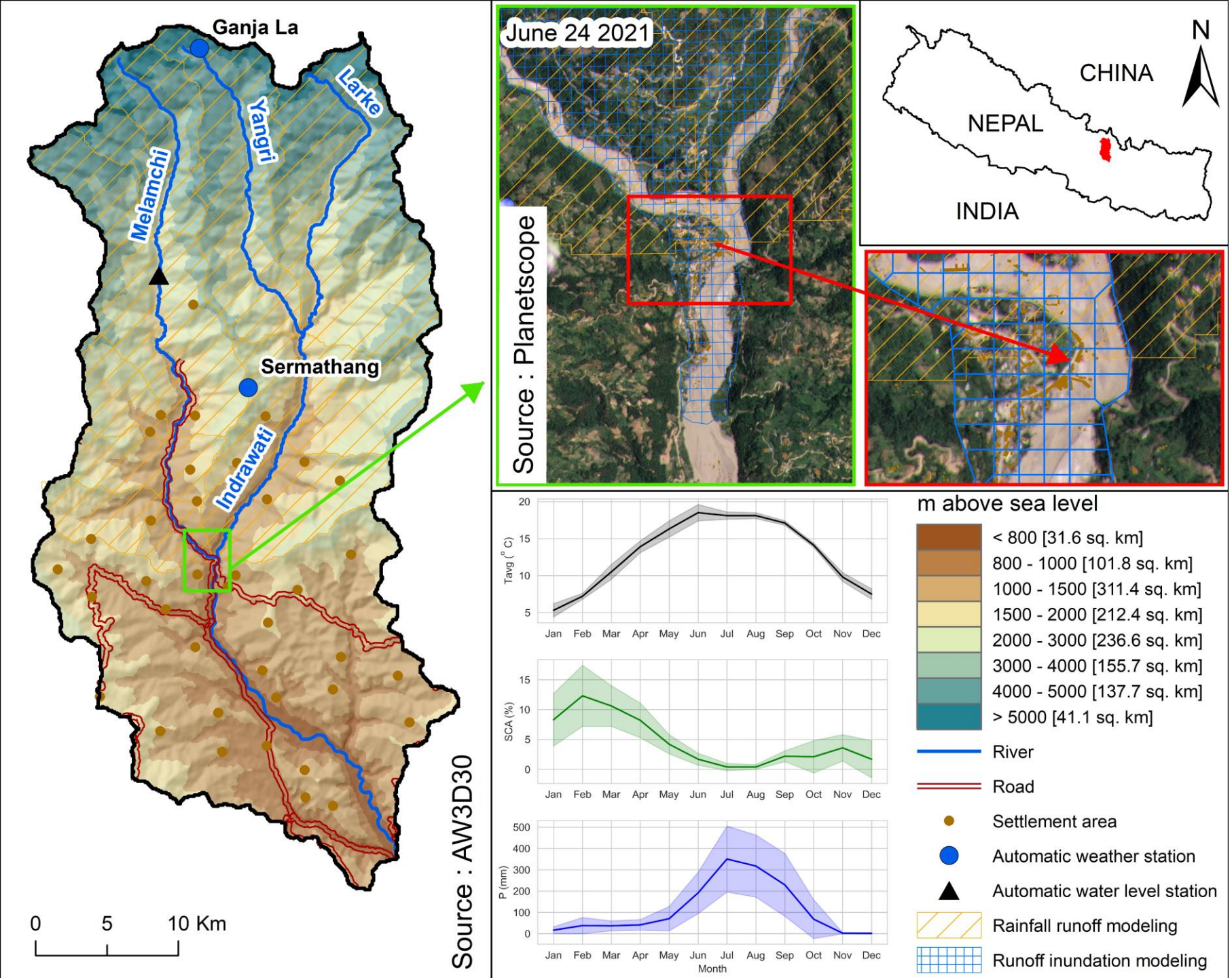
30°N
28°N
80°E
82°E
84°E
86°E
88°E
N
Baisari
Seti
Melamchi
Kathmandu
Jure
Elevation (m)
8848
59

Triggering factor
Secondary hazards
Absent in the chain
Sectors
Human settlement
Energy
Transportation
Trade
Water supply
Scale
Local
Regional
National
Duration
Week
Months
Year



Rakhal, Talchabhadel, Sharma et al. [in preparation]





Observations

Remote Sensing

Machine learning

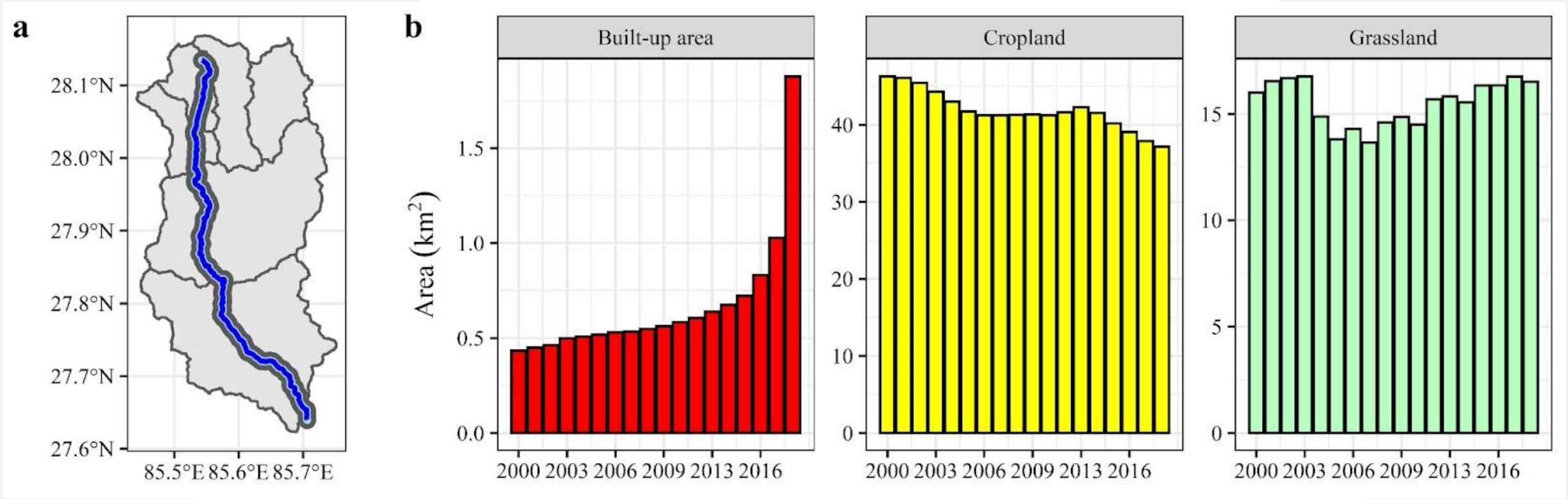
Hydrological model

Hydrodynamic model

Sediment transport

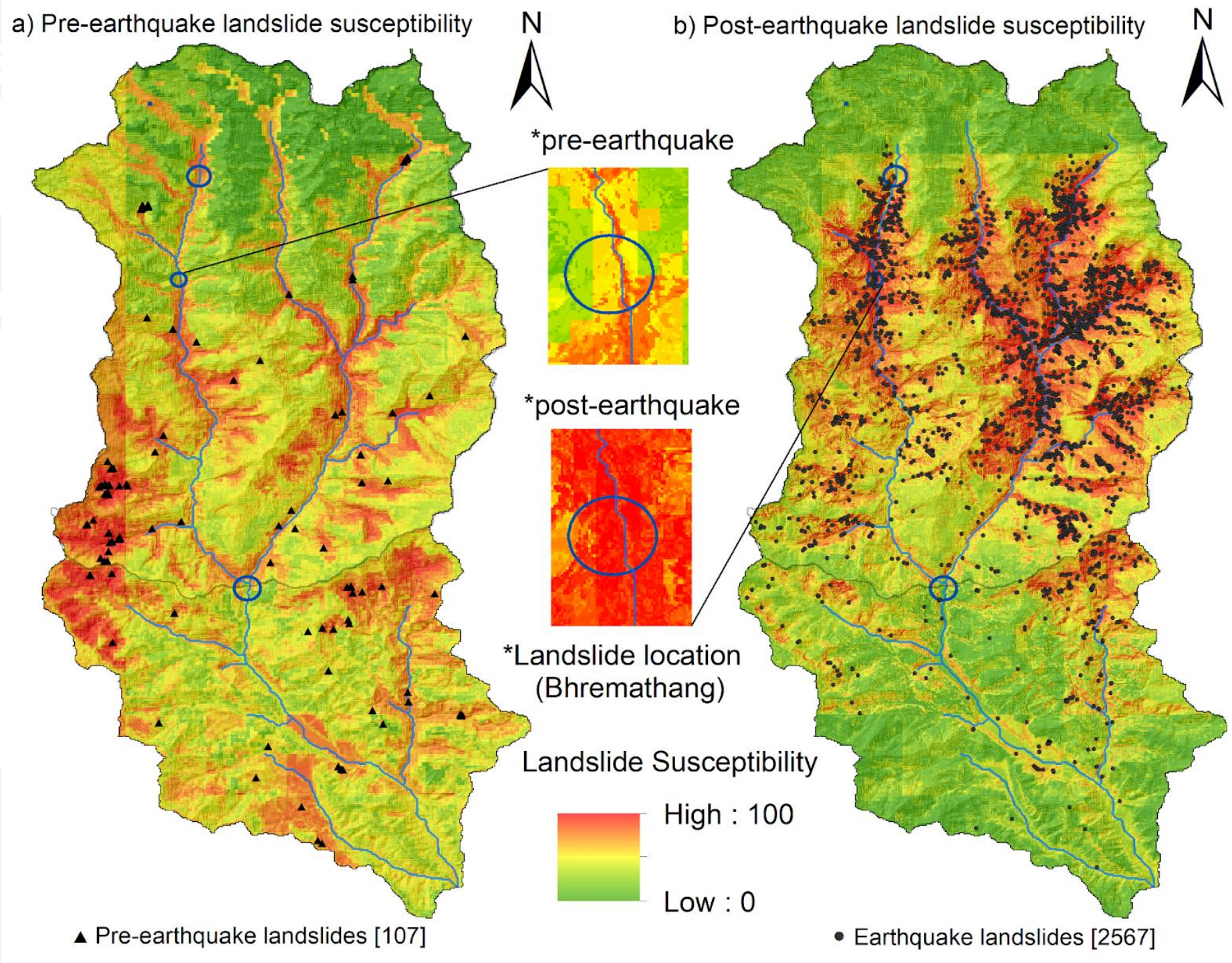
Socio economic data

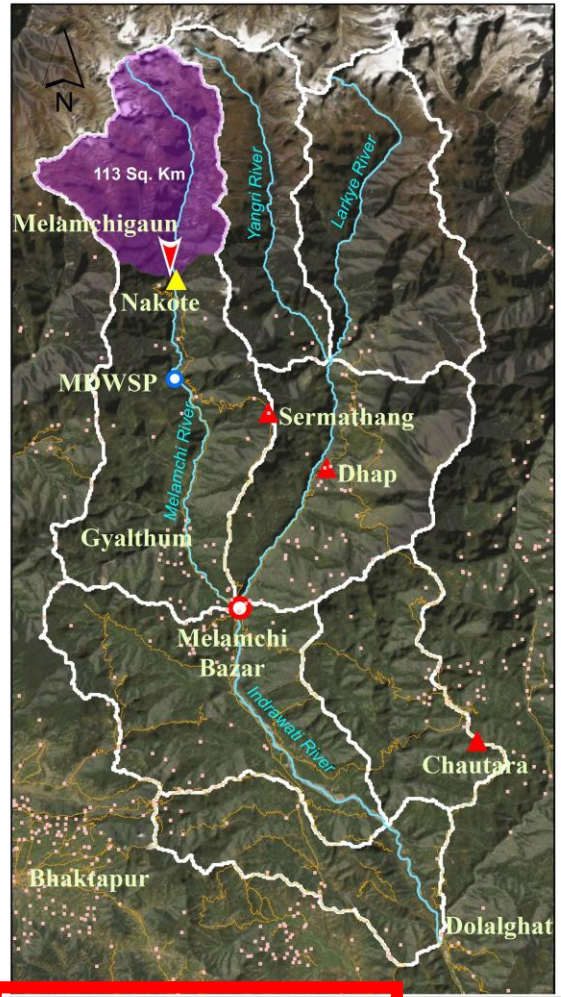
Experts' opinion

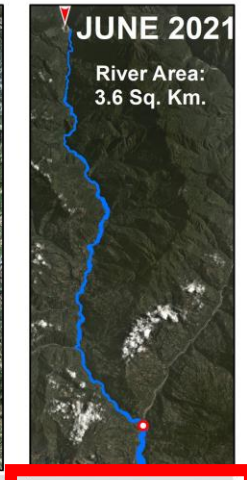


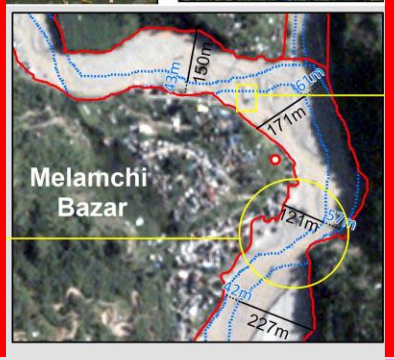
Land use land cover changes across the flood plain (1 km buffer)

Landslide Susceptibility Before and After 2015 Gorkha Earthquake (Mw 7.8)









Settlements | Meteorological station | Road network | Before flood | Landslide catchment
Landslide | Hydrological station | Major rivers | After flood | Indrawati watershed

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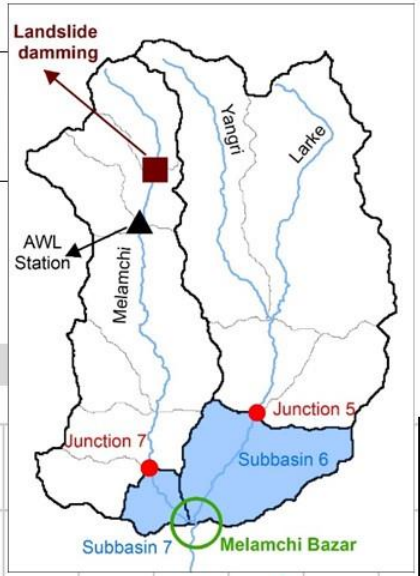
[in preparation]

Damming Scenarios

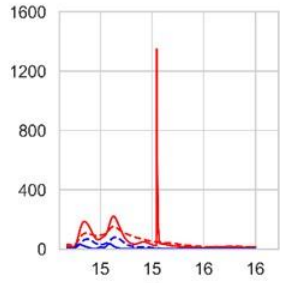
a) Different scenarios

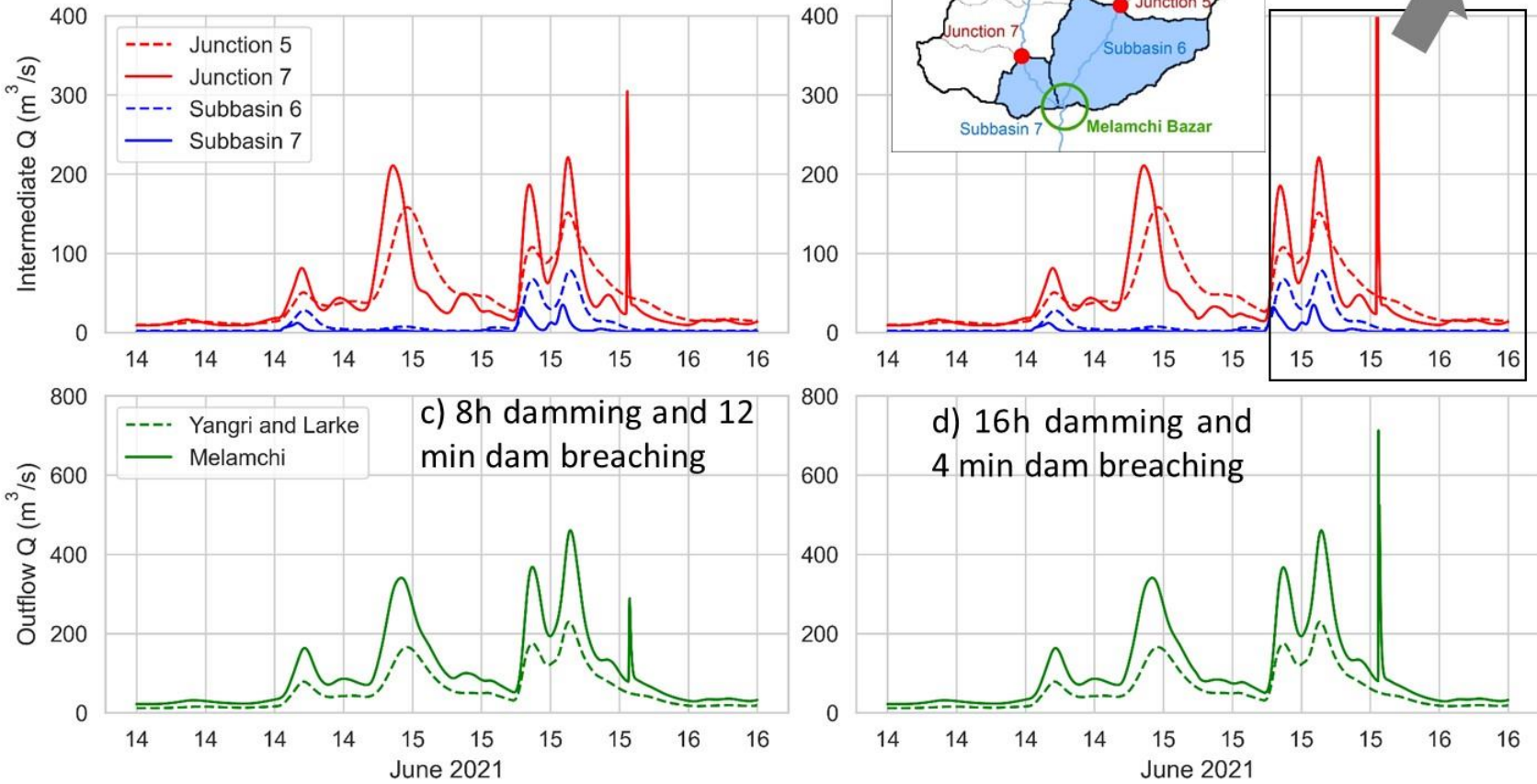
Landslide dam breaching time	Peak discharge based on water volume stored time				
	16 h damming (in m^3/s)	14 h damming (in m^3/s)	12 h damming (in m^3/s)	10 h damming (in m^3/s)	8 h damming (in m^3/s)
4 min	1921.6	1468.3	974.7	881.8	816.1
6 min	1364.6	1057.8	763.2	697	652.6
8 min	1064.2	833.6	597.9	546	521.7
10 min	847.6	665.6	474.6	434.9	407.9
12 min	724.2	569.4	407.7	375	352.3

b) Major junctions and sub basins



e) Close view





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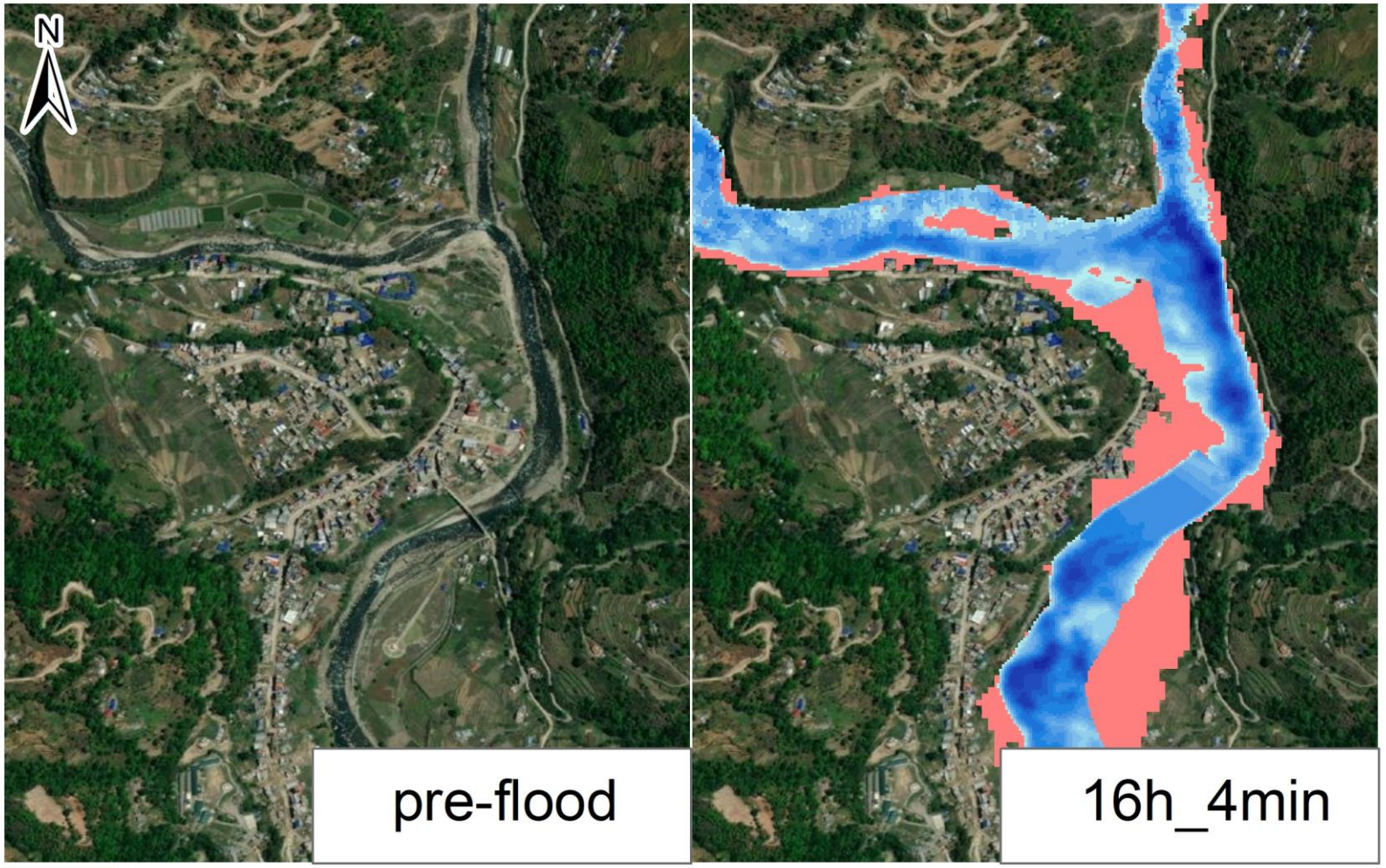
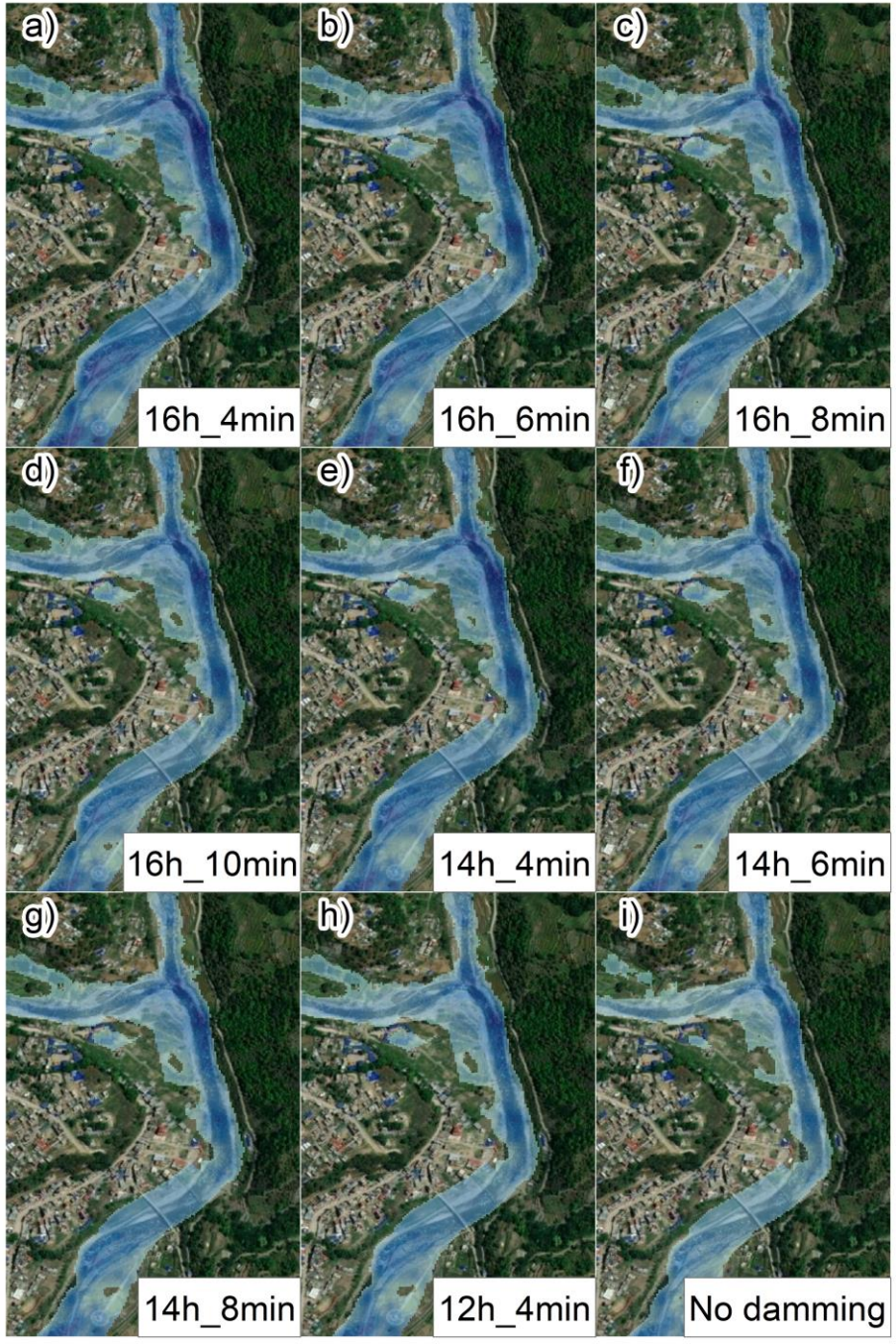


SENTINEL-based inundation

0 (simulated water depth in meter) 7.5

0 0.25 0.5
Km



0 (water depth in meter) 7.5

0 0.15 0.3 Km

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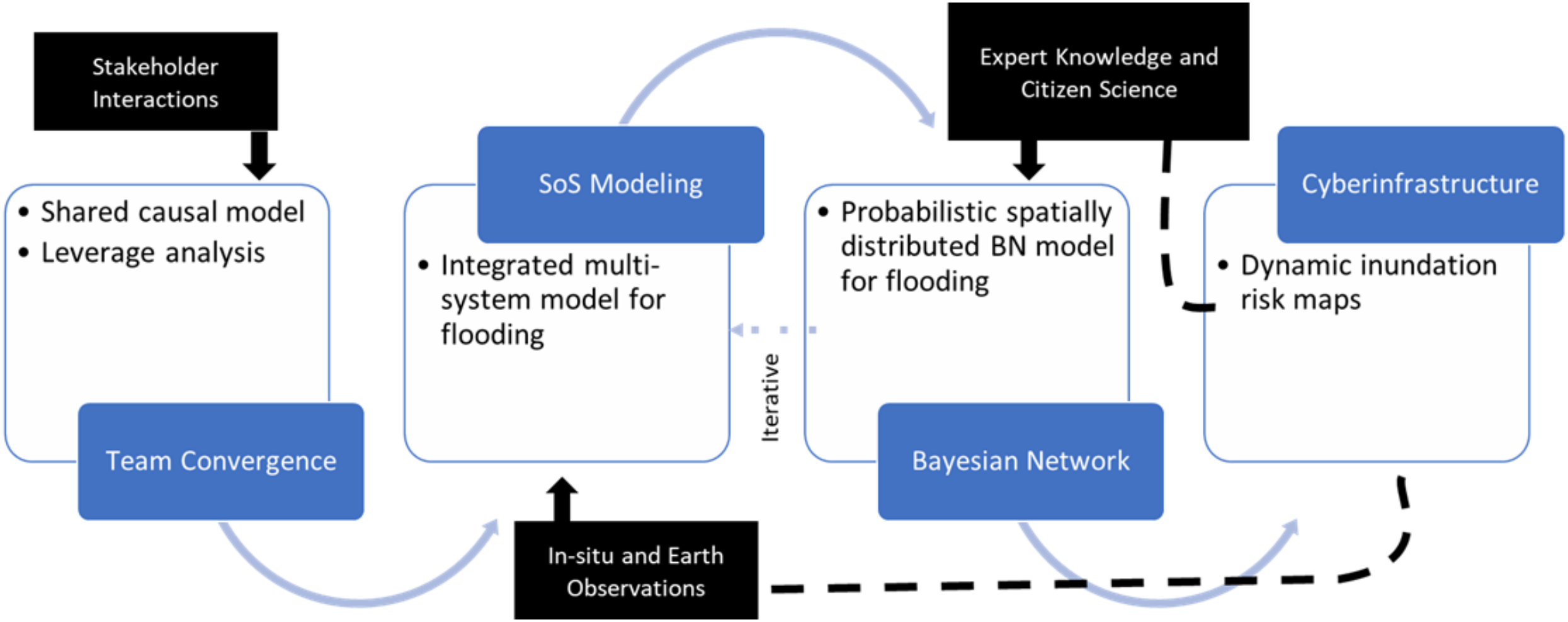
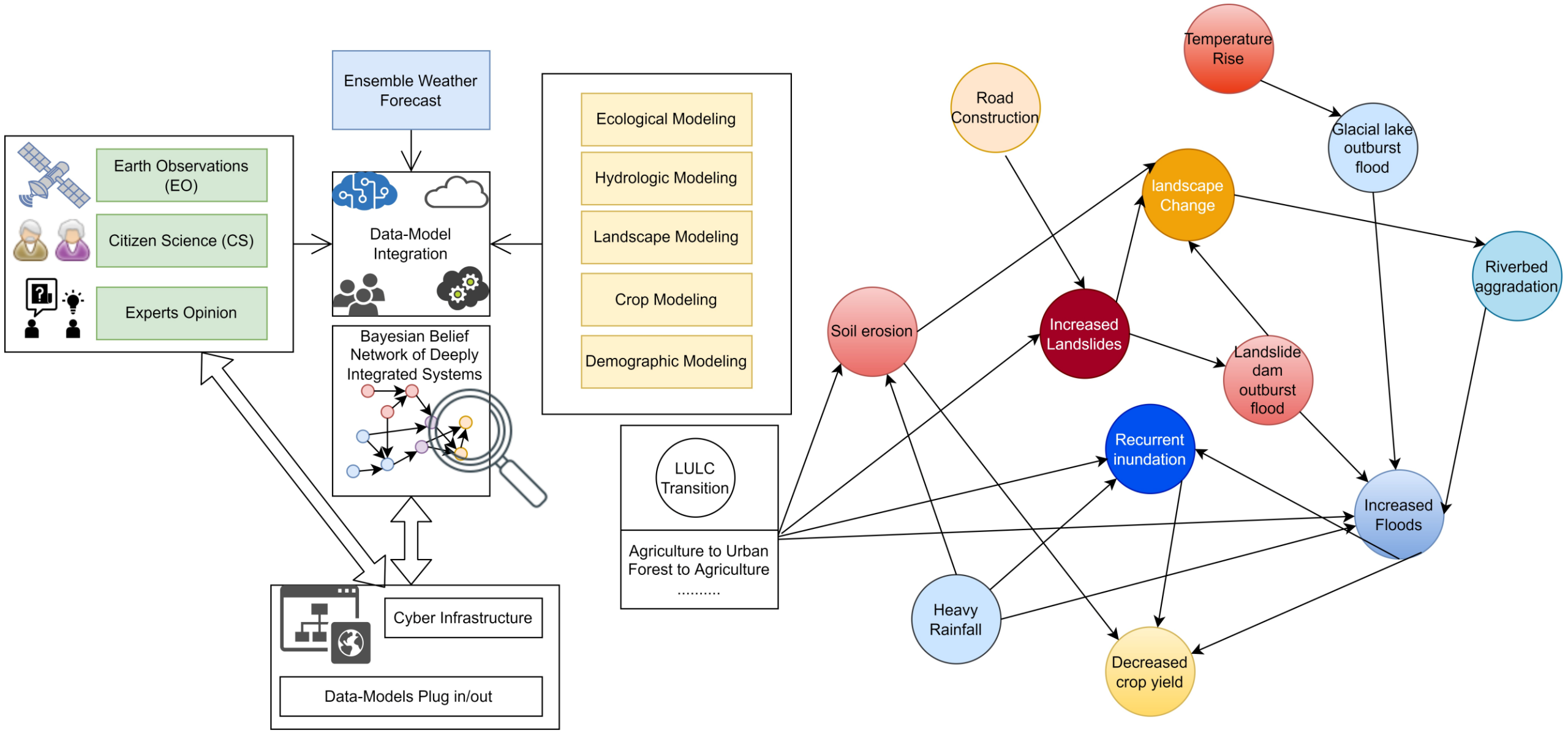
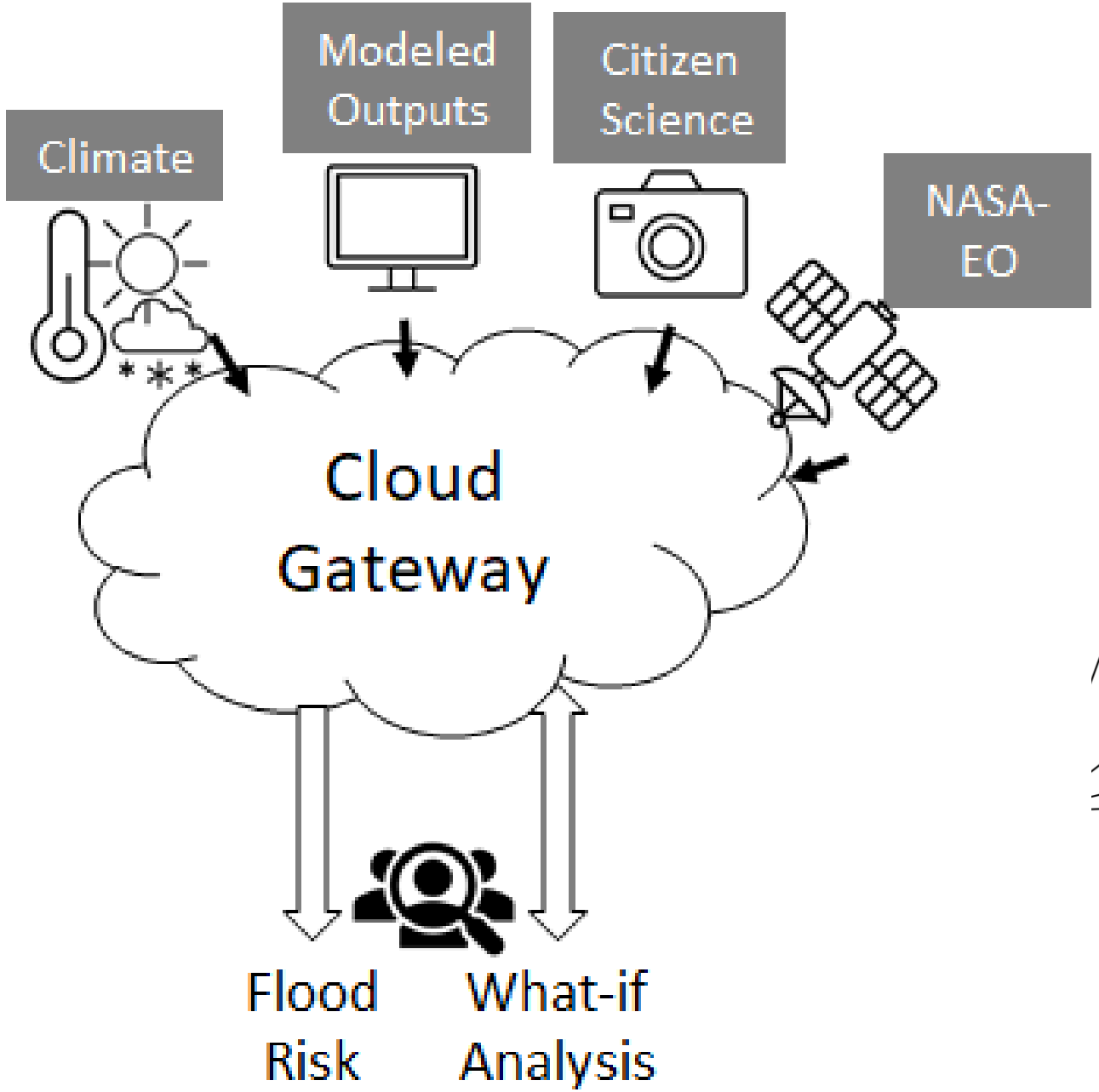
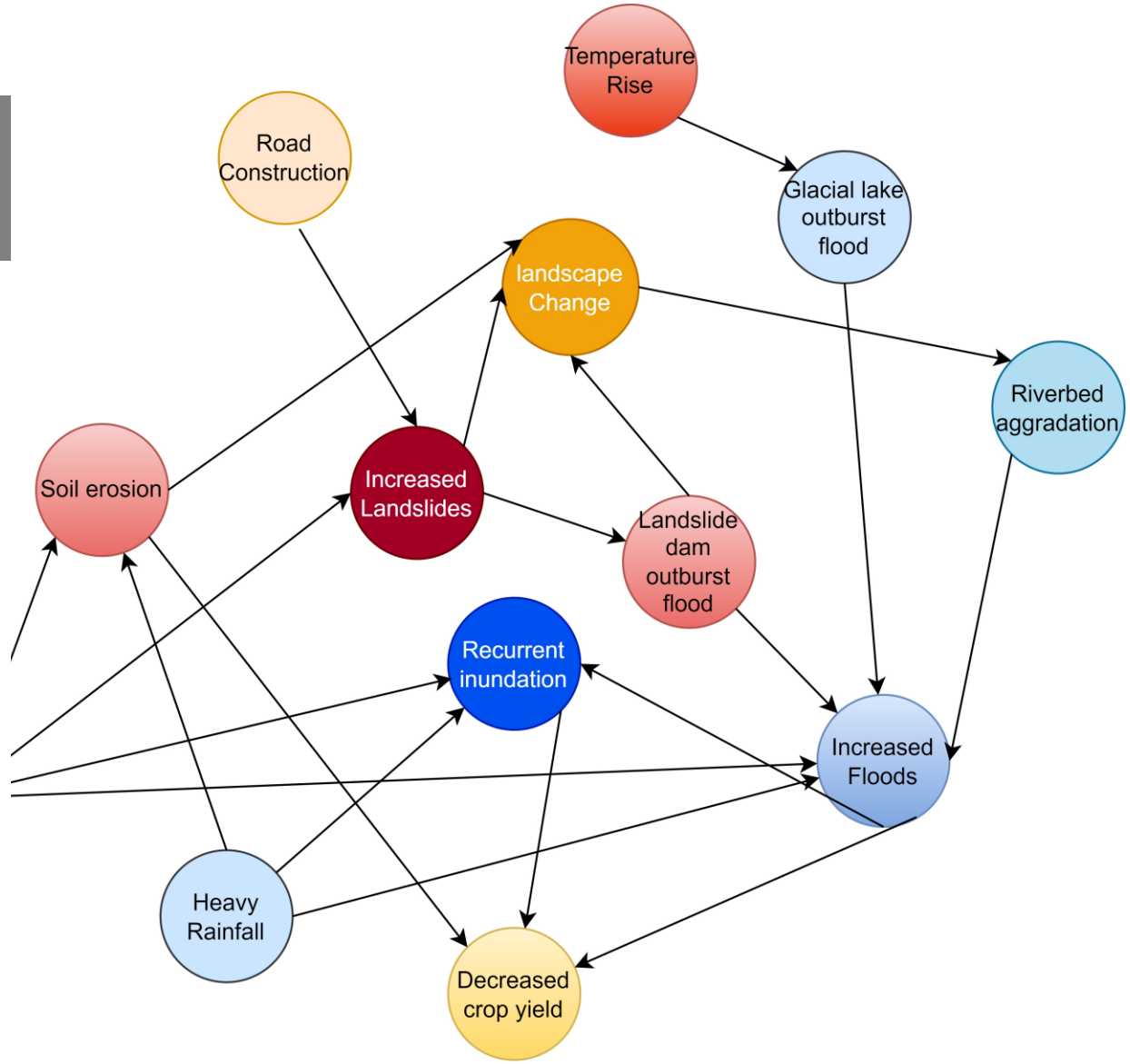
Proposed frameworkc

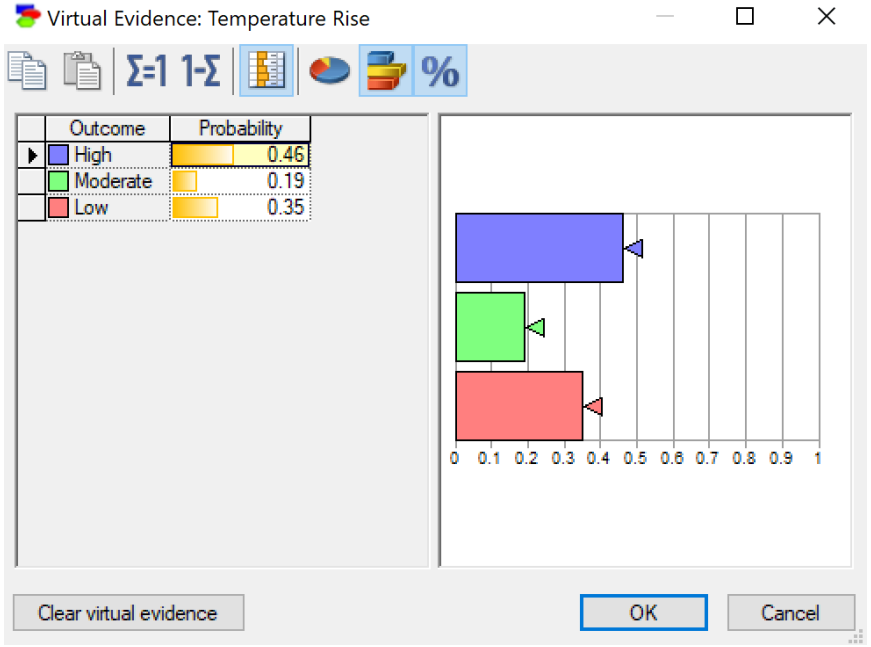


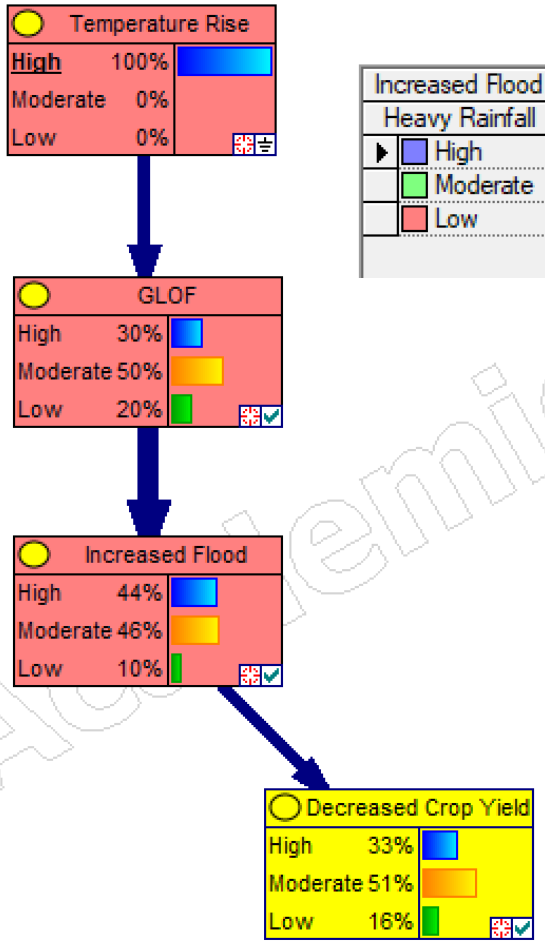

Ensemble Weather Forecast
Earth Observations (EO)
Citizen Science (CS)
Experts Opinion
Data-Model Integration
Bayesian Belief Network of Deeply Integrated Systems
Ecological Modeling
Hydrologic Modeling
Landscape Modeling
Crop Modeling
Demographic Modeling
LULC Transition
Agriculture to Urban
Forest to Agriculture
.....
Cyber Infrastructure
Data-Models Plug in/out
Temperature Rise
Road Construction
Glacial lake outburst flood
landscape Change
Riverbed aggradation
Soil erosion
Increased Landslides
Landslide dam outburst flood
Recurrent inundation
Increased Floods
Heavy Rainfall
Decreased crop yield


Climate
Modeled Outputs
Citizen Science
NASA-EO
Cloud Gateway
Flood Risk
What-if Analysis

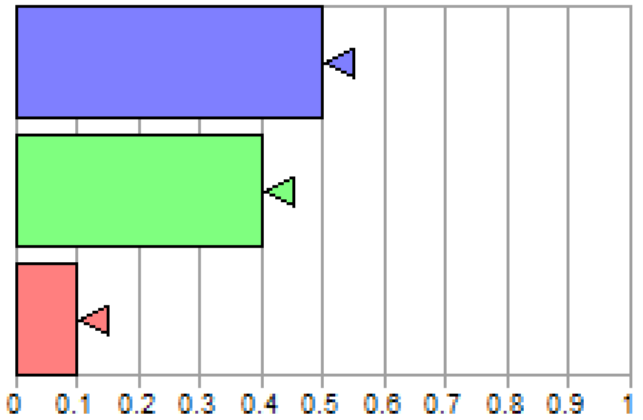

Temperature Rise
Road Construction
Glacial lake outburst flood
landscape Change
Riverbed aggradation
Soil erosion
Increased Landslides
Landslide dam outburst flood
Recurrent inundation
Increased Floods
Heavy Rainfall
Decreased crop yield

Sample Bayesian Network



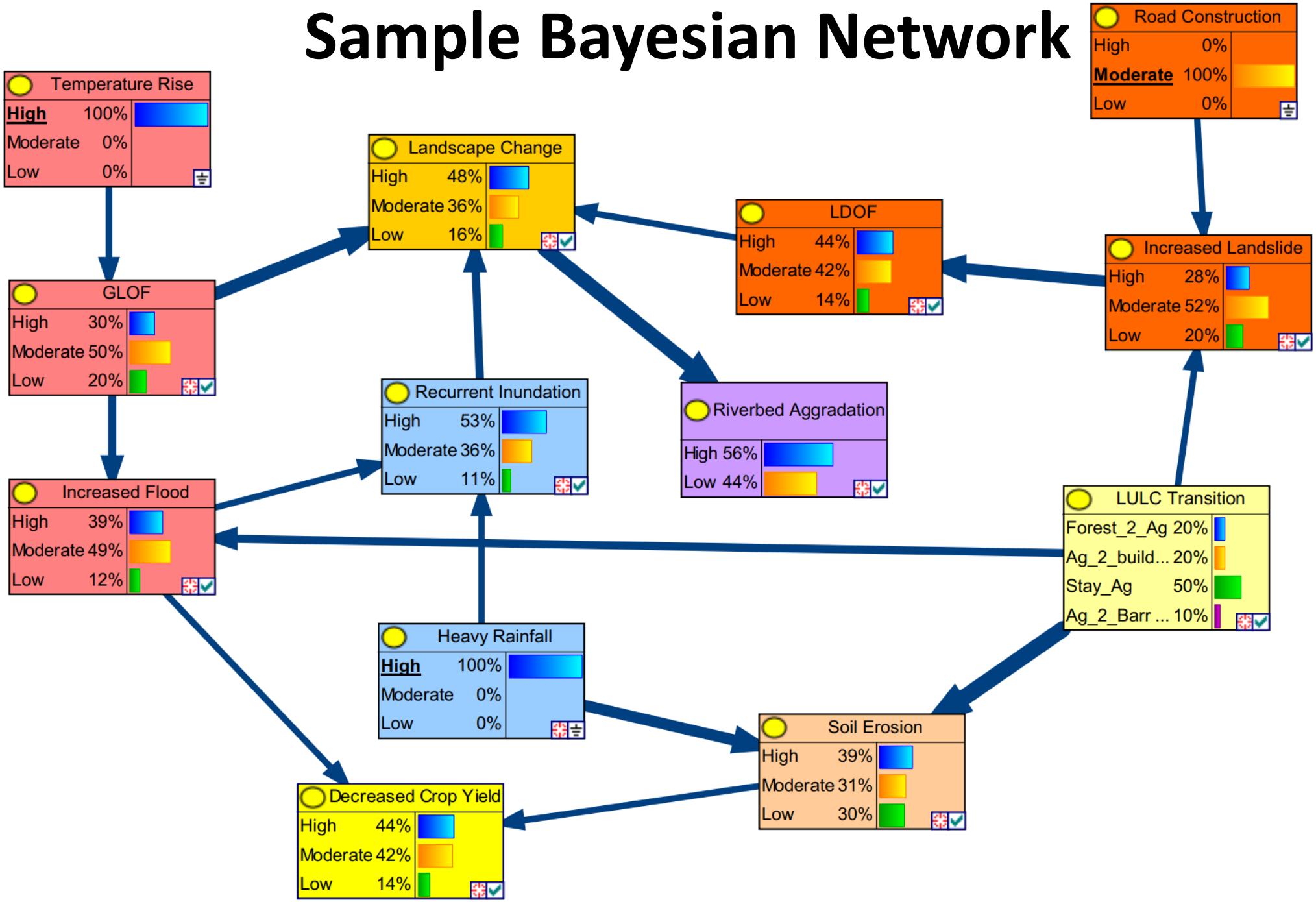


Increased Flood	High			Moderate		
Heavy Rainfall	High	Moderate	Low	High	Moderate	Low
High	0.6	0.5	0.4	0.5	0.4	0.3
Moderate	0.3	0.3	0.4	0.4	0.4	0.5
Low	0.1	0.2	0.2	0.1	0.2	0.2



Heavy Rainfall	High				Moderate				Low			
LULC Transition	Forest_2_Ag	Ag_2_building	Stay_Ag	Ag_2_Barren	Forest_2_Ag	Ag_2_building	Stay_Ag	Ag_2_Barren	Forest_2_Ag	Ag_2_building	Stay_Ag	Ag_2_Barren
High	0.6	0.2	0.3	0.8	0.4	0.1	0.2	0.6	0.3	0.1	0.15	0.5
Moderate	0.3	0.2	0.4	0.15	0.4	0.6	0.5	0.3	0.3	0.7	0.6	0.3
Low	0.1	0.6	0.3	0.05	0.2	0.3	0.3	0.1	0.4	0.2	0.25	0.2

Sample Bayesian Network



Currently, we are developing questionnaire survey to capture experts' opinions to force Bayesian Network.

We highly appreciate your comments, suggestions, and feedback.

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THANK YOU