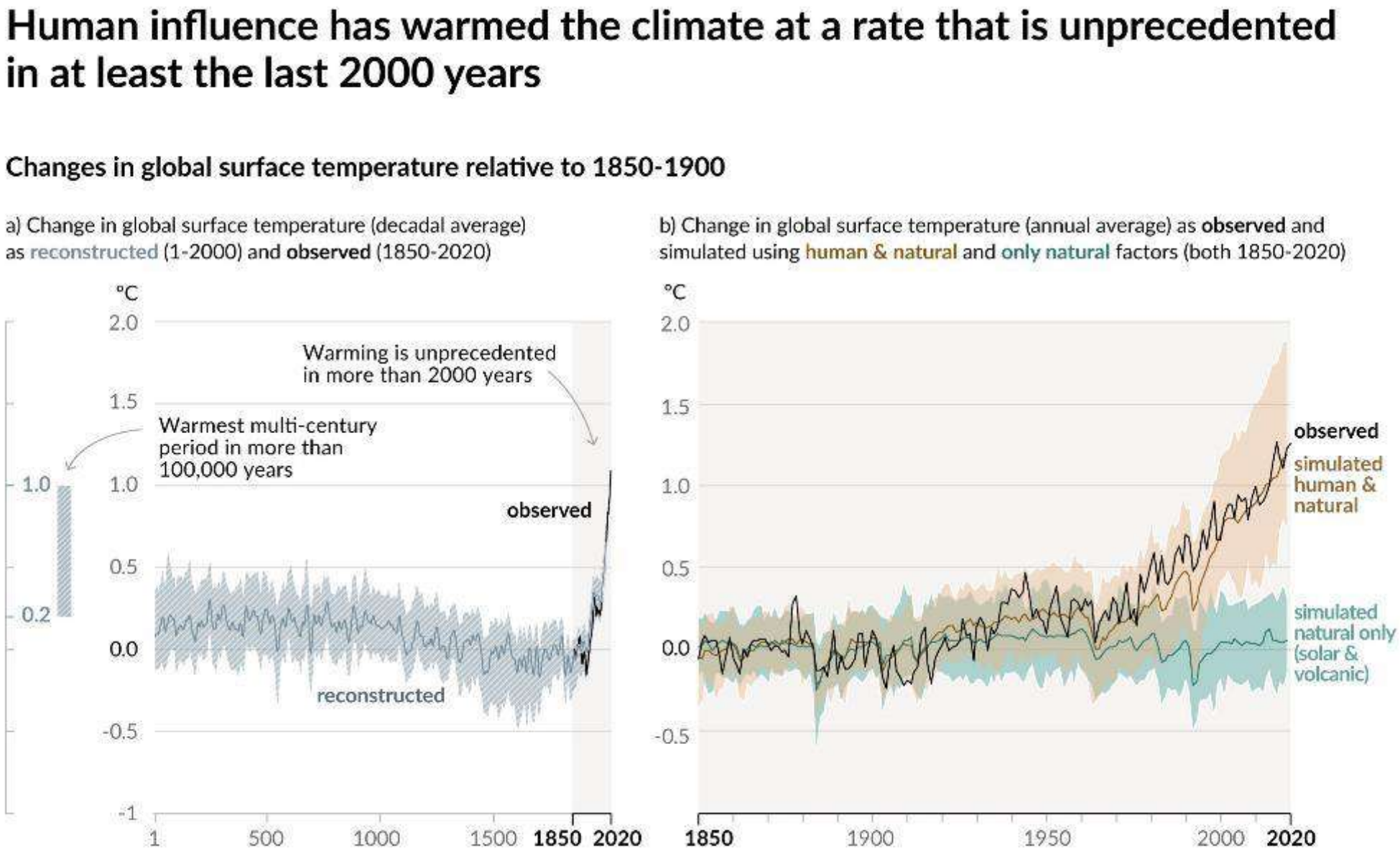
Local Vulnerabilities to Global Climate Change

Uttam Babu Shrestha

Global Institute for Interdisciplinary Studies

Human Influence on Earth's climate

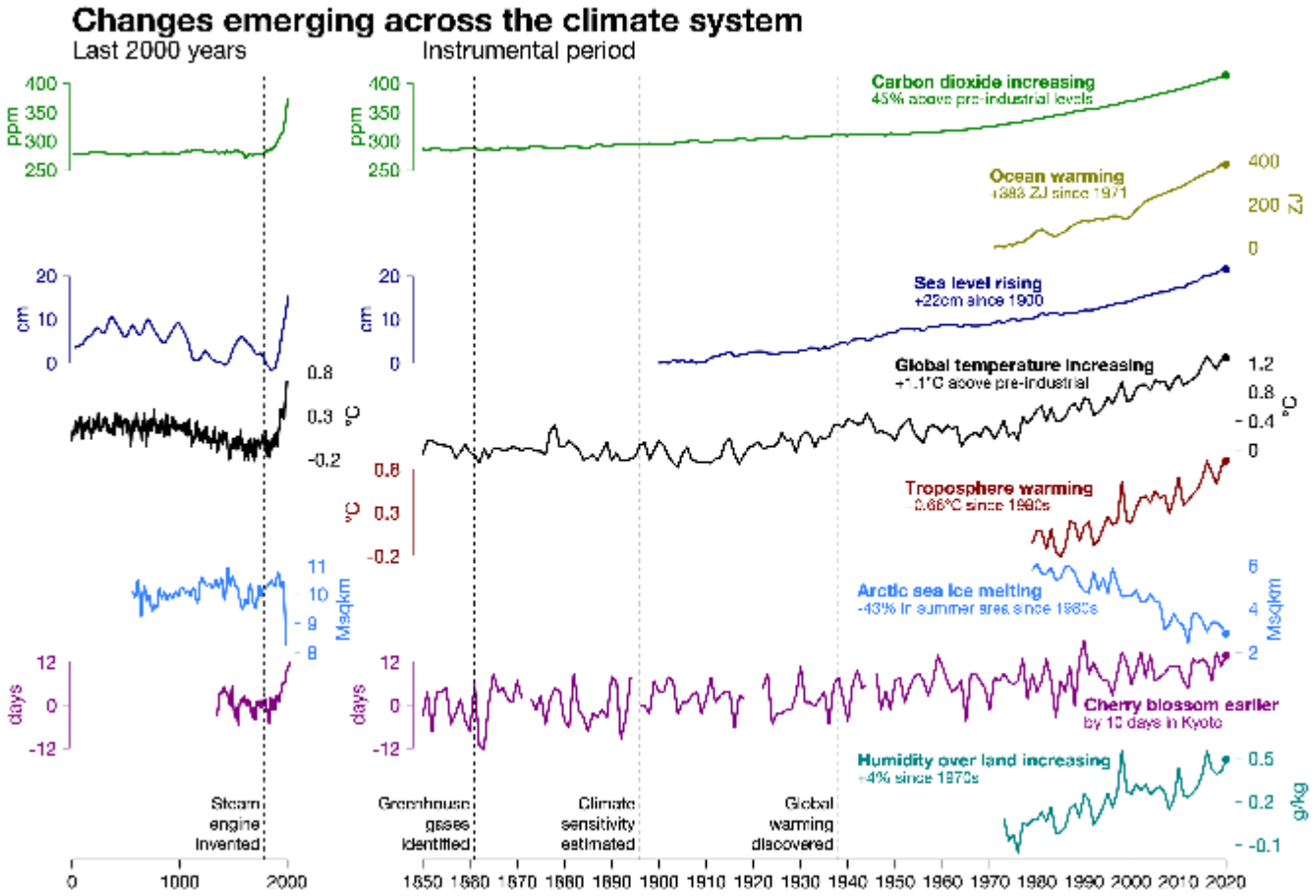


IPCC 2021

Changes in Earth Climate System

Climate indicators

- Atmospheric carbon dioxide concentration ↑
- Ocean heat content ↑
- Global sea level ↑
- Global mean surface temperature ↑
- Global lower tropospheric temperatures ↑
- Arctic ice amount ↓
- Kyoto cherry blossom date ←
- Specific humidity over land ↑



Hawkins 2021

Changes were seen in Atmosphere, Cryosphere, Biosphere and Ocean

Increasing Climate Extremes in South Asia

South Asia

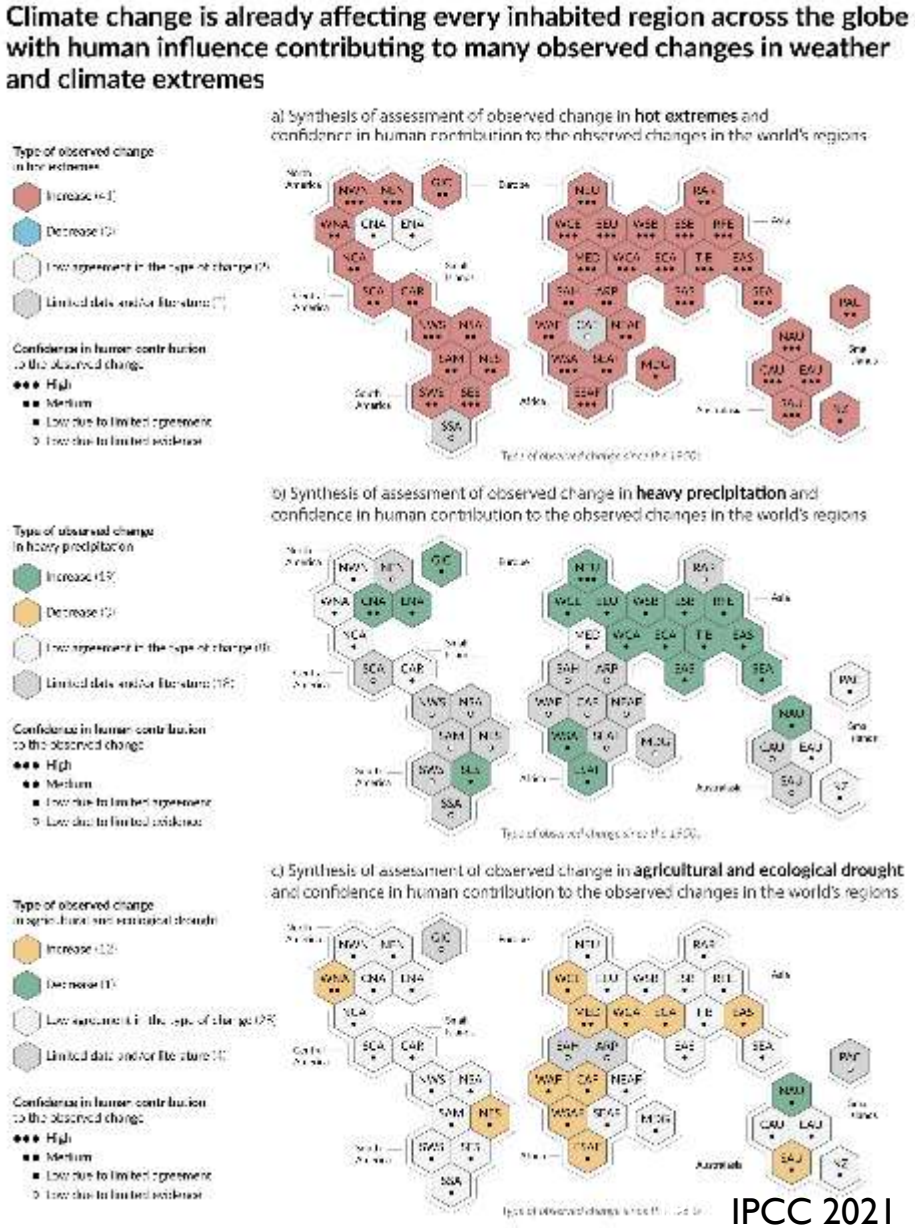
- **Hot extremes are increasing** (high confidence)

More intense and more frequent

- **Heavy precipitation is increasing** (low confidence)

Increases in monsoon precipitation, Human induced cc is likely main driver

- **No change in agriculture and ecological droughts** (based on surface soil moisture, water balance)



IPCC 2021

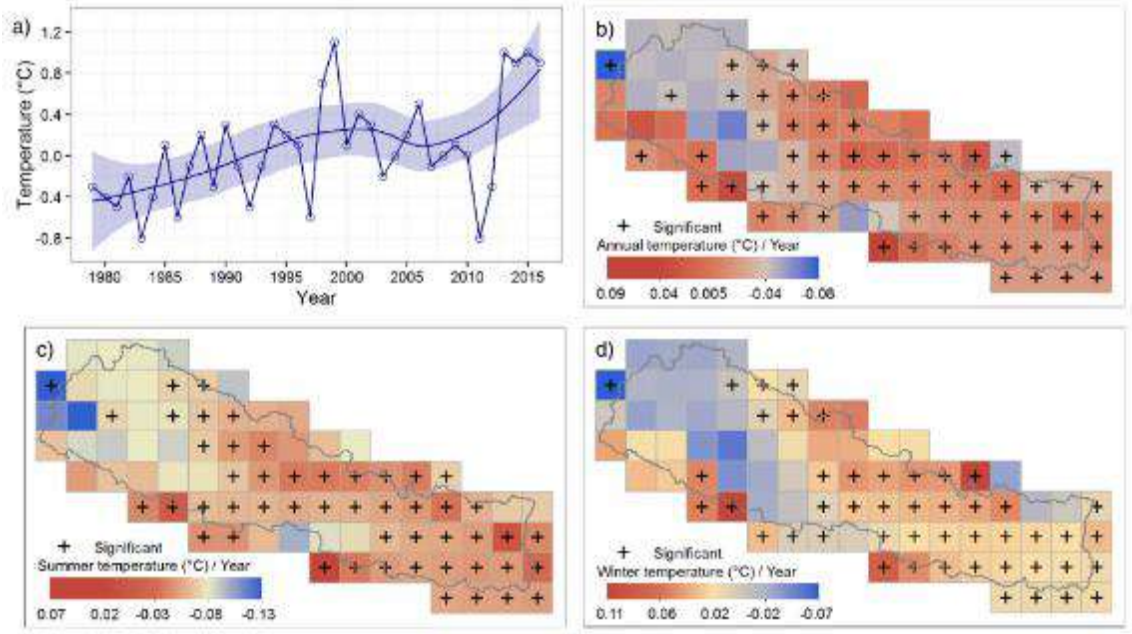
Climate Change in Nepal

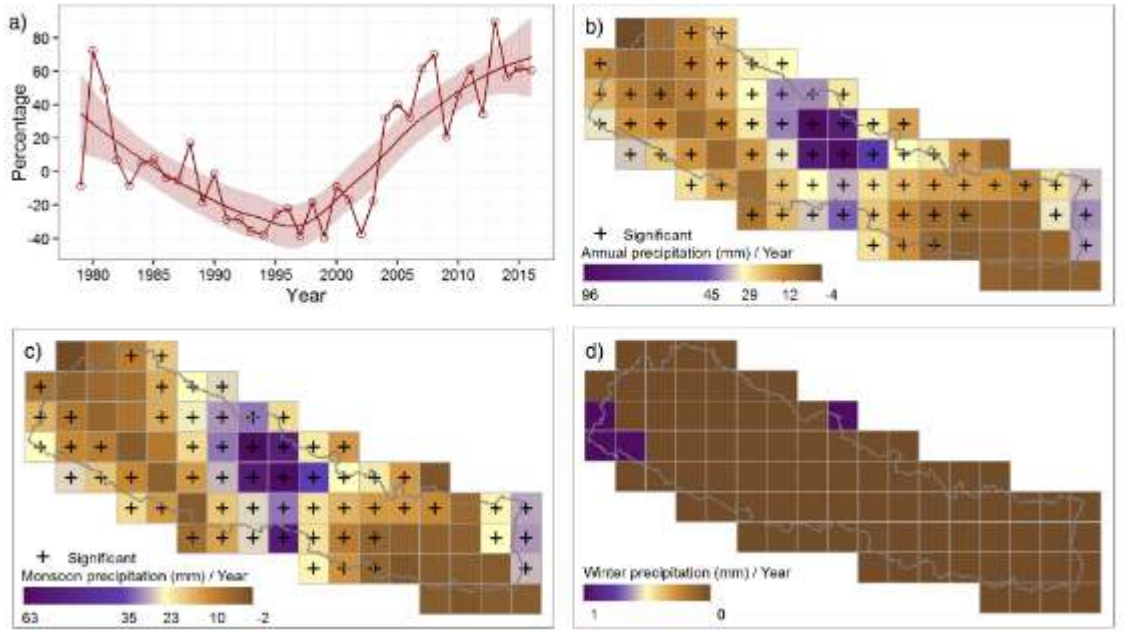
Average and seasonal changed in temperature and precipitation based on climate data from 1979-2016

Climatic Change
https://doi.org/10.1007/s10584-019-02418-5

Climate change in Nepal: a comprehensive analysis of instrumental data and people's perceptions

Uttam Babu Shrestha[1,2] · Asheshwor Man Shrestha[3] · Suman Aryal[1] · Sujata Shrestha[2] · Madhu Sudan Gautam[4] · Hemant Ojha[5]





Average temperature (0.03°C/yr)
Maximum temperature by 0.02°C/yr
Minimum temperature by 0.04°C/yr
Warming is higher in the high mountain areas

Increased mean annual precipitation by 8.7 mm/year
Monsoon precipitation increasing

Shrestha et al. 2019

Climate Extremes in Nepal

- Extreme warm days/nights are increasing
- Cool days/nights are decreasing
- Number of rainy days, and very wet days are increasing
- Consecutive wet days are increasing
- Consecutive dry days are decreasing

Climatic Change
https://doi.org/10.1007/s10584-019-02418-5

Climate change in Nepal: a comprehensive analysis of instrumental data and people's perceptions

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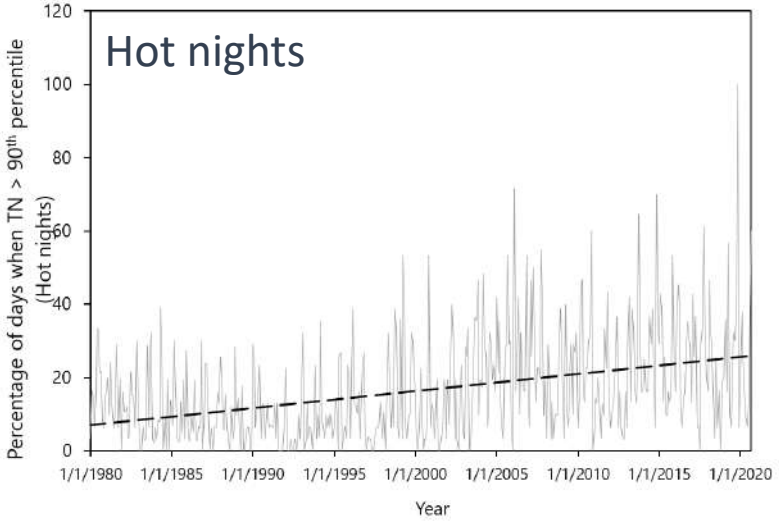
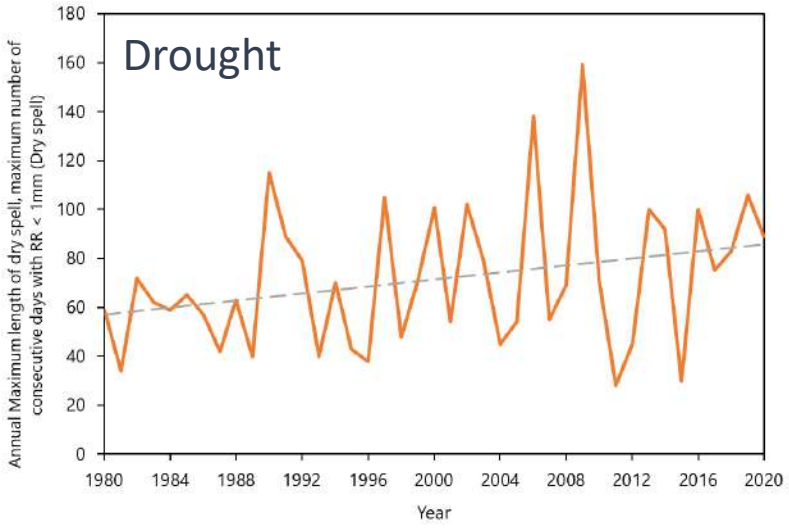
Climate indexes	Significantly decrease	Decrease	No change	Increase	Significantly increase
Annual precipitation		1		17	64
Monsoon precipitation	1			23	58
Winter precipitation		31		51	
Mean annual temperature	1	1		22	58
Mean summer temperature	1	7		25	49
Mean winter temperature	1	10		25	46
Hot days (TX90p)	4	17		39	22
Hot nights (TN90p)	1	10		41	30
Cold days (TX10p)	26	46		9	1
Cold nights (TN10p)	49	16		16	1
Dry spell (CDD)	25	54		3	
Wet spell (CWD)		1	4	22	55

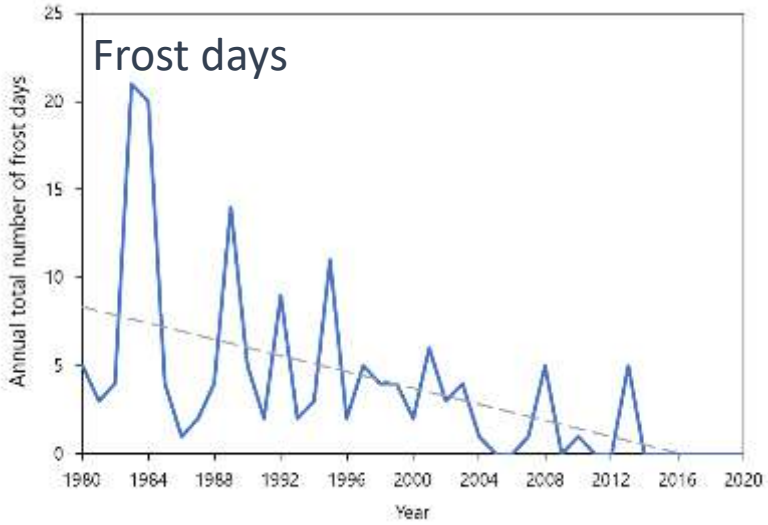
Shrestha et al. 2019

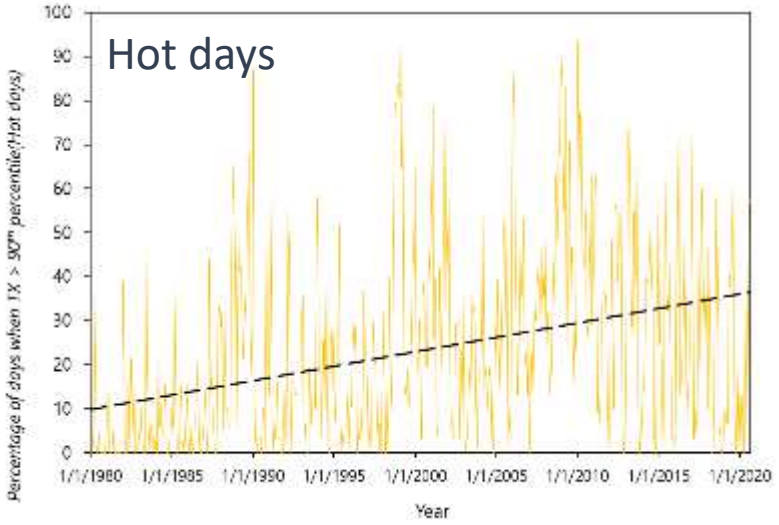
Climate Extremes in Kathmandu

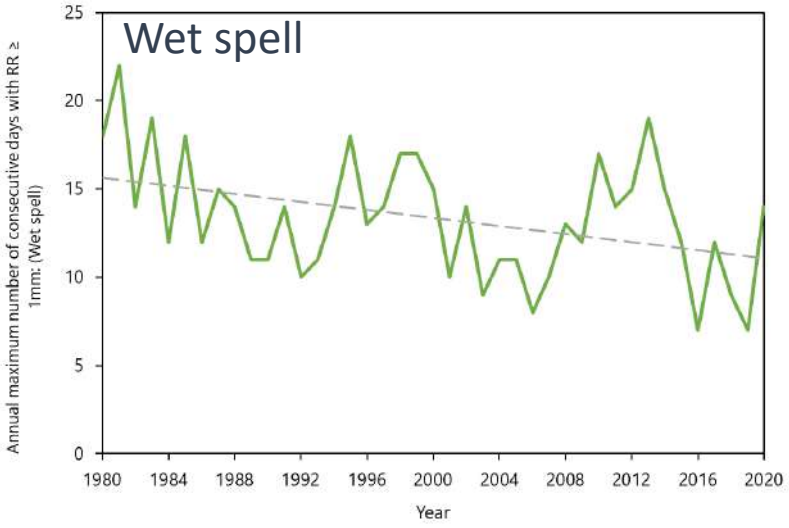
Based on data of Kathmandu Airport (1980-2020)

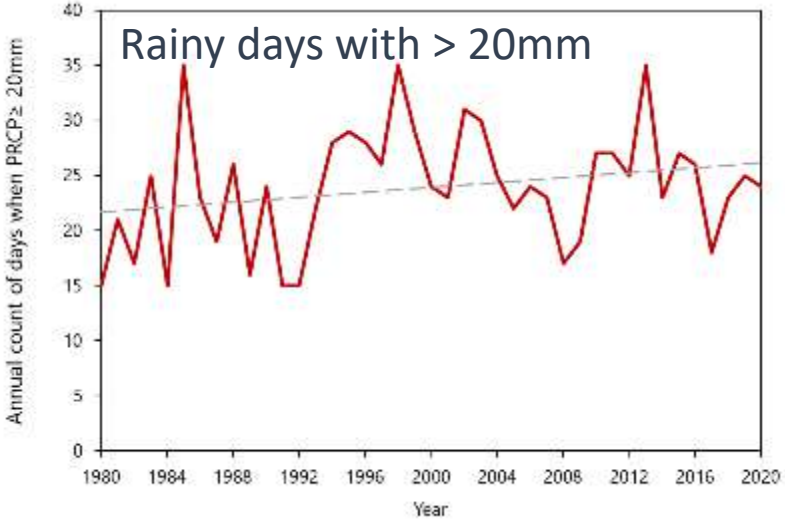








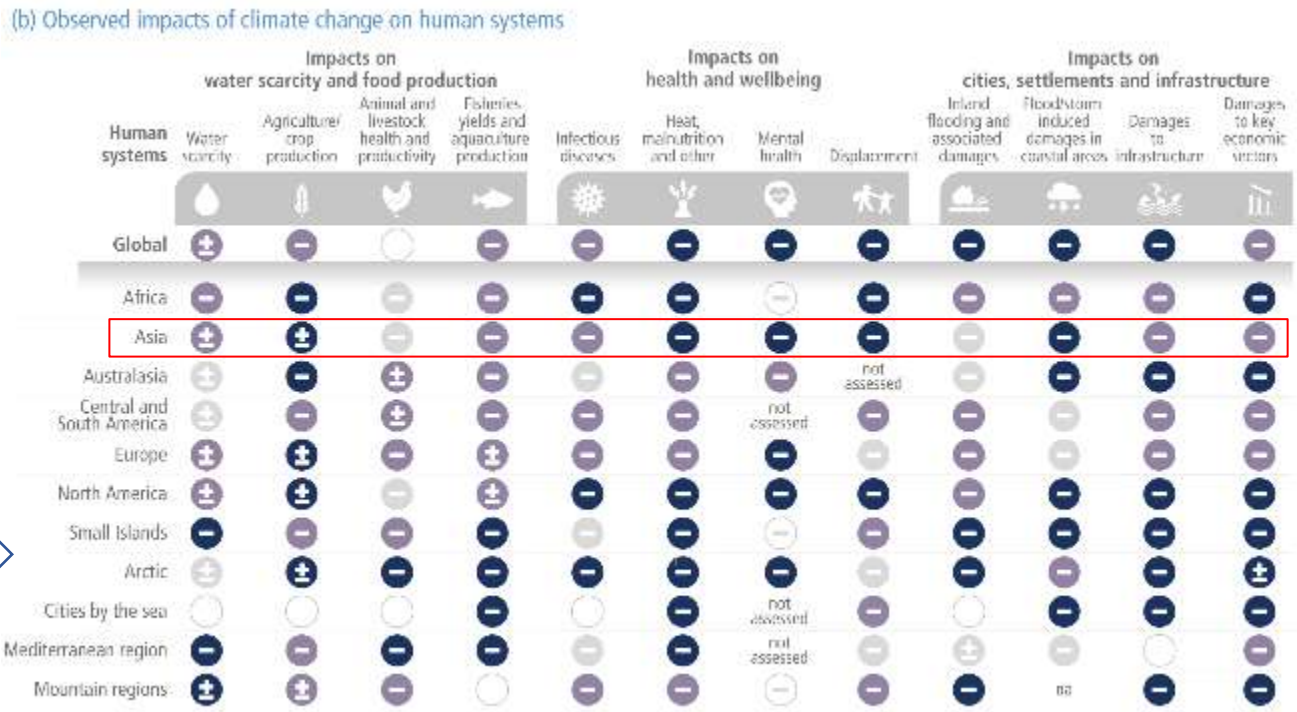




Impacts of Climate Change

Observed impacts of climate change on ecosystems and human systems

Ecosystem structure, species range shifts and phenological change although the level of confidence in attribution to climate change is medium in Asia

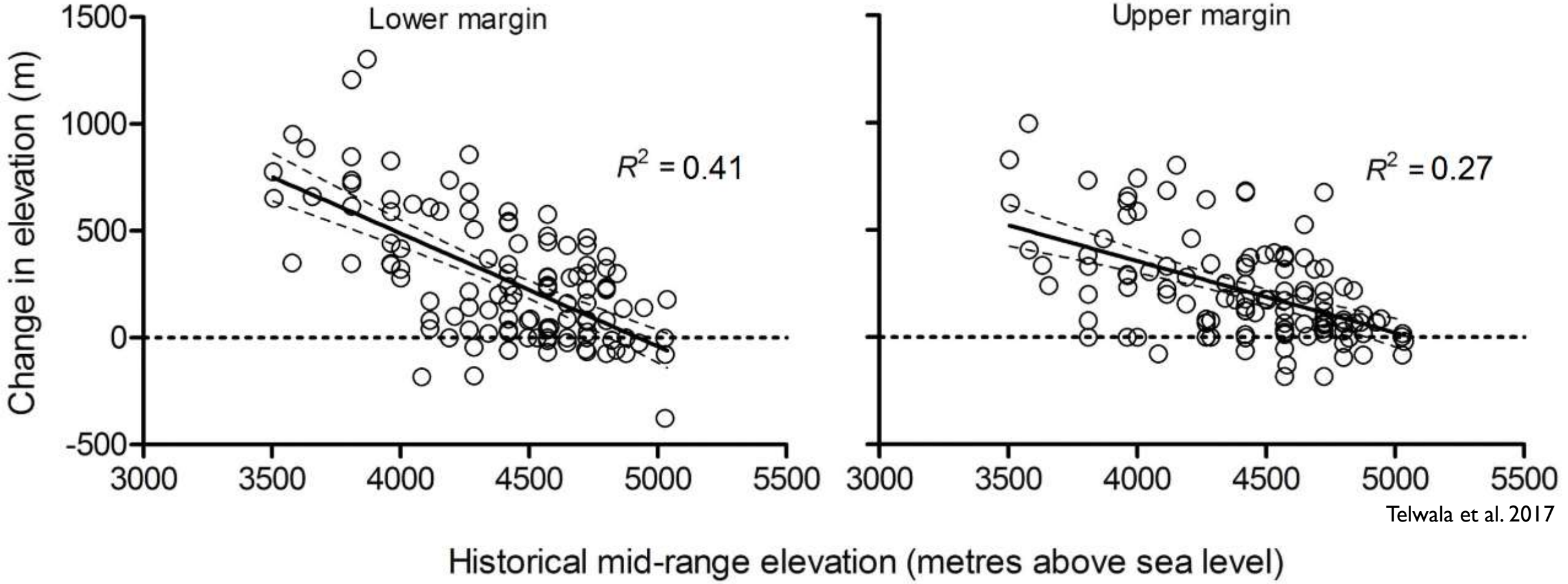


Both positive/negative Impacts on water scarcity and food production, negative impacts on health and wellbeing, negative impacts on cities, settlements and infrastructure in Asia

IPCC 2021

Impacts of Climate Change

Range shifts of Himalayan plants



Telwala et al. 2017

Warming-driven geographical range shifts were recorded in 87% of 124 endemic plant species studied in the region; upper range extensions of species have resulted in increased species richness in the upper alpine zone, compared to the 19th century.

Impacts of Climate Change

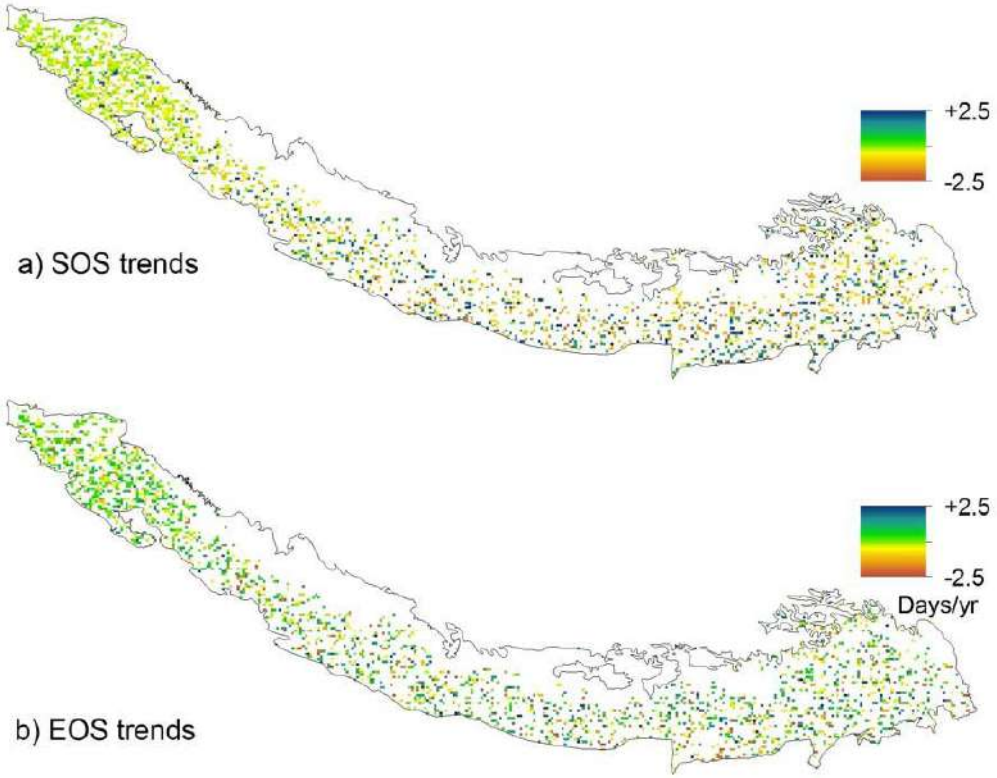
Phenological change in Himalaya

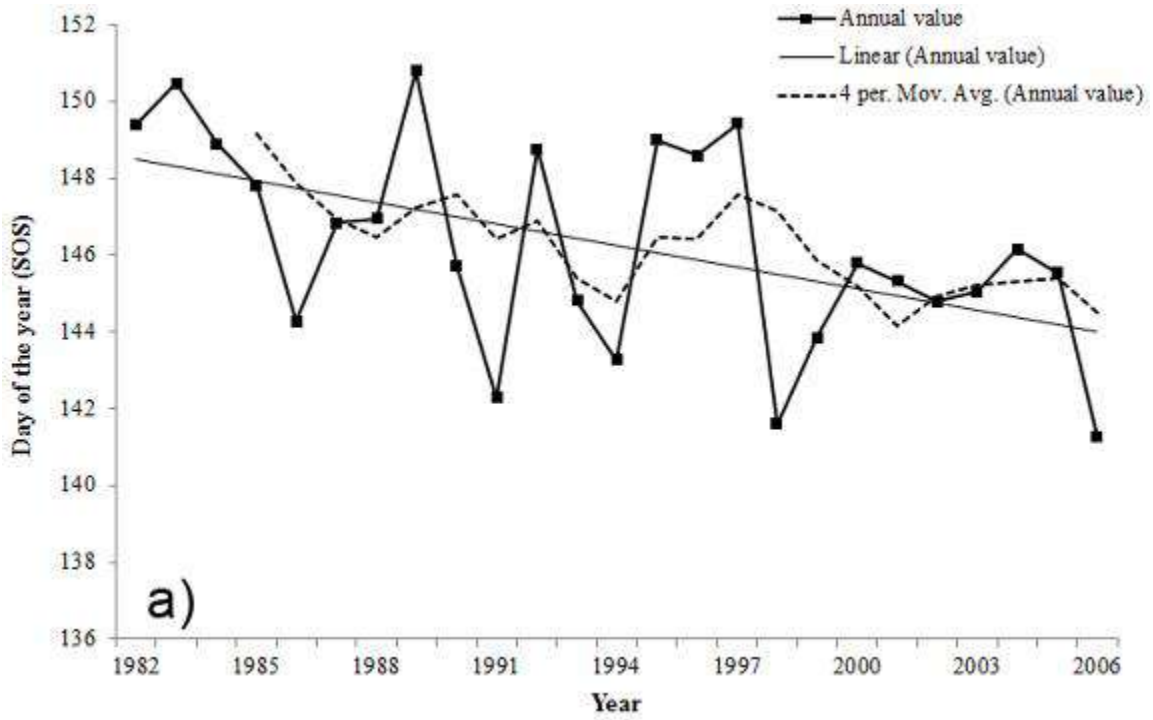
OPEN ACCESS Freely available online PLoS one

Widespread Climate Change in the Himalayas and Associated Changes in Local Ecosystems

Uttam Babu Shrestha[1,2*], Shiva Gautam[3], Kamaljit S. Bawa[1,4,5]

1 University of Massachusetts, Boston, Massachusetts, United States of America, 2 Harvard University Herbarium, Harvard University, Cambridge, Massachusetts, United States of America, 3 Department of Biostatistics, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, Massachusetts, United States of America, 4 Sustainability Science Program, Harvard University, Cambridge, Massachusetts, United States of America, 5 Ashoka Trust for Research in Ecology and Environment (ATREE), Bangalore, India





Start of the Season (SOS) has significantly advanced by 4.7 days during 25 years from 1982-2006

Impacts of Climate Change

Distribution change (native species)

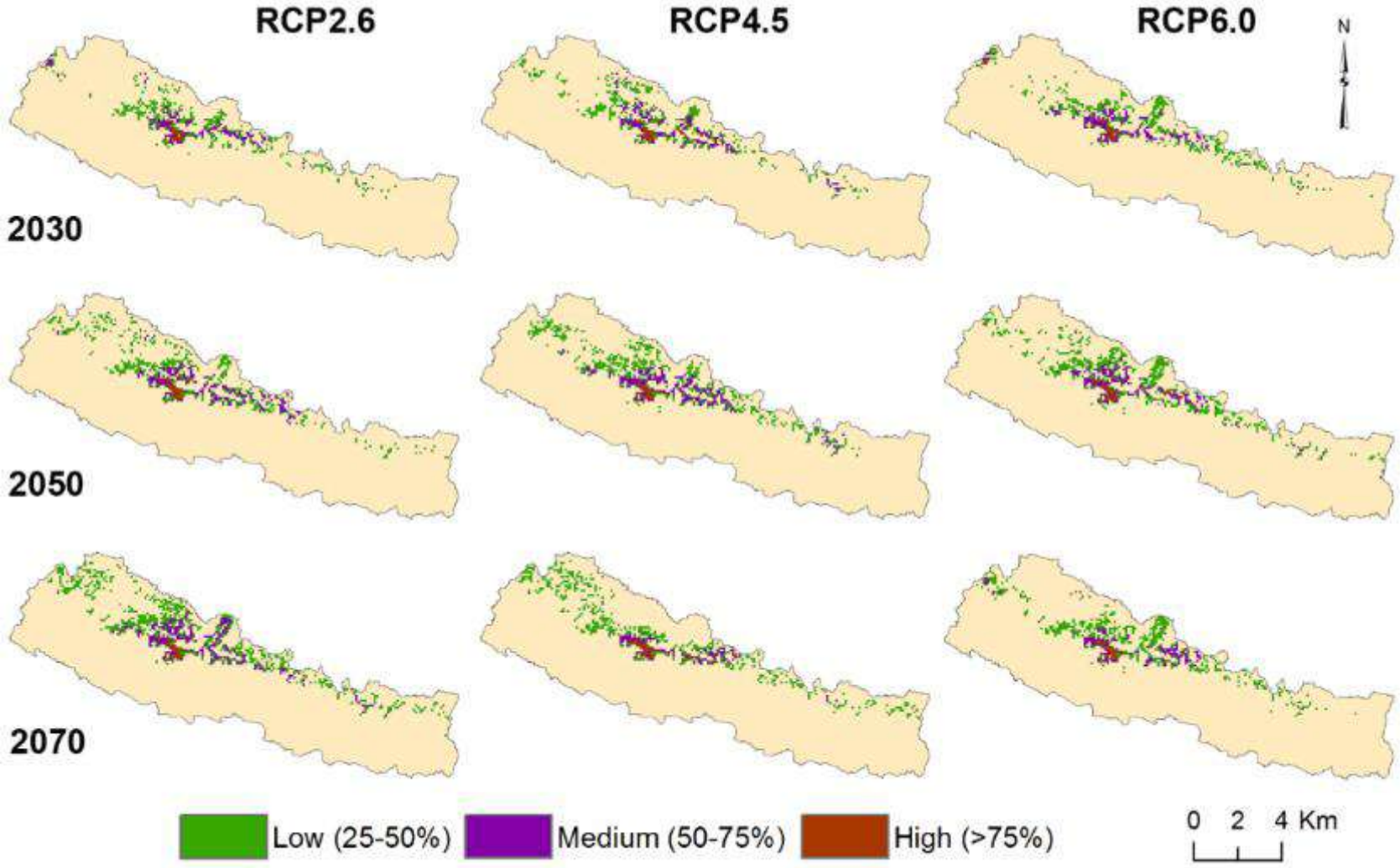
OPEN ACCESS Freely available online

PLOS ONE

Impact of Climate Change on Potential Distribution of Chinese Caterpillar Fungus (*Ophiocordyceps sinensis*) in Nepal Himalaya

Uttam Babu Shrestha[1]*, Kamaljit S. Bawa[2,3]

1 Institute for Agriculture and the Environment, University of Southern Queensland, Toowoomba, Queensland, Australia, **2** Department of Biology, University of Massachusetts, Boston, Massachusetts, United States of America, **3** Ashoka Trust for Research in Ecology and Environment (ATREE), Bangalore, India



Future climate change will open-up new suitable habitats for the caterpillar fungus (Yartsgumba).

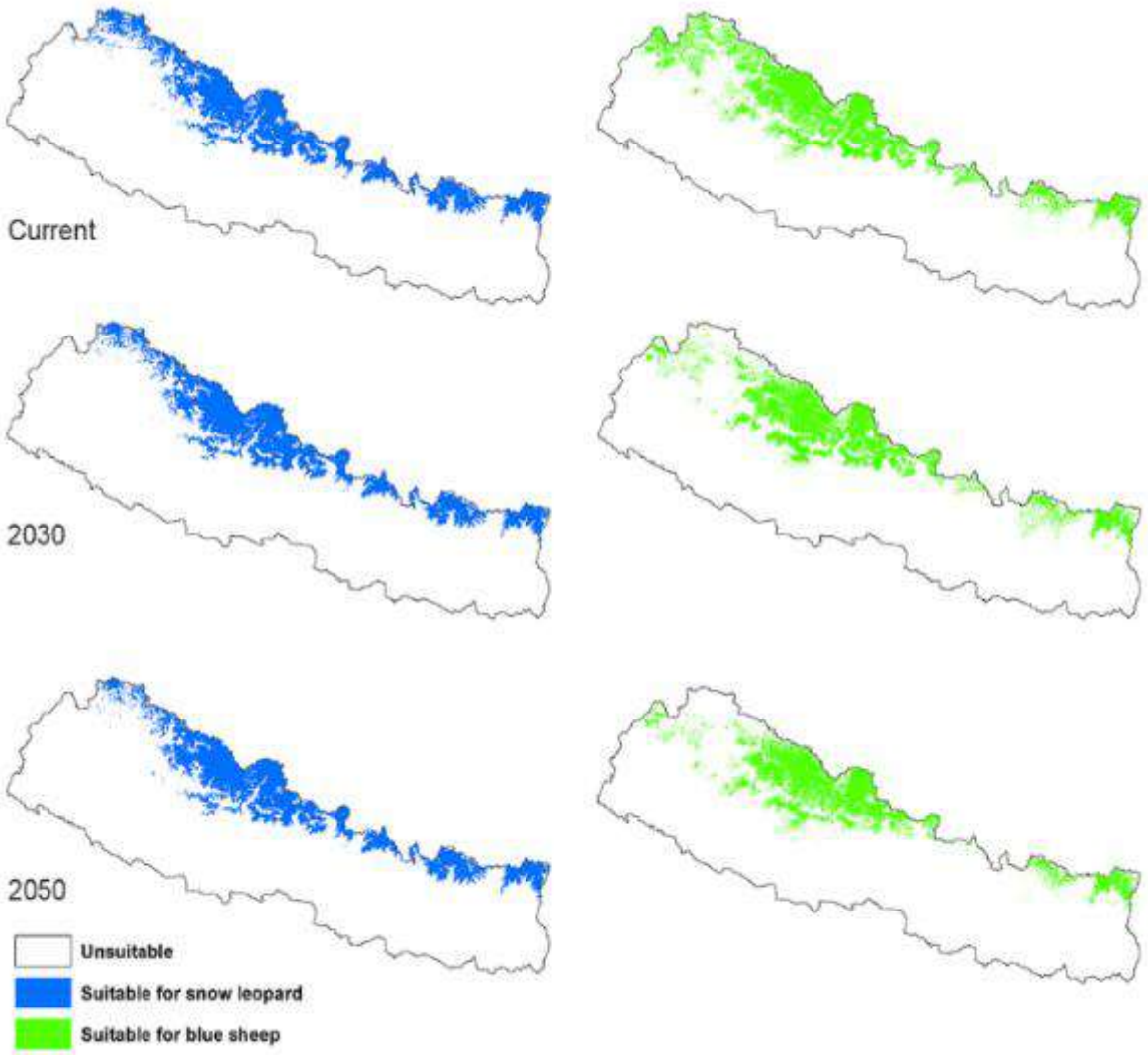
Impacts of Climate Change

Distribution change predator-prey habitats

Ecology and Evolution
Open Access

Predicting the distributions of predator (snow leopard) and prey (blue sheep) under climate change in the Himalaya

Achyut Aryal[1,2], Uttam Babu Shrestha[3], Weihong Ji[1], Som B. Ale[4,5], Sujata Shrestha[6], Tenzing Ingty[6], Tek Maraseni[3], Geoff Cockfield[7] & David Raubenheimer[1,2,8]

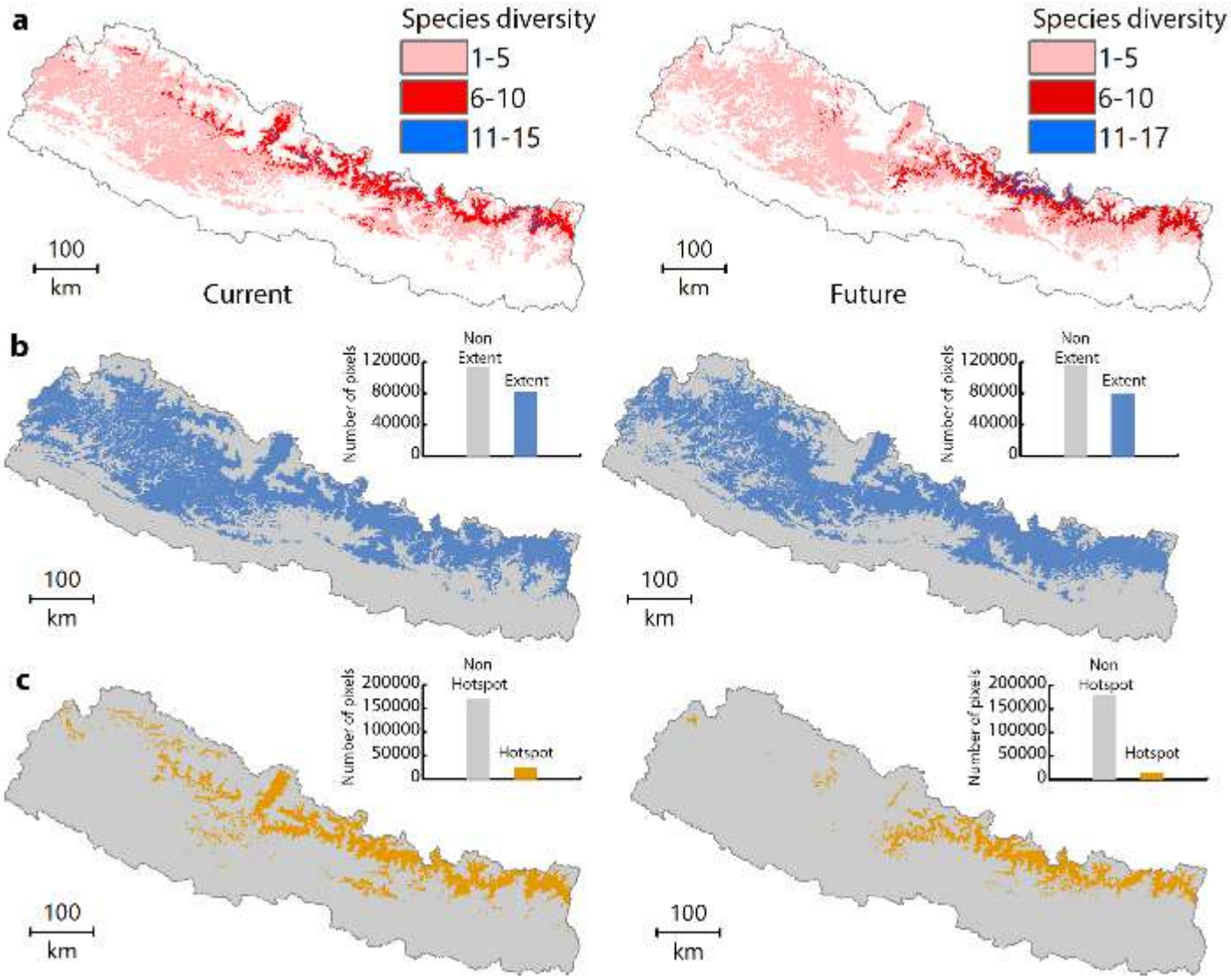


Suitable habitats of both snow leopard and blue sheep will be reduced under future climate change.

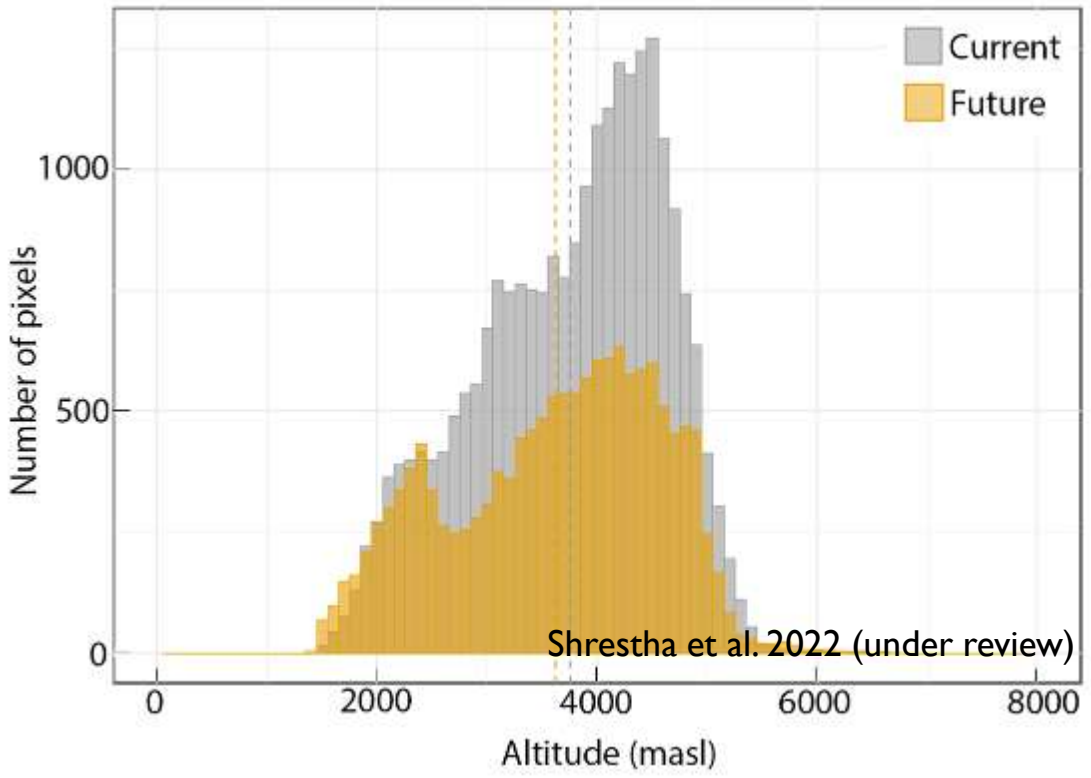
Suitable habitat of the snow leopard is further decreased when blue sheep habitat is incorporated in the model.

Impacts of Climate Change

Distribution change of 29 species of medicinal plants



Future climate change will reduce climatically suitable areas of two third of the 29 studied species and decrease climatically suitable hotspots across altitude, physiography, ecoregions, federal states, and protected areas in Nepal.



Shrestha et al. 2022 (under review)

Impacts of Climate Change

Distribution change (invasive species)

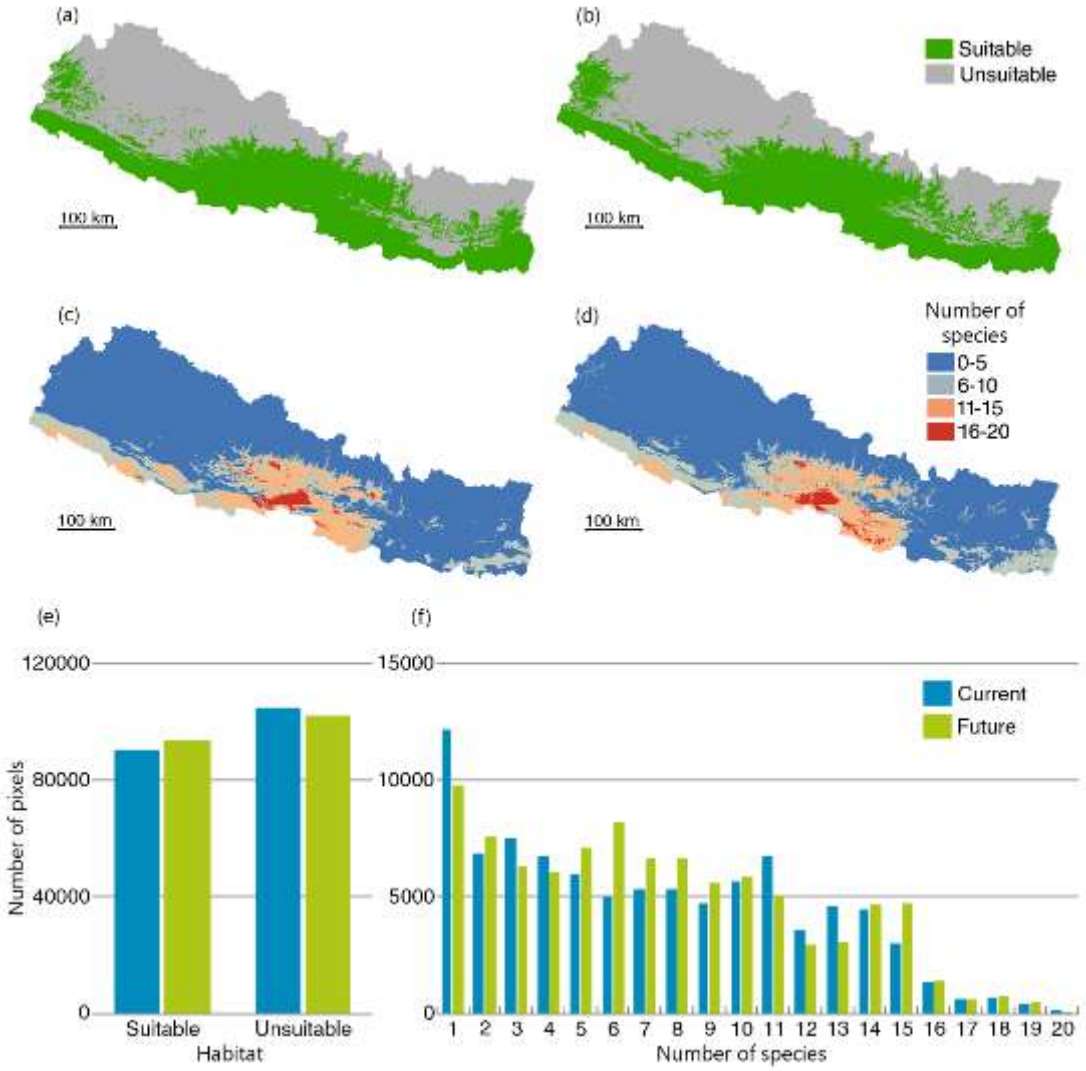
Received: 14 November 2018 | Revised: 12 June 2019 | Accepted: 16 June 2019
DOI: 10.1111/ddi.12963

BIODIVERSITY RESEARCH

Diversity and Distributions WILEY

Climate change amplifies plant invasion hotspots in Nepal

Uttam Babu Shrestha[1] | Bharat Babu Shrestha[2]



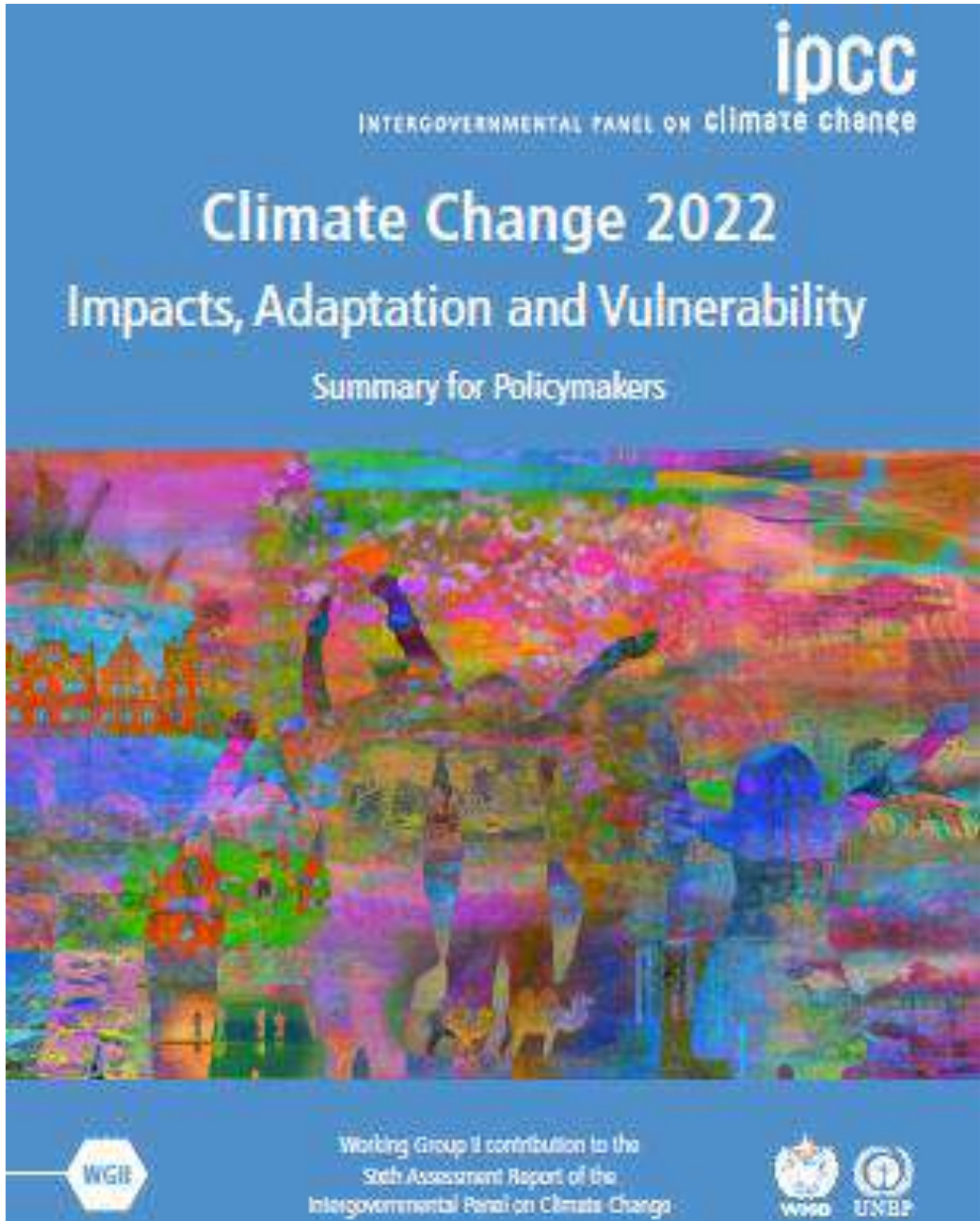
Future climate amplifies both the intensity and extent of the suitable habitats of invasive alien plants in Nepal

Vulnerability to Climate Change

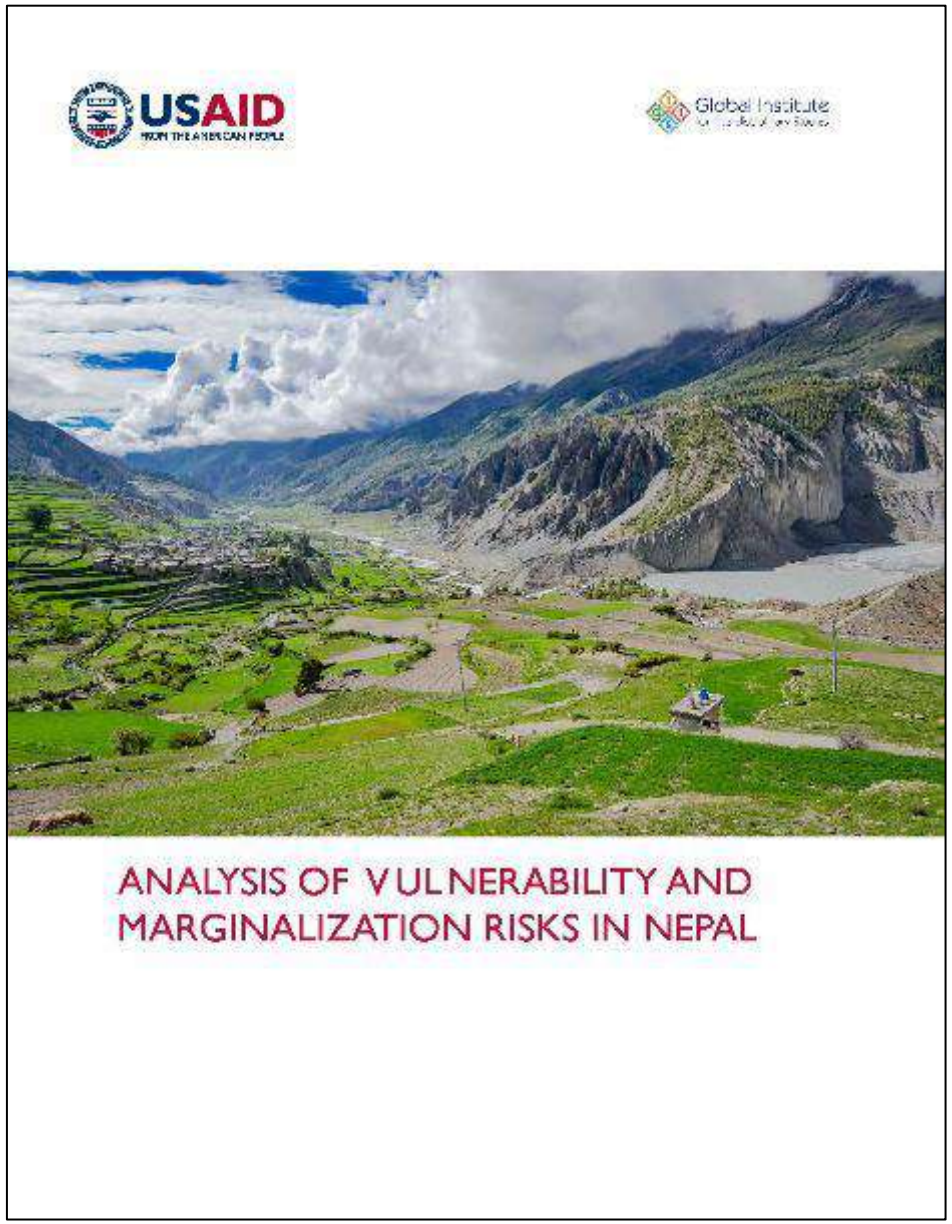
- Vulnerability of ecosystems and people to climate change differs substantially among and within regions (very high confidence), driven by patterns of intersecting socioeconomic development.

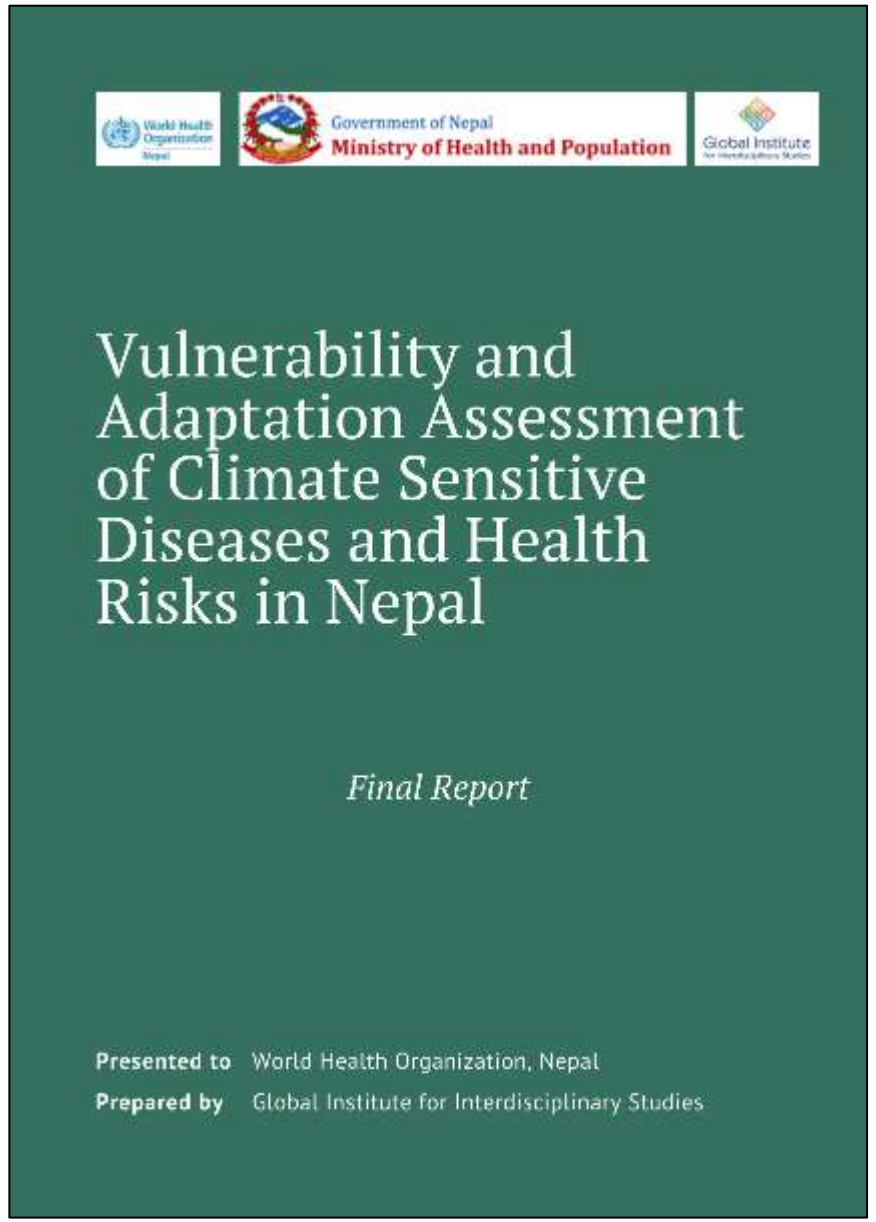
- Approximately 3.3 to 3.6 billion people live in contexts that are highly vulnerable to climate change (high confidence).

- Current unsustainable development patterns are increasing exposure of ecosystems and people to climate hazards (high confidence).



Local Vulnerability to Climate Change






Nepal Hazard Risk Assessment
Government of Nepal
adpc
NGI
Asian Disaster Preparedness Center (ADPC)
Norwegian Geotechnical Institute (NGI)
Centre for International Studies and Cooperation (CECI)
Supported by
THE WORLD BANK
GFDRR
RAPID ASSESSMENT OF SOCIO ECONOMIC IMPACT OF COVID-19 IN NEPAL
UNDP
Risk and Vulnerability in Nepal
Findings from the Household Risk and Vulnerability Survey
Thomas Walker, Yasuhiro Kawasoe and Jui Shrestha
November 2019
Government of Nepal
Climate Change Vulnerability Mapping for Nepal
Disaster Risk Reduction in Nepal
Status Report 2019
adpc
UNDRR
NEPAL
HUMAN DEVELOPMENT REPORT 2020
Beyond Graduation:
NEPAL
Monitoring the situation of children and women
Multiple Indicator Cluster Su
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National Planning Commission
Central Bureau of Statistics
unicef
United Nations Children's Fund
GOVERNMENT OF NEPAL
NATIONAL PLANNING COMMISSION
NEPAL
Multidimension
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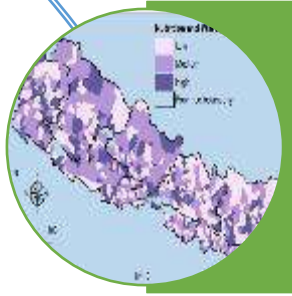
वार्षिक प्रतिवेदन
Vulnerability and Risk Assessment and Identifying Adaptation Options
Summary for Policy Makers
In partnership with
OPHI
OXFORD
Demographic and Health Survey
2016
Nepal COVID-19
Economic Vulnerability Index
Overview and Technical Guidance
WFP
World Food Programme
July 2020
Climate Change Vulnerability, Impact, and Adaptation Assessment
A Report Submitted to
Government of Nepal
Ministry of Forests and Environment
Third National Communication Project
Singh Durbar, Kathmandu
Central Department of Environmental Science
Institute of Science and Technology
Tribhuvan University
Kirtipur, Nepal
August 2018

Palika Level Analysis of Vulnerability and Risks

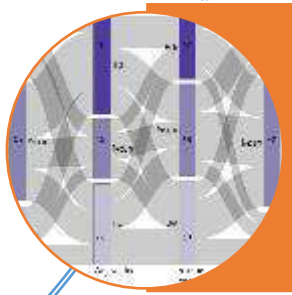
Innovation in terms of methodology and data



Scale: Palika-level (753)

Approach (Multi-Hazards Risk) Sendai framework (2015-2030)

29 different hazards belonging to hydro-meteorological (*n=5*), geological (*n=3*), environmental (*n=2*), biological (*n=18*), and technological (*n=1*)



Data (Most comprehensive datasets including COVID-19)

Social Vulnerability (n=48), Marginalization (12 variables)

COVID-19 risk (11 variables). **All together 160**

Climate Induced Hazards (Incidences and Impacts)

~650 people died in Nepal each year as a result of climate-induced disasters.

Tarai floods in 2017 caused economic loss of USD 63.19 million (2.08 % the GDP)

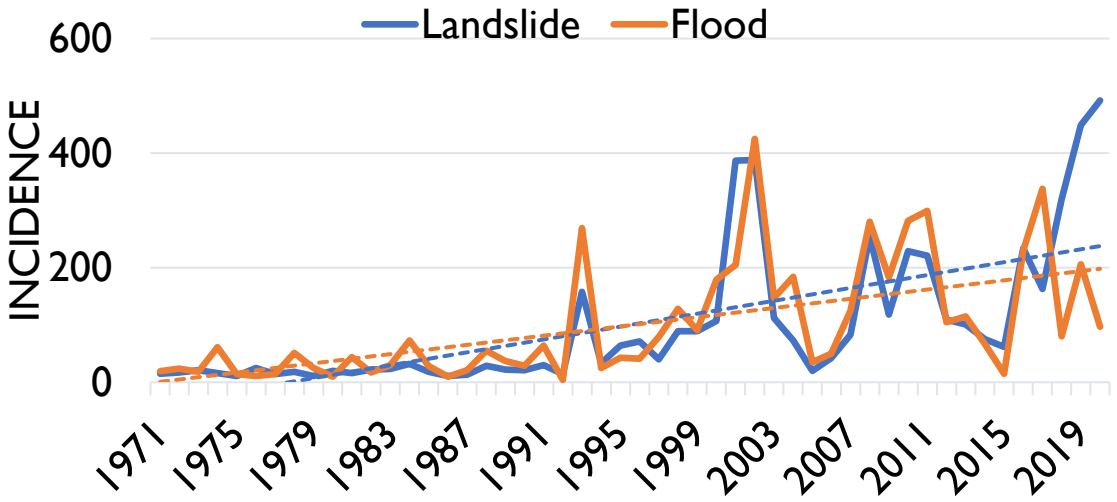
Incidences (1971-2021)	
Avalanche	128
Cold Wave	696
Fire	20066
Flood	5104
Forest Fire	294
Landslide	5267
Others (Non-Natural)	369
Snowstorm	199
Storm	131
Heat wave	49
Heavy Rainfall	1526

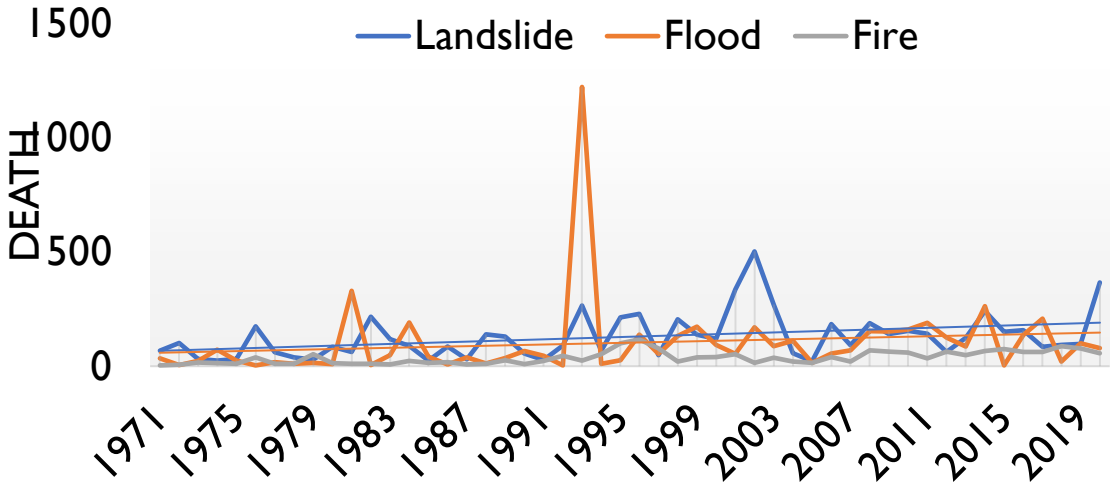
Impact by hazards (1971-October 2021)	
Landslide Deaths	2530
Landslide Injured	1142
Landslide Missing	496
Landslide Houses Destroyed	9494
Landslide Houses Damaged	25752
Fire Deaths	807
Fire Injured	1358
Fire Houses Destroyed	49770
Fire Houses Damaged	2043
Flood Deaths	2193
Flood Injured	273
Flood Missing	688
Flood Houses Destroyed	59760
Flood Houses Damaged	69743

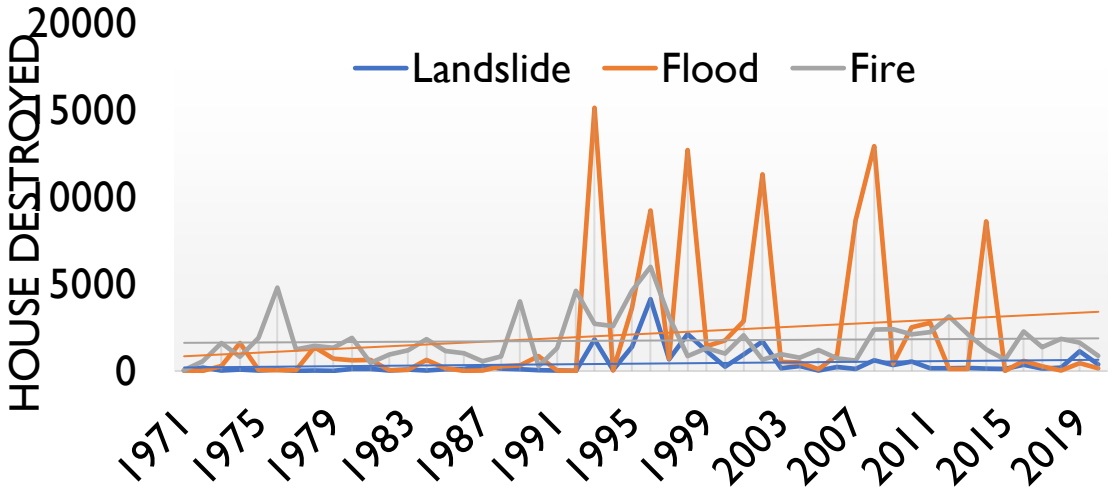
Source: GIIS, 2021 Data from DesInventar and Bipal portal

Climate Induced Hazards in Nepal

Landslide, Flood and Fire from 1971-2021

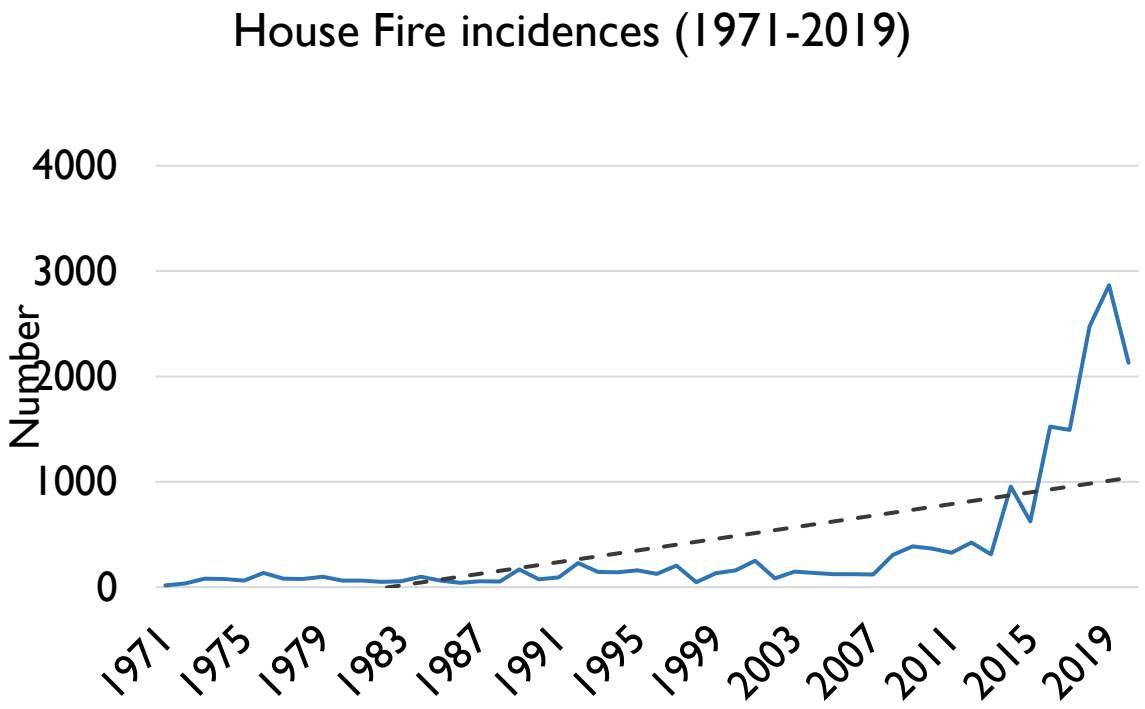


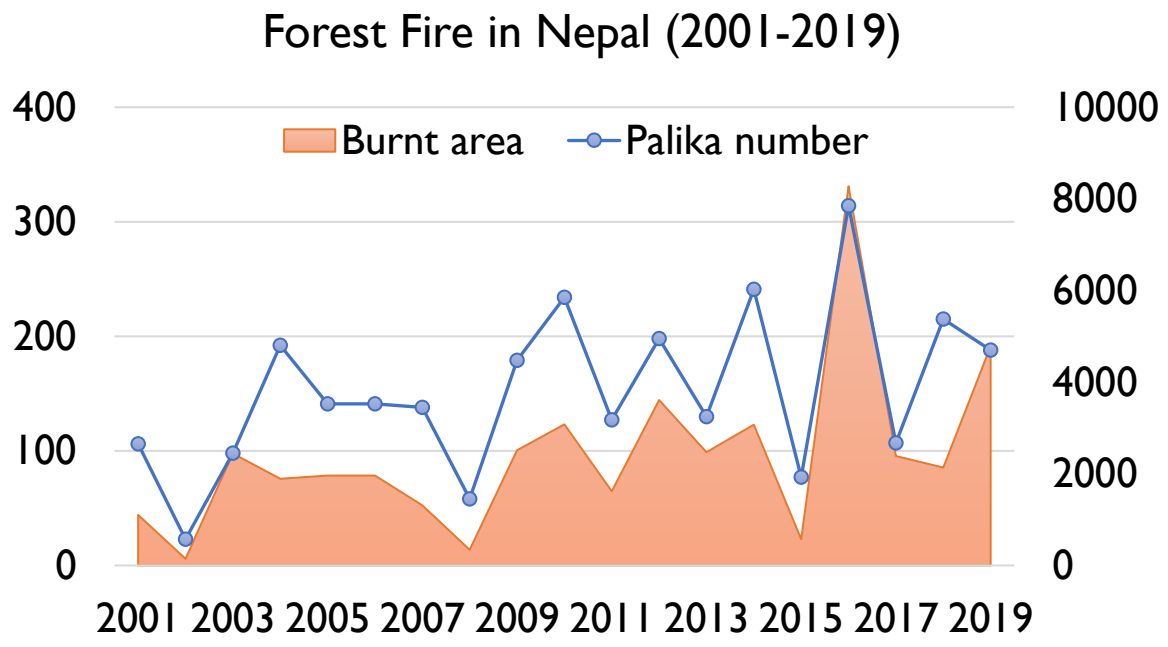




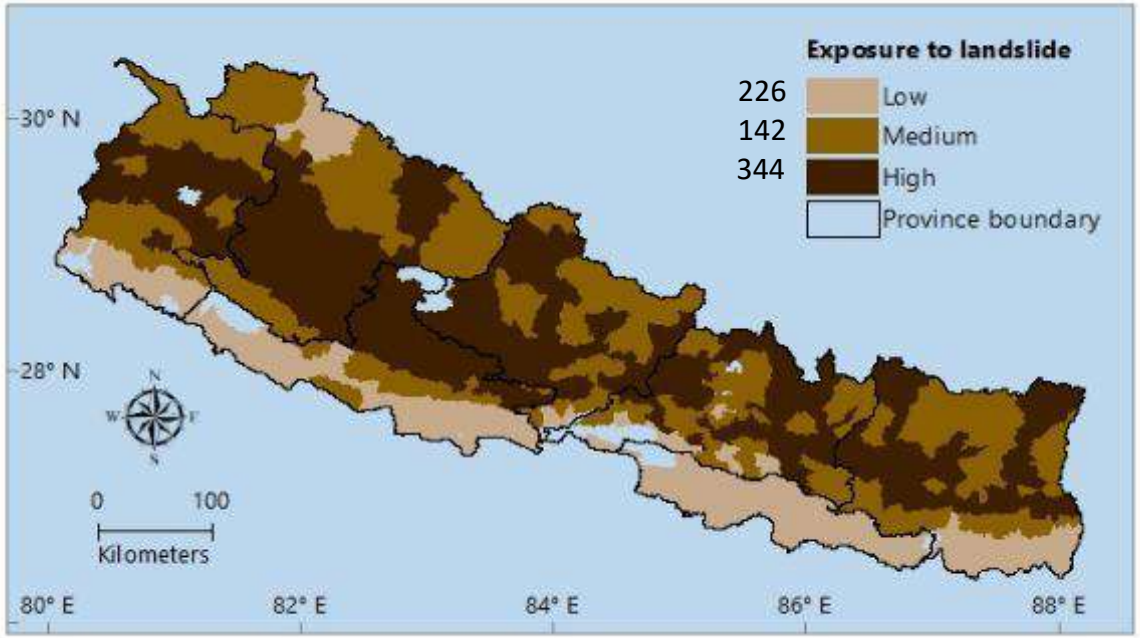
Data source: DesInventar and BIPAD

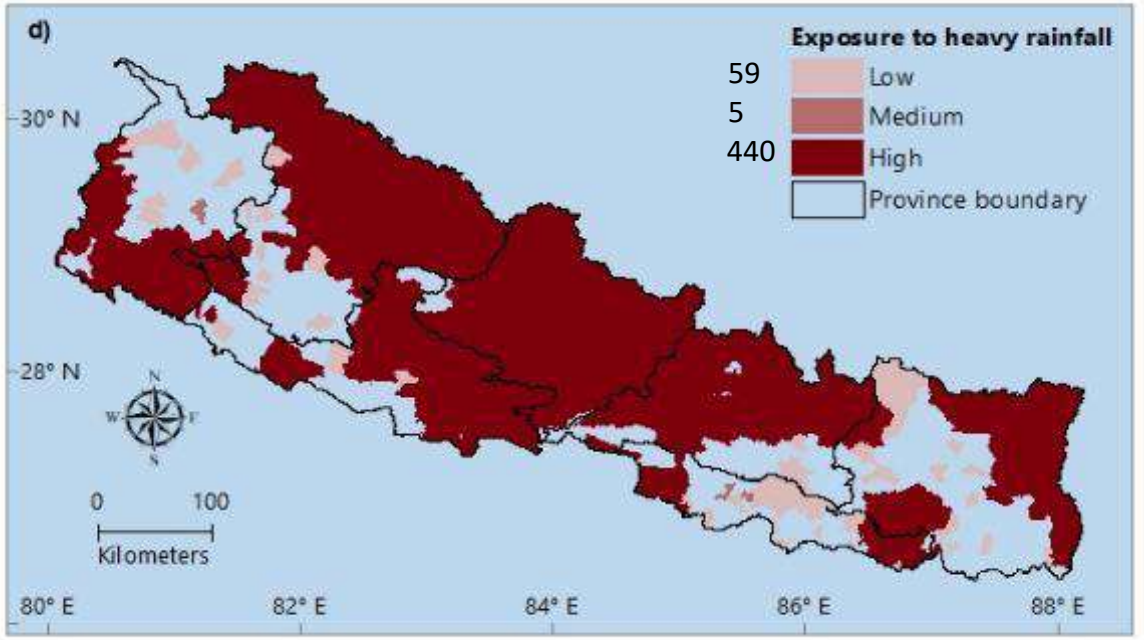
Climate Induced Hazards in Nepal

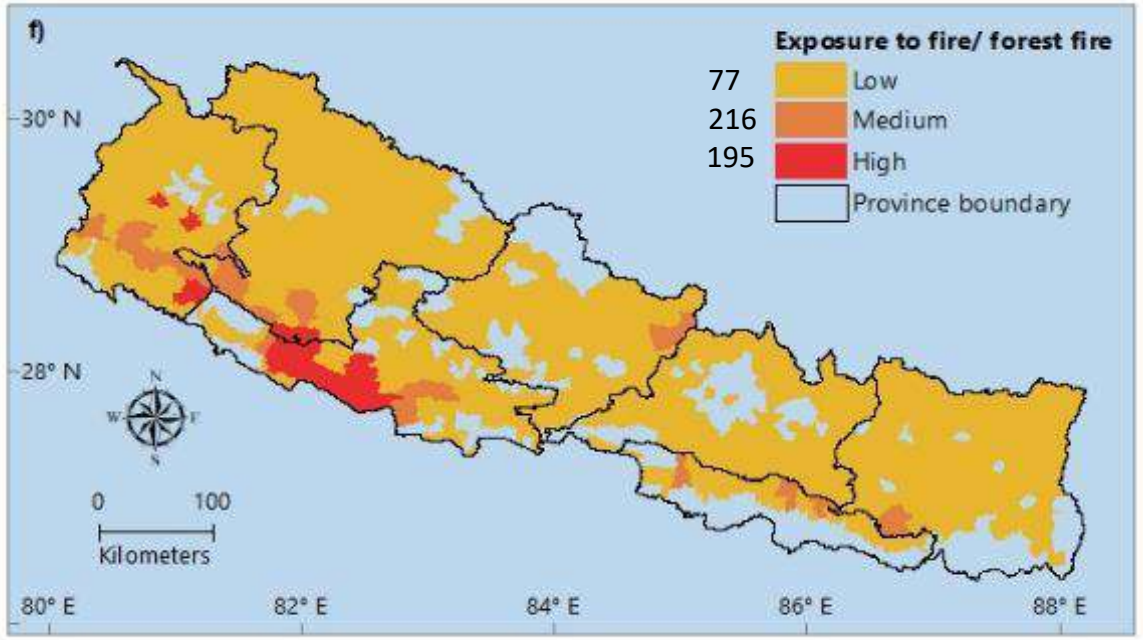


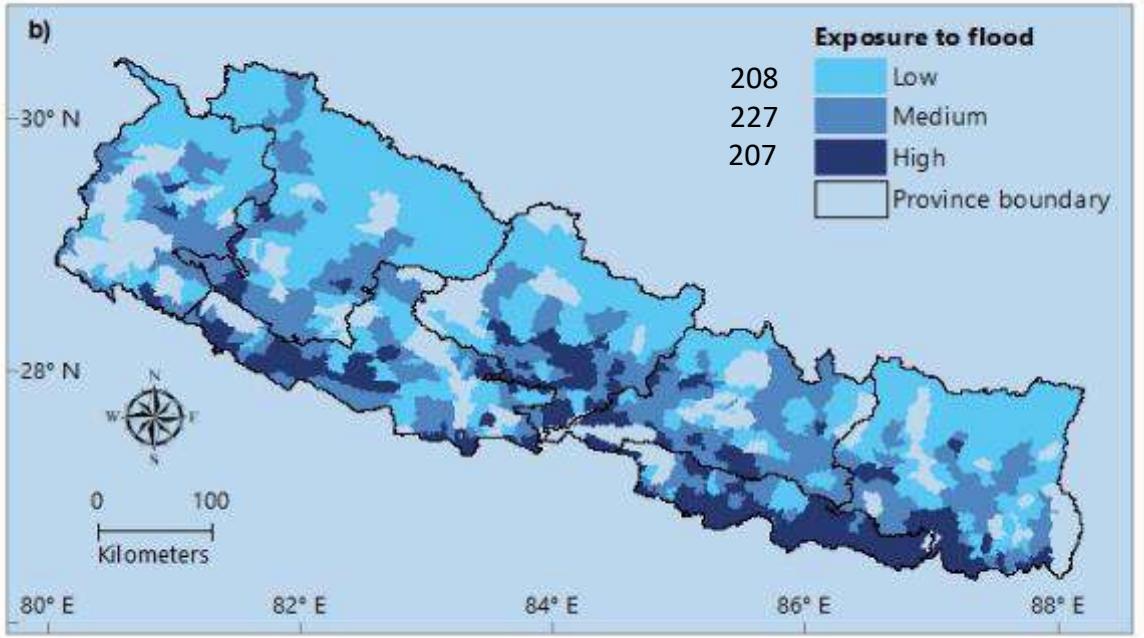


Data source: MODIS/FIRMS


Exposure to landslide
226 Low
142 Medium
344 High
Province boundary
30° N
28° N
0 100
Kilometers
80° E
82° E
84° E
86° E
88° E


d)
Exposure to heavy rainfall
59 Low
5 Medium
440 High
Province boundary
30° N
28° N
0 100
Kilometers
80° E
82° E
84° E
86° E
88° E

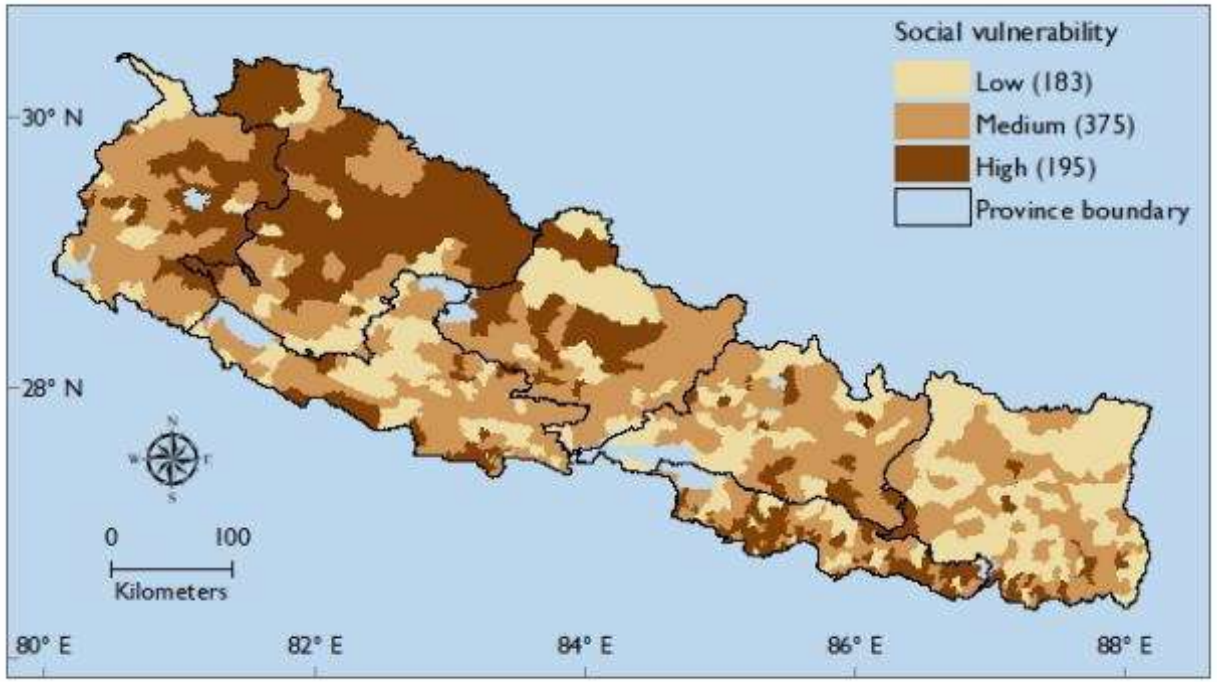

f)
Exposure to fire/ forest fire
77 Low
216 Medium
195 High
Province boundary
30° N
28° N
0 100
Kilometers
80° E
82° E
84° E
86° E
88° E

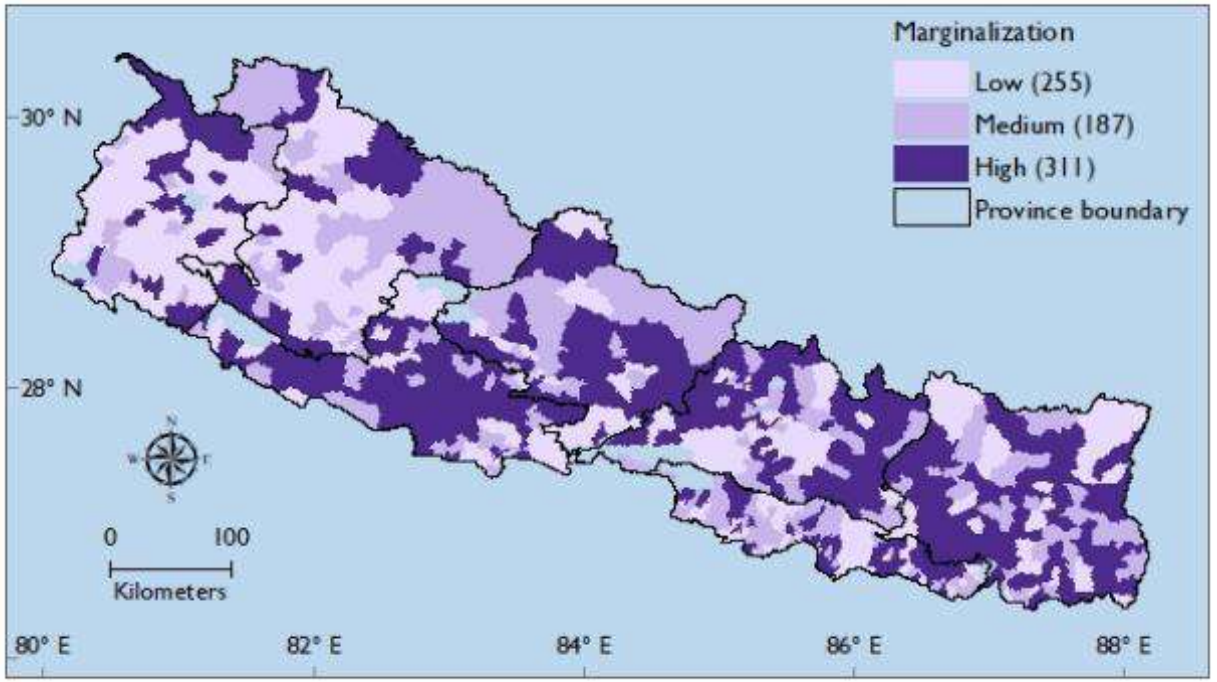

b)
Exposure to flood
208 Low
227 Medium
207 High
Province boundary
30° N
28° N
0 100
Kilometers
80° E
82° E
84° E
86° E
88° E

Social Vulnerability and Marginalization in Nepal

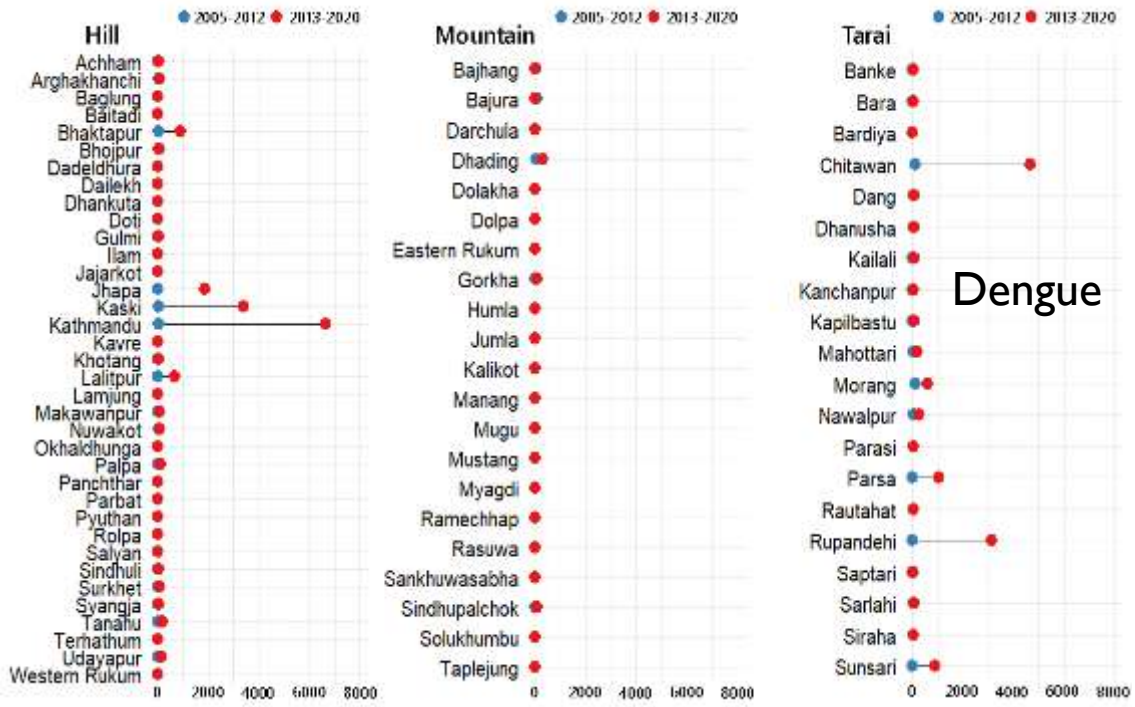
The impacts of hazards have differential among social groups in Nepal

Pre-existing conditions of an individual such as caste, ethnicity, gender, poverty, age, education, and religion play significant roles as individual factors or intersect (a poor minority woman who is disabled) to aggravate disaster risk outcomes.

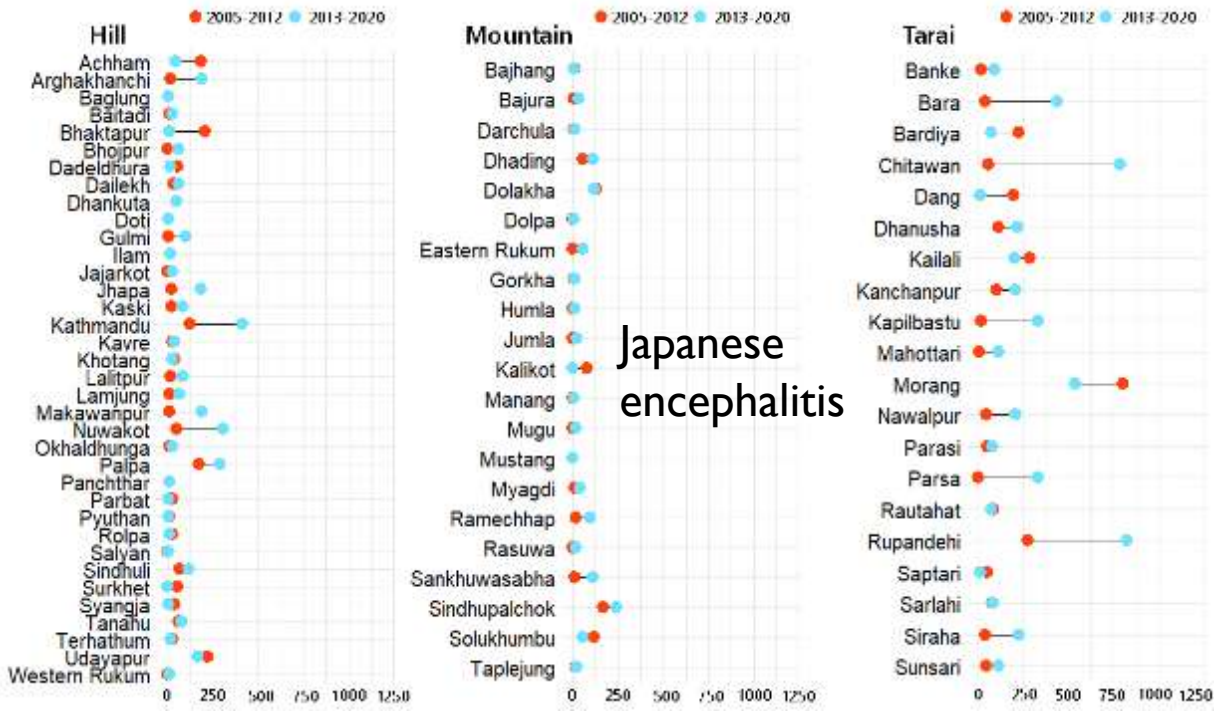




Trends of Climate Sensitive Diseases



Dengue



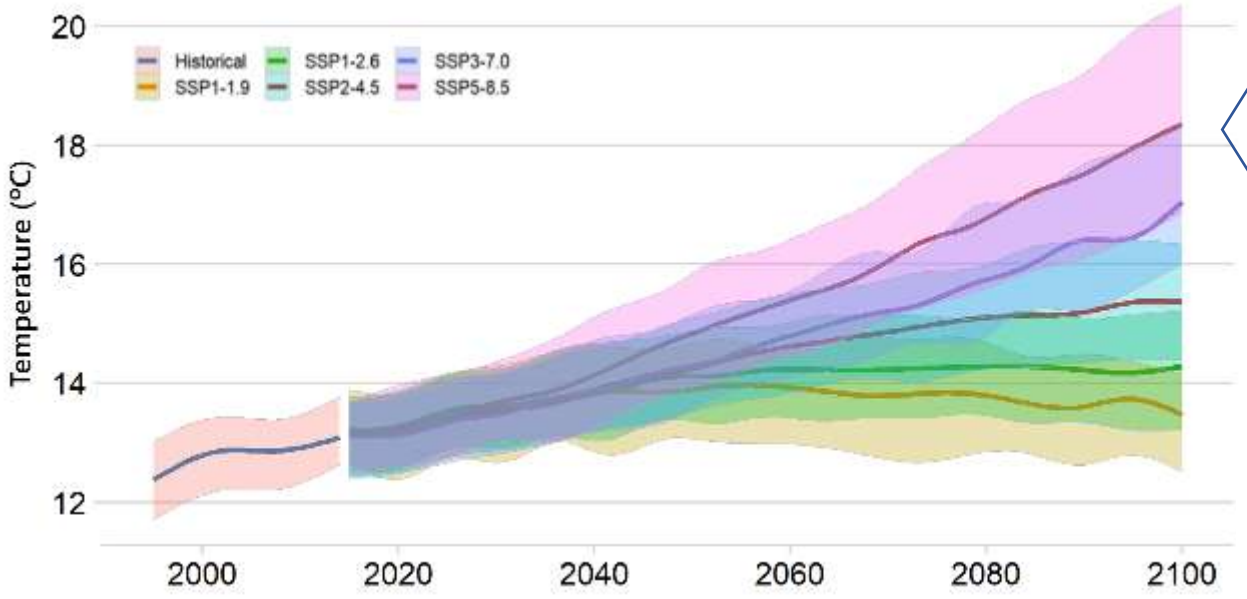
Japanese encephalitis

Dengue cases appeared to be reported only after 2010

Frequent outbreaks of Japanese encephalitis cases were reported in some districts

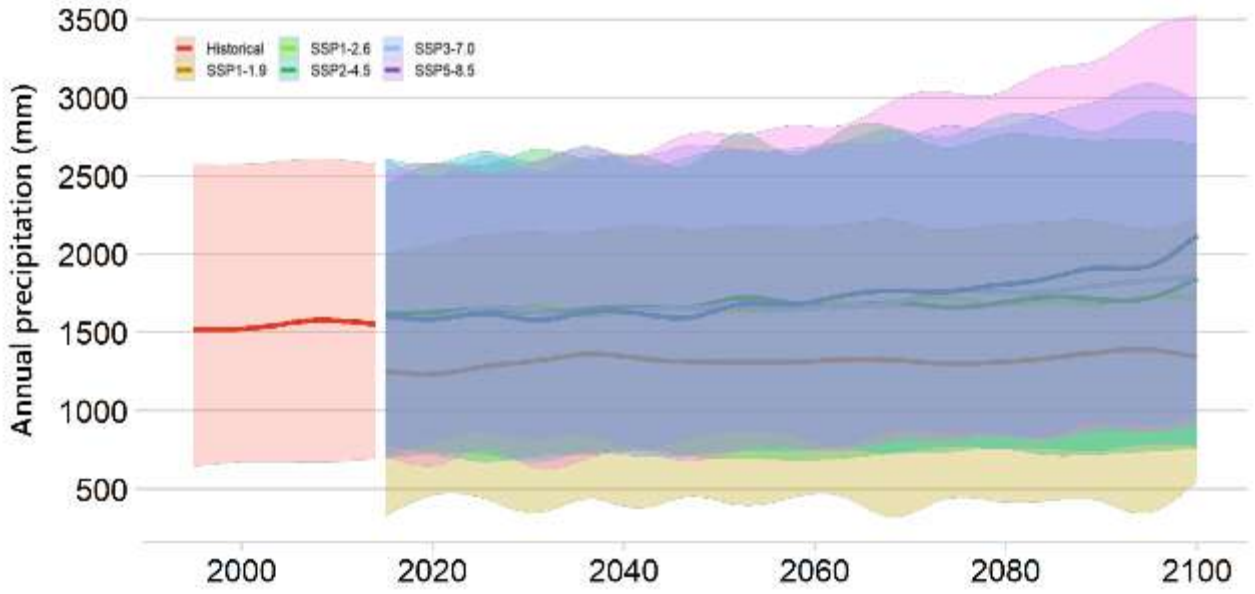
Future Climate Change

Change in average temperature and precipitation in future based on 13 different GCMs



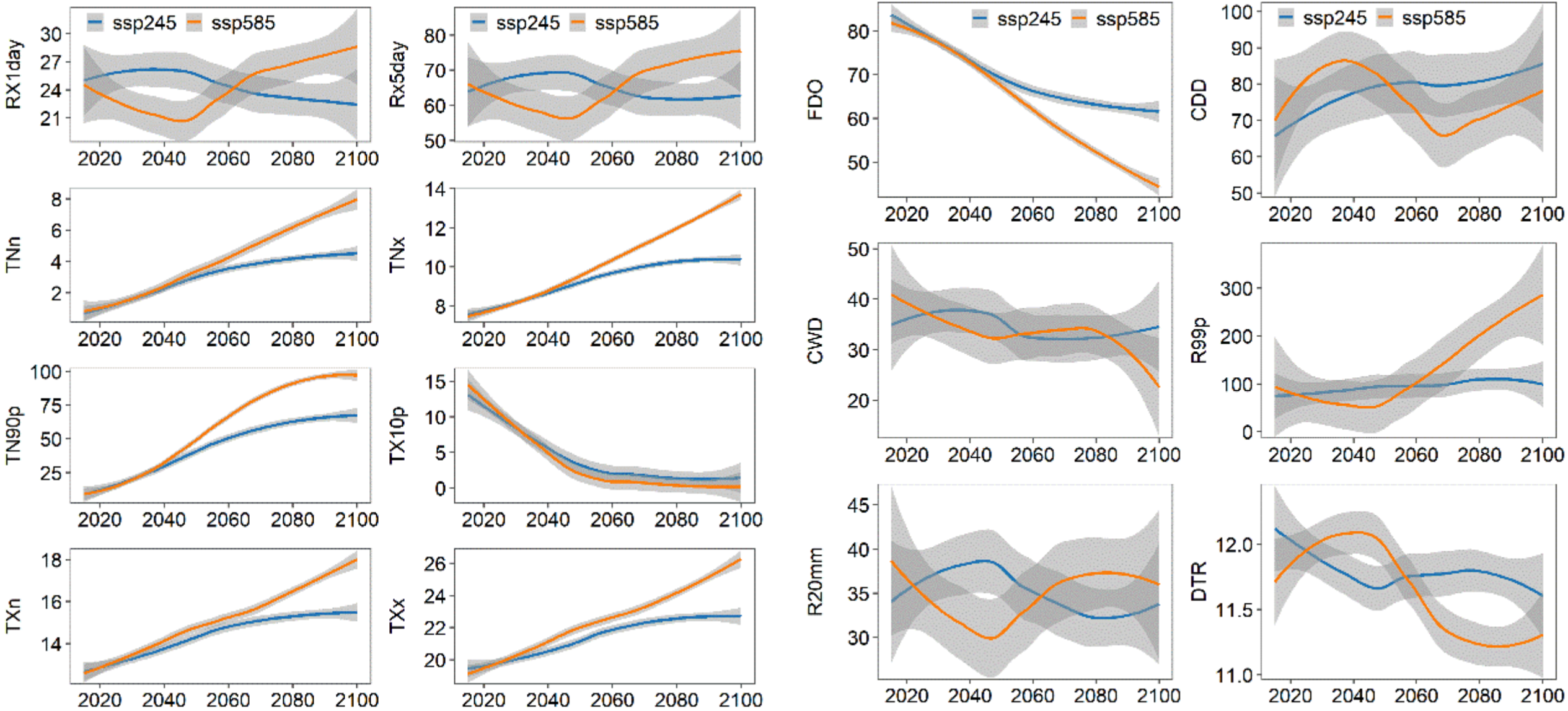
Depending on the scenarios, mean annual temperature over Nepal will increase between 0.75°C and 0.84°C by 2020-2040, between 1.09°C to 2.03°C by 2041-2060, 0.92°C to 4.03°C by 2061-2100.

Except SSP1-1.9 scenario, total annual precipitation over Nepal will increase in the range of 3-5% by 2020-2039, 5-8% by 2040-2059, 9-12% by 2060-2079 and 10-12% by 2080-2099.



Future Climate Change

Change in extreme temperature and precipitation indices



Vulnerability Amplifiers

Haphazard road construction increased risk of landslides in Nepal y driver

Nat. Hazards Earth Syst. Sci., 19, 655–660, 2019
https://doi.org/10.5194/nhess-19-655-2019

Natural Hazards and Earth System Sciences
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Invited perspectives: Mountain roads in Nepal at a new crossroads

Karen Sudmeier-Rieux[1], Brian G. McAdoo[2], Sanjaya Devkota[3], Purna Chandra Lal Rajbhandari[4], John Howell[5], and Shuva Sharma[6]

Climate Change Science: Gaps/Challenges

Attribution challenges (Urban Flood): Climate Change
vs Land use change being the primary driver

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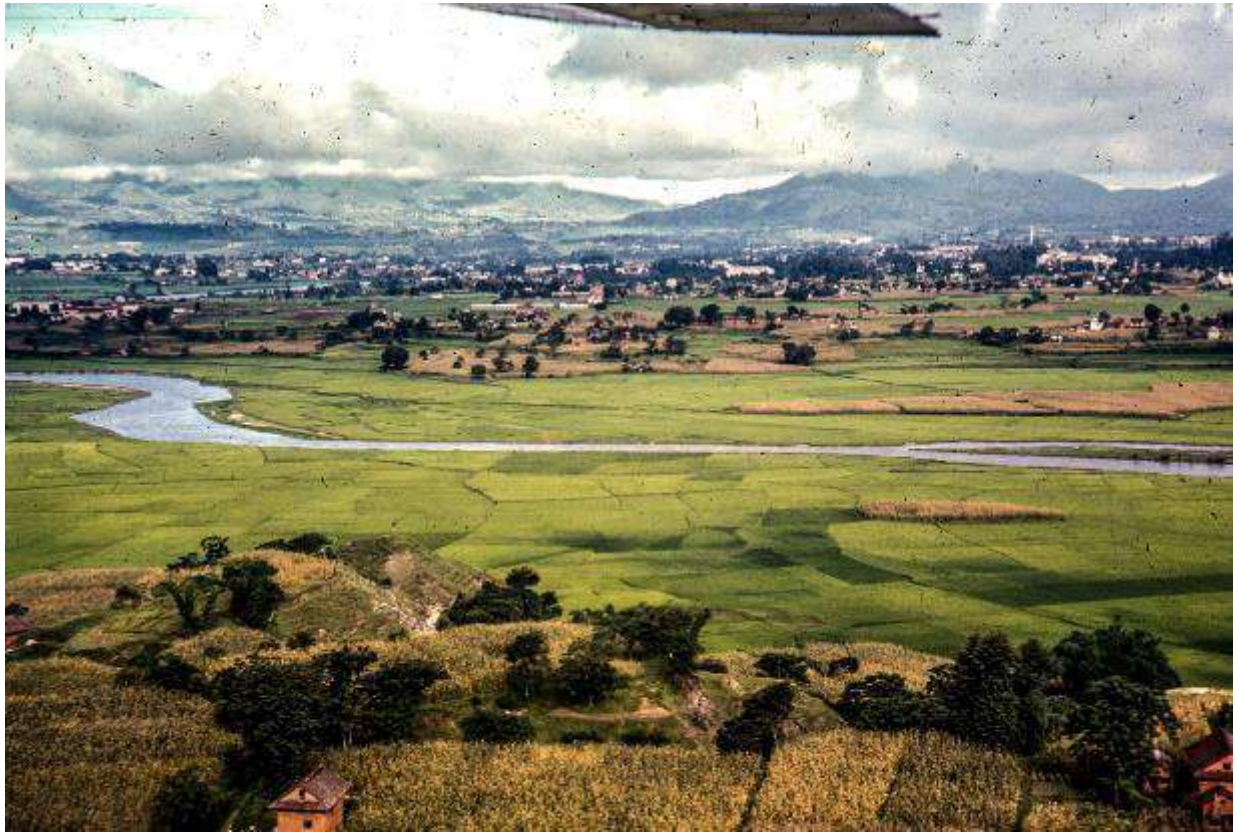

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Concluding Remarks

- Invest in research, data preparation, knowledge generation, scientific capacity development (e.g., MoFE) , and innovation
- Foster credible, legitimate and relevant knowledge production to inform policy and fact-based international negotiations.
- Tackle Climate Change along with other environmental and development problems at the local level.