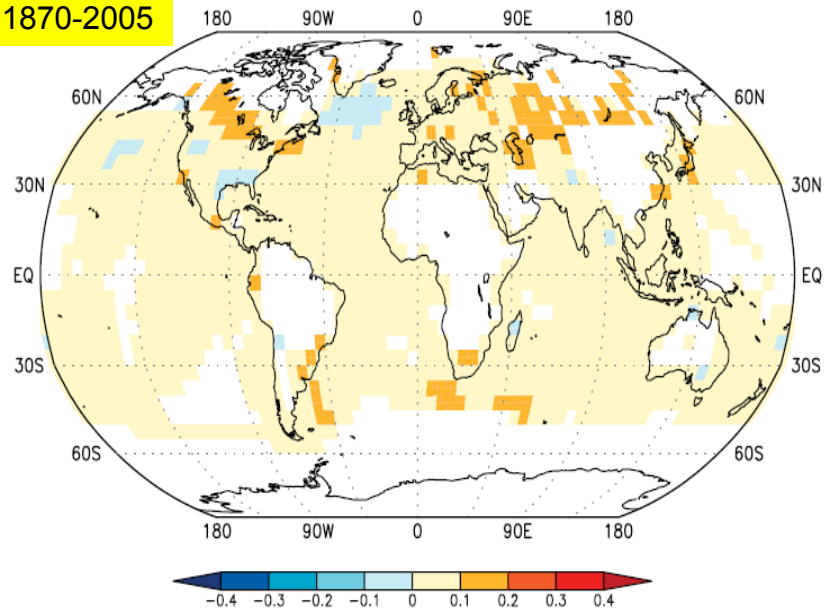
Biological responses of Climate change in Himalaya

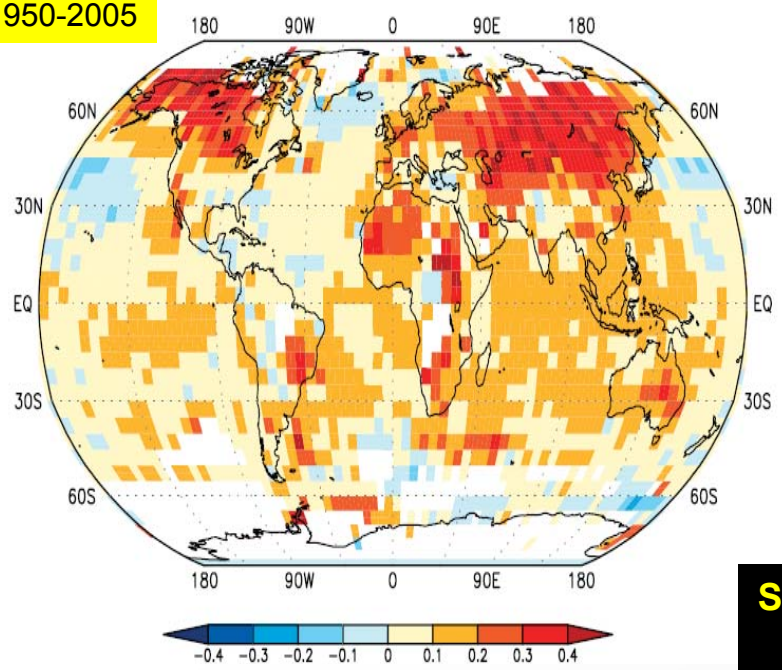
Introduction

1870-2005



- Earth's average surface temperature has increased during the last century ~0.8° C (Bluemle, 1999)

1950-2005



- In response to climatic warming, plant species show ecological responses
  - Altitudinal shifts
  - Phenological changes
  - Community assemblage changes

(Parmesan, 1996; Parmesan & Yohe,2003; Walther *et al.*, 2005; Hickling *et al.*, 2006)

Source: Joint institute for the study of atmosphere and ocean, University of Washington

Background

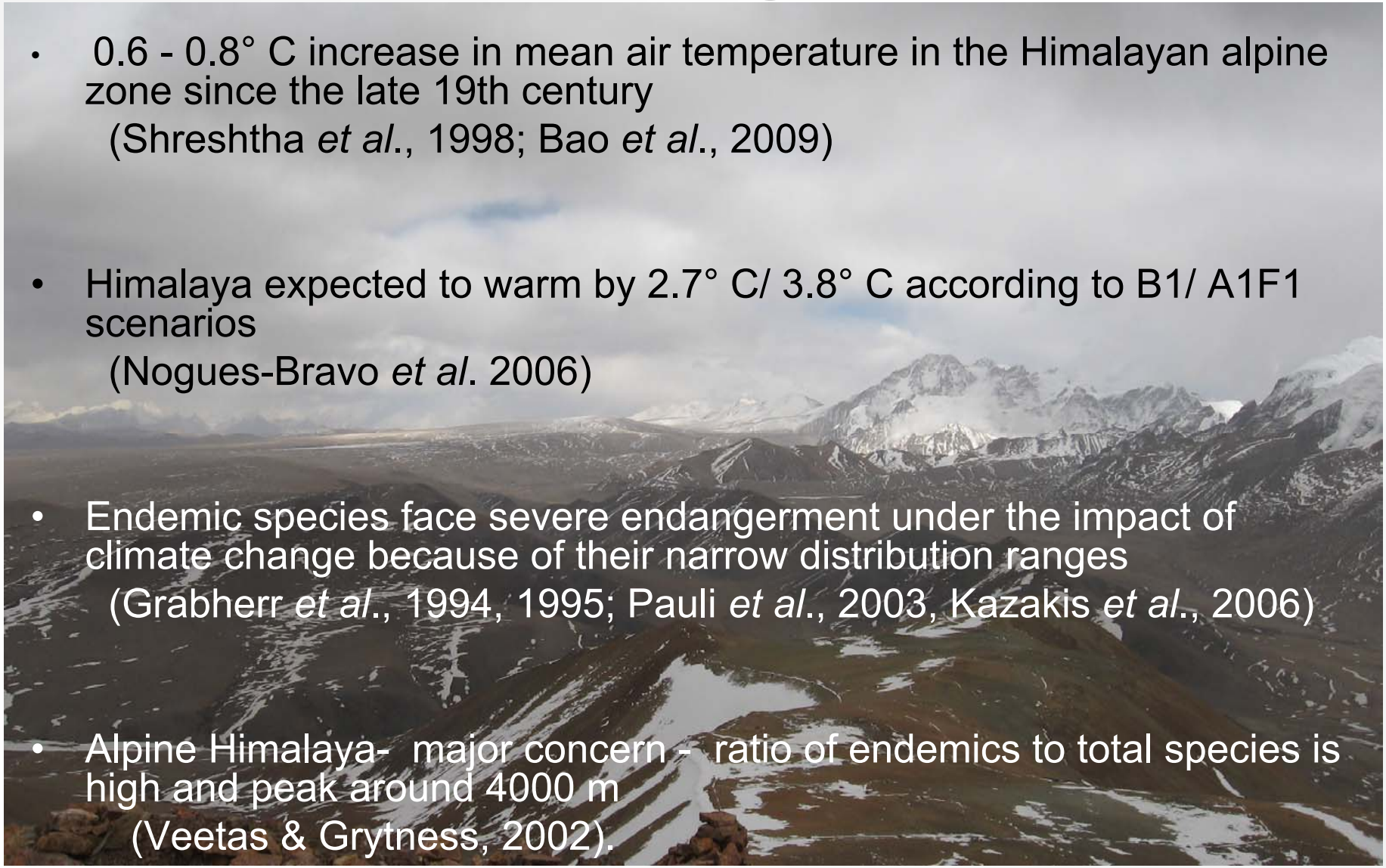
- The ‘alpine ecosystems’ of the mountains are considered to be highly sensitive to climate change (Grabherr *et al*., 1994; Körner 1999)

- Alpine areas – Climate change observatories- least transformed by human activities

- European Alps - Evidence of climate driven upward range shifts of alpine plant species (Kullman, 2002; Klanderud & Birks, 2003; Walther *et al*., 2005; Parolo & Rossi, 2008)

- No evidence from Himalaya

Himalaya



- 0.6 - 0.8° C increase in mean air temperature in the Himalayan alpine zone since the late 19th century
  (Shreshtha *et al*., 1998; Bao *et al*., 2009)

- Himalaya expected to warm by 2.7° C/ 3.8° C according to B1/ A1F1 scenarios
  (Nogues-Bravo *et al*. 2006)

- Endemic species face severe endangerment under the impact of climate change because of their narrow distribution ranges
  (Grabherr *et al*., 1994, 1995; Pauli *et al*., 2003, Kazakis *et al*., 2006)

- Alpine Himalaya- major concern - ratio of endemics to total species is high and peak around 4000 m
  (Veetas & Grytness, 2002).

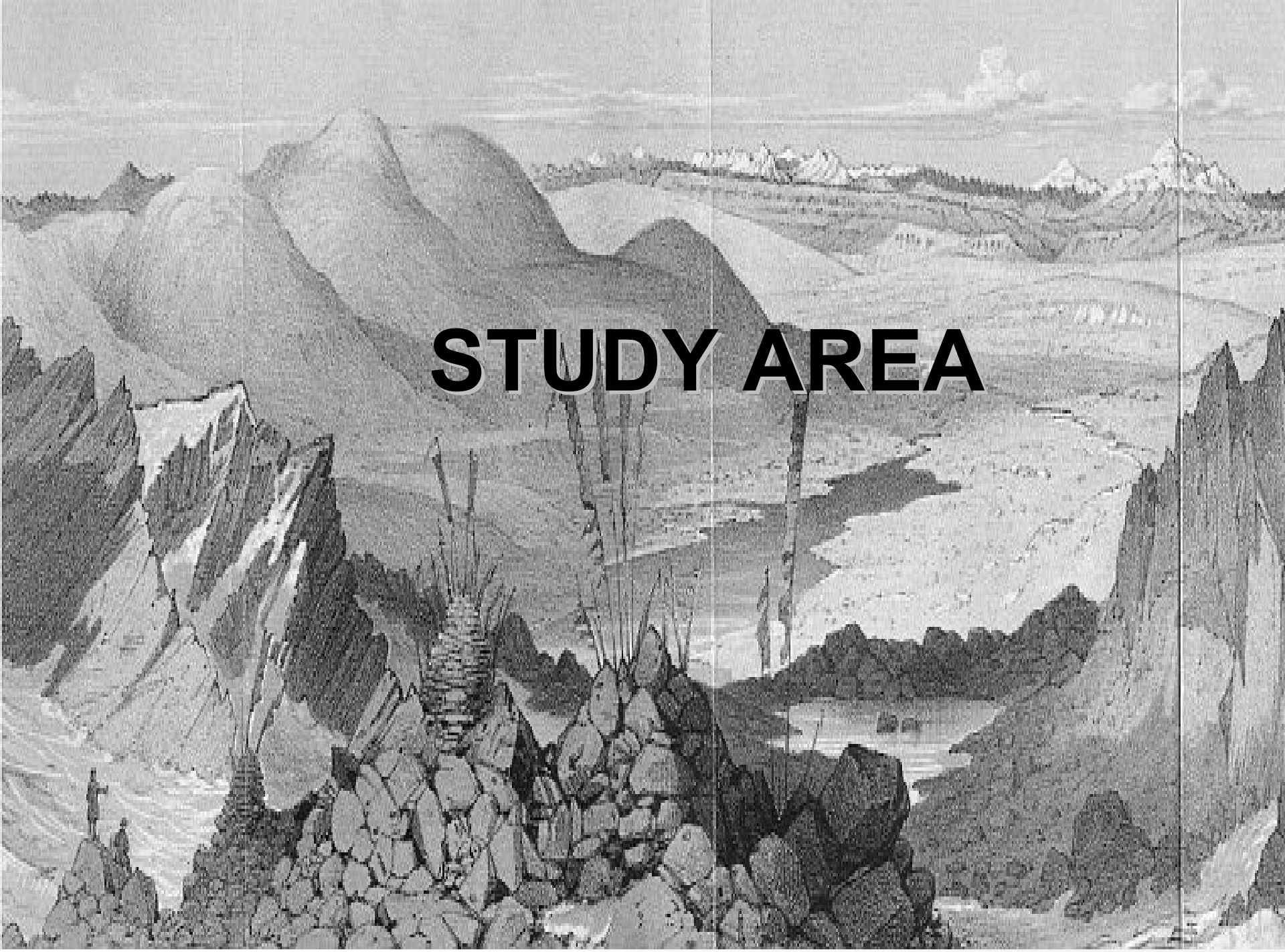
Eastern Himalaya

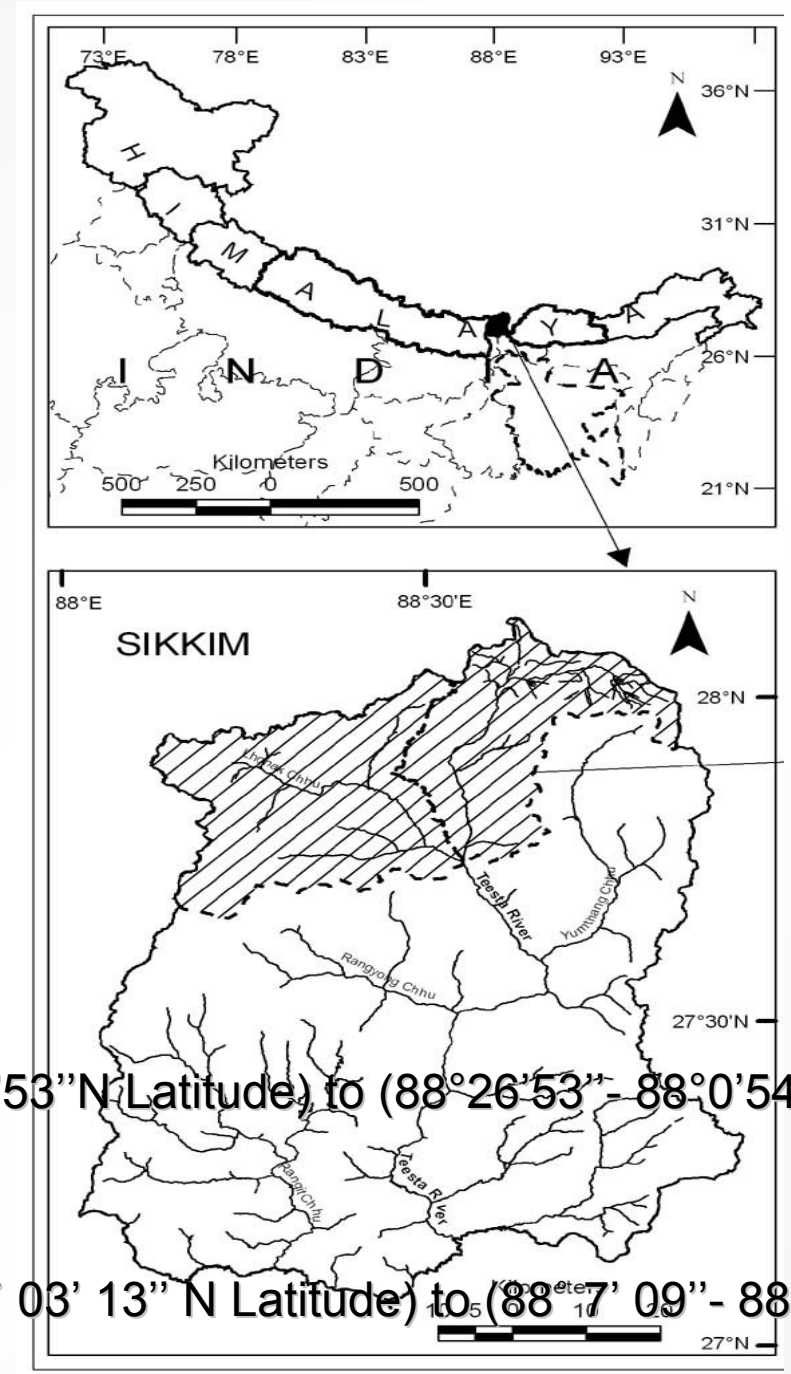
- **Eastern Himalaya form distinct floristic phytogeographic region (Behera *et al*., 2001)**

- **Exhibit higher degrees of endemism in alpine plants compared to the Western Himalaya or the neighboring regions (Behera *et al*., 2001; Dhar 2002; Pandit *et a*l., 2007)**

- **Altitudinal limitation of the alpine belt of the Eastern Himalaya (5500 m) higher than Western Himalaya (4000 ± 200 m)**

- **Low latitudinal placement and close proximity to the Bay of Bengal (controls the moisture and wind patterns for the whole Himalayan region**


STUDY AREA



- **Sikkim**
- **Lachen** (27°45’00’ - 28°7’53’’N Latitude) to (88°26’53’’ - 88°0’54’’E Longitude)
- **Lhonakh** (27° 40’15’’- 28° 03’ 13’’ N Latitude) to (88° 7’ 09’’- 88° 32’ 21’’ E Longitude)

Objectives

1. **To establish the baseline data for climate change studies in Himalaya**

2. **To estimate the response of endemic plant species to the climate change during the last century**

3. **To predict the ranges of endemic plant species for the present and future climatic scenario**

4. **On the basis of the present study to evaluate the most suitable directions for the future climatic research in Himalaya**

Objective 2

Species occurence

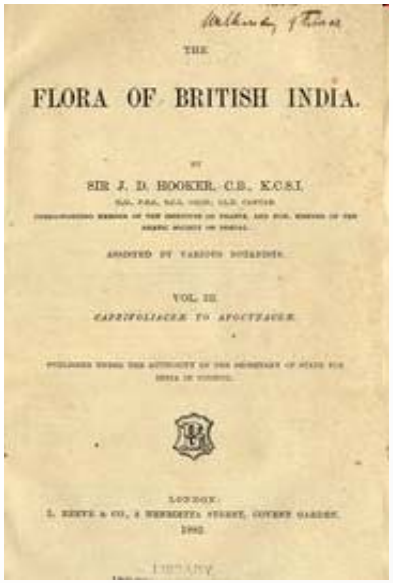
- **Compiled list of all vascular alpine plant species of alpine Sikkim**

  Historic records:

  Floras — Flora of British India (1850-72)

  Vegetation of Zemu and Lhonakh valley

  Herbarium records-BSI- Kolkata, Gangtok (1909)


THE

FLORA OF BRITISH INDIA.

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VOL. III.

LONDON:

- **Scanned the list** — Selected endemic species

  Known range boundaries& occurrence sites

- **Range comparison - 124 Endemic alpine plant species from 2 valleys Lachen and Lhonakh**

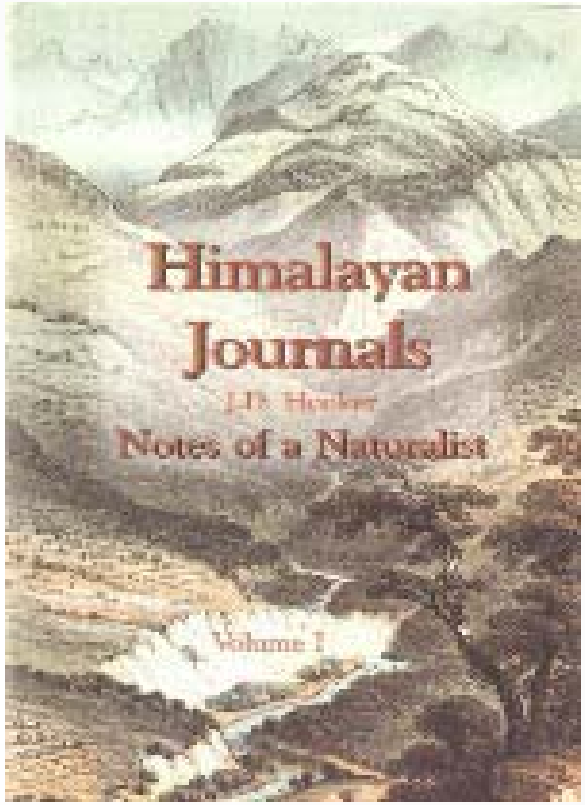
Objective 1 and 2

Historic Data set

- **Temperature**

Historic data sets:

Himalayan Journals Notes of Naturalist
J.D. Hooker- 1850 A.D



Recent data sets:

2007-09 daily ambient mean air temperature records from 17 stations in study area

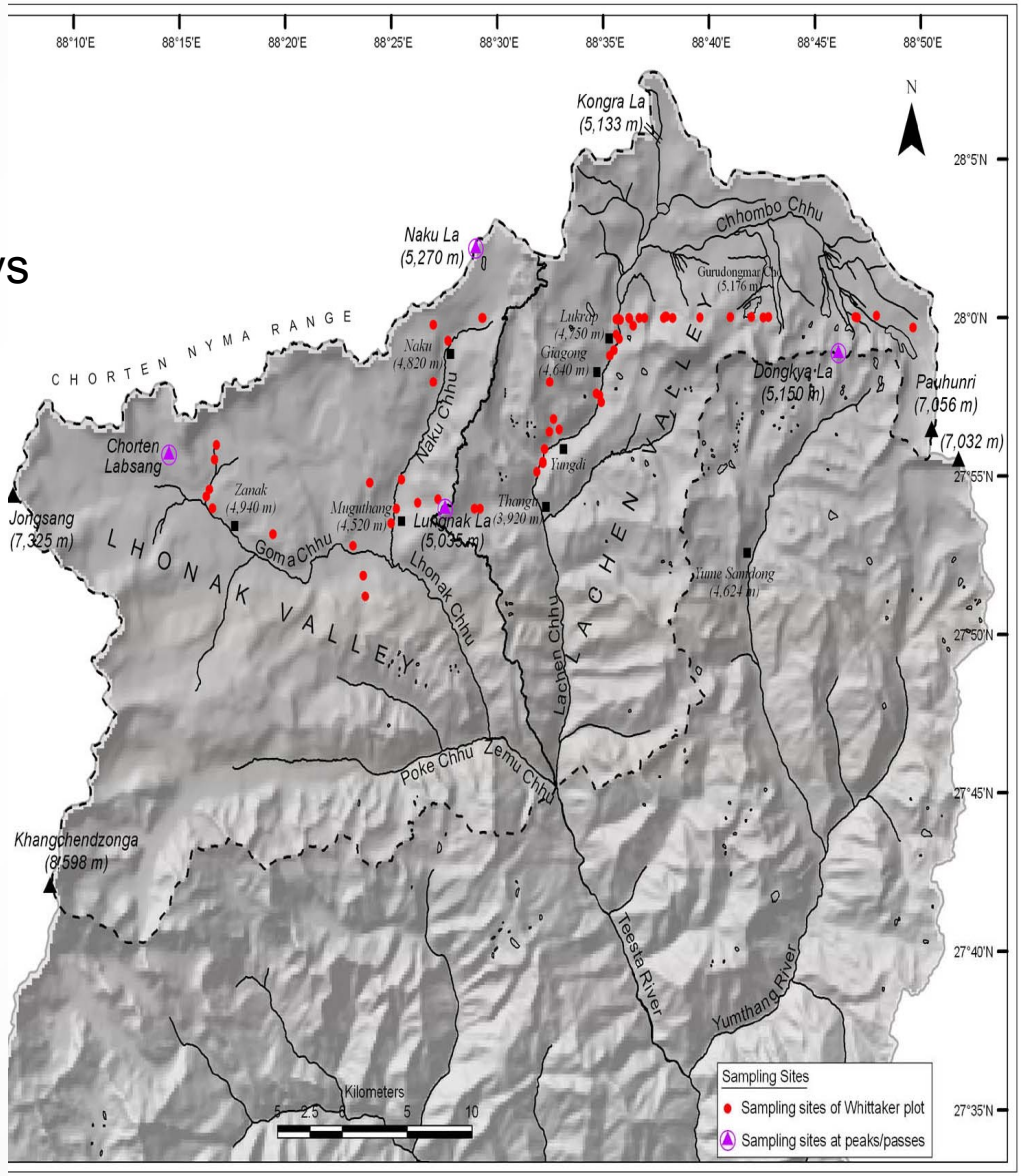
Objective 2

Recent records

- **Field reinvestigation**
  July to Sept 2008-09
  Lachen, Lachung and Lhonakh valleys

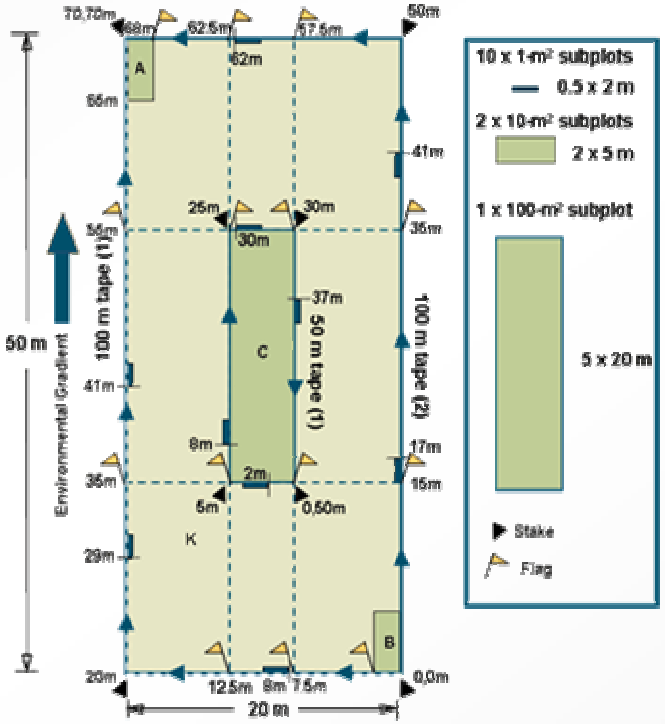
- **Northward altitudinal transact**

- **Vegetation sampling plot**
  after every 50-100 m interval



Objective 1 and 2

Modified Nested Whittaker plot



- Stratified- Habitat types
- Northward transact
- Species presence (1000 sq m)
- Cover, frequency and density (10 &100 sq m)
- Used in calculating IVI values of species

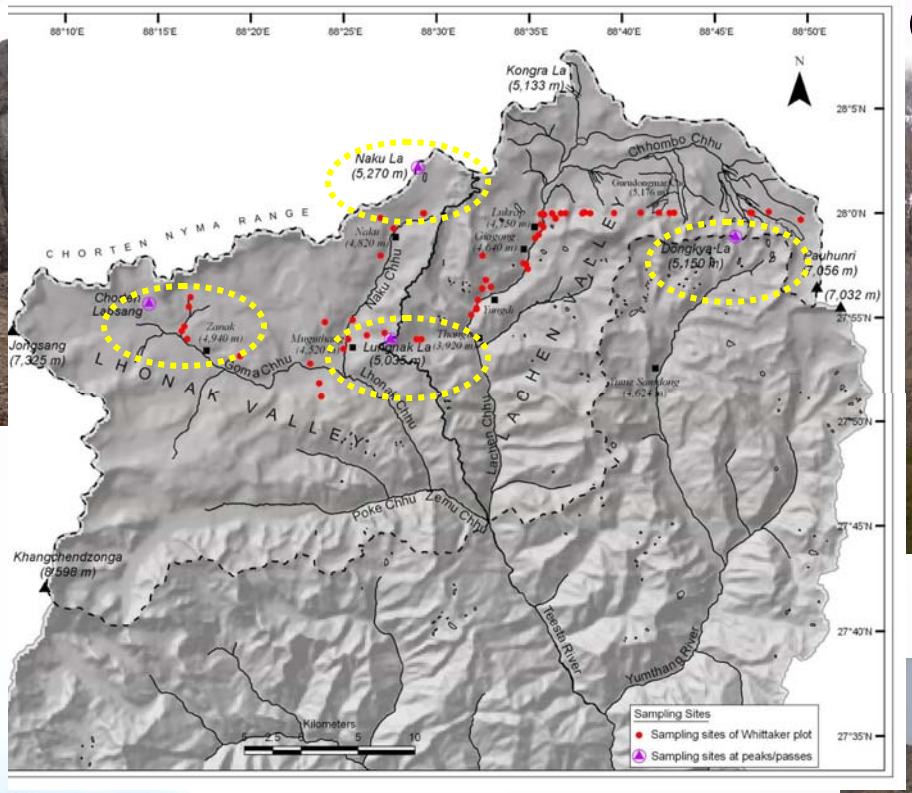
Objective 2

Range shift studies

- Altitude of plot of first occurrence of species - Lower range margin
- Altitude of plot of last occurrence of species – Upper range margin
- Species recent range margin compared with the historic range margin
- Uppermost 200 m elevation of mountain passes were searched in detail to mark presence of all the plant species present and compared with the past collections from the passes

Resurvey of mountain passes

Lugna la

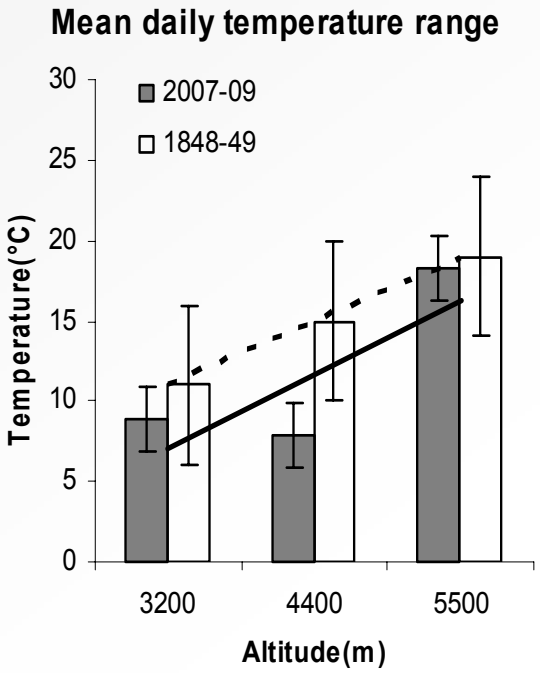


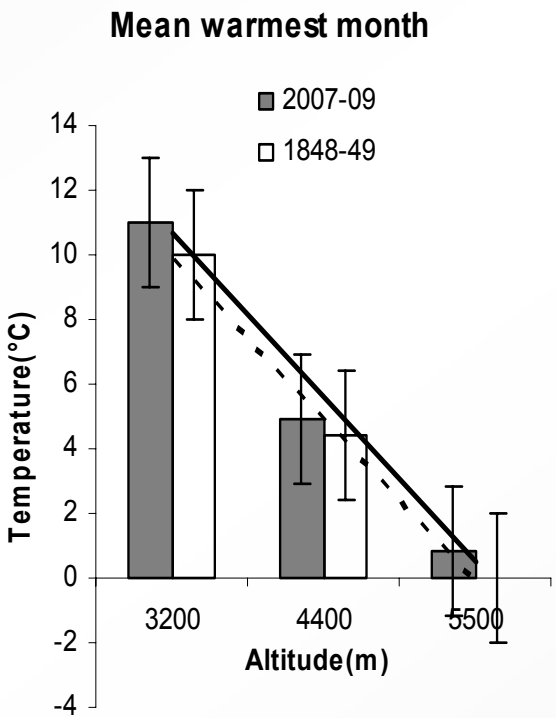
Chortenima la

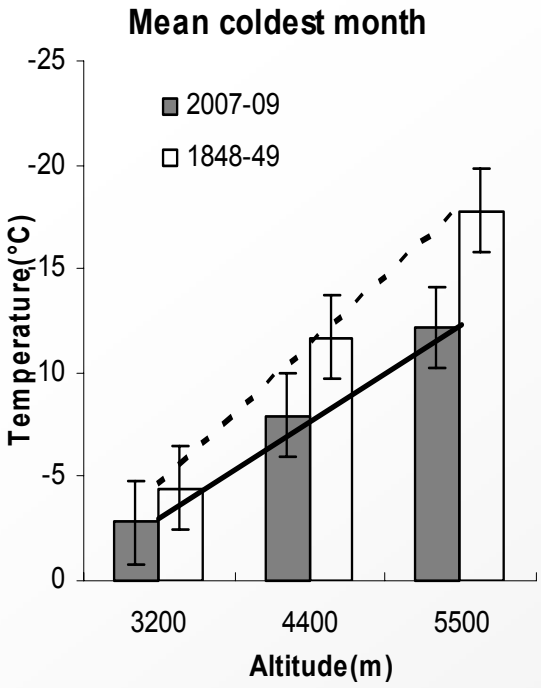
Thankra la

Naku la

Results


Mean daily temperature range
2007-09
1848-49
Temperature(°C)
30
25
20
15
10
5
0
3200
4400
5500
Altitude(m)


Mean warmest month
2007-09
1848-49
Temperature(°C)
14
12
10
8
6
4
2
0
-2
-4
3200
4400
5500
Altitude(m)


Mean coldest month
2007-09
1848-49
Temperature(°C)
-25
-20
-15
-10
-5
0
3200
4400
5500
Altitude(m)

Results

(I) **Upward shifts of the range margins of the endemic plant species-**
Most species showing shifts in range 200-300 m

(II) **Upward shift in the establishment of species from the historic range centre**

(III) **Increase in no. of species at the uppermost 200 m elevation of the passes**

(IV) **Upward shift in the altitude of maximum species richness** - 4500 to 4700 m

(V) **Range contraction and/or disappearance of narrow range habitat specific endemic alpine plant species**

FUTURE PLANS

- Objective 1

  Baseline data

  Vegetation classification

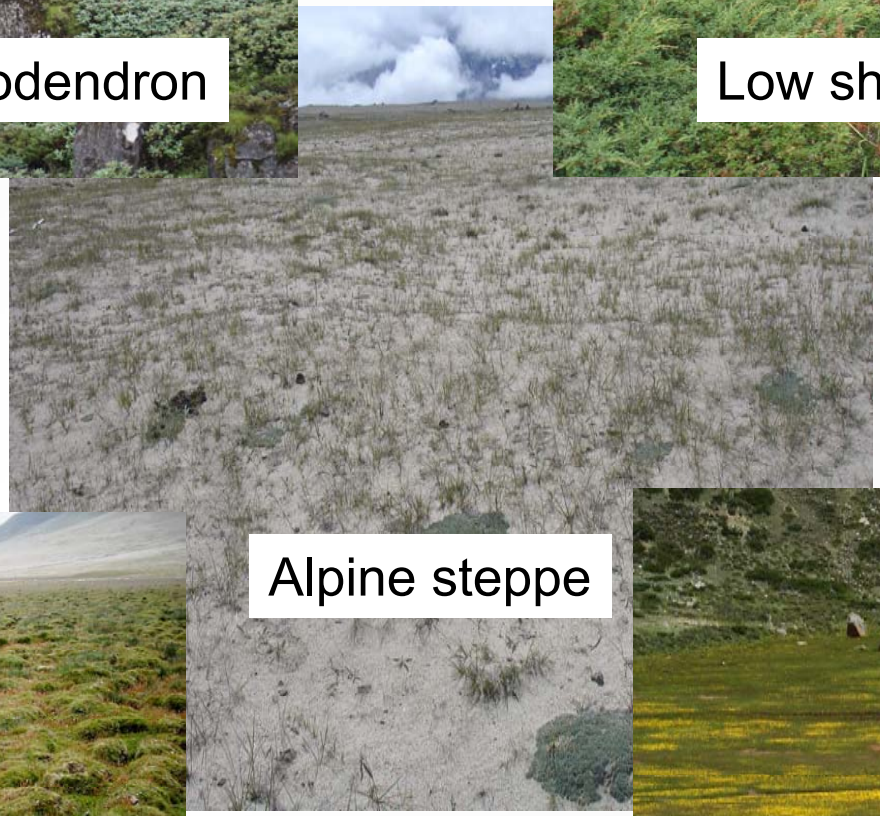
- Objectives 3 and 4

To predict the ranges of endemic plant species for the present and future climatic scenario

On the basis of the present study to evaluate the most suitable directions for the future climatic research in Himalaya


Low shrub- Rhododendron


Low shrub- Juniper


Alpine steppe


Alpine hummocks
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Marsh land

Alpine Moist Scrub and Transitional communities

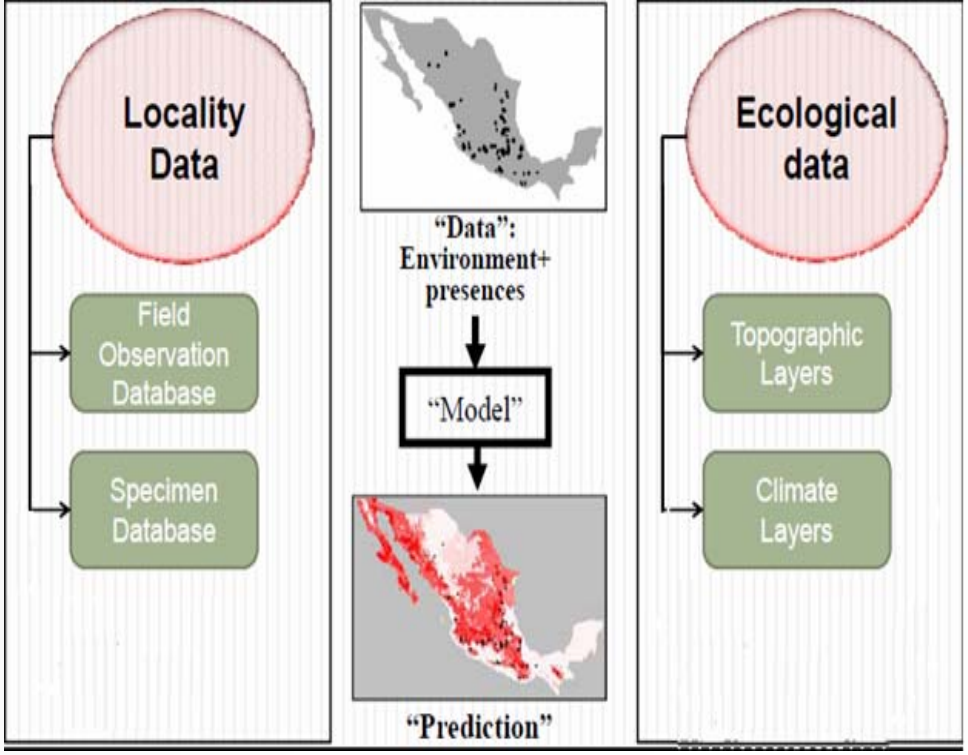
- ***Juniperus- Rhododendron- Anaphalis***
- ***Rhododendron campanulatum***

Scrub Steppe and Mixed Herbaceous communities

- ***Ephedra gerardiana – Anaphalis – Artemisia – Oxytropis***
- ***Caragana – Elymus* type**
- ***Androsace - Arenaria - Saussurea serecia***
- ***Potentila biflora***
- ***Hedinia - Elsholtzia – Dracocephalum - Microgynaecum tibeticum***
- ***Rhodiola - Festuca - Potentila - Arenaria* type**

Vegetation classification – TWINSPAN
Species diversity

Factors controlling species distribution – ORDINATION
Slope
Aspect
Precipitation
Temperature
Soil parameters



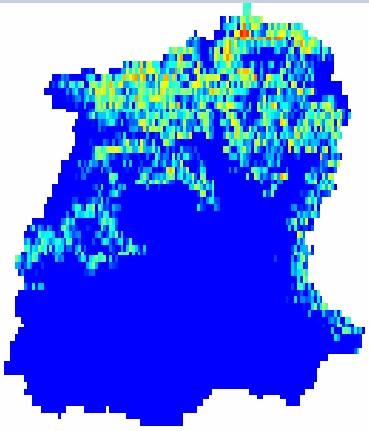
Endemic species distribution

Present and **Future** climatic scenario

Environmental Niche Modeling

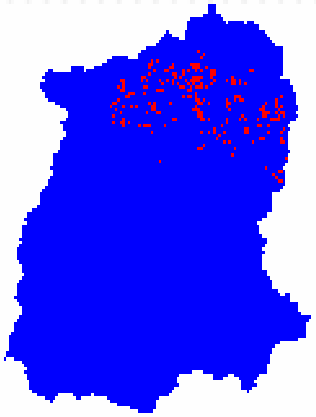
E N M

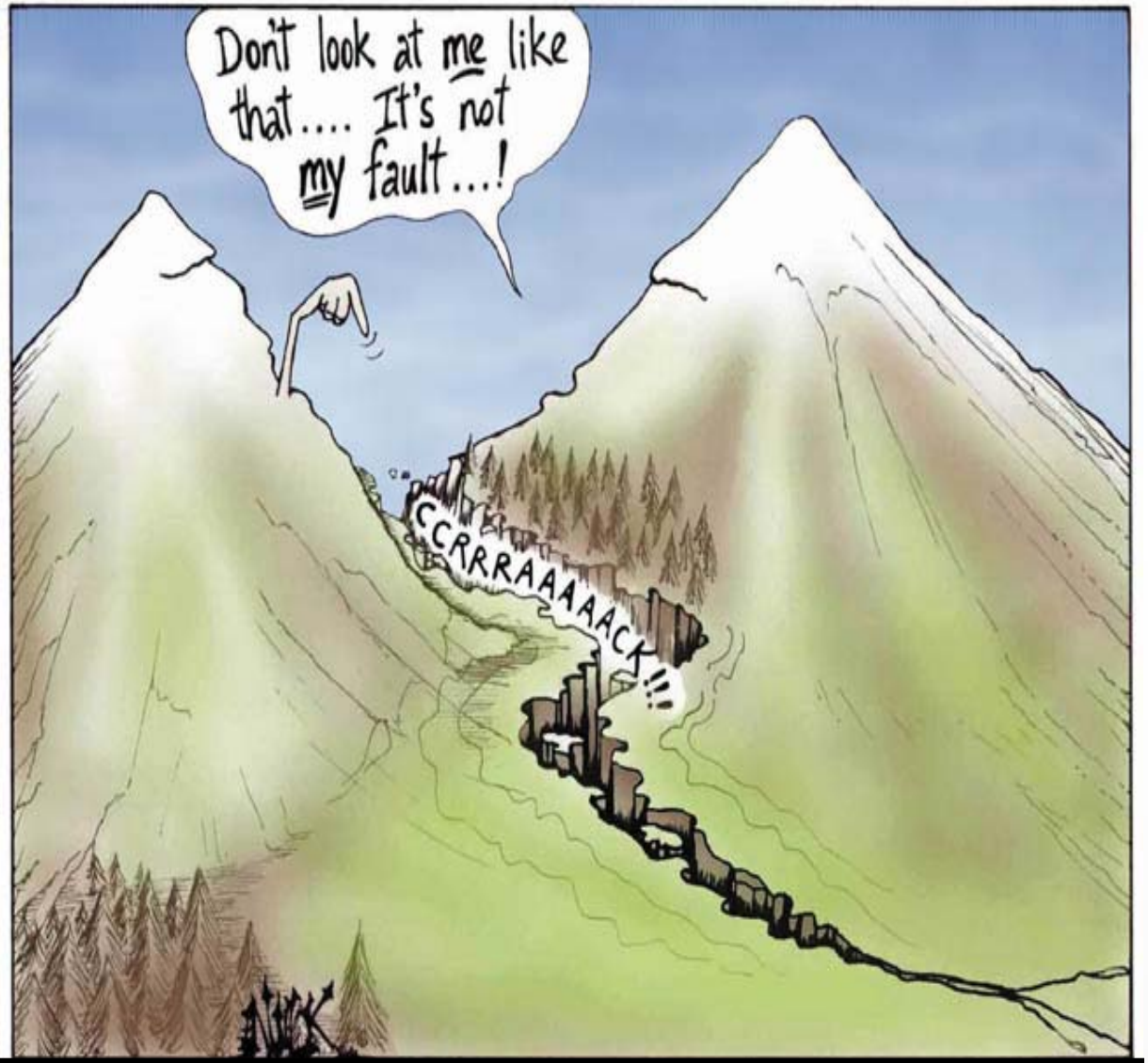
Distributional prediction in the present



Climate change

Distributional Projection in the future





We're in a giant car heading toward a brick wall
and everyone's arguing over
‘Where they're going to sit’

THANK YOU