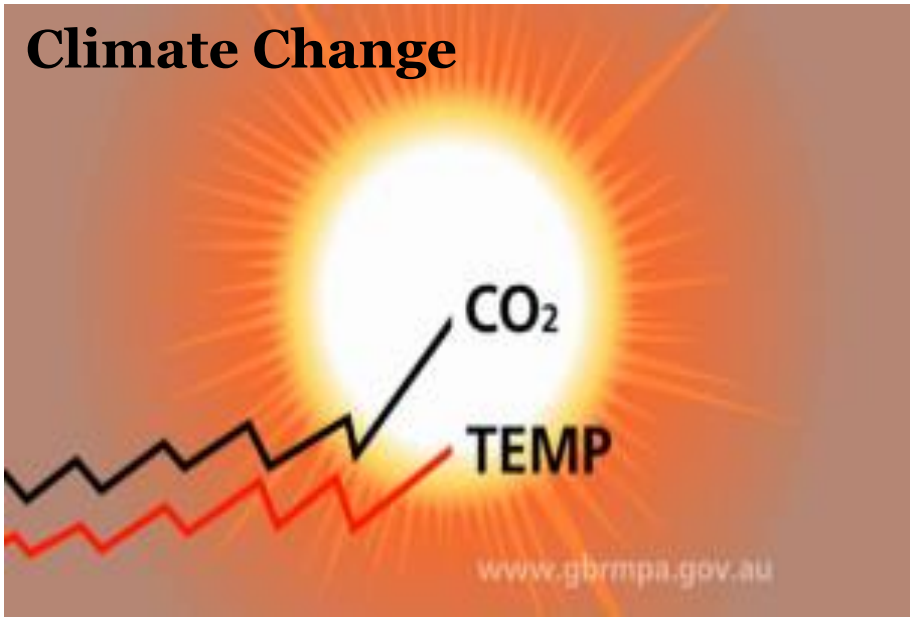
Challenges in long-term ecohydrological monitoring in Himalaya

Manish Kumar

PhD Student
ATREE



Water Scarcity as well as Excess

How will Climate Change influence Water Cycle?

Very few studies from sub-tropical mountains like Himalaya

Huntington, 2006; Jasechko et al., 2013; Jentsch & Beierkuhnlein, 200 8; Vörösmarty et al., 2010

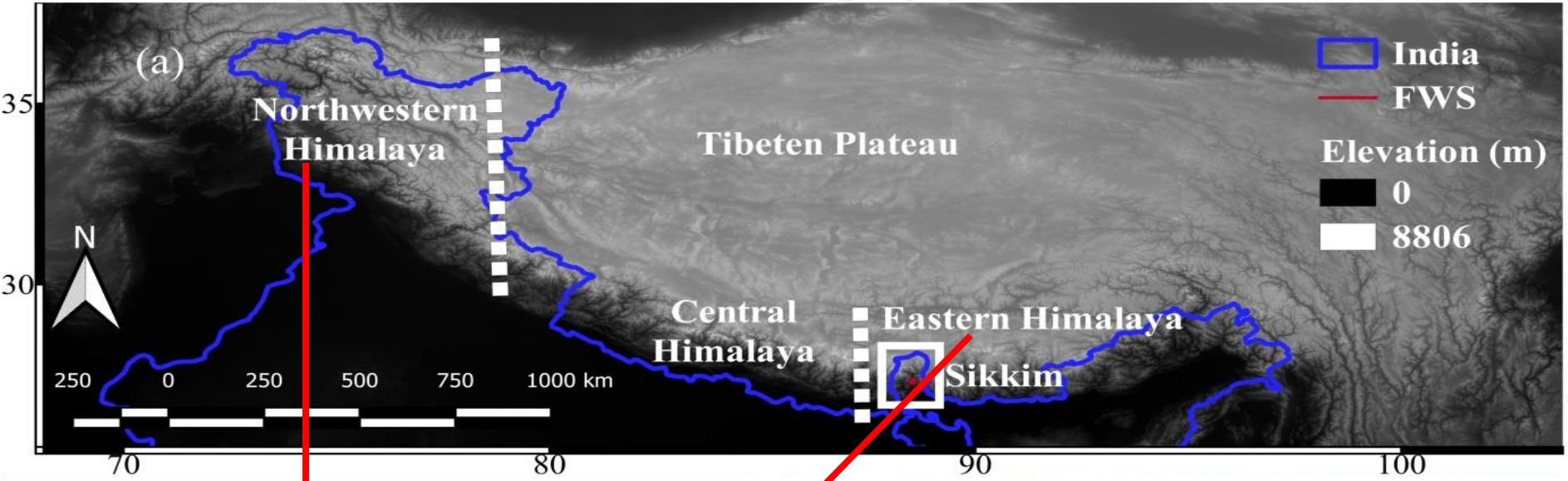
Climate change in Himalaya

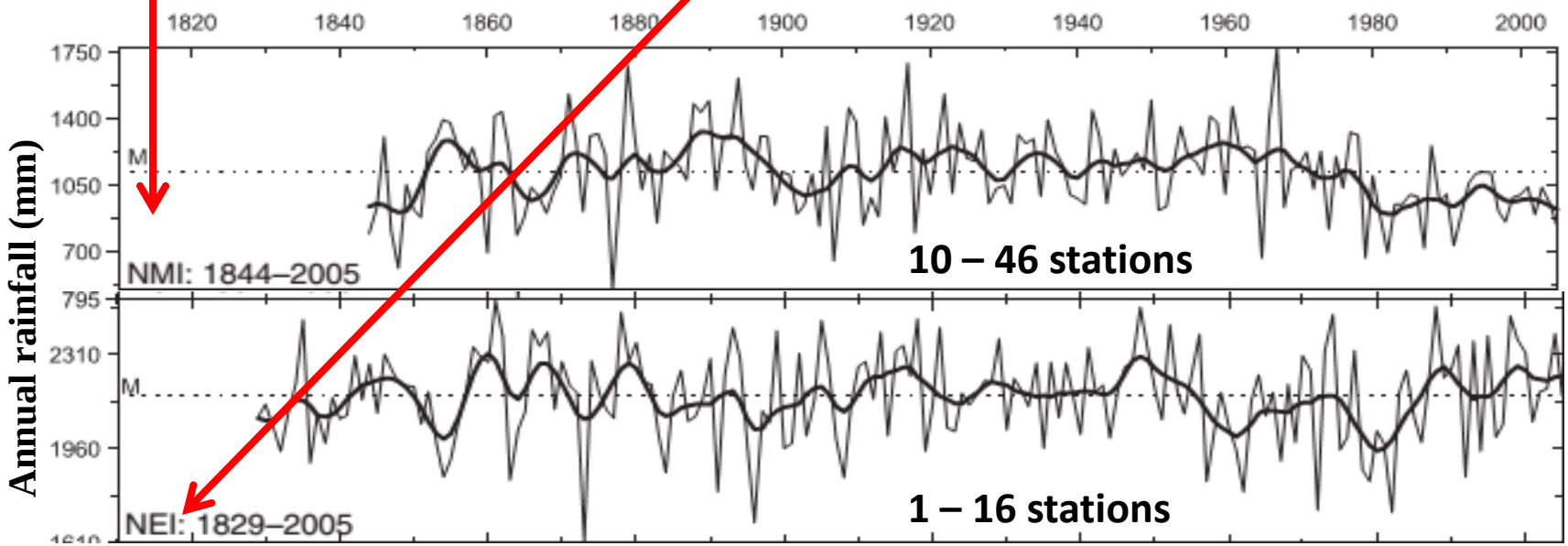
- **Temperature increase of 0.5-5 °C**
- **Rainfall increase of 20-40 %**

But what is the underlying data behind these models??

Kulkarni et. al., 2013; Ren et al., 2017; Sanjay et al., 2017

Climate monitoring in Himalaya





Sontakke et. al., 2008, Instrumental period rainfall series of the Indian region (AD 1813-2005): Revised reconstruction, update and analysis

Hydrological monitoring in Himalaya

1904 – 1905 (Pearson 1907)

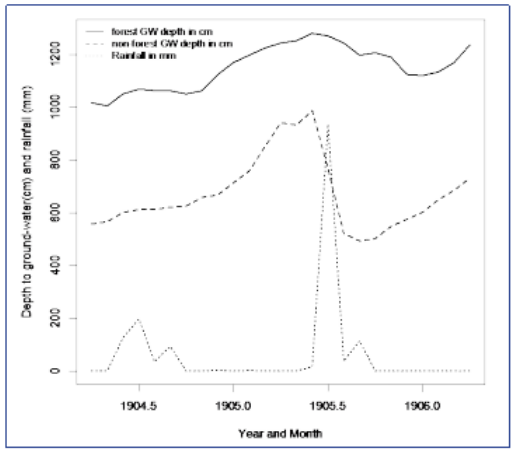


Figure 1. The first forest hydrology observations in India (Pearson, 1907).

1934-1946 (Saberwal 1999)

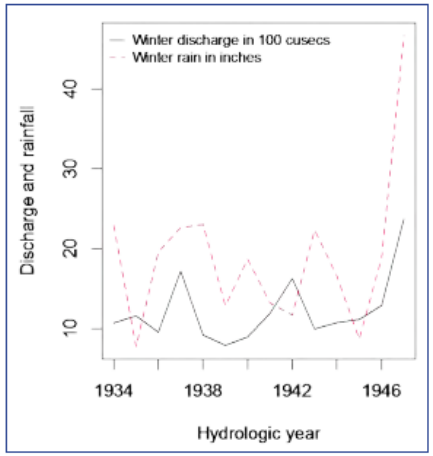


Figure 4. The second forest hydrology experiment in India.

1962-1970 (Gupta et al. 1980)

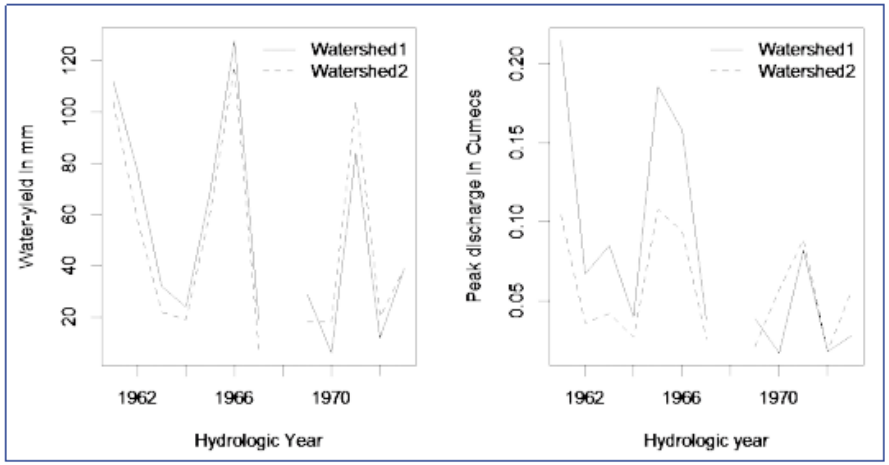


Figure 5. One of India's first post-independence paired catchment studies in the lower Himalayas (Gupta et al. 1980).

Krishnaswamy J., 2017, Forest Management and Water in India, Chapter 7 **in** García Chevesich, P., Neary, D. G., Scott, D. F., Benyon, R. G., & Reyna, T. (2017). *Forest management and the impact on water resources: a review of 13 countries*. UNESCO Publishing.

Hydrological monitoring in Himalaya

Haigh et al. 1990, Hydrological impact of deforestation in the central Himalaya

- first hydrological monitoring station in the Central Himalayas
- Linking Diurnal cycle in streamflow with evapotranspiration

Valdiya & Bartarya et al. 1991; Negi & Joshi 2002, Spring Sanctuaries in Himalaya

- first studies on Himalayan springs
- Linking forest types and geology to spring flows

Krishnaswamy J., 2017, Forest Management and Water in India, Chapter 7 **in** García Chevesich, P., Neary, D. G., Scott, D. F., Benyon, R. G., & Reyna, T. (2017). *Forest management and the impact on water resources: a review of 13 countries*. UNESCO Publishing.
Negi, G.C.S., Joshi, V., 2002. Drinking Water Issues and Development of Spring Sanctuaries in a Mountain Watershed in the Indian Himalaya. Mt. Res. Dev. 22, 29–31. https://doi.org/10.1659/0276-4741(2002)022[0029:DWIADO]2.0.CO;2
Valdiya, K.S., Bartarya, S.K., 1991. Hydrogeological Studies of Springs in the Catchment of the Gaula River, Kumaun Lesser Himalaya, India. Mt. Res. Dev. 11, 239. https://doi.org/10.2307/3673618

Research Gaps

- **Reduced focus on field hydrology**
- **Lack of long-term springs, streams & climate monitoring**
- **Fewer comparative & inter-disciplinary studies across Himalaya**

(Kulkarni et al., 2013; Shrestha et al., 2012; Tambe et al., 2012; Pant, 2003; Singh et al., 2011; Grabs and Pokhrel 1992; Fujita et al 1997; Shrestha et al 1999)

Our efforts…

ASHOKA TRUST FOR RESEARCH IN ECOLOGY & THE ENVIRONMENT

भारतीय प्रौद्योगिकी संस्थान रूड़की
Indian Institute of Technology Roorkee

Advanced Center for Water Resources Development and Management, Pune

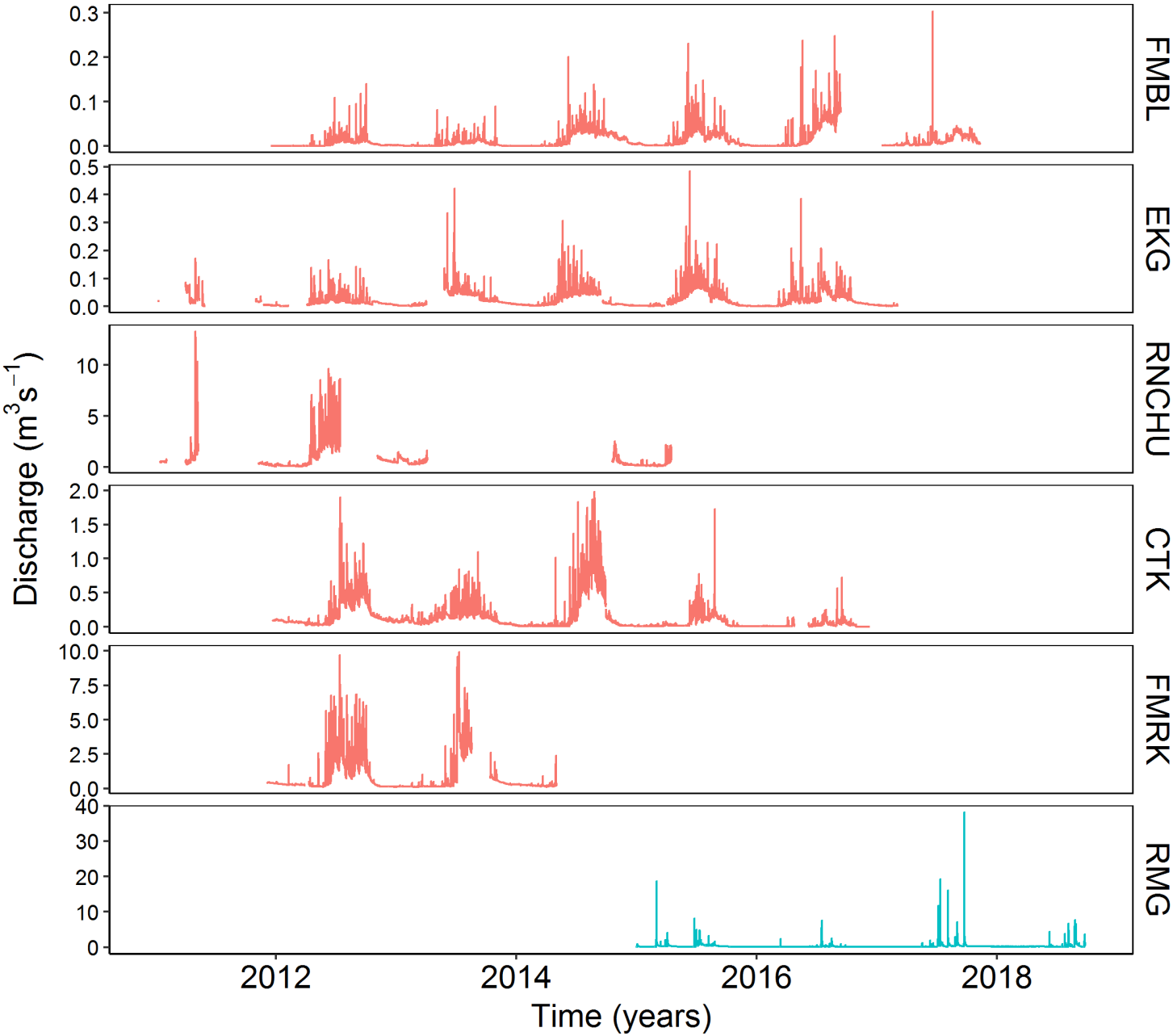
Chirag

Central Himalayan Rural Action Group

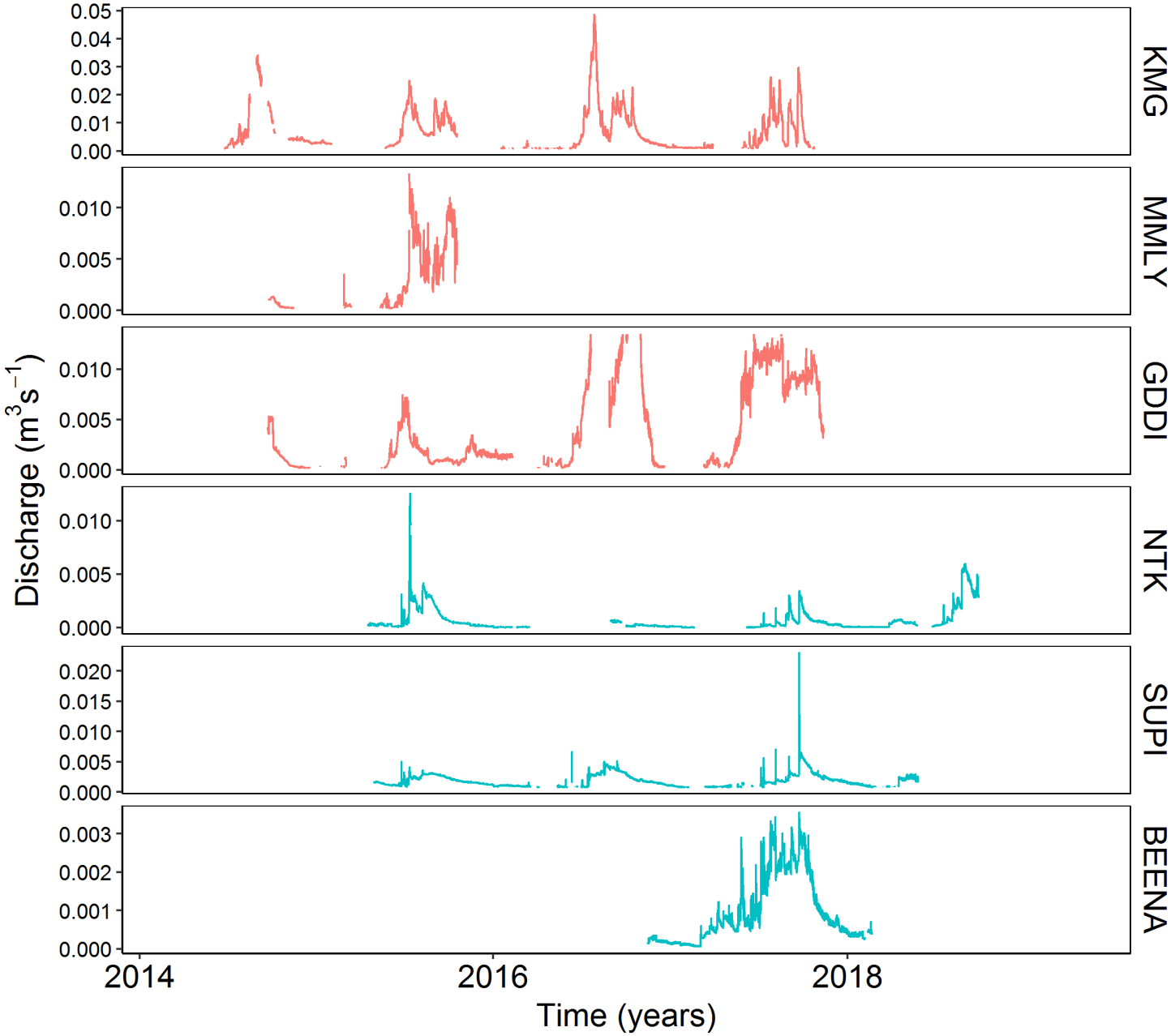
Eastern Himalaya

Western Himalaya

Long-term monitoring of Himalayan Streams

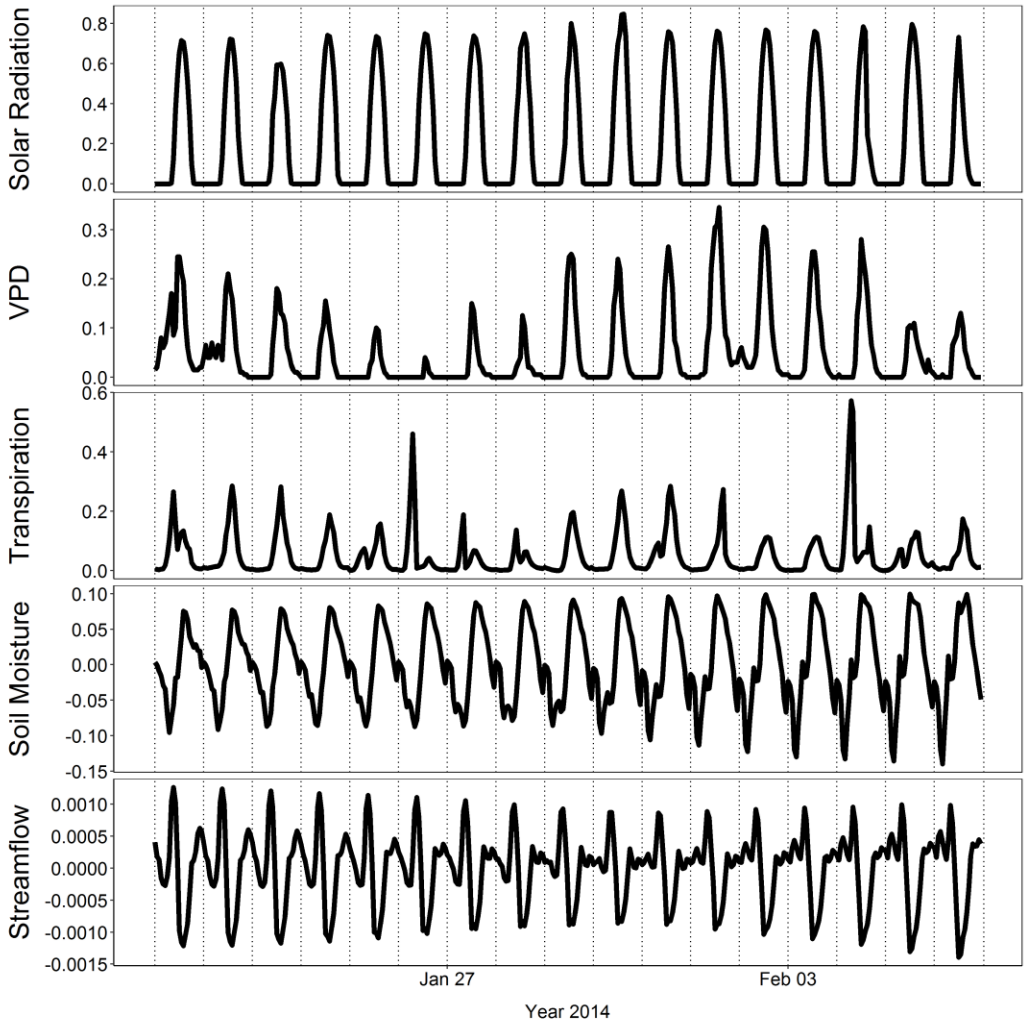


Long-term monitoring of Himalayan Springs



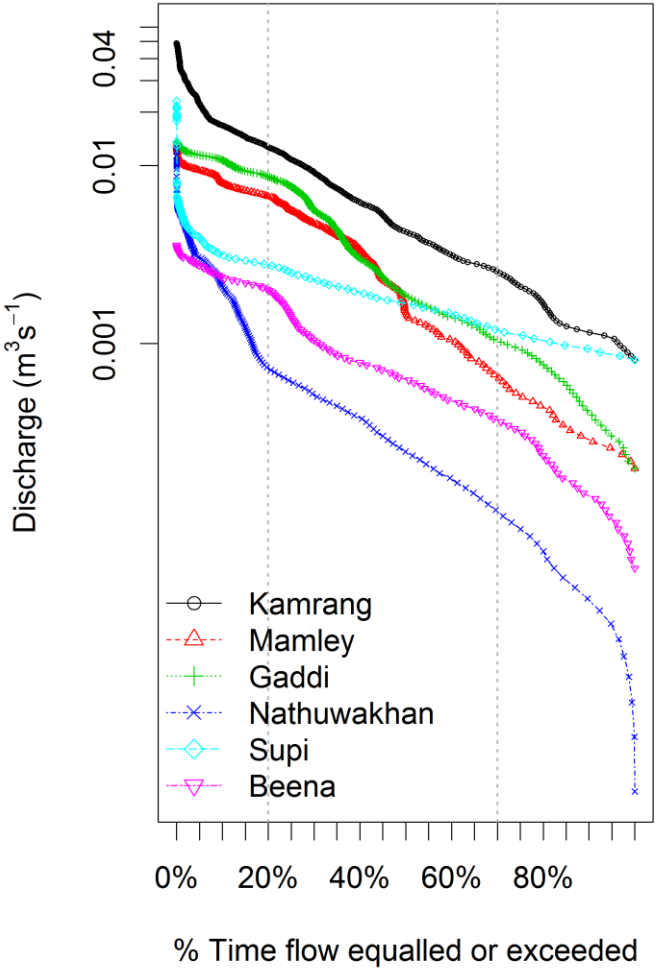
Preliminary results

1. First reports of transpiration controlling lean season streamflow in Eastern Himalayan forests



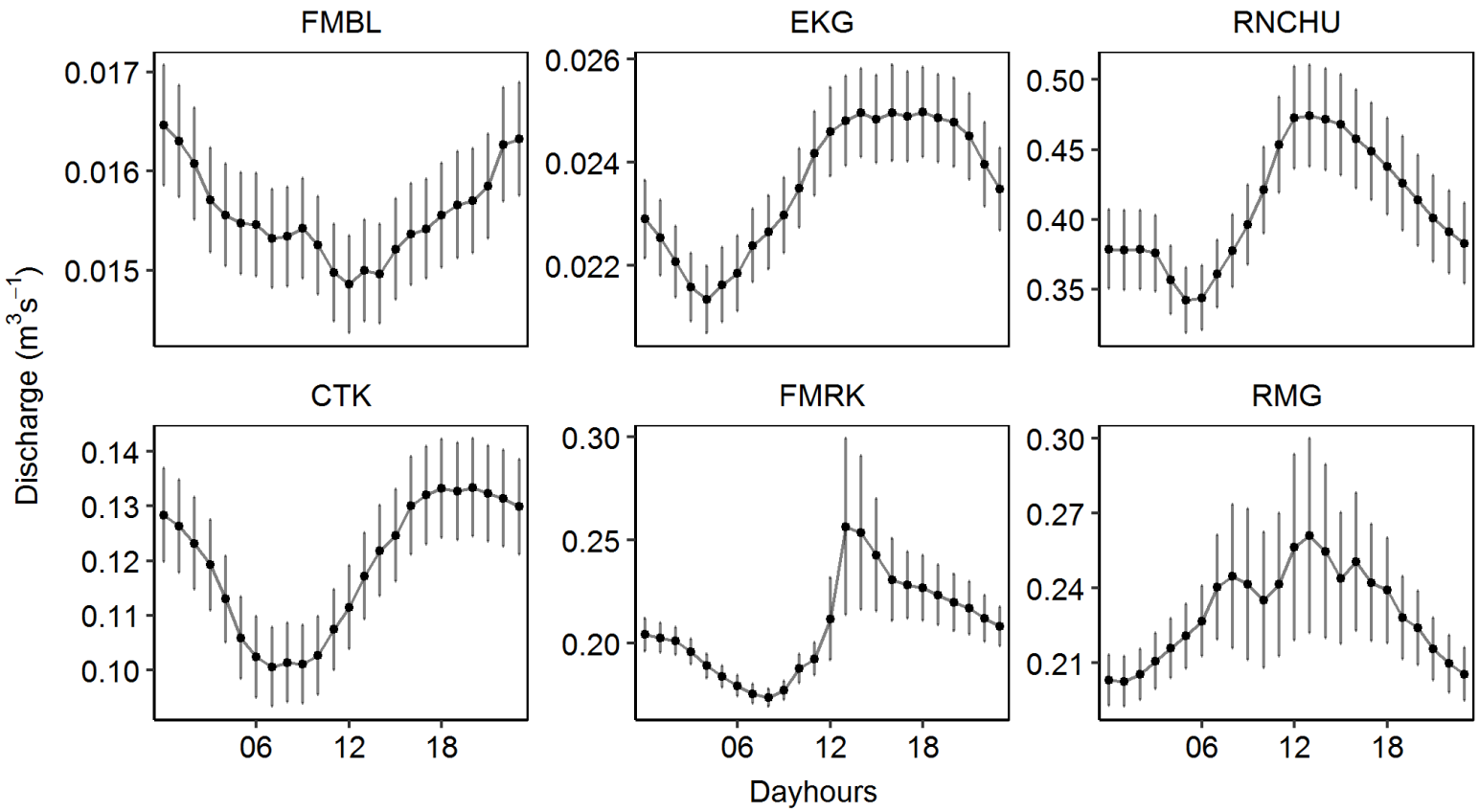
***Kumar et al., 2019 (Under review*) Diurnal and seasonal patterns in transpiration drive streamflow dynamics in broad-leaved evergreen forests of Sikkim Himalaya**

2. Categorisation of Himalayan springs into typologies using discharge monitoring & hydrogeological surveys



***Kumar et al., 2019 (in prep*) Hydrological characterisation of Himalayan springs: comaprison across Western and Eastern Himalaya**

2. Distinct diurnal patterns in streams of different orders across Himalayan gradient



***Kumar et al., 2019 (in prep*) Hydrological characterisation of Himalayan springs: comaprison across Western and Eastern Himalaya**

Key Challenges

- **Instrumentation-related:**
  - **Expensive instrumentation**
  - **Equipment failure and loss in extreme environments**

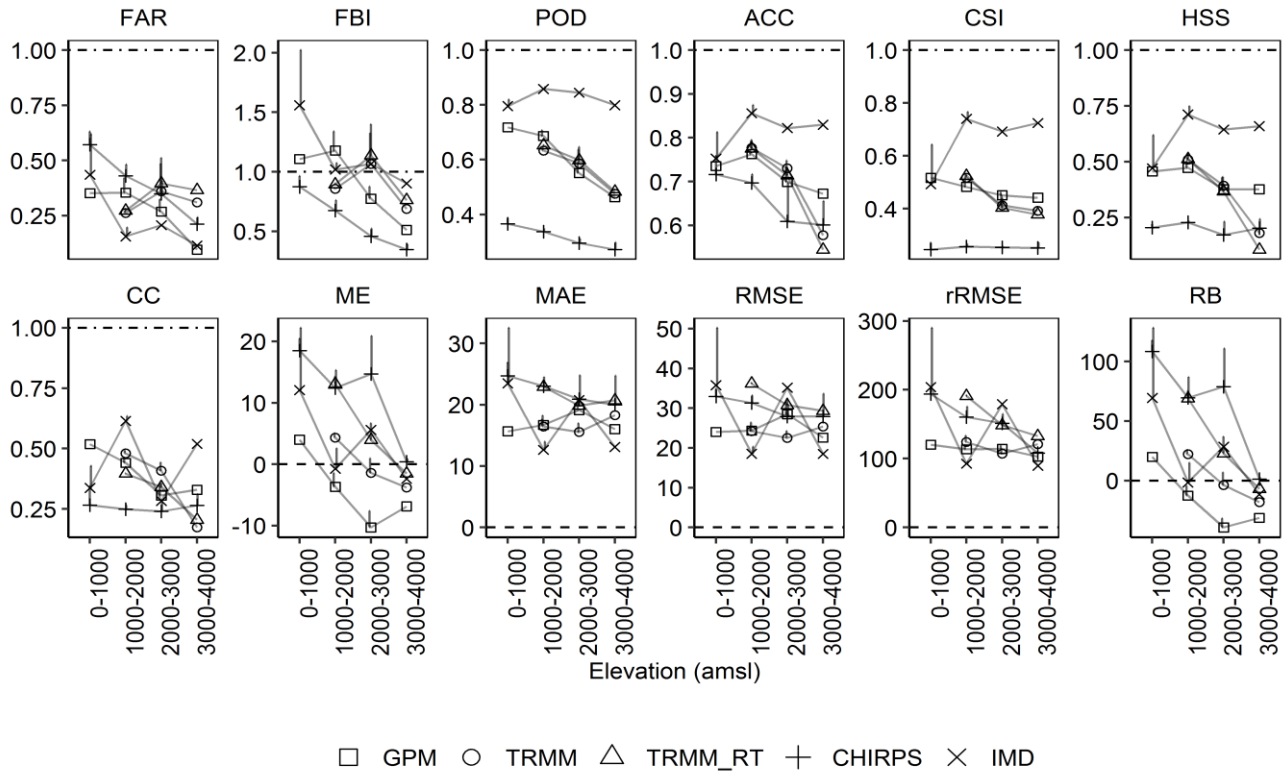
- **Issues of scale:**
  - **Lack of studies connecting plot-regional scales**
  - **Common methodologies**

- **Coordination & Collaborations:**
  - **Inter-disciplinary approaches**
  - **Access to data**

Potential solutions

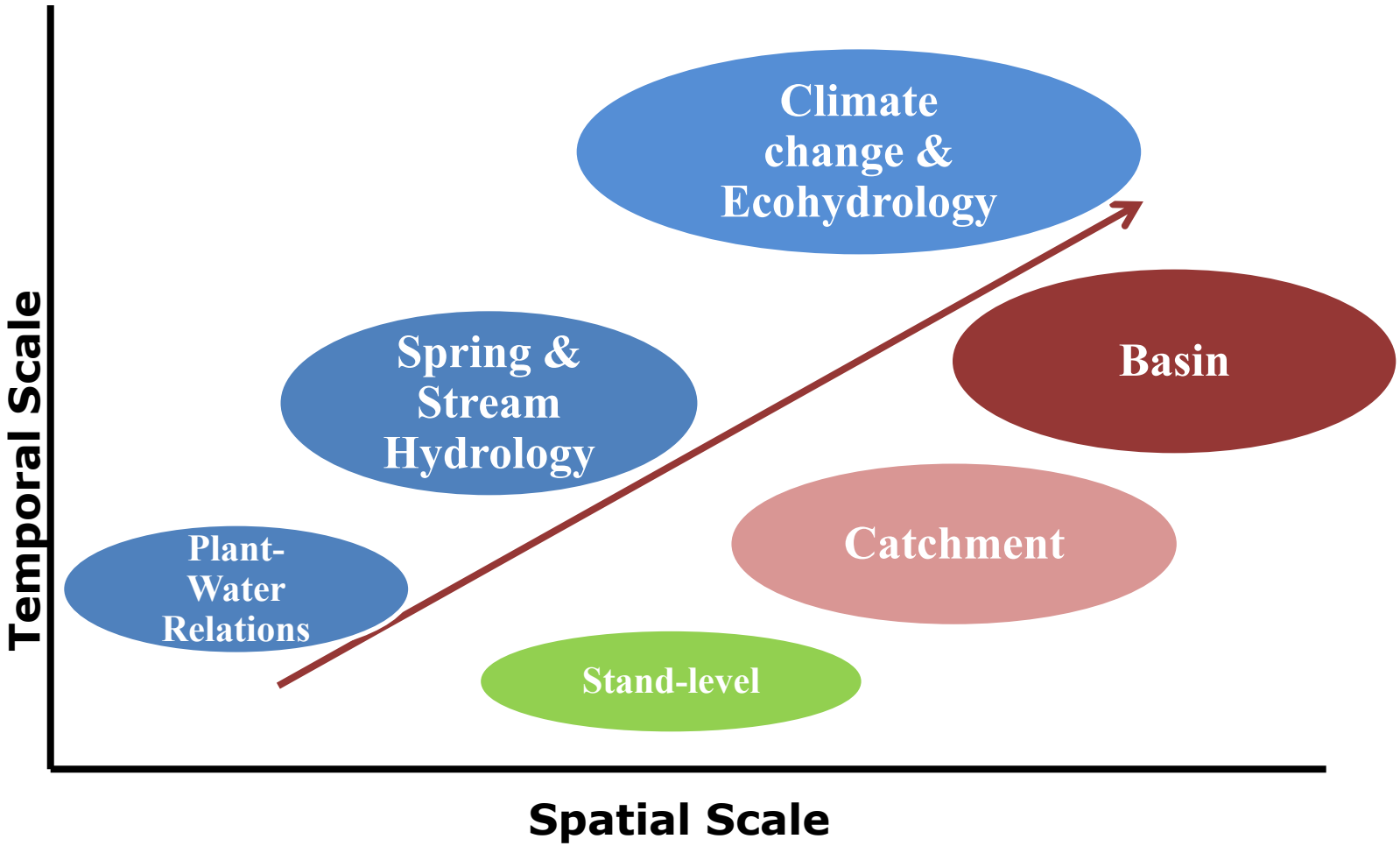
Remote sensing & gauge-interpolated gridded datasets

Validation and bias-correction is very important before application



***Kumar et al., 2019 (Under revision*) Ground validation of gridded precipitation products for assessment of spatio-temporal patterns in Eastern Himalaya**

Issues of scale



- **Integrated methodologies**
- **Cost of equipment**

Cost of equipment

800 Euro

8 Euro

Investment in low-cost sensors and innovations needed

Science-practice convergence

Krishnaswamy et al. 2019, (*under review)* Springing a surprise in the Himalaya: A case study for an encouraging science-practice collaboration

Thank You…