A coupled human and landscape conceptual model of risk and resilience in mountain communities

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Risk and Resilience Cluster: www.risk-resilience.giub.unibe.ch

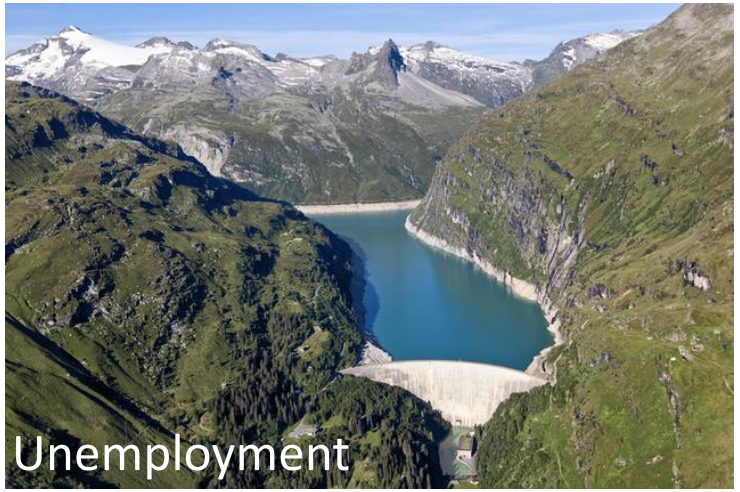
Background

Mountain communities are exposed to physical and socio-economic shocks

How resilient are mountain communities to these shocks?

Physical shocks

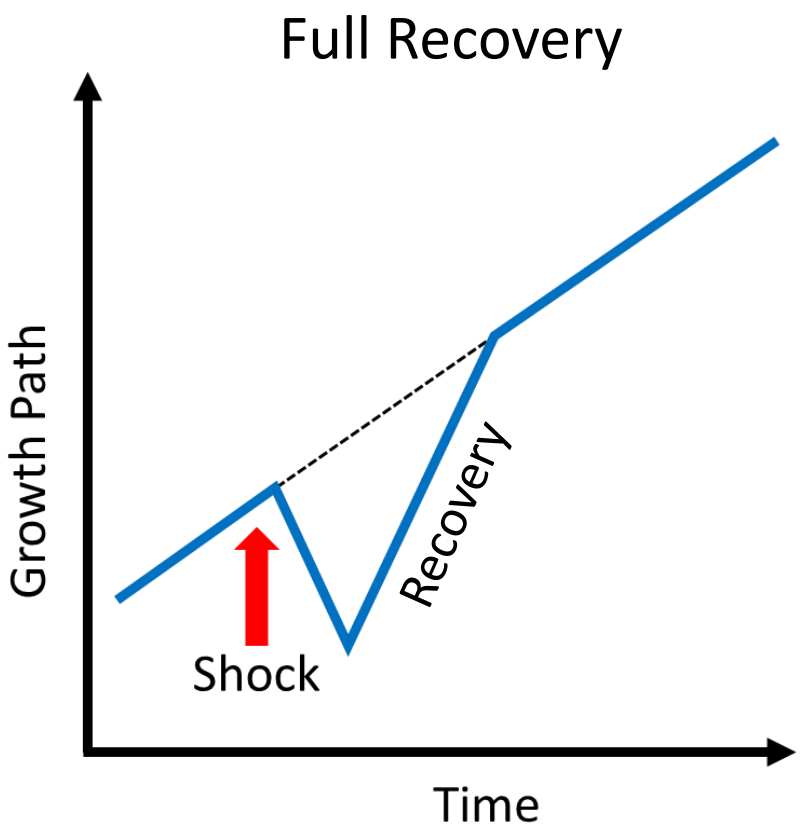
Socio-economic shocks

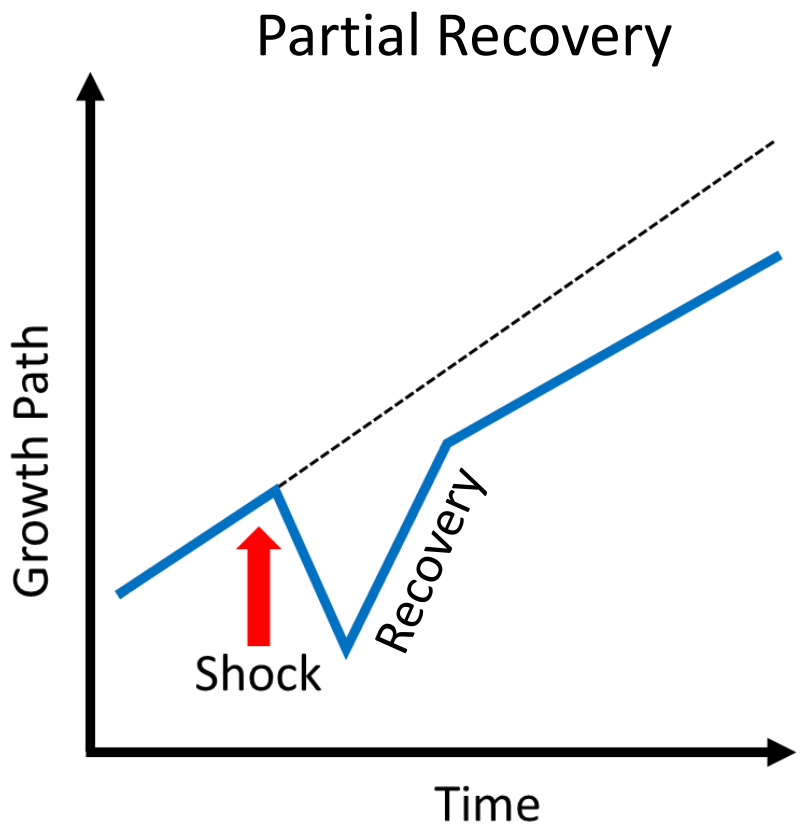


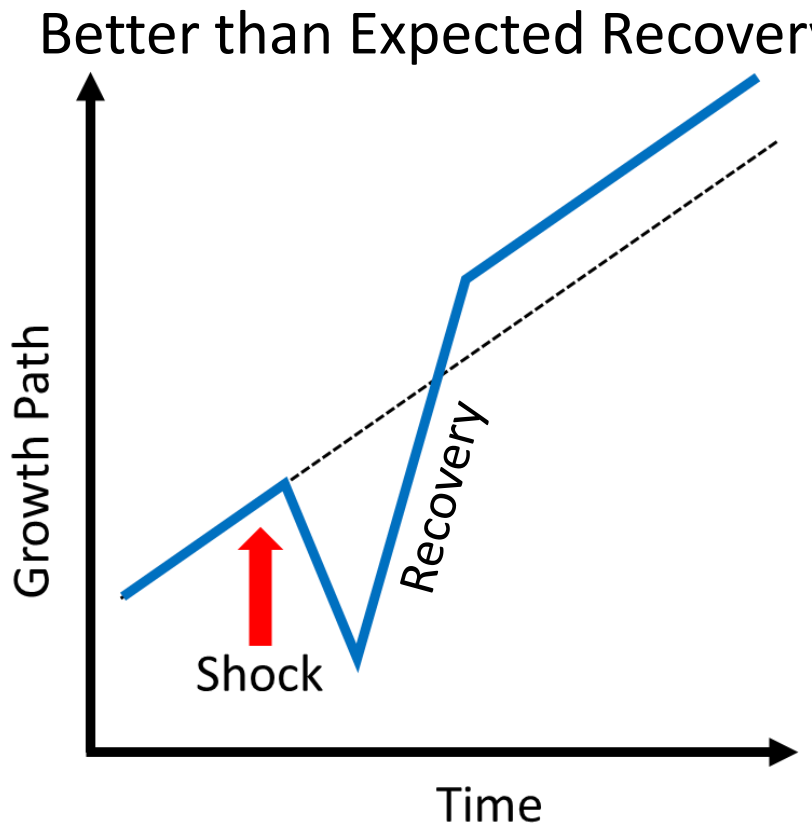
Sources: planat.ch, air-worldwide.com, myswitzerland.com, swissinfo.ch

Background

Mountain community economic response to physical and socio-economic shocks

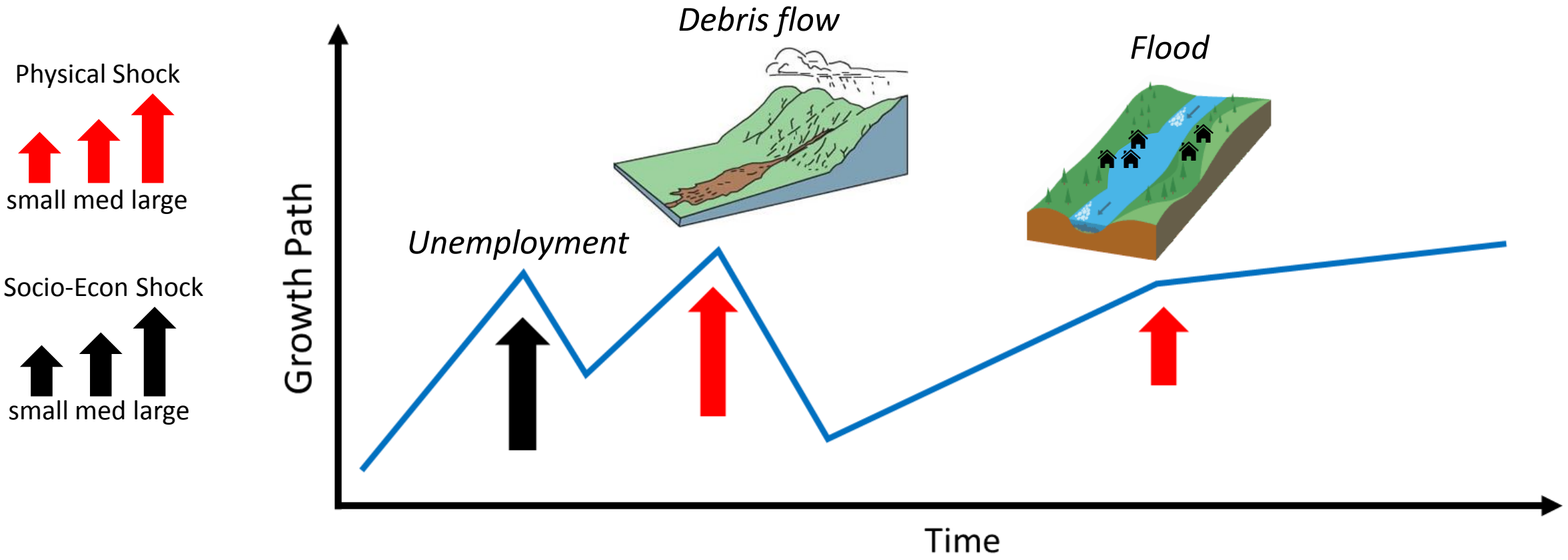






Background

What magnitude and frequency of shocks are buffered by mountain communities?
Do socio-economic or physical shocks have a greater affect on mountain communities?



Source: geology.com

Modelling approach

- Spatial simulation of landscape and mountain community processes
- Fully coupled model
  - Landscape evolution model (LEM) that replicates floods and debris flows
  - System dynamics model that replicates socio-economic interactions
- Develop a generic model that is loosely based on Swiss mountain communities, but is transferable to other mountainous regions
  - Data availability
  - Model calibration possible with historic data

Mountain communities

Mountain Community	Type	Geographic Size	Income Level	Community Moral	Demand for Local Goods	Vulnerability	Resilience	Sustainability
Downward spiral	Peripheral	Small	Low	Low	Low	High	Low	Low
Stagnation	Semi-urban	Medium	Medium	Medium	Medium	High	Medium	Medium
Upward spiral	Urban	Large	High	High	High	High	High	High

Downward Spiral

Stagnation

Upward Spiral

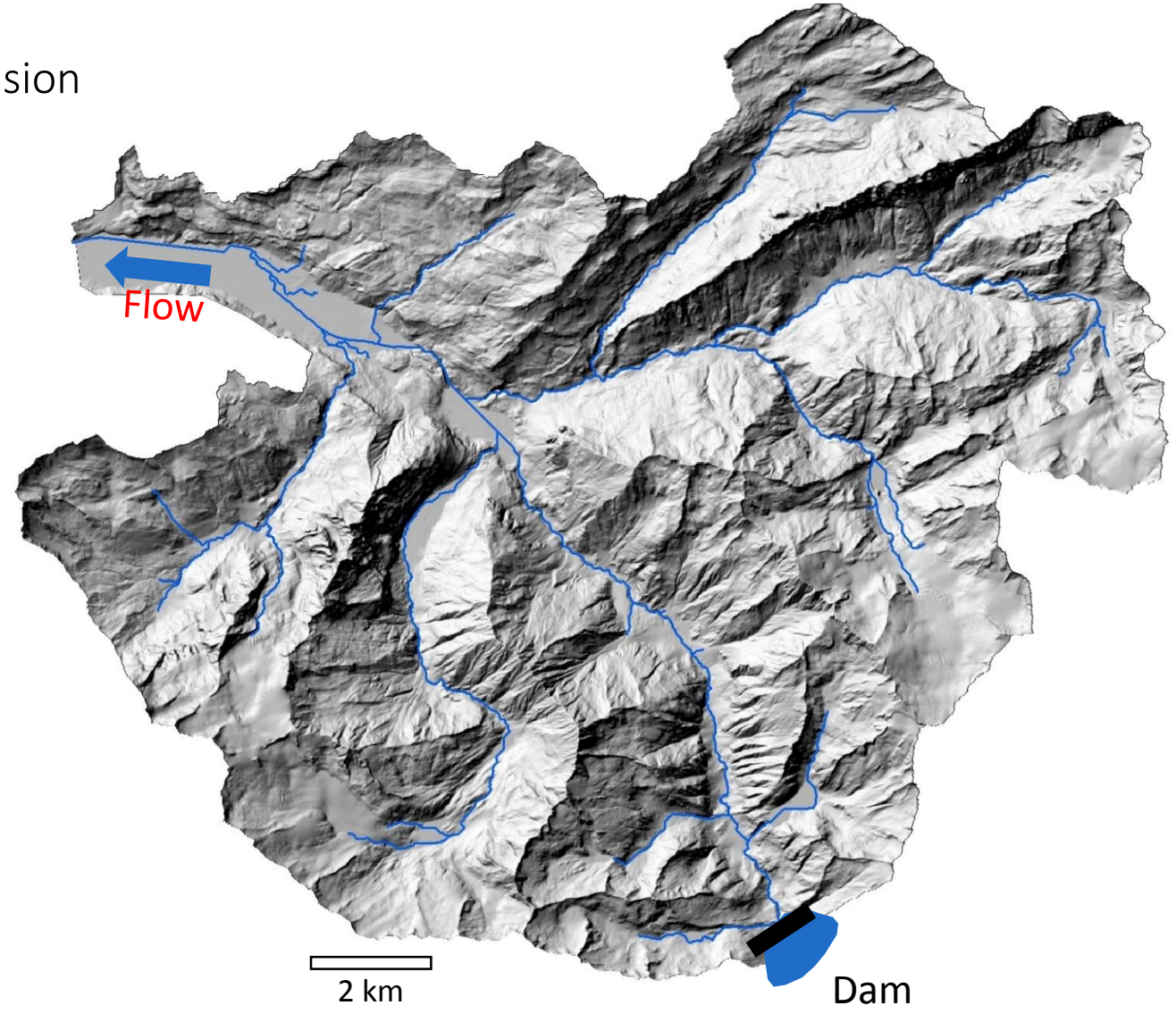
Sources: thomsonlakes.co.uk, derbund.ch, cbronline.com

Modelling scales

Mountain catchment with:

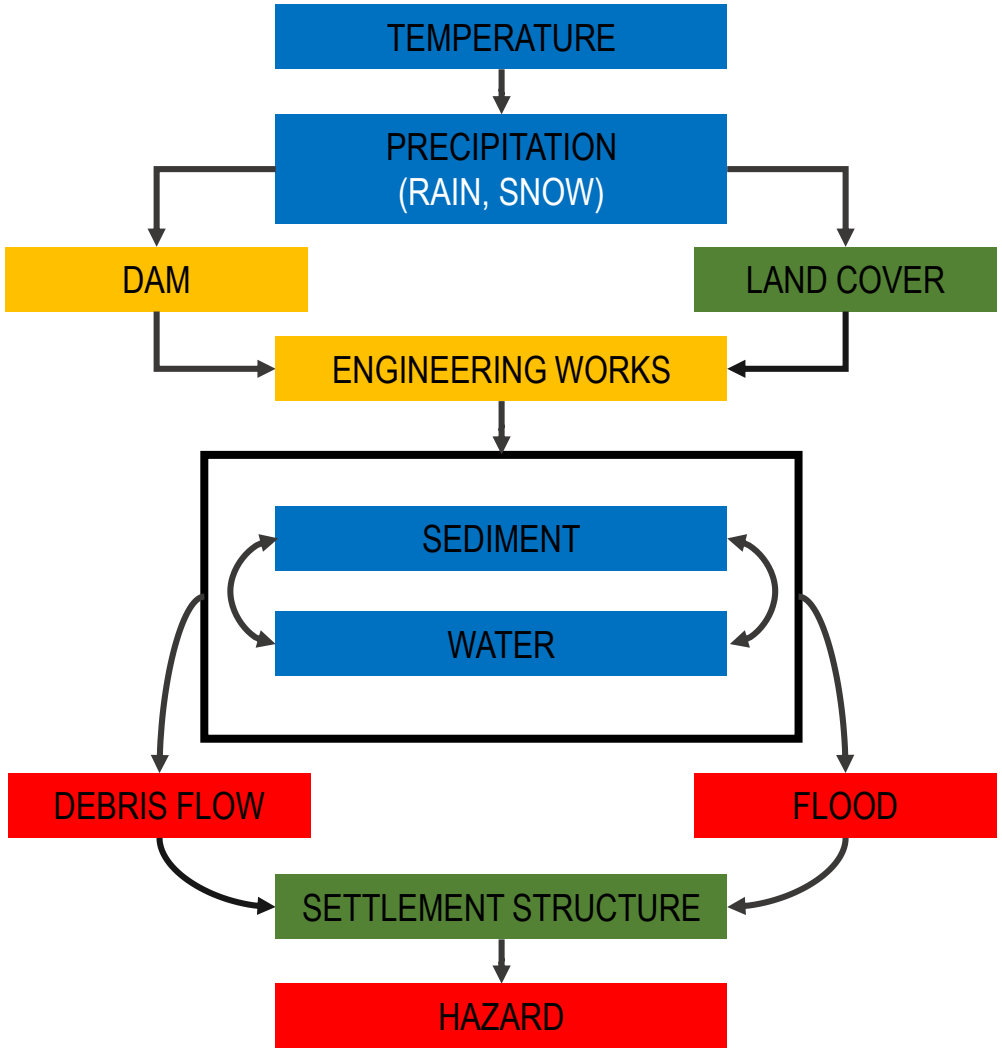
- **Geographic scale:** 20 m resolution topography
  - Representative alpine catchment
  - Area: 450 km^2
  - Elevations: 500 - 3700 m
  - Steep slopes and isolated valleys

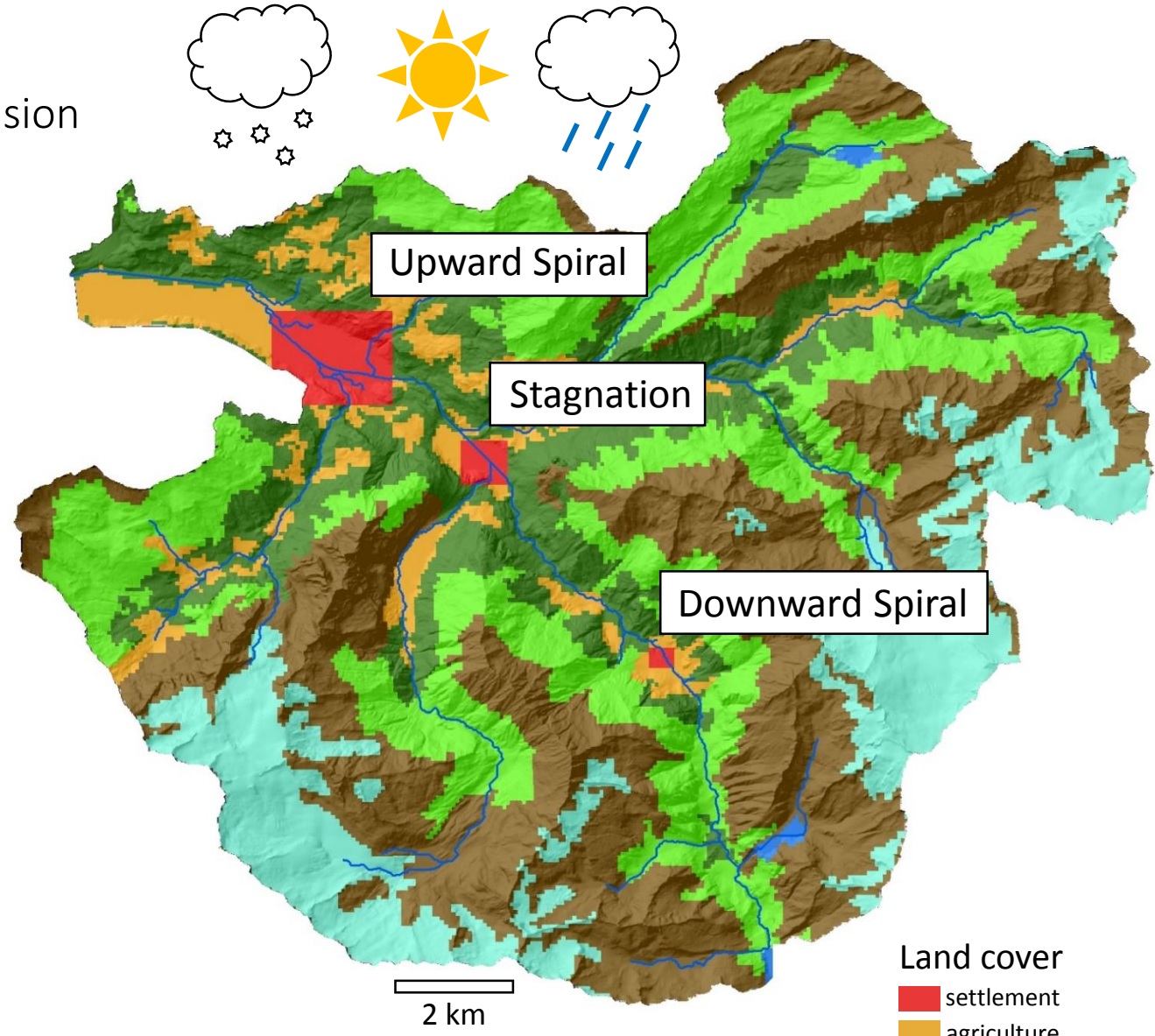
- **Temporal scale:** Present day to 2060



Landscape model

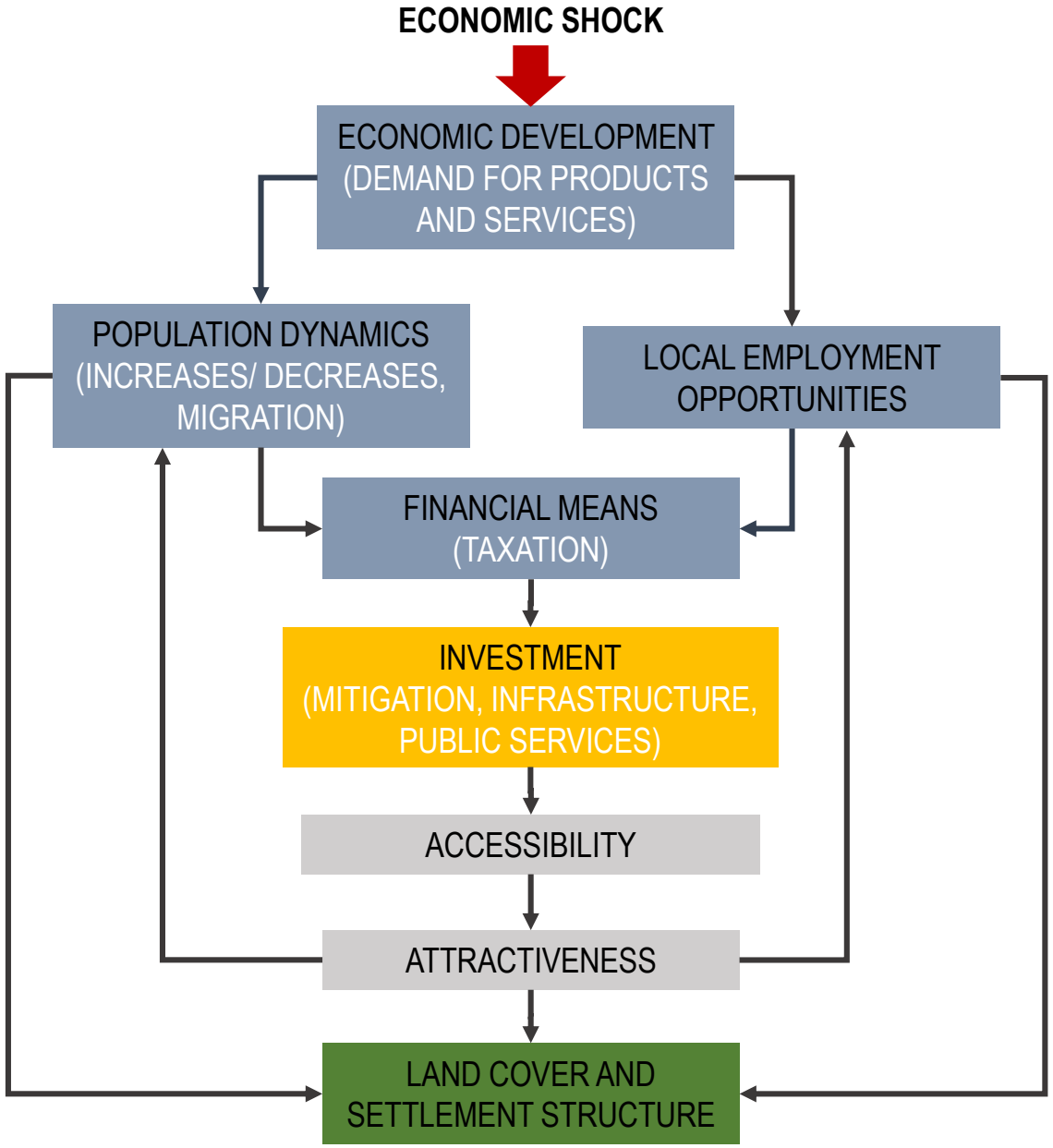
- Representation of landcover & 3 community types
- Model drivers include rainfall, snowfall, & snow melt



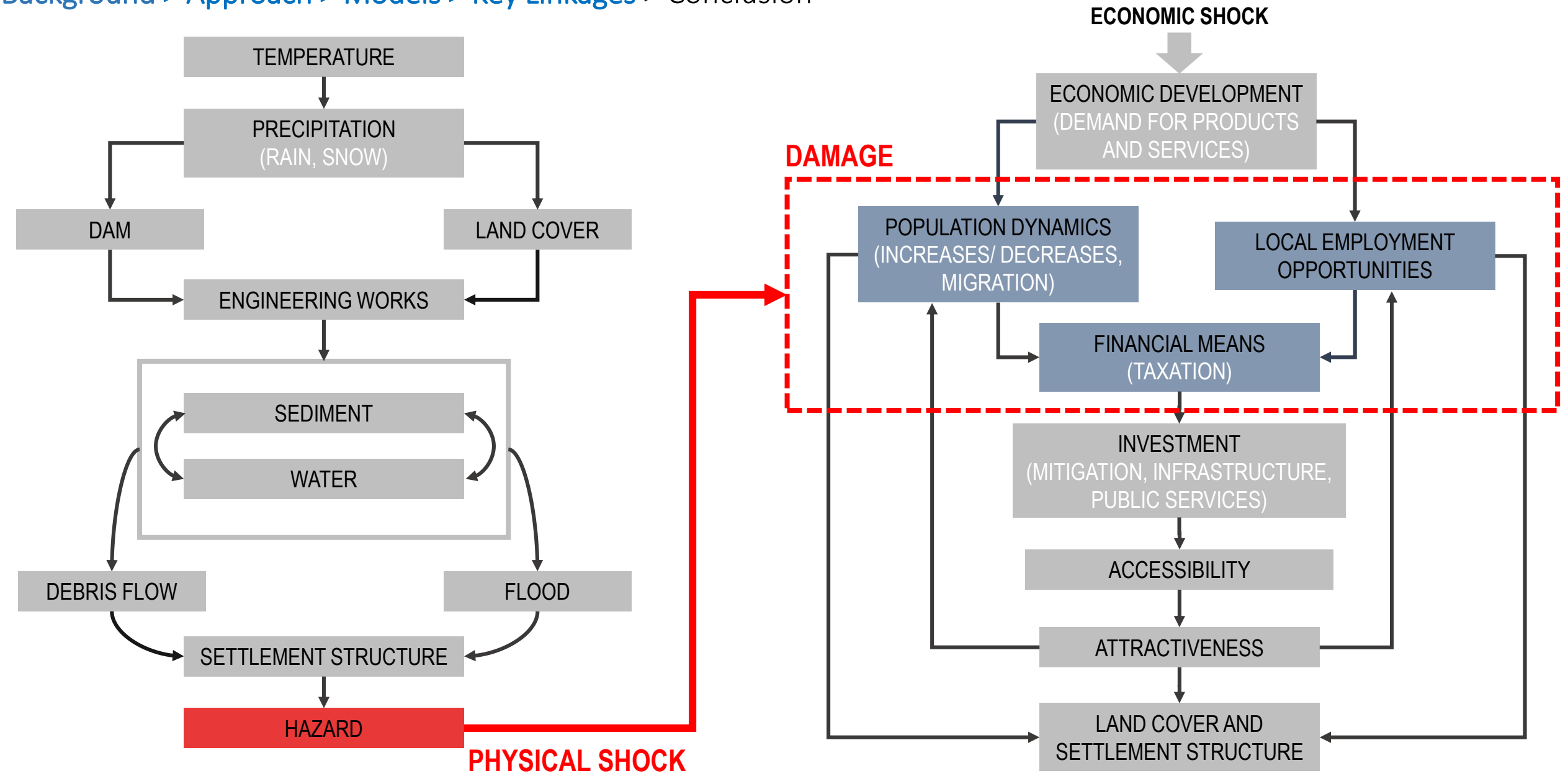


Socio-economic model

- Model drivers are financial means, population dynamics, local employment,
- Additionally important are accessibility and attractiveness of the community

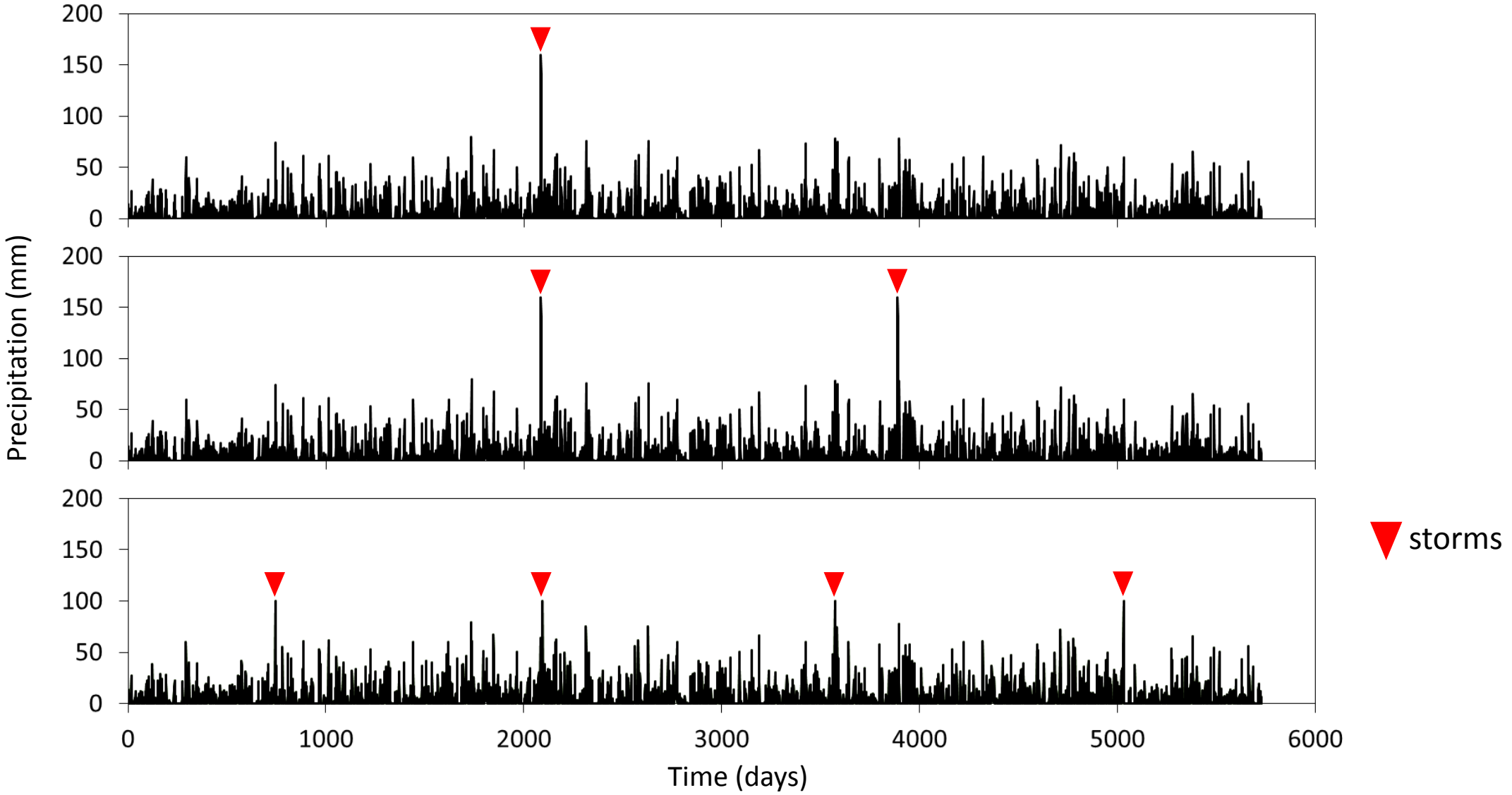


Linkage: Damage and Loss

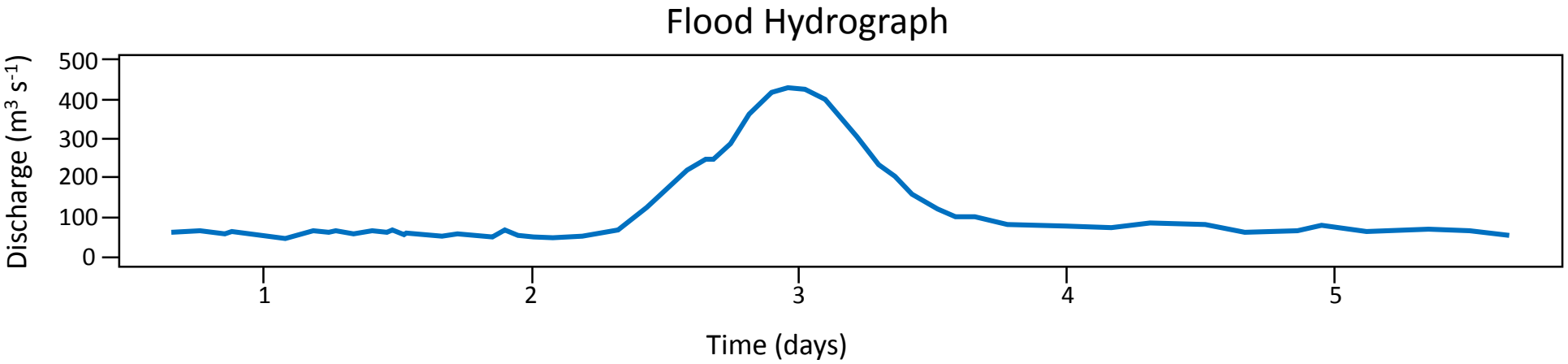


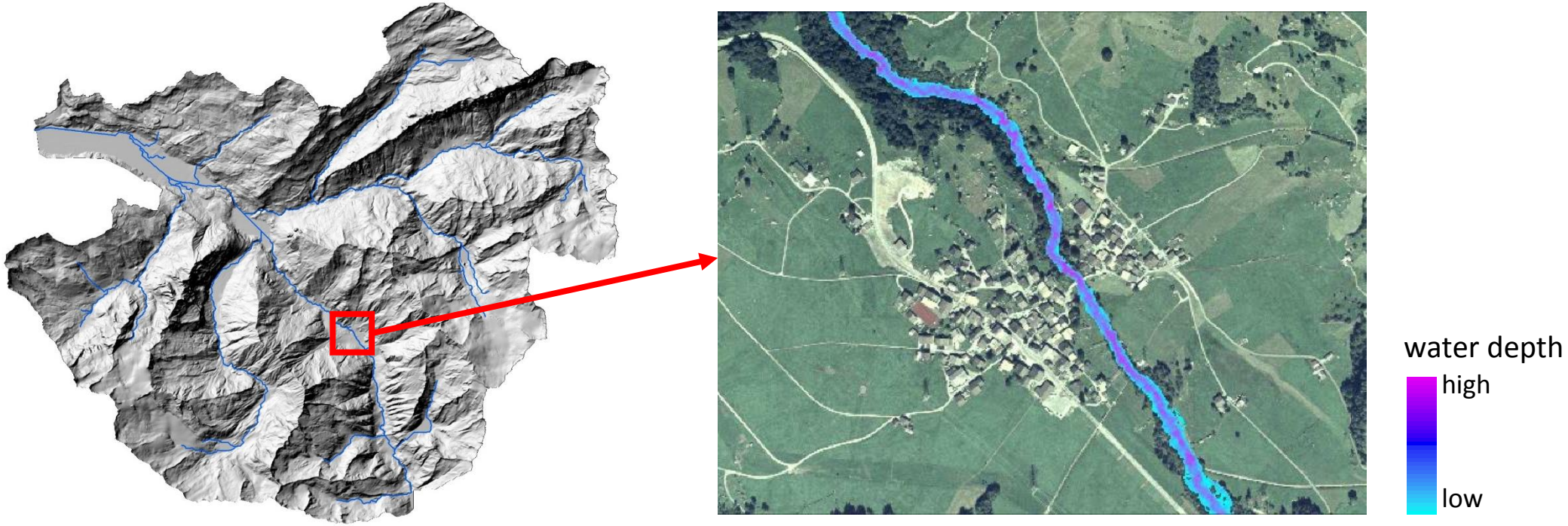
Linkage: Damage and Loss

Intensity of rainfall most important in movement of **sediment and causing floods**

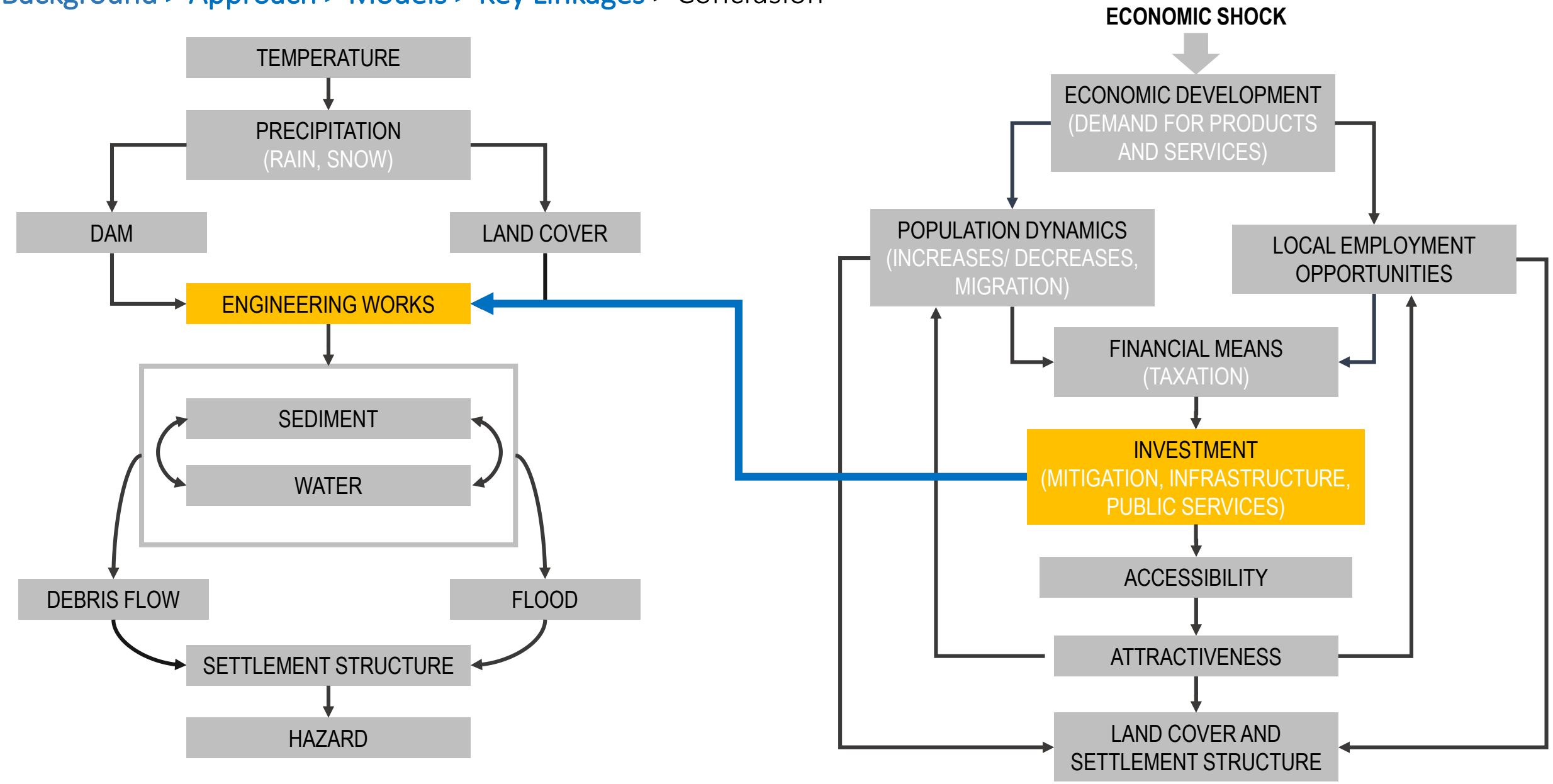


Linkage: Damage and Loss





Linkage: Mitigation



Linkage: Mitigation

River Engineering:

Flooding → Levees, Dams

Debris Flows → Check dams, retention basins

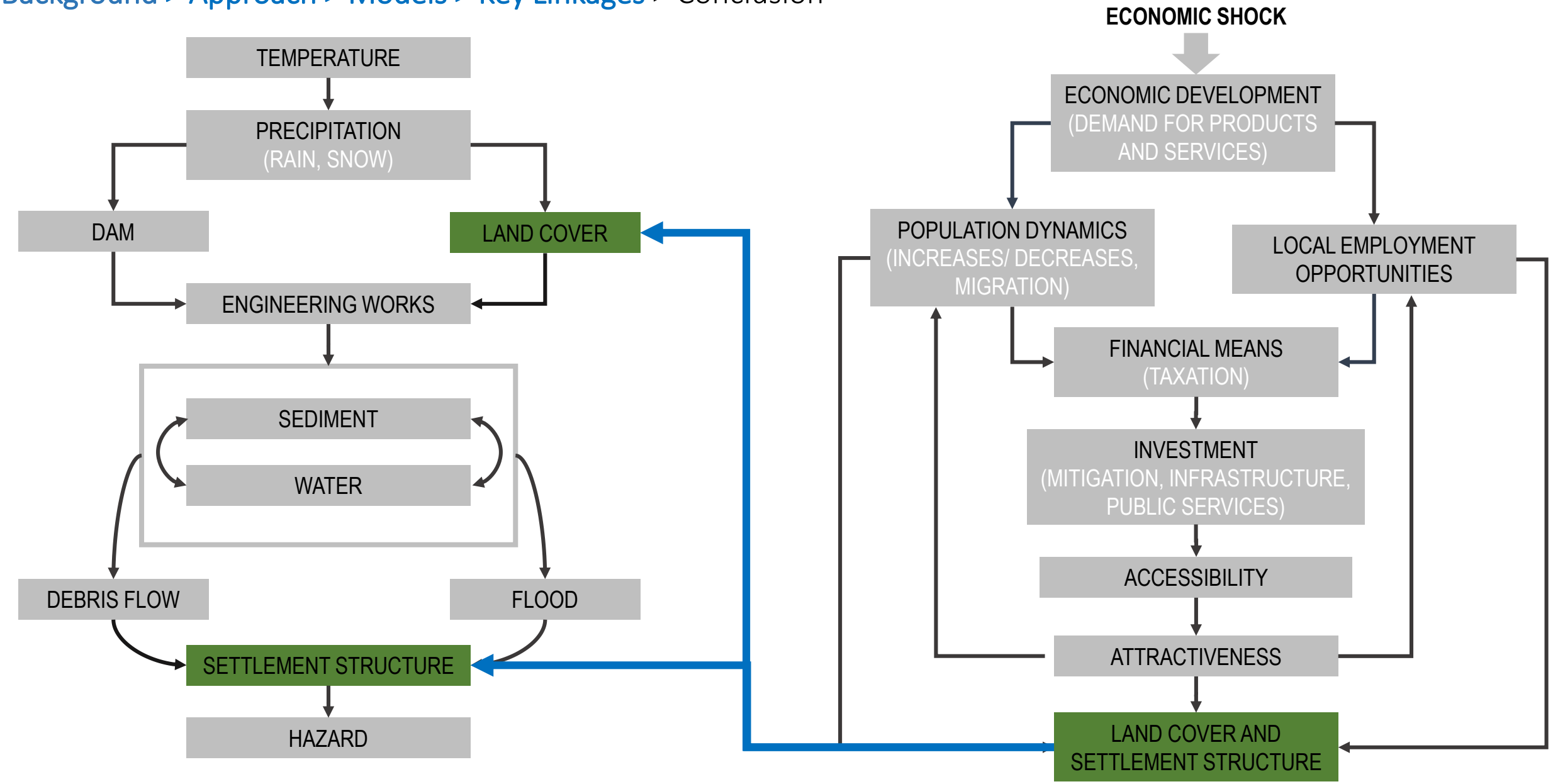
Levees

Check dams

Retention basin

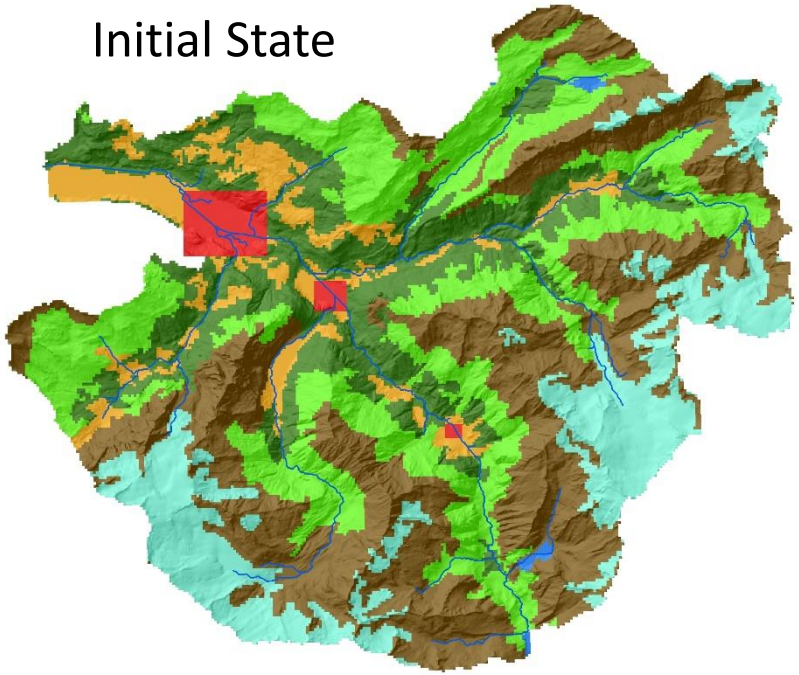
Sources: footage.framepool.com

Linkage: Landcover

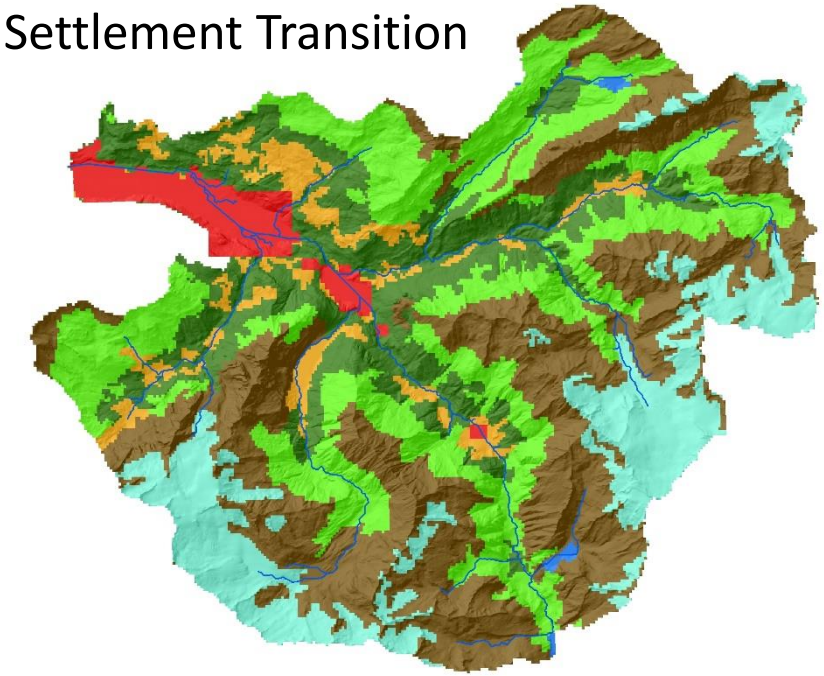


Linkage: Landcover

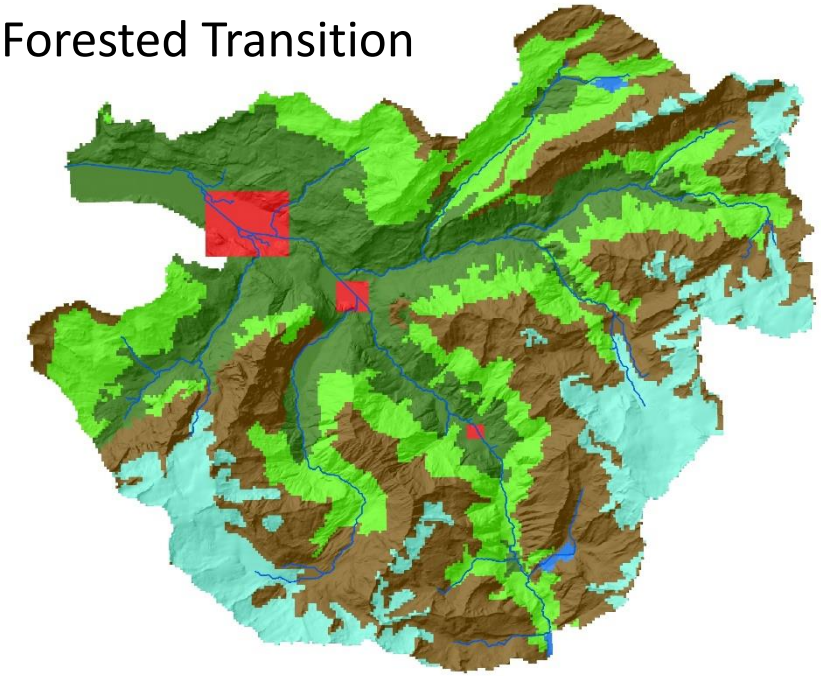
Initial State



Settlement Transition



Forested Transition



Land cover

- settlement
- agriculture
- sparse vegetation
- glacier
- grass
- forest
- water

Conclusion

- Our modelling approach will be able to determine the resilience of different mountain communities to **combined physical and socio-economic shocks**
- We consider **linkages** between both systems
- The conceptual model is **generic** and can be applied to most Alpine mountain communities
- Future work will focus on the development of the conceptual model using existing computer models