

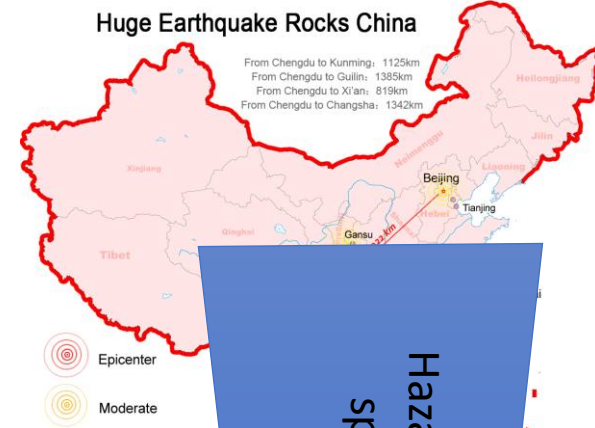
# Challenges to developing resilience to post-earthquake landslides



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# The 7.8 Wenchuan Earthquake



May 12, 2008- Earthquake shaking

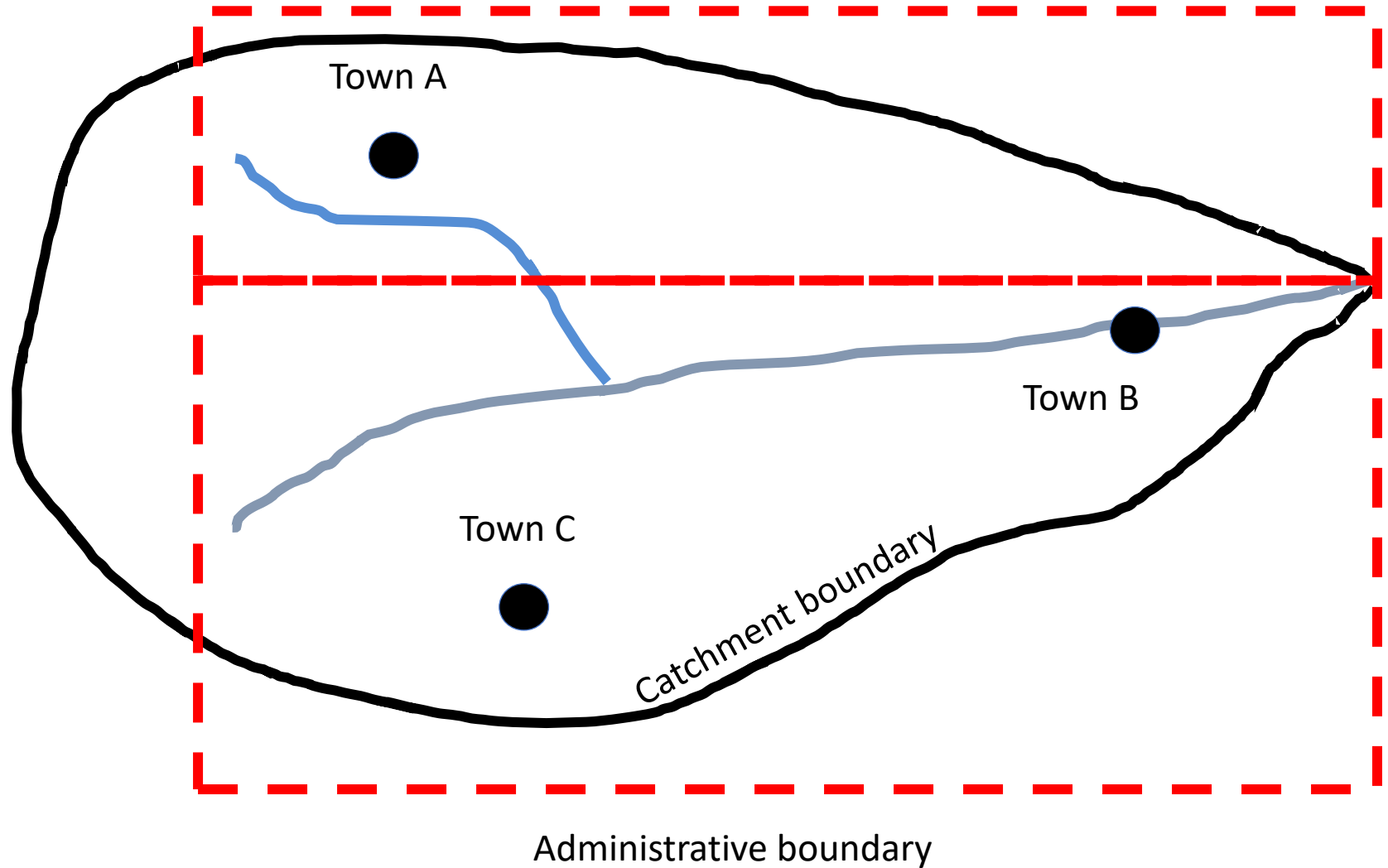
12 min post-earthquake-landsliding

June 10, 2008-landslide dam collapse

Sept 24, 2008- 1<sup>st</sup> post earthquake debris flow

Hazard concentrating from a wide spatial area to river valleys at decreasing frequency

# What are the spatial and temporal scales that are appropriate for enhancing resilience?



# Research Question

- How do we develop resilience to post-earthquake debris flow hazards?
  - How does hazard vary with time?
  - At what spatial and temporal scale does resilience develop?

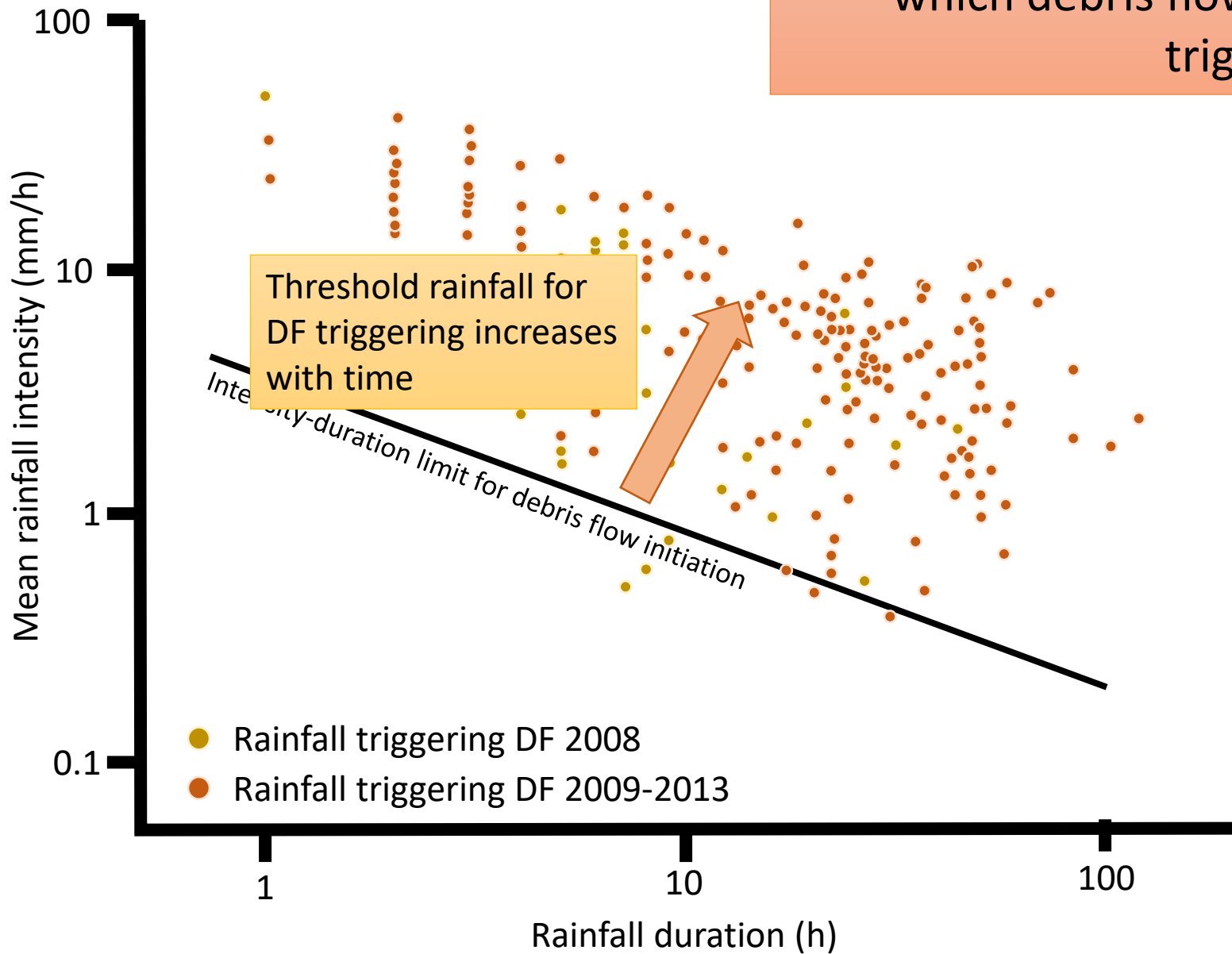


# Post earthquake debris flow - 2010



# 2010 Qingping Debris Flow

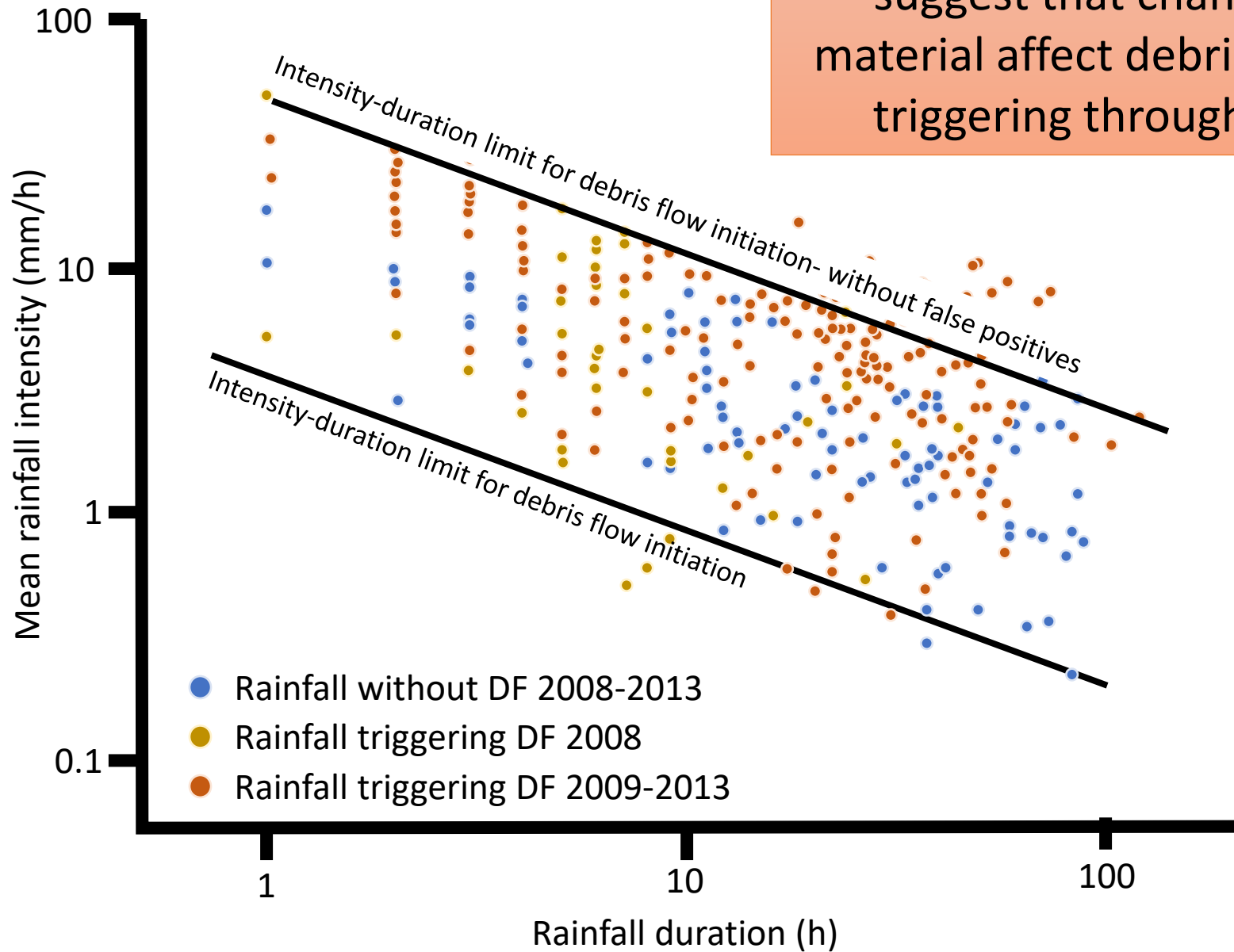




Rainfall conditions under which debris flows are triggered

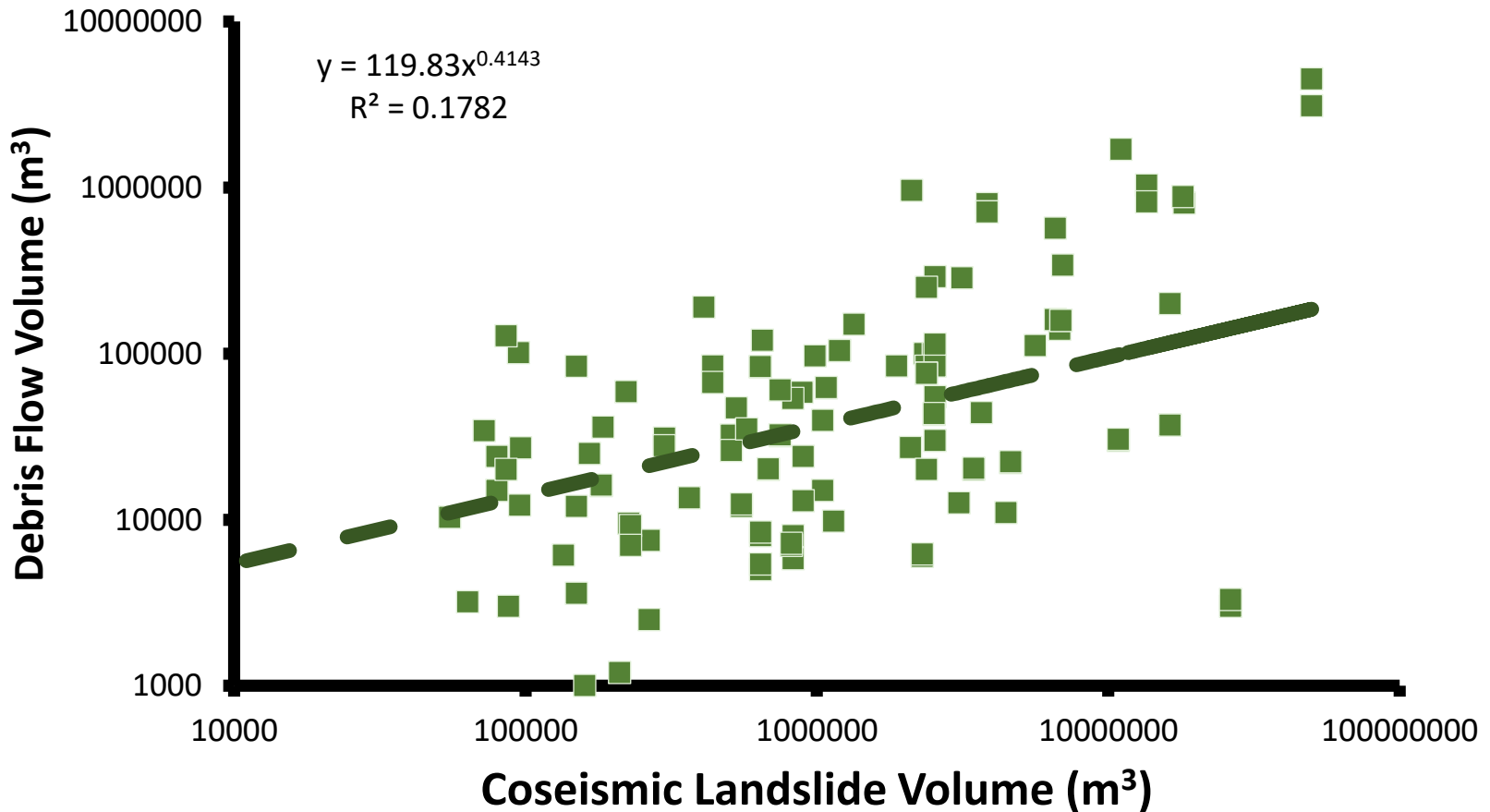
Threshold rainfall for DF triggering increases with time

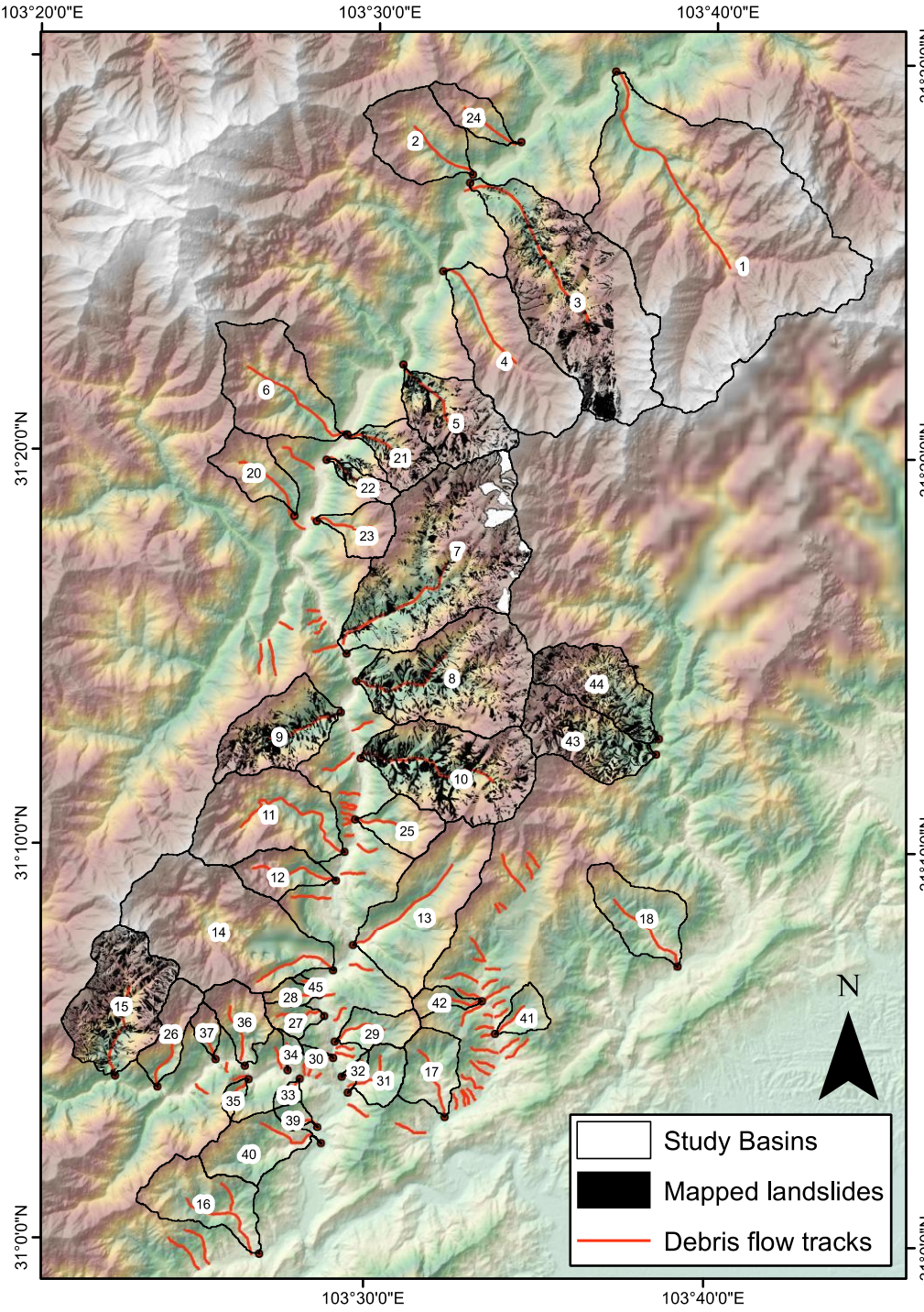
Variable rainfall thresholds suggest that changes in material affect debris flow triggering through time



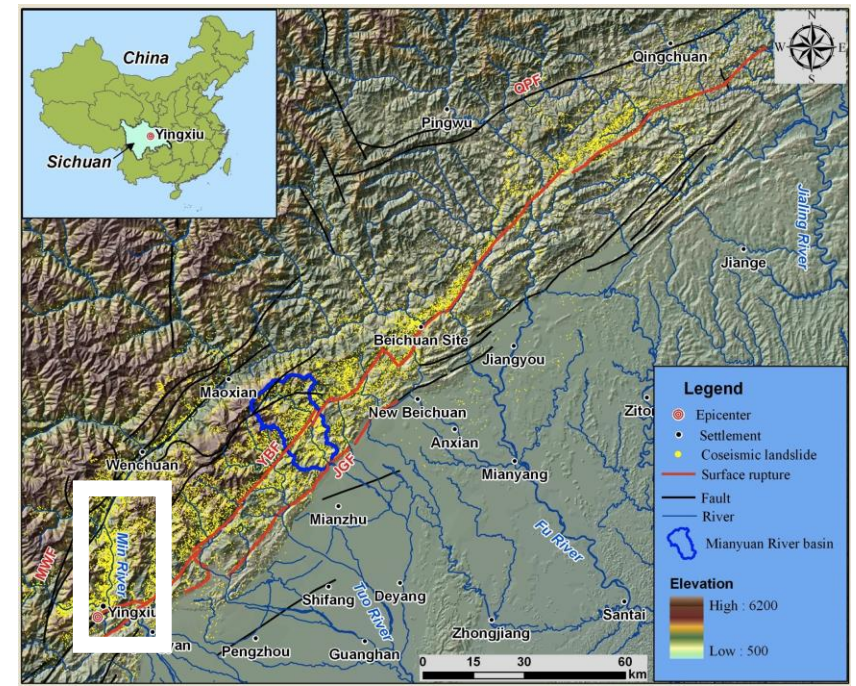


# Poor correlation between debris flows and availability of debris

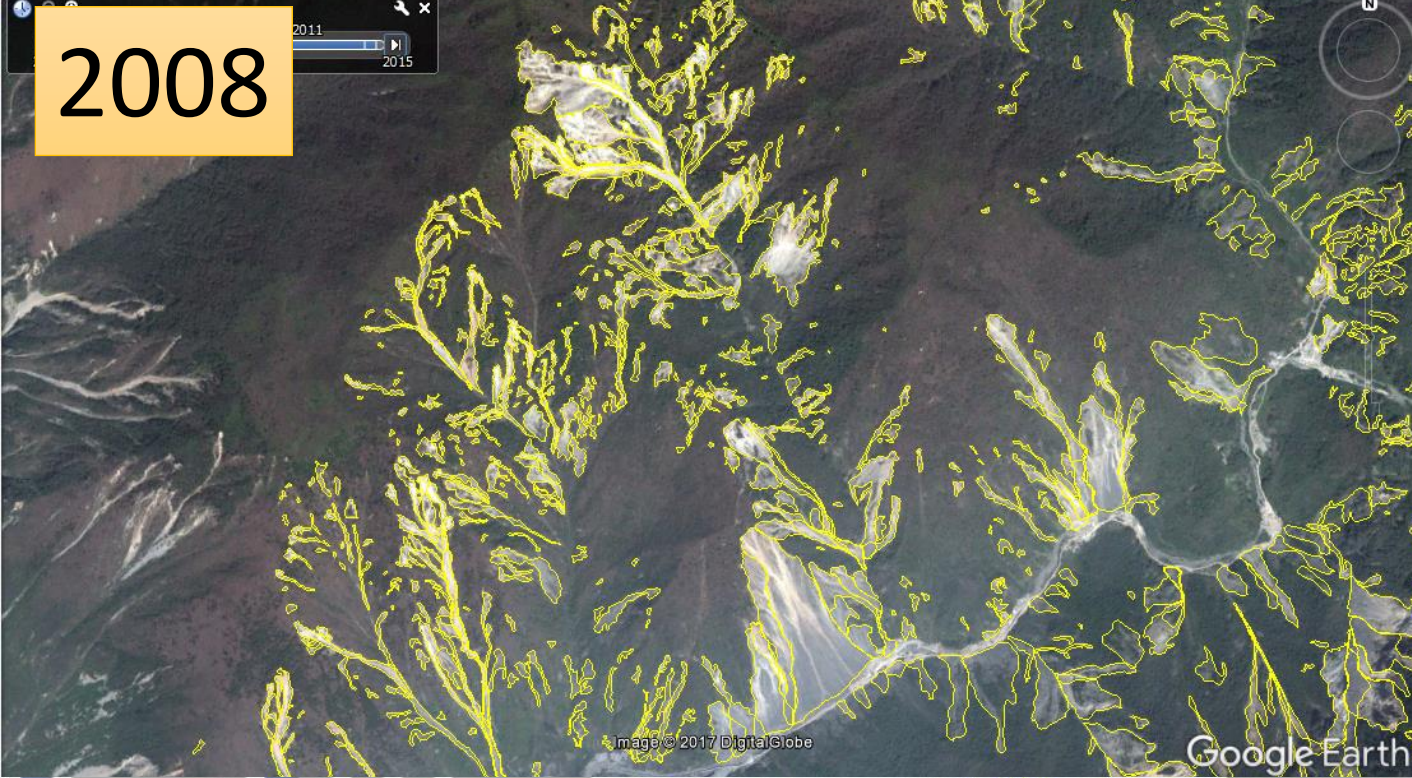




## Study area: Mianjiang River



2008







2014

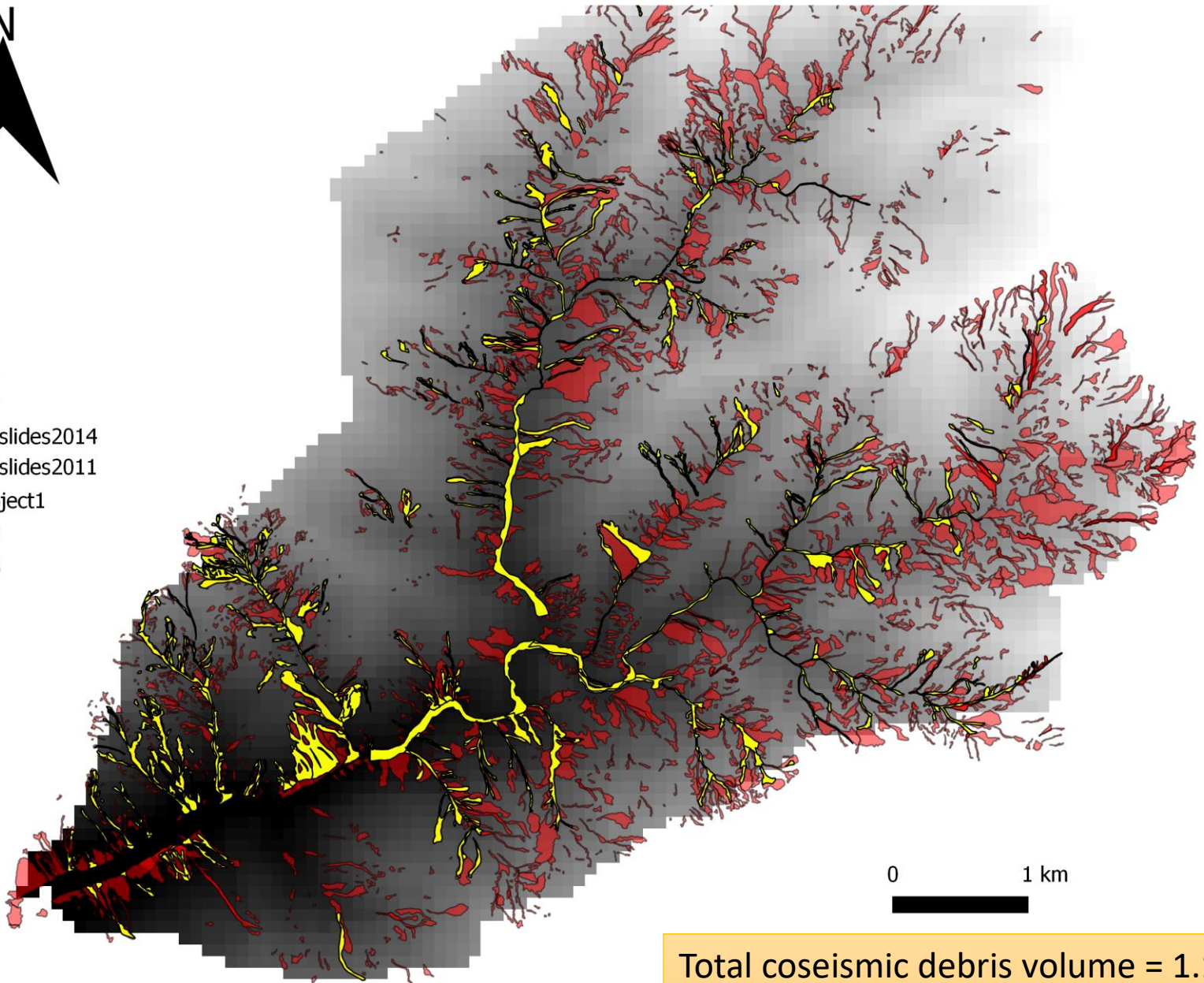


We mapped the “activity” levels of coseismic landslides since 2008



### Legend

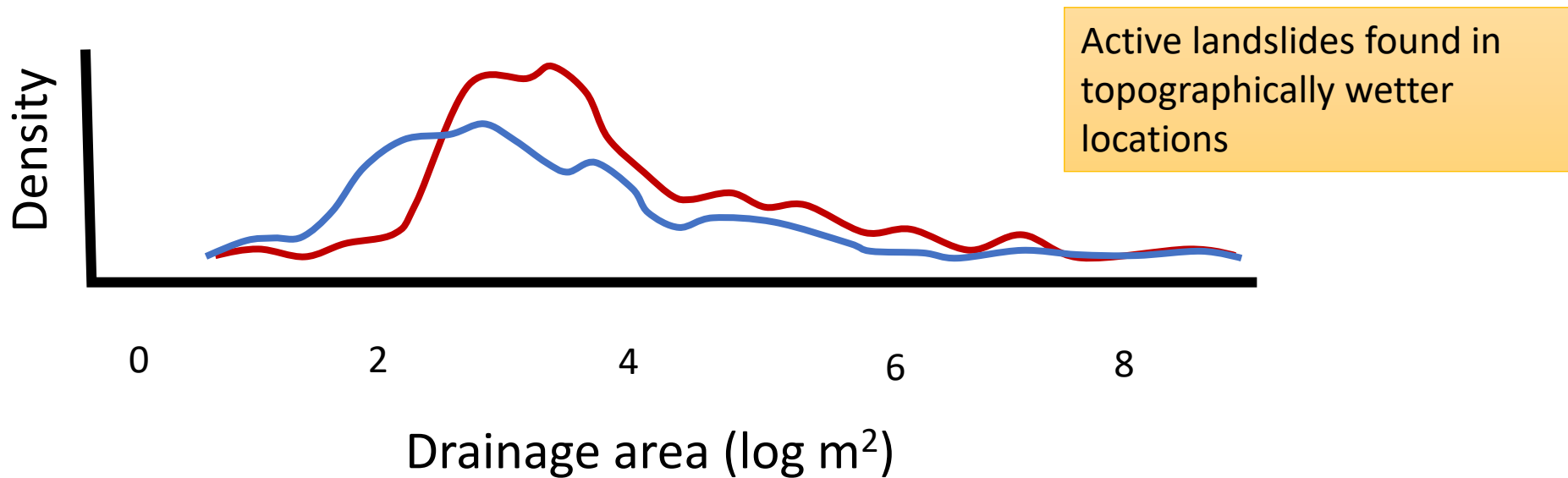
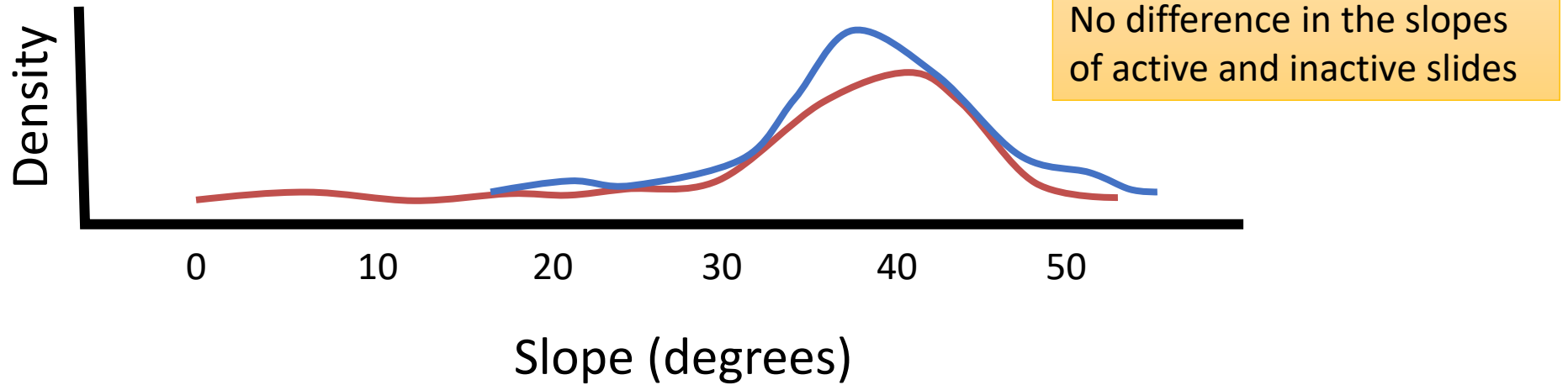
-  Landslides2014
-  Landslides2011
- DEMreproject1
  -  1367
  -  3586



Total coseismic debris volume = 1.1 km<sup>3</sup>  
Volume remaining in 2011 = 1.0 km<sup>3</sup>

# Topographic drivers of debris flows

— “Active” landslides  
— “Inactive” landslides



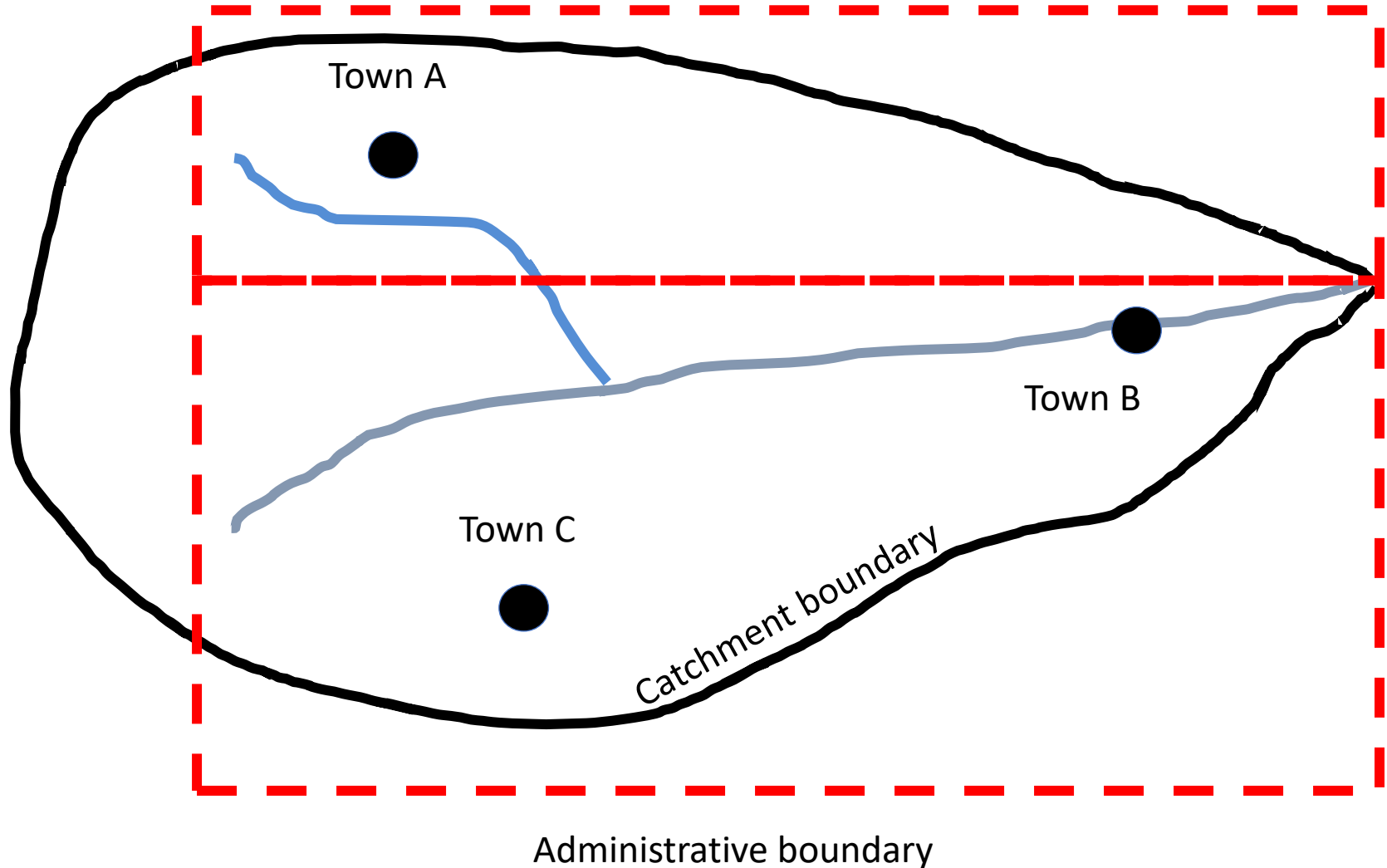
Why is there so much uncertainty in understanding where debris flows initiate?

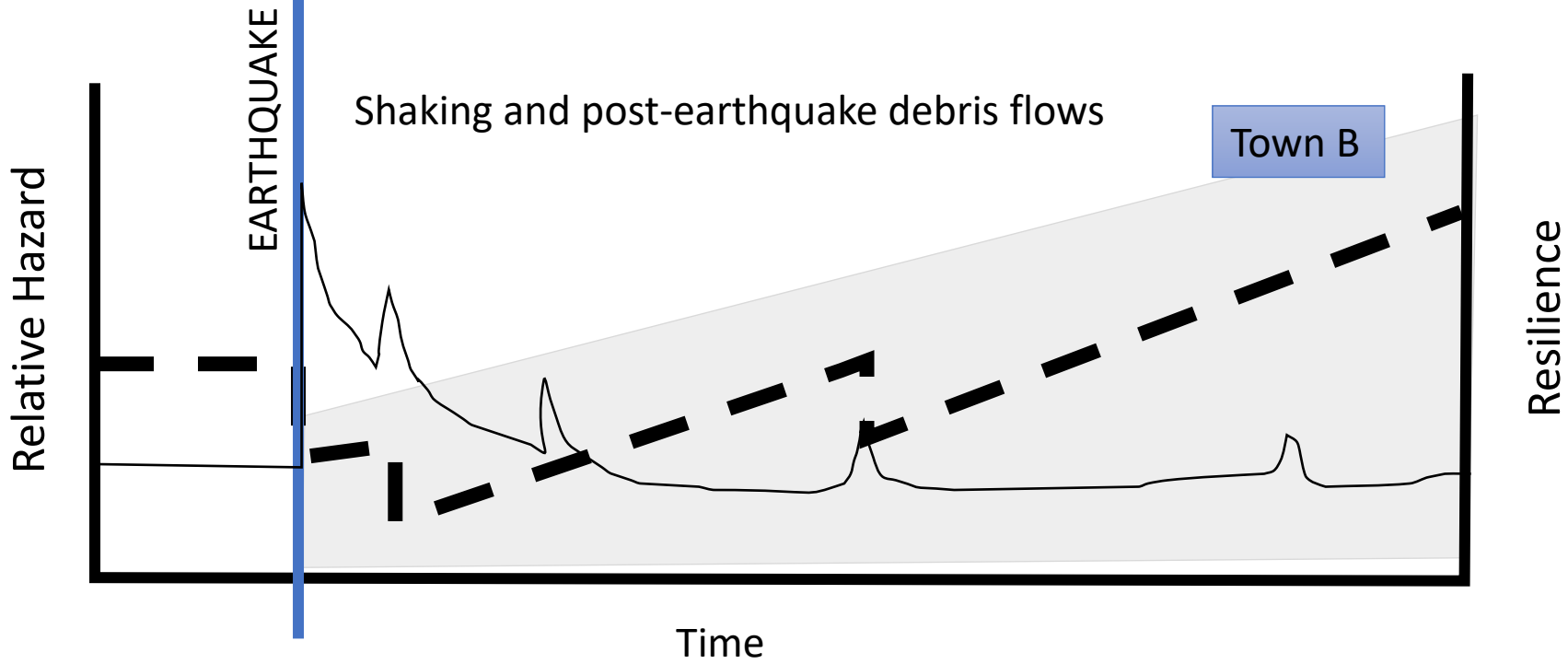
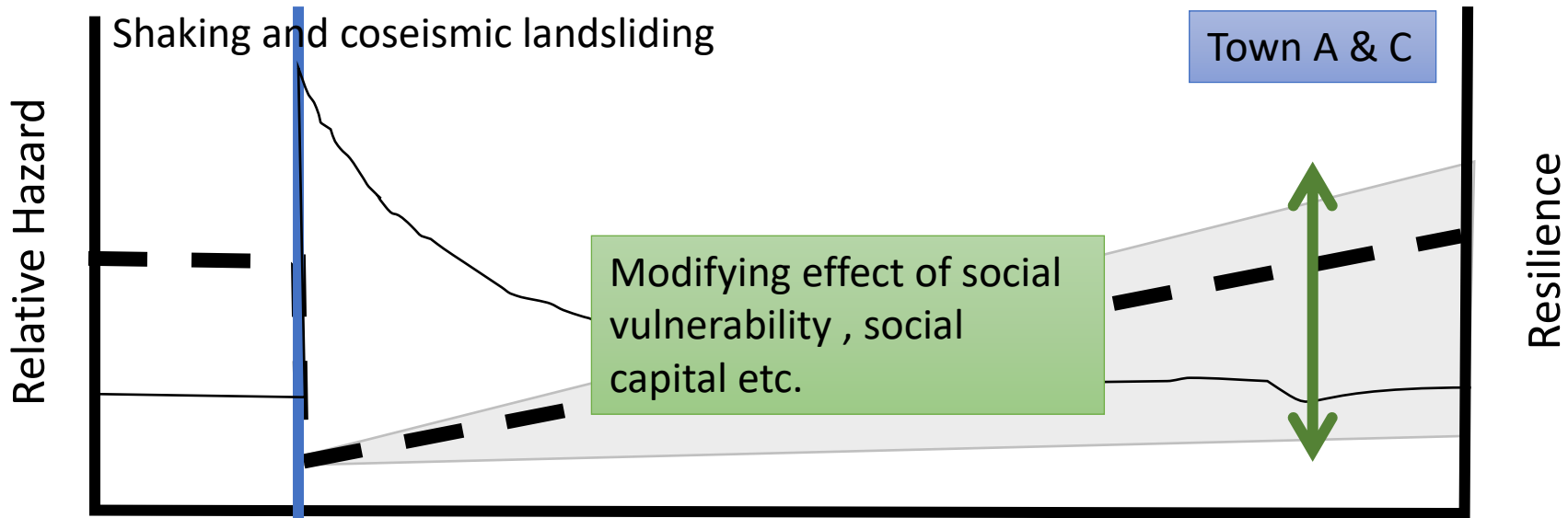


## **USGS DEBRIS-FLOW FLUME**

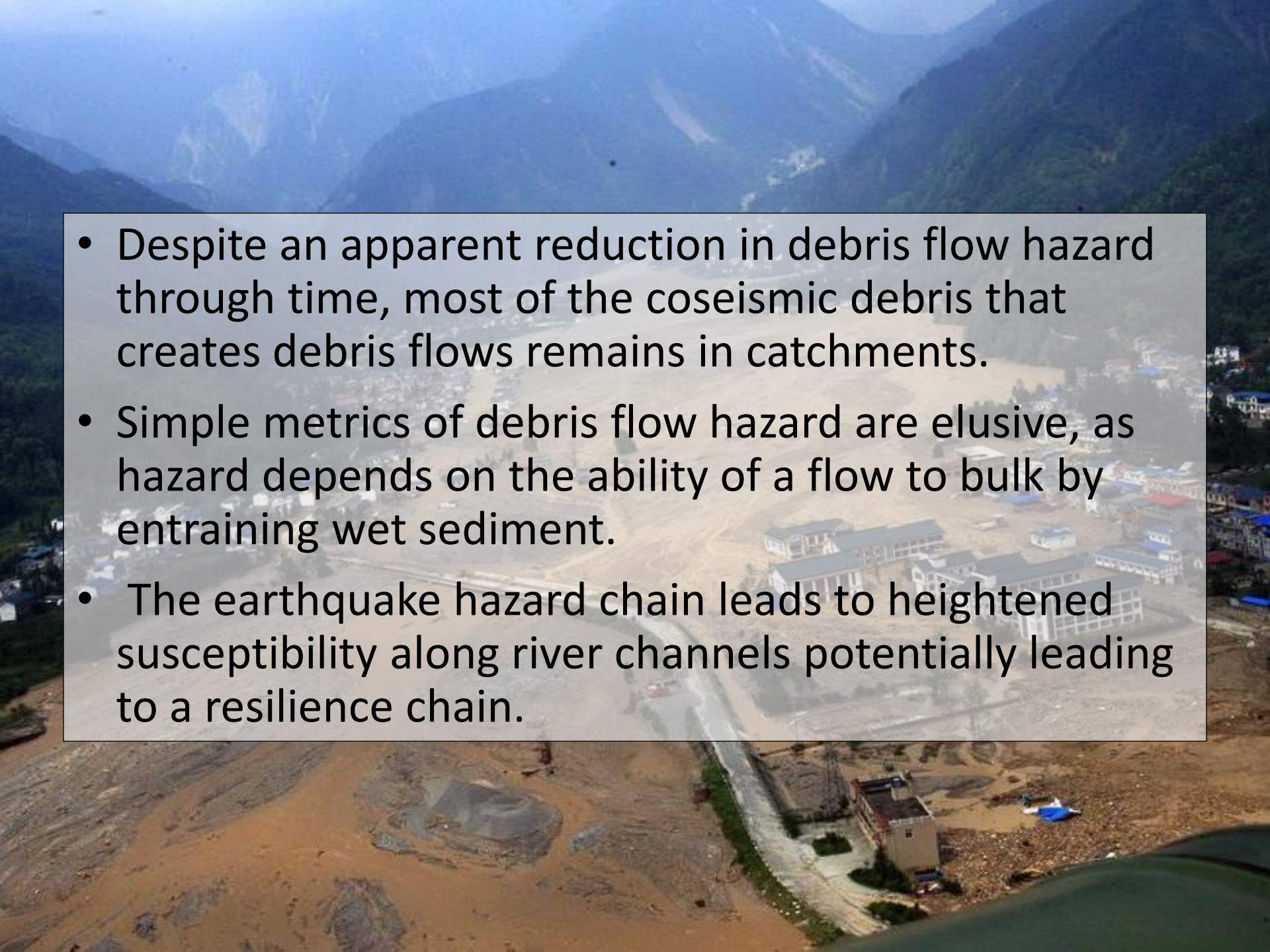
**Debris flows on wet vs. dry erodible beds (each flow is 6m<sup>3</sup> water-saturated sand/gravel/20% loam initially).**

# What are the spatial and temporal scales that are appropriate for enhancing resilience?

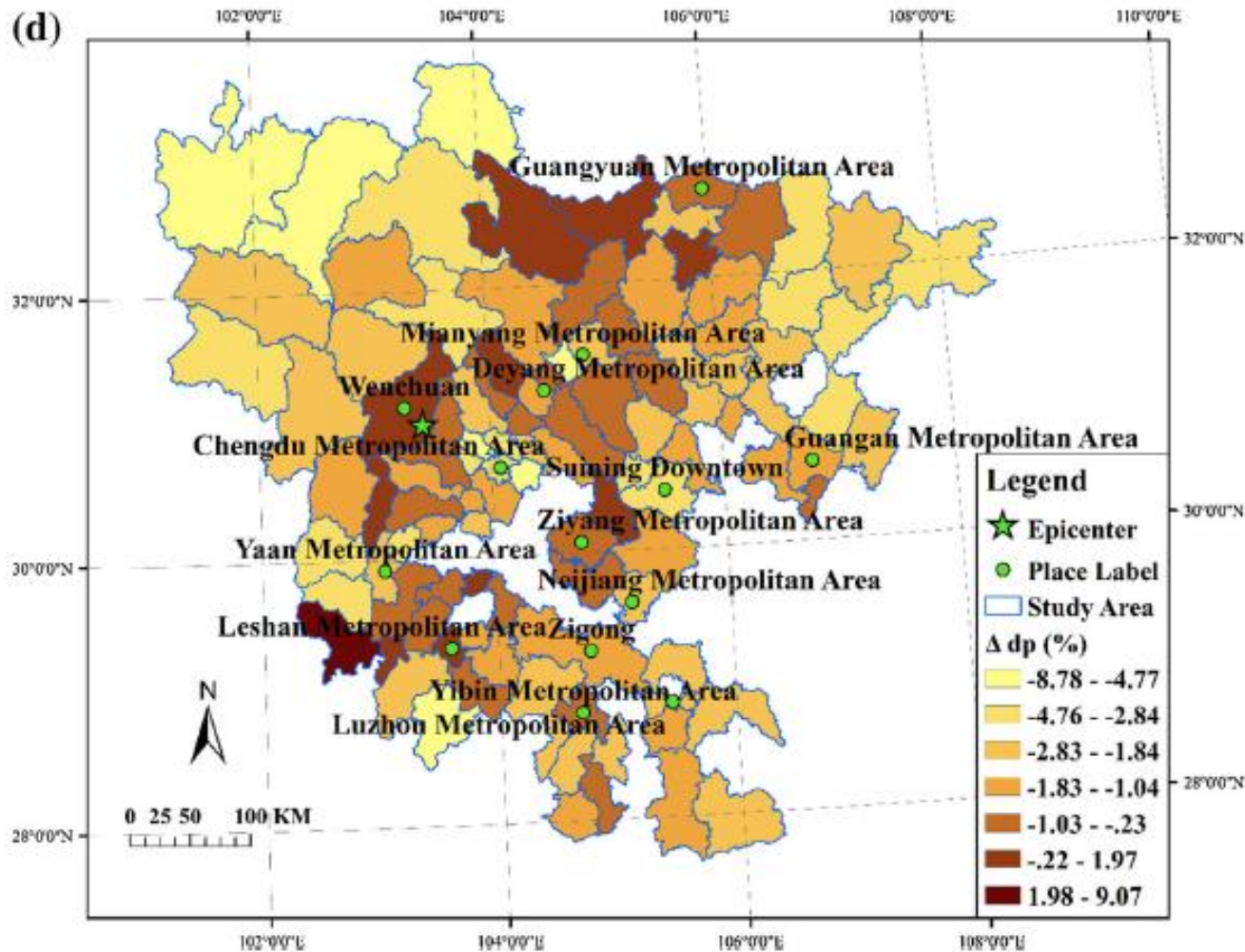






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- Despite an apparent reduction in debris flow hazard through time, most of the coseismic debris that creates debris flows remains in catchments.
  - Simple metrics of debris flow hazard are elusive, as hazard depends on the ability of a flow to bulk by entraining wet sediment.
  - The earthquake hazard chain leads to heightened susceptibility along river channels potentially leading to a resilience chain.

# Spatial measurements of resilience



Changes in post-earthquake population growth rates