

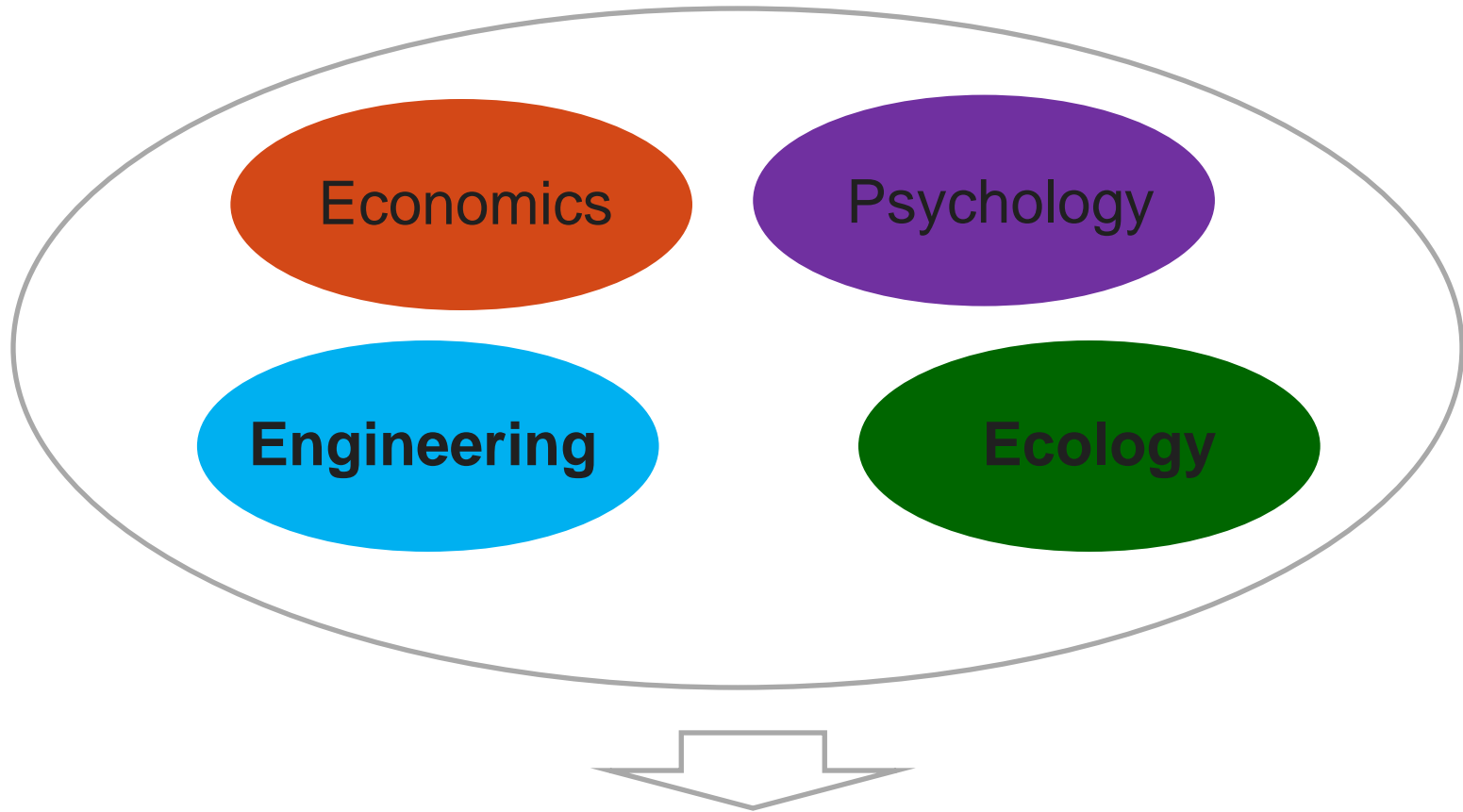
# Multiple Perspectives of Resilience and Some Implications on Reducing Disaster Risks and Impacts of Electricity Networks

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# || Perspectives on Resilience



**Disaster Risk Management**

# Resilience - Engineering

*"The ability of a system to return to an equilibrium or steady-state after a disturbance...such as flooding or earthquakes, or a social upheaval, such as banking crises, wars or revolutions."* (Davoudi 2012, pg. 300)

*"...focuses on persistence, change, and unpredictability – all attributes at the core of engineers' desires for **fail-safe** design."* (Holling 1996, pg. 33)

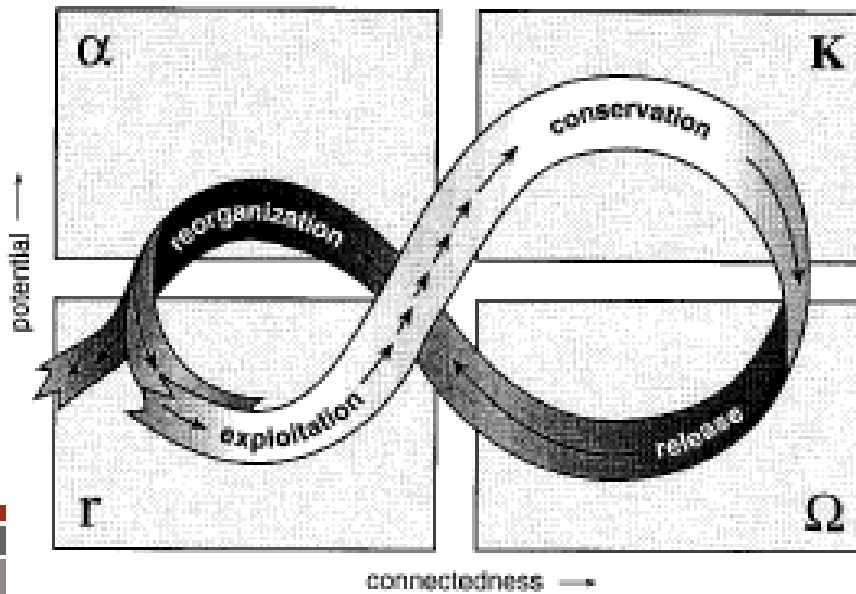
# || Resilience - Ecological

## Ecological resilience (Holling 1973):

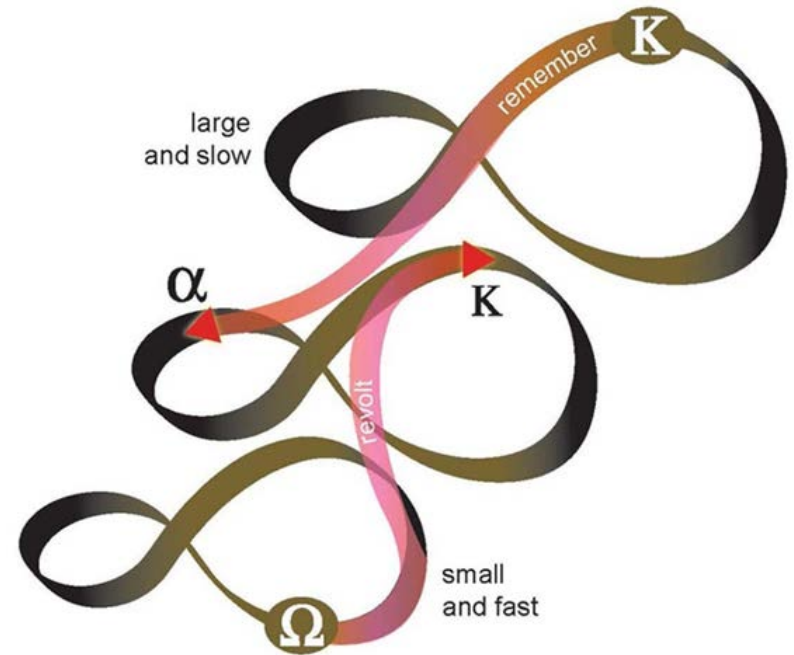
*"...resilience, that is a measure of the persistence of systems and their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables."*

Contrasted with **stability**: *"...represents the ability of a system to return to an equilibrium state after a temporary disturbance; the more rapidly it returns and the less it fluctuates, the more stable it would be."*

# Adaptive cycle and Panarchy



Adaptive cycle



Panarchy

# Two Major Paradigms

- **Engineering Resilience**

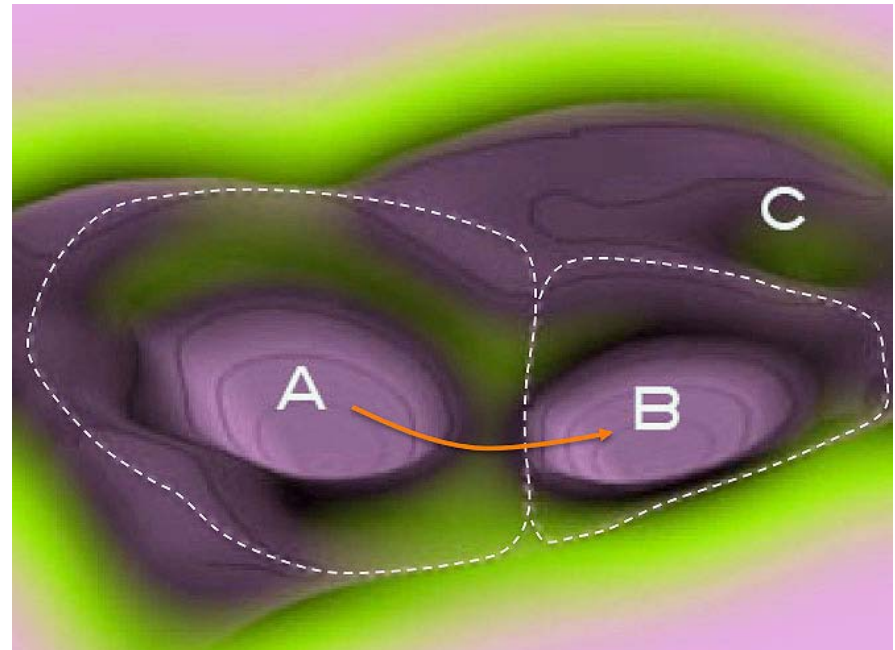
focuses on efficiency,  
constancy, predictability

– Defined as stability near an  
equilibrium or steady state

- **Ecological Resilience**

focuses on persistence,  
change, unpredictability

– Defined as the capacity of a  
system to absorb disturbance  
and reorganize while  
undergoing change



# Resilience – other perspectives

- **Psychological** – individual's response and recovery from a traumatic/adverse event.
- **Economic** – ability of an entity or system to maintain function (e.g., continue producing or growth) when shocked by recession, change in consumer preferences, damage to capital (disaster) etc.
- Resilience of **Social-Ecological Systems (SES)** – the capacity of a system, be it an individual, a forest, a city or an economy, to deal with change and continue to develop. It is about the capacity to use shocks and disturbances like a financial crisis or climate change to spur renewal and innovative thinking.

# Resilience – Disaster Risk Management





# || Resilience – Disaster Risk Management

*"Resilience is achieved within a system (economic, infrastructure, ecological, social) that includes multiple activities, interactions and relationships. Our point of departure working within complex systems are communities and putting local people, who are able to act within their sphere of influence, in the centre of the process. At the same time, a wider enabling environment which recognises the interdependency of local communities on others in terms of policy or access to wider resources is identified." (IFRC 2012, pg. 5)*

# Resilience – Disaster Risk Management

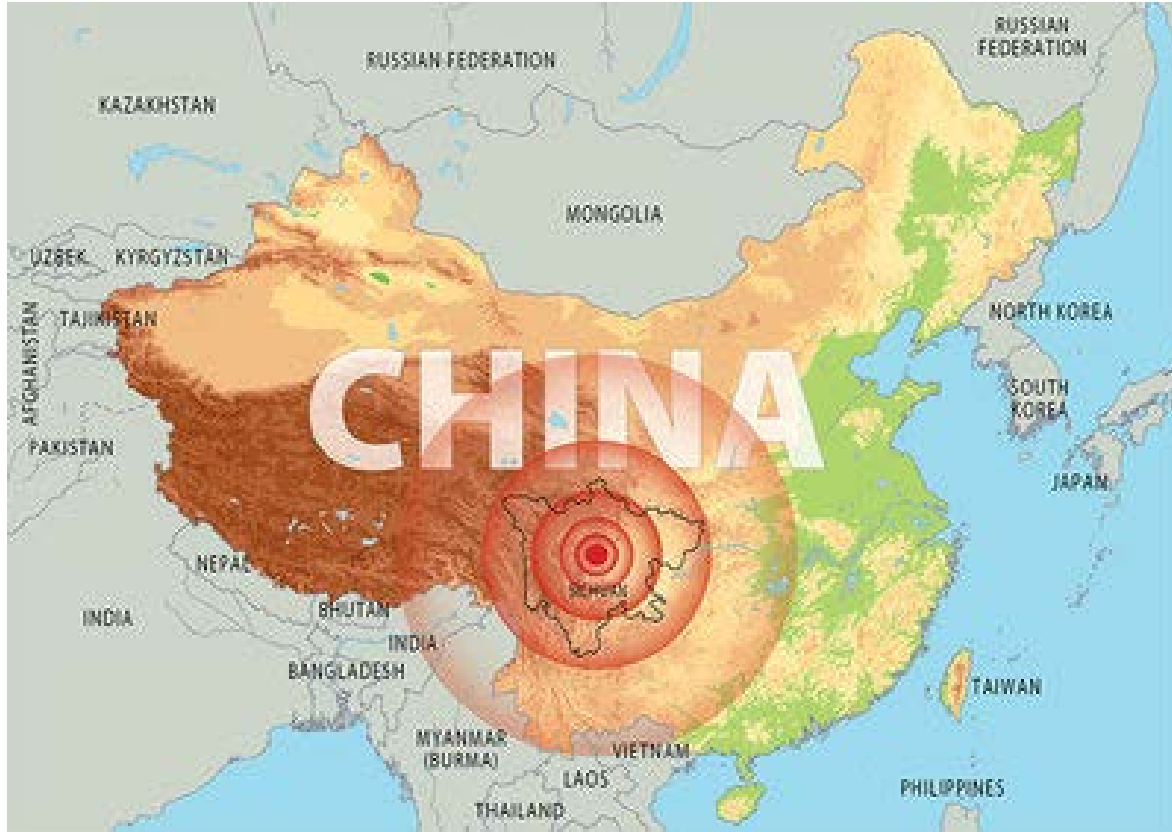
- **Disaster risk reduction** - denotes both a policy goal or objective, and the strategic and instrumental measures employed for anticipating future disaster risk, reducing existing exposure, hazard, or vulnerability, and **improving resilience**. This includes lessening the vulnerability of people, livelihoods, and assets and ensuring the appropriate sustainable management of land, water, and other components of the environment. (IPCC, 2012)
- **Resilience** - the ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a potentially hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions (IPCC, 2012)

# Resilience (the Four Rs)

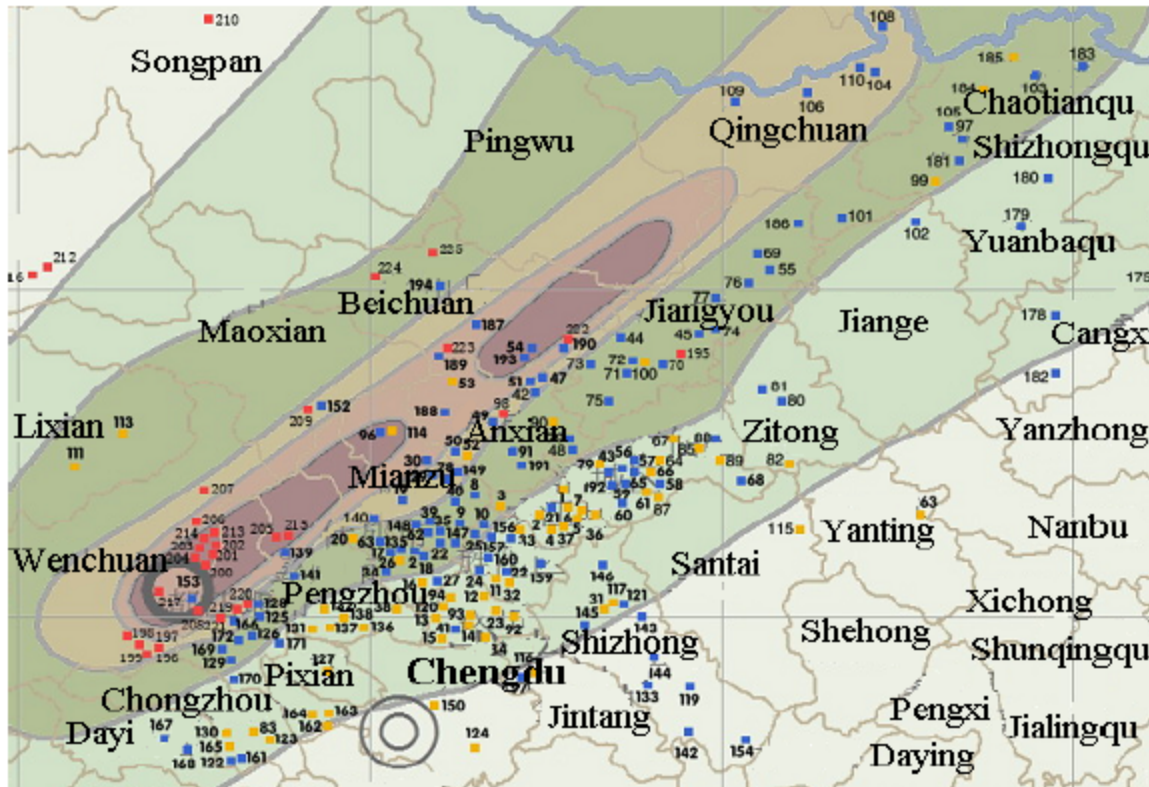
- Robustness (ability to withstand a shock)
- Redundancy (functional diversity)
- Resourcefulness (ability to mobilize when threatened)
- Rapidity (ability to contain losses and recover in a timely manner)



# The 2008 Wenchuan Earthquake, China



# Damage to Electricity Network System, Sichuan Province



Source: Liu et al. 2012

# Damage to Electricity Network System



**Figure 3.1.** Transformer toppling down in 220kv Ertaiشان substation



**Figure 3.2.** Most of transformers and circuit breakers are damaged in Beichuan 110kv Qimingxing substation

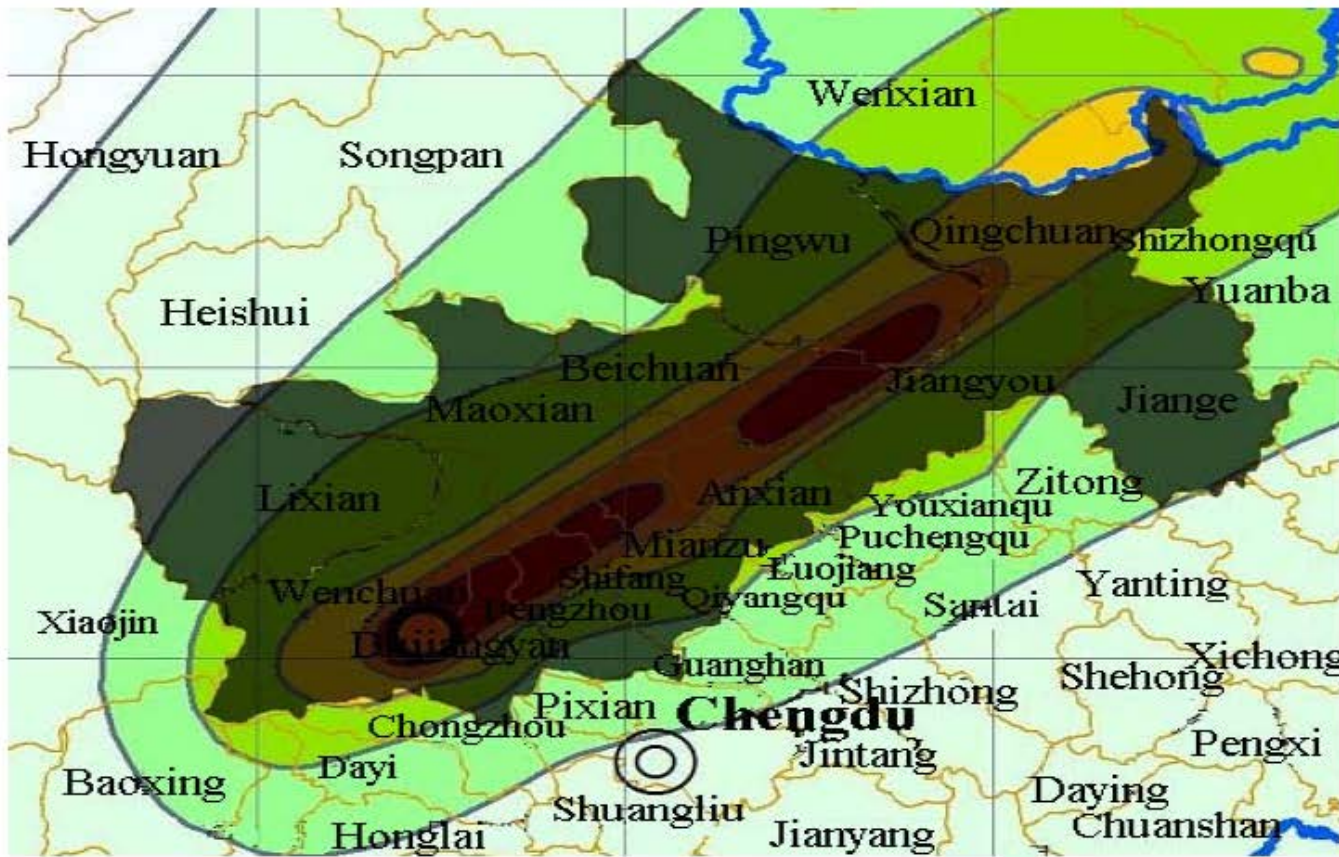


**Figure 3.3.** 10kv capacitor three-way reactor burnout and porcelain insulator burst in Guanghan Sanxingzhui substation

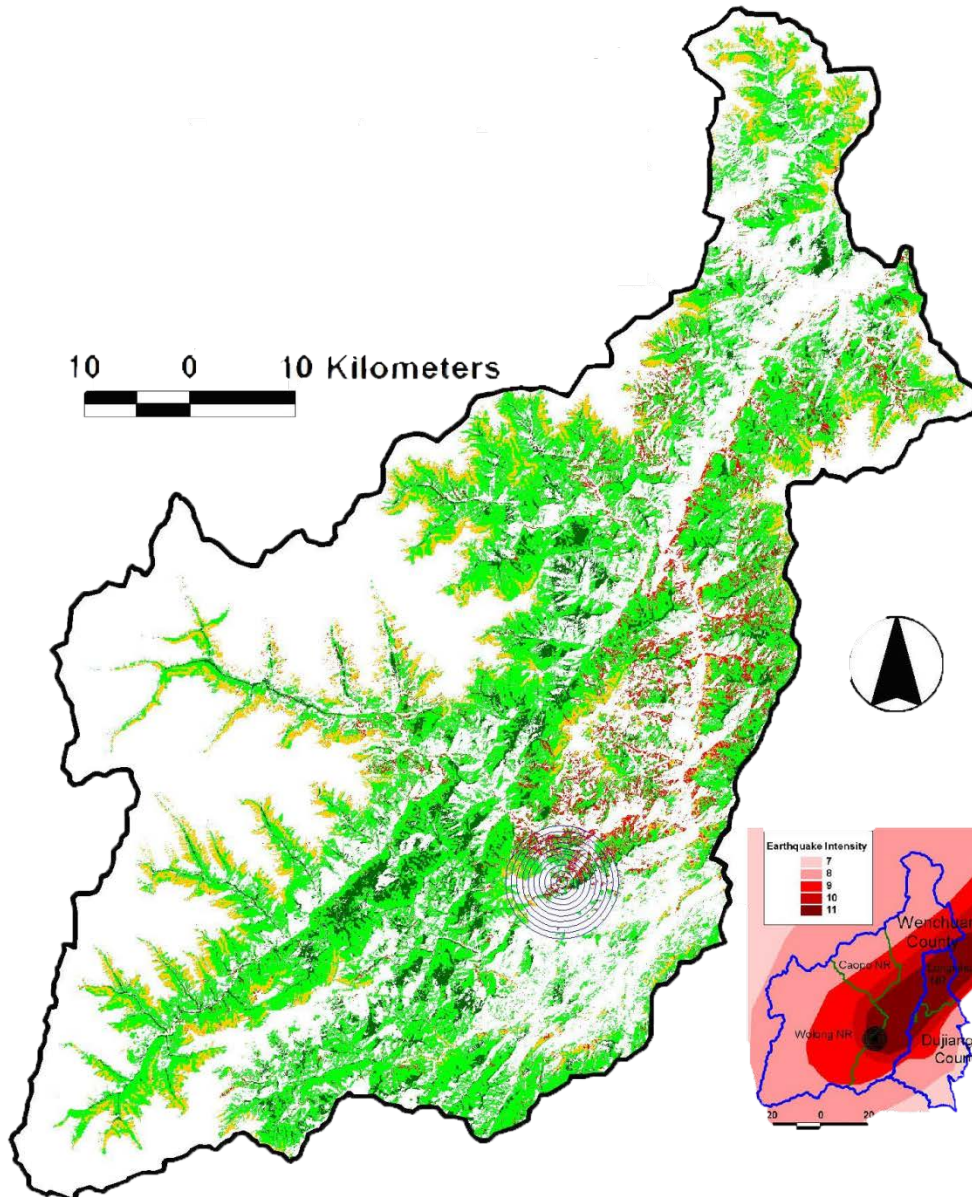


**Figure 3.4.** Main control room collapsed, transformer displaced and oil leaked

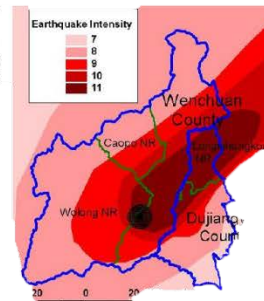
# Electricity Outage in the Earthquake Area



# Wenchuan County



- Population >100,000, Tibetan and Qiang ethnic minorities
- Economic and energy transitions
- **Wolong Nature Reserve** (~2000 km<sup>2</sup>) - Endangered species (e.g., Giant Pandas) and biodiversity conservation

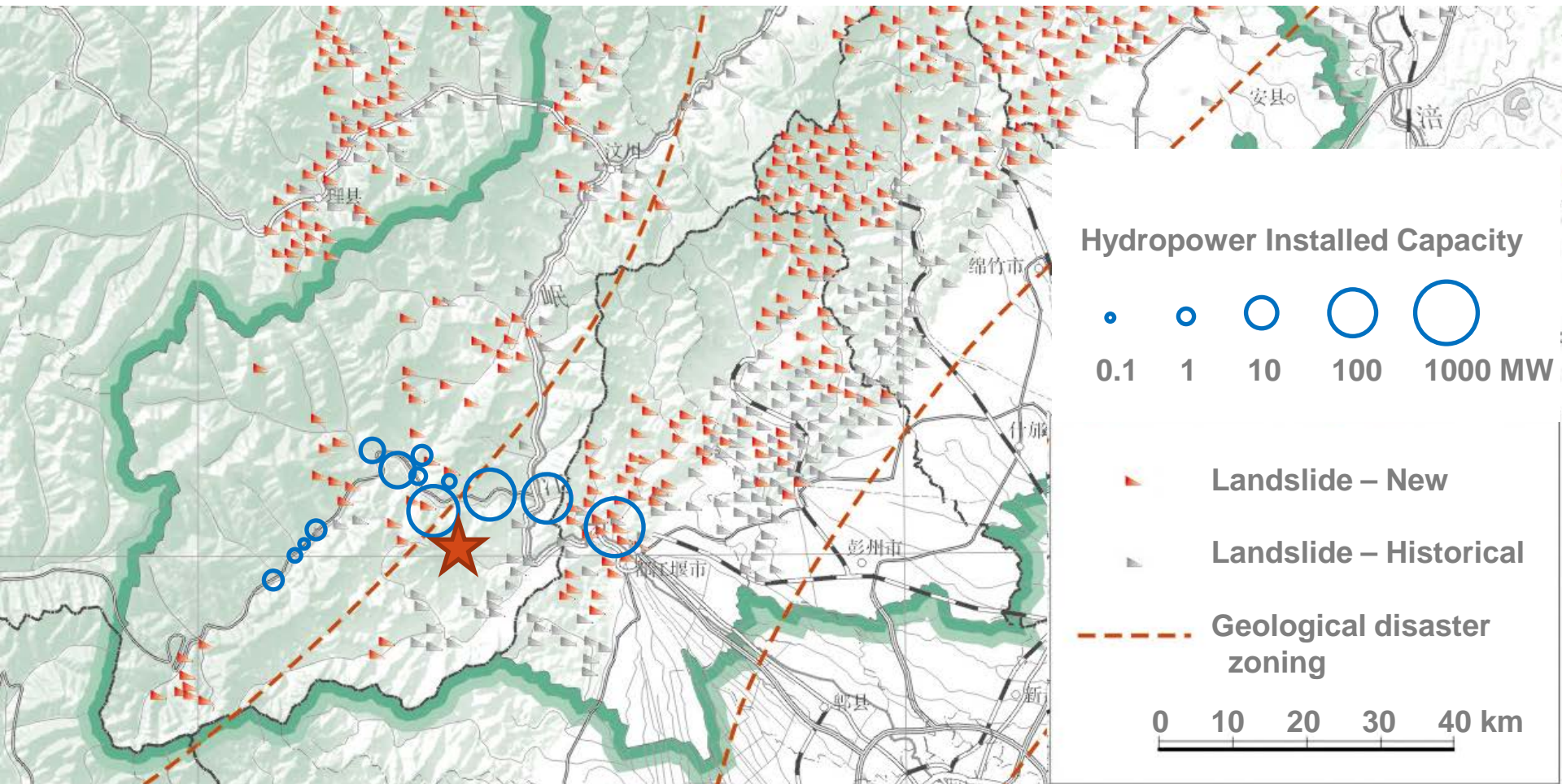




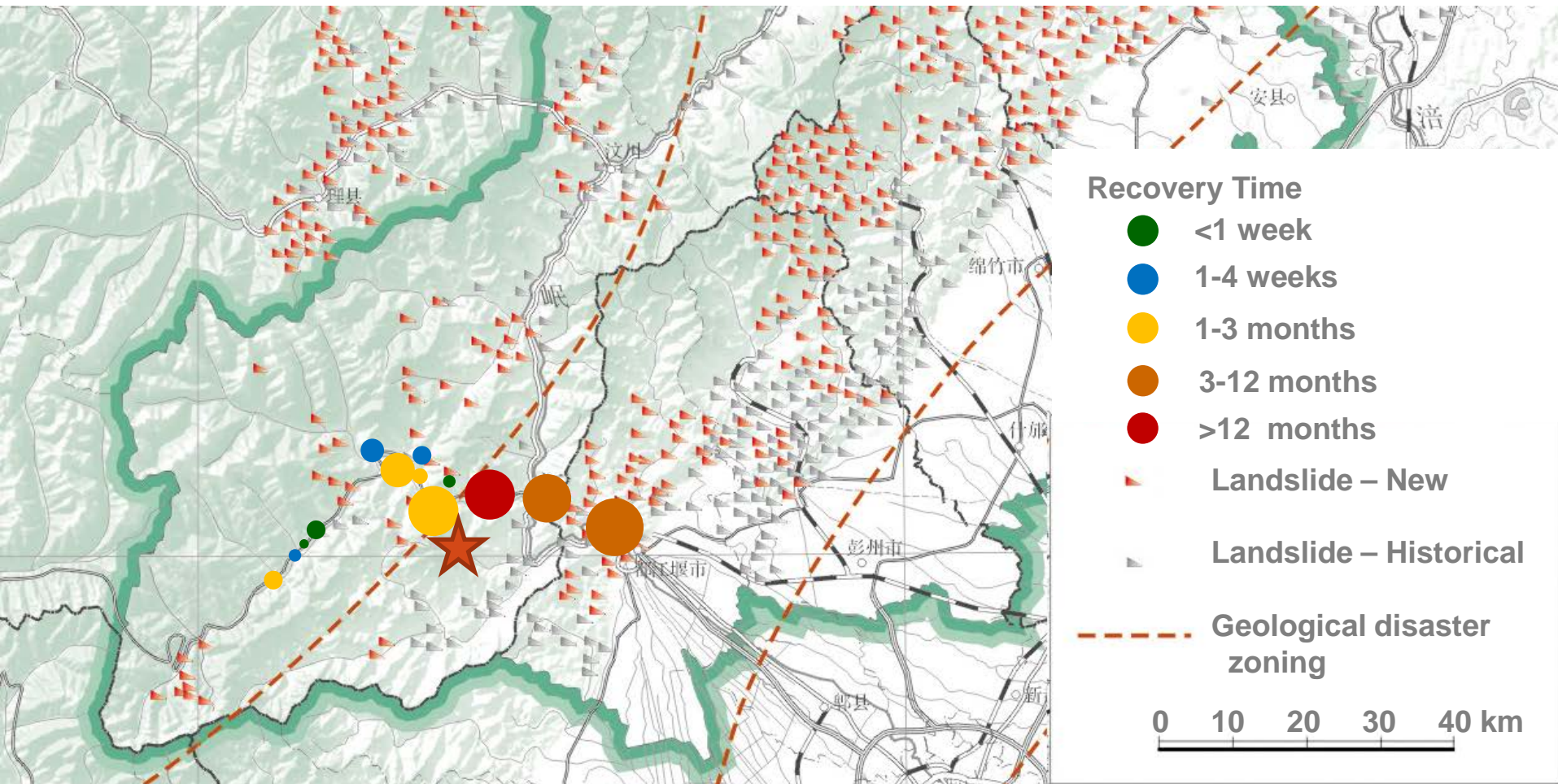




# Electricity System in WNR and nearby



# || Damages, Impacts and Recovery



# Reconstruction





# Reconstruction - A Learning Process



# Implications

- The Four Rs for Electricity Network System and other Critical Infrastructure Systems
  - Robustness (ability to withstand a shock)
  - Redundancy (functional diversity)
  - Resourcefulness (ability to mobilize when threatened)
  - Rapidity (ability to contain losses and recover in a timely manner)
- Integrate Electricity Network into the Broad Social-Ecological System Contexts