# Fukushima Daiichi: Japan's Resilience to Nuclear Plant Meltdown

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***To what extent can a country be resilient to nuclear plant disasters?***

- **Resilience**: The ability for a system to adapt to change while still maintaining function. In order to be effective, must include subjects and influence "actual decision making" (Benson and Craig 2014, 780).
- **Social Ecological Systems (SES):** Nested social systems and ecological systems that interact in ways interlinking resilience individually and collectively.
- **Disaster Resilience:** Characteristics of SES that affect disaster resilience include capacity, vulnerability, and risk, of which humans play a major role. Must be reassessed for disasters including radiation and long-term hazards.

## CS Holling

- The **panarchy** describes the "evolving nature of **adaptive cycles**" in which a system's collapse, restructuring, and regrowth are cyclical realities.
- Larger/slower and smaller/faster systems are continuously influencing other scales of the panarchy.

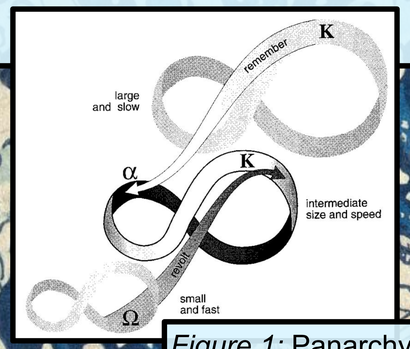


*Figure 1:* Panarchy of different adaptive cycles nested together.

## Protective Action Decision Making (PADM)

- Combines influences of place, people, and system.
- Context, psychological process, and situational factors are used to better understand how an actor takes protective action.
- Cycle (including feedback) of analysis and reaction that repeats in short time spans throughout events.

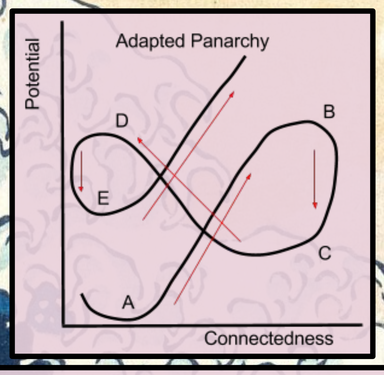


*Figure 3:* Adaptive cycle with exaggerated distance between old and new cycles.

## Research

***To what extent has Japan demonstrated resilience to the Fukushima Daiichi Nuclear Plant meltdown?***

- Each point of the Adapted Panarchy highlights a collection of different components from the PADM model. Together these are arranged in tables and used to assess event characteristics from the local, prefectural, and national scales.
- Chart of event characteristics over spectrums of resilience and scale across SES. Creates a bigger picture of the nuclear power plant meltdown and expands conversation of resilience beyond binaries.
- Objective of tables and chart is to specify event actors, or 'subjects,' and determine 'actual decision making' throughout events.

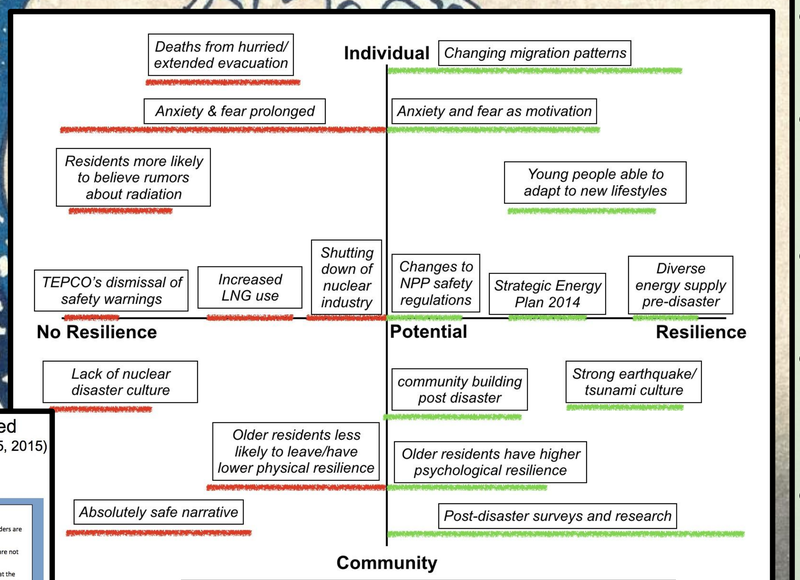


*Figure 4:* Chart highlighting resilience and scale as a spectrum using examples from Fukushima events.

## Discussion

- **Point A:** Stakeholders set the stage for events by making decisions that ignore nuclear power hazards across all scales.
- **Point B:** During the evacuation, lack of information about both evacuation and radiation danger caused evacuees unnecessary stress and frantic responses across all scales.
- **Point C:** Protective action, such as evacuation and thyroid screening is continued long past the initial recovery stage because radiation is a long-term hazard.
- **Point D:** Given that the ecological system of the region is not longer able to provide for the social system, the SES of Fukushima splits. Other SESs nested within Japan must adapt to support the splitting SES.
- **Point E:** As the disaster extends in time, due to radiation, lifestyle changes suggest adaptation. This comes at great cost; nuclear disaster survivors show increased stress and fear.
- **Big Picture:** Each scale of Japan has dealt with the events at different speeds and levels of efficiency, much like the different scales of Figure 1.

## Fukushima Nuclear Plant

- 2011 9+ magnitude earthquake in Japan's Tohoku region.
- Tsunami floods Fukushima Daiichi, causing reactor cores to meltdown (Wang et. al. 2013).
- Many evacuations from radiation still in place today, seven years later
- All 50 Japanese nuclear power plants temporarily shut down for safety inspections.

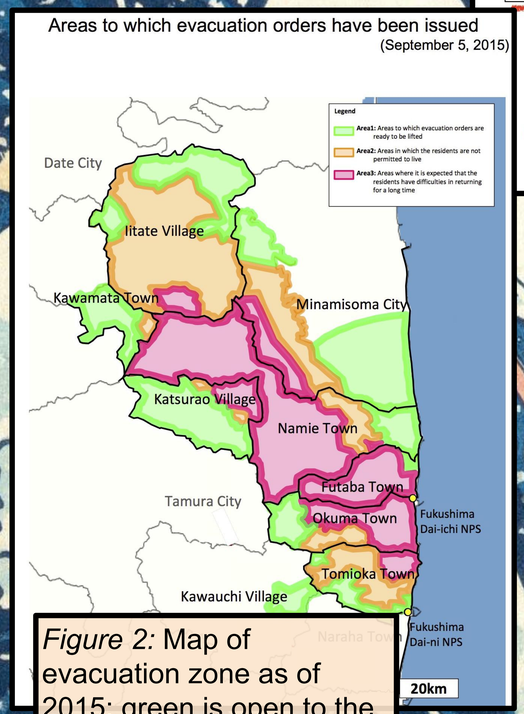


*Figure 2:* Map of evacuation zone as of 2015; green is open to the public.

## Implications

- Fukushima must push radiation disaster preparedness forward the same way that Chernobyl did. Research and surveys have already been established, but must continue through multiple decades because of radiation timeline.
- While adaptations have happened across scales in Japan, whether or not Japan has been resilient to the disaster is an agglomeration of answers like 'somewhat resilient.'
- Already there have been international shifts away from nuclear power, altering the context of alternative energy sources.
- Resilience should be measured across a spectrum because the dichotomy eliminates the possibility for the evidence to mean different things over extended spaces and time.

Benson, Melinda Harm, and Robin Kundis Craig. 2014. "The End of Sustainability." *Society & Natural Resources* 27 (7):777–82.

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Wang, Qiang, Xi Chen, and Xu Xi-chong. 2013. "Accident like the Fukushima Unlikely in a Country with Effective Nuclear Regulation: Literature Review and Proposed Guidelines." *Renewable Sustainable Energy Review* 17:126–46.

*Map*

Japan Ministry of Economy, Trade, and Industry (METI). 2015. *Areas to which evacuation orders have been issued.* http://www.meti.go.jp/english/earthquake/nuclear/roadmap/evacuation_areas.html