

Guidelines for Individual Homework 2: Fukushima Causal Loop Mapping

Background: The National Diet of Japan's Independent Investigation Commission regarding the March 2011 accident at the Fukushima Daiichi nuclear power plant concluded that while triggered by a combined massive earthquake and tsunami, the accident was a "profoundly man-made disaster that could and should have been foreseen and prevented." The plant was operated by the Tokyo Electric Power Company (TEPCO) and regulated by the national government's Nuclear and Industrial Safety Agency (NISA). **The cascading disaster of flooding, power loss, core meltdowns, hydrogen explosions, and widespread release of radioactive material** has been deemed the world's second largest nuclear accident, exceeded only by Chernobyl in 1986.

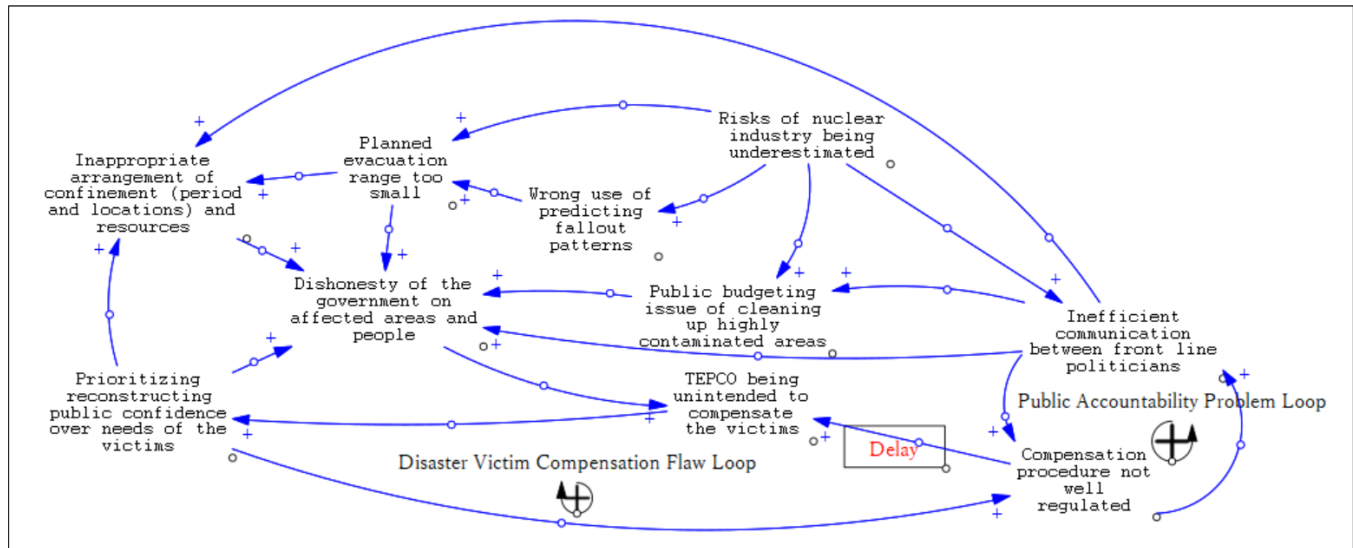
Objective: Your task is to construct a sparing yet powerful causal loop diagram (CLD) explaining how the causal interaction of root causes **raised the probability of the occurrence of the disaster**. You should not delve into the technical details of the immediate causes of the event (i.e., boiling water reactor design, valves, pumps, batteries, vents, etc.). Instead, focus on the causal interaction of deeper **structural, informational, cultural, political, institutional, and motivational reasons** (i.e., "the systemic rules of the game") that might account TEPCO's propensity for **risky policies and behaviors**, along with the associated **regulatory failures of the government**. Focus on the **accident and immediate emergency management response** rather than the longer-term struggles to stabilize the stricken plant, clean-up the damage, and compensate the victims.

Guidelines: As a reference for CLD construction, you will find Chapter 5 "Causal Loop Diagrams," from Sterman's **Business Dynamics: Systems Thinking and Modeling for a Complex World** on Canvas. This is a long chapter, but a very valuable one! Pay careful attention to Sterman's guidelines for CLD construction. Go to Fukushima folder in the files section of the Canvas page, which contains a variety of documents focused on the many causes of the disaster. Most of the information that you need to construct the CLD can be found in 1: the National Diet of Japan, 2: Funabashi and Kitazawa - A complex disaster and 3: Greenpeace "Lessons from Fukushima." Some additional supplemental materials have also been uploaded if you are interested, but don't get bogged down. As always, review the materials with a critical eye and consider the underlying objectives of the author/organization.

Avoid the temptation to construct a detailed, comprehensive CLD with dozens of variables. Instead, endeavor to identify no more than about **ten important root causes** likely to be **causally related to each other**. Your selected root cause variables for inclusion in your CLD should be nouns or noun phrases, not verbs! All the cause and effect action in your CLD will happen via your arrows. Follow CLD guidelines for variable names, causal arrows, assigning link polarity, determining closed loop polarity, naming your loops, and **identifying important delays** within your loops. Be sure to consider each pair of causally linked variables in isolation from all other variables in your CLD (i.e., holding all else constant, what is the nature of the causal connection between the two variables?). More information on CLD's can also be found in Chapter 9 of Ford's **Modeling the Environment**.

Deliverables: Your assignment submission should include your completed CLD (preferable created in Vensim but can be hand-drawn) and a concise description of **how two causal loops (closed sequences of cause and effect or closed paths of action and information) operating among root causes may have significantly contributed to the disaster (less than 2 pages of text plus references)**.

CLD



Description

Variables in the CLD above include insufficient preparation within the political and policy system, mistakes in engineering estimation and disaster prevention expertise, and poor government-civic relationship. Before the disaster could happen, flaws in prevention work implied of the happen of the severe damage. In addition to the technical inaccuracy of underestimated risks of nuclear industry, neither the evacuation and resource allocation procedure nor the disaster victim compensation regulation were thoroughly defined. However, the government kept hiding the truth from the public, worsening the situation of staying unaware of the tragedy from the government to the civic.

I first scoped “risks of nuclear industry being underestimated” because technical misstep along with the natural calamity was the source of this harm, following by multiple artificial failures. The underestimation of risks caused negligence in both emergency response and political system: software was not operated correctly to quickly obtain the correct value of evacuation range, which was planned too narrow to protect the affected residents and nearby workers from exposing to harmful radiation; miscommunication prior to the event and inefficient ways of communicating between front-line politicians resulted in delays in responding to the victims’ needs. While public servants paid little attention to the potential crisis, and thus conversations before and after the explosion were not effective, relative legislation was also under superficial examination. The public accountability was barely deployed, but the negatively reinforcing loop fortified the unconstructed statutes of protection and the mistake in political agencies to be unnoticed.

With little victim protection regulation in the laws, it provided a basis for TEPCO to avoid the responsibilities of compensation when the catastrophe happened. Complicated process, unapproachable terms, and long application documents were delivered to the victims, forcing some to skip fighting for their rights to live and for being protected.¹ The disaster victim compensation failure loop was then reinforced because without sufficient daily supply, victims were busy navigating ways to keep their living, and were not able to union and take powerful political actions such as demonstrating to better off their lives. They were so vulnerable that neither the private company, TEPCO, nor the local Japanese government were willing to prioritize the victims over their own interests. Workers from outside of the town were sent to salvage the emergency, while local medical personnel and essential employees were retreated, keeping the volunteer workers isolated in terms of backups. Inappropriate announcements of confinement, asylum, and resource allocation chain were then revealed, leading to an increase number of victims and lengthening the convalescence.

Another concern raised due to risk underprediction centered around budgeting of cleaning up highly contaminated areas. Since many sections of the preparation process were not done

Extension Permitted

comprehensively, the public budget was not proposed and approved adequately to cover all the actual damages to the environment, and thus to the individuals. TEPCO also faced financial difficulties repairing the disturbance.ⁱⁱ While both departments were incapable of making up the losses, the Japanese government remained dishonest to their people about the affected ones. The natural environment kept exposing to radiation, making it less and less suitable to plant and nourish the next generations of crops, livestock, wild animals, and human beings. Local economic system became more suffering after series of improper recovering work.ⁱⁱⁱ

The two causal loops indicate manual error of pre-planning in political and legislative systems. If the injury and loss had been taken more seriously than they were, regulations related to this emergency would have been structured better, and responsible parties would have burdened more of they should before the tragedy, expectedly with improved remedial plans for financial and personnel arrangement. If citizens had been prioritized because the public servants were aware of their duties of work, public accountability—one of the elements in democracy, would have been deployed, hopefully bringing feasible and affordable best-off groundwork for evacuation or confinement. With these assumptions, the causes were better, but not wholly, prevented.

ⁱ Greenpeace International. (Feb. 2012.) **Lessons from Fukushima.**

ⁱⁱ Fukushima Nuclear Accident Independent Investigation Commission. (2012.) **The official report of the Fukushima Nuclear Accident Independent Investigation Commission.** *The National Diet of Japan.*

ⁱⁱⁱ Yoichi Funabashi and Kay Kitazawa. (Mar. 2012.) **Fukushima in review: A complex disaster, a disastrous response.** *Bulletin of the Atomic Scientists.*