Calling on the Future to Assure the Mission: Downscaled Climate Model Data as a Decision-Making Enabler for Infrastructure Planners and Defenders

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Background/Objectives. Out of all things that could happen to the grid and other critical infrastructure assets, some of which have made their presence felt before and others possible but still hypothetical, the physical forces the planet is hurling at North American and global energy infrastructures are the most tangible and easily the most likely they get more disruptive and damaging year upon year.

History is replete with extreme weather events: tornadoes, hurricanes, nor'easters, ice storms, heat waves and droughts. In the US and elsewhere, electric utilities learned there was strength in numbers and built reciprocal relationships via mutual assistance programs so that equipment and linemen could be shared across town, state or province, or even national borders in times of great need. However, in the 2020s we're seeing storms and other events of such sweeping geographic magnitude and duration that even the best-intentioned and resourced neighbors may not have the ability to assist.

And recent events like the Texas freeze in 2021 and this year's heat wave that struck the UK and Western Europe demonstrated that our current infrastructures were not designed to operate in the current climate, let alone what's coming in the next five, 10, or 20 years. For example, in Texas, gas compression stations failed, wind turbines froze and a nuclear power plant had to shut down due to a sensor failure. And in the UK and Europe, two data centers had to cease operations because their HVAC systems could not keep up, and multiple nuclear plants had to power down as water intended to cool them was too warm.

As far as infrastructure protection is concerned, climate change-related challenges fall into two broad categories: mitigation; and adaptation and resilience. Other often-used words are sustainability and adaptation, where the former often intends to capture the full sweep of climate change-related activities including mitigation and resilience, and the latter speaks to changing social and technological policies or processes to sidestep the worst impacts. My work focuses almost exclusively on adaptation and resilience.

Whether it's an individual, a process, a system, a city or a military unit's ability to prosecute its mission, in a climate context resilience is the ability to endure harmful physical forces and maintain or return to an acceptable posture. It's more easily understood in the case of rapid onset and departure events like storms, floods, heatwaves or freezes that have a duration of days or weeks. Preparation, weathering the event, and recovery and restoration operations are the typical phases.

Slow onset events like drought, melting permafrost and sea level rise, with durations measured in years, decades, with no foreseeable end date, demand more radical measures, which demand adaptation in addition to resilience measures. Recent policies and programs of relevance are:

- Executive Order 14008, Tackling the Climate Crisis at Home and Abroad, signed 1 Feb 2021

- US Federal climate actions flowing from the EO, like the Department of Energy's Climate Adaption and Resilience Plan (CARP) and Vulnerability Assessment and Resilience Planning (VARP) guide
- The National Climate Adaptation and Resilience (NCARS) Act

While mitigation – the reduction of greenhouse gas emissions – is getting a great deal of attention and capturing the majority of funds allocated in response to the climate crisis, infrastructure adaption and resilience are not adequately prioritized at present. Without a means to identify and protect the most important infrastructure elements that undergird essential functions, key assets will begin to experience unacceptable impairment and, potentially, failure. My project aims to proactively address this challenge in ways that empower decision makers at all levels of government and industry.

Approach/Activities. What's proposed for discussion is an anticipated extension to DHS/INL's core All Hazards Assessment (AHA) interactive infrastructure interdependency mapping and analysis platform that layers in high resolution climate data and, in so doing, enables users to zoom in both spatially and temporally to understand what types of damaging or disruptive physical forces are due to arrive in the regions they care most about, and by approximately what year.

When built, this tool will offer sector-specific regional and more granular "lenses" that allow drill down by asset type and impact within a sector.
Examples:

- Electricity delivery -- Generation (coal, natural gas, nuclear, geothermal, hydro, wind, solar), T&D (substations & transformers, transition lines & distribution feeders, towers, etc.), control centers, energy storage (hydro, compressed air, battery, hydrogen)
- Water treatment – primary components for drinking water, wastewater treatment
- Floodwater - dams, levees, sea walls, nature-based (e.g., mangroves, bioswales, etc.)
- ONG -- refineries, pipelines, storage facilities, etc.
- Transportation -- ports, airports, roads, bridges, etc.
- Communications – data centers, cell towers, major fiber runs, etc.

A tailorable risk scoring system will allow for different foci: national security, regional economic security, public health, equity, etc.

This project is currently proposed as a FEMA Region 9 pilot for DHS funding and will have reached a decision point by the time ICR23 is help, potentially with some early findings we might share.

Results/Lessons Learned. The AHA platform is already in use by a variety of users to better understand the relationships between various infrastructure elements. And from those polled so far, as well as prospective others, there is strong interest in a decision support tool with the capabilities described above that layer in projected physical climate forces over time.