ASCE AMERICAN SOCIETY OF CIVIL ENGINEERS

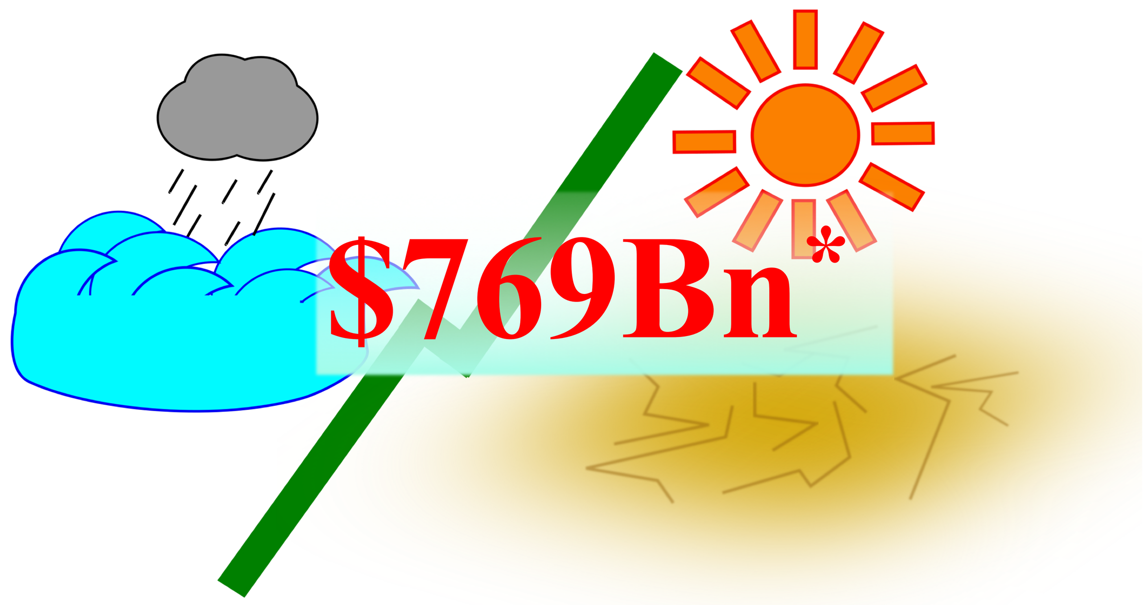
COMMITTEE ON ADAPTATION TO A CHANGING CLIMATE

Prioritizing Actions to Adapt America's Infrastructure for Climate Change

SUB-COMMITTEE ON FUTURE WEATHER AND CLIMATE EXTREMES

Mari Tye, Jason Giovannettone, Amir Aghakouchak, Ana Barros, Edward Beighley, William Capehart, Ellen Douglas, Noah Fehrenbacher, Robert Fields, Auroop Ganguly, Josh Huang, Laurna Kaatz, Ning Lin, Dagmar Llewellyn, Ben Lord, Karen MacClune, Rolf Olsen, Ariane Pinson, Costa Samaras, Ting Shi, Jay Snyder, and Farshid Vahedifard

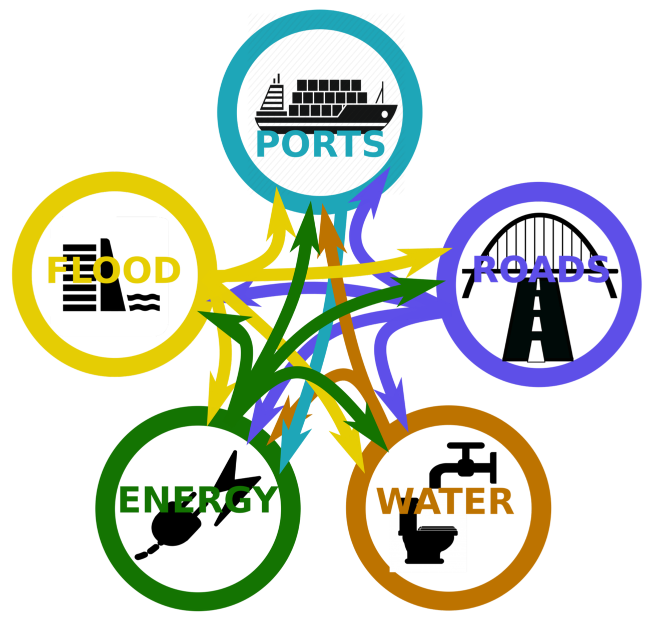
Extreme Weather



Losses in North America since 2010 from extreme weather events affecting critical infrastructure. **70% of which were preventable given adequate investment**.

* Source Munich Re 2019

Interdependent Infrastructure

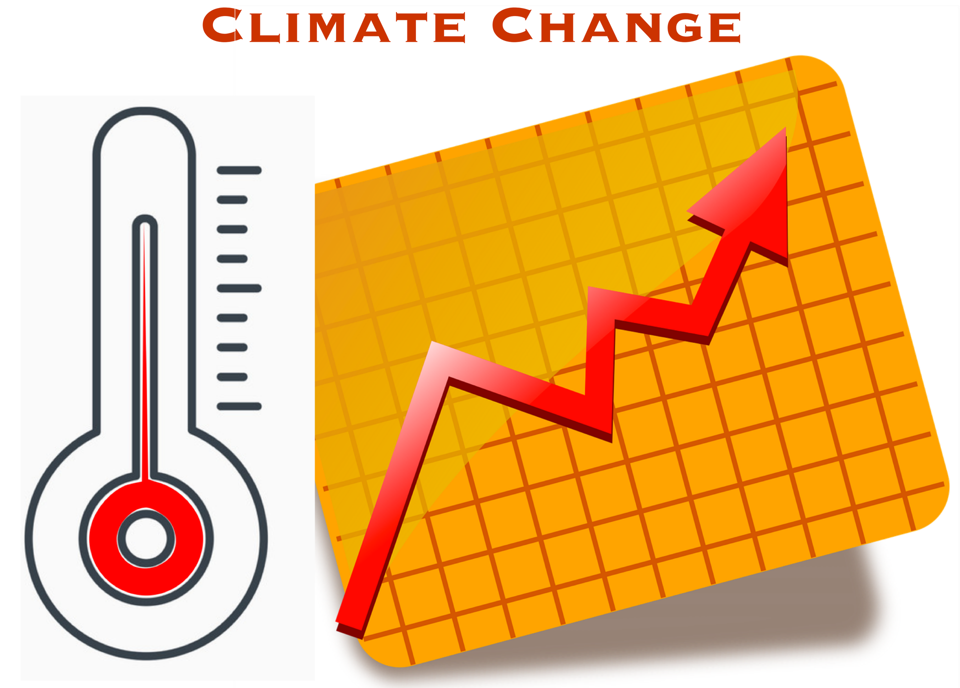


Increasing complexity and interconnectedness increases cascading impacts from infrastructure failure, increasing societal vulnerability and negatively affecting economies, education and health care among others.

Aging Infrastructure

Investment needed to bring USA's critical infrastructure to a state of good repair for **current climate conditions** and reduce impacts from events like Hurricane Harvey. Increasing resilience globally requires $10Tn investment.

Climate Change



Exacerbates weather extremes, increases infrastructure sensitivity through repeated exposure and reduces adaptive capacity as weather exceeds previous design standards. All leading to increased vulnerability.

Vulnerability Assessment

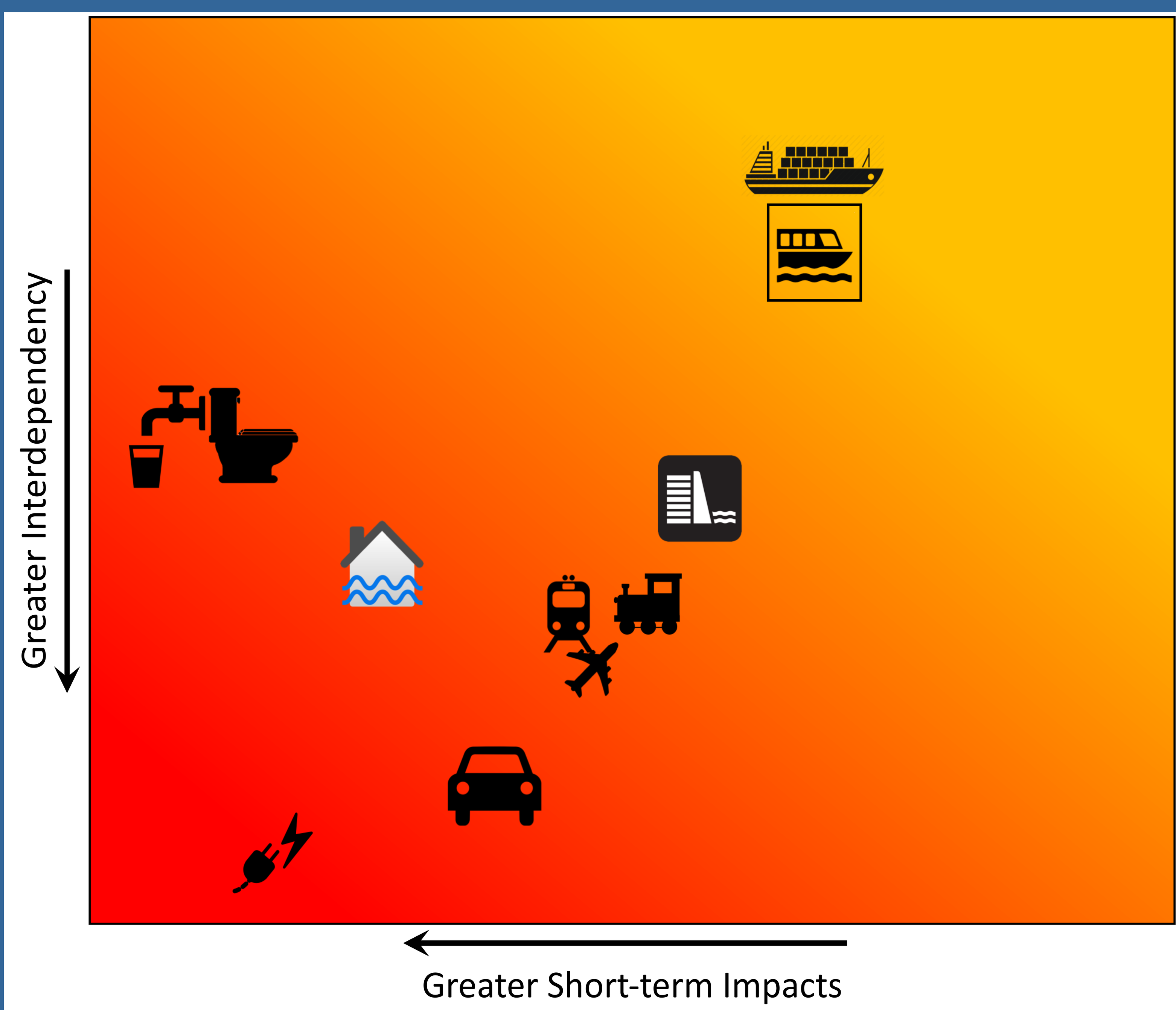
The **Energy** sector is ill prepared for the effects of climate change. Extreme weather will increasingly affect generation and transmission; demand will also increase significantly. The potential impact of failures is **extremely high**. While current resiliency is **adequate**, the adaptive capacity is **very low**.

Transportation is **highly sensitive** to the effects of extreme weather and climate change. The overall risk of failure and associated disruption and consequences are **very high**. Risk analyses are well advanced, but adaptive actions are **not**, and risk design lock-in or maladaptation.

Drinking Water and Wastewater systems are **highly exposed** to extreme weather and **highly sensitive** to future climate changes. The potential impacts of losses are **severe**. Current adaptive capacity is **adequate** and vulnerability is **moderate**, but will worsen in the future.

Water storage and Flood infrastructure are **highly exposed** to extreme weather and **sensitive** to climate change. Dams and reservoirs are **responsive** to current management actions but increased flexibility is needed. Vulnerability is **moderate**, but the impacts of failure are **severe**.

Navigation, Ports and Harbors are **vulnerable** to extreme weather and to the effects of climate change. Adaptive capacity is **low**. Dependence on supporting infrastructure means that consequences of failure are mostly **economic**.



Conclusions

1. All infrastructure systems are vulnerable to extreme weather, but the failure of some systems could have far greater consequences. Water, Energy and Transportation systems are considered "super critical".
2. Replacing end-of-life infrastructure is an opportunity to adopt emergent technologies, consider future climate risks, and increase redundancy.
3. The dramatic changes needed in planning, design, construction, operation and decommissioning require Interdisciplinary collaboration between engineers, climate scientists, policymakers, and other experts.
4. Collaborative research is needed to understand how climate change will impact specific locations, regions, and assets over different time scales.
5. Improved two-way communication is essential to address uncertainties in climate modeling and integrate these considerations into engineering and design.

White Paper due for release early January 2020 at www.asce.org