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European Space Agency

United Nations/Germany High Level Forum: The way forward after UNISPACE+50 and on Space2030

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“Multi-criteria approach for minimizing the space weather risk on critical infrastructure”

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Purpose of Work

Understanding and building resiliency to space weather risk requires the implementation of R2O process.

Research to Operations (R2O)

...intricacies of turning a scientific result into a forecasting model.

Analyses have clearly shown the monotonically increasing vulnerability to extreme events. There are a number of interrelated critical factors that have contributed to this increased vulnerability.



Catastrophic Events



Risk is the **potential for realisation of unwanted, adverse consequences** to human life, health, property, or the environment (Society for Risk Analysis)

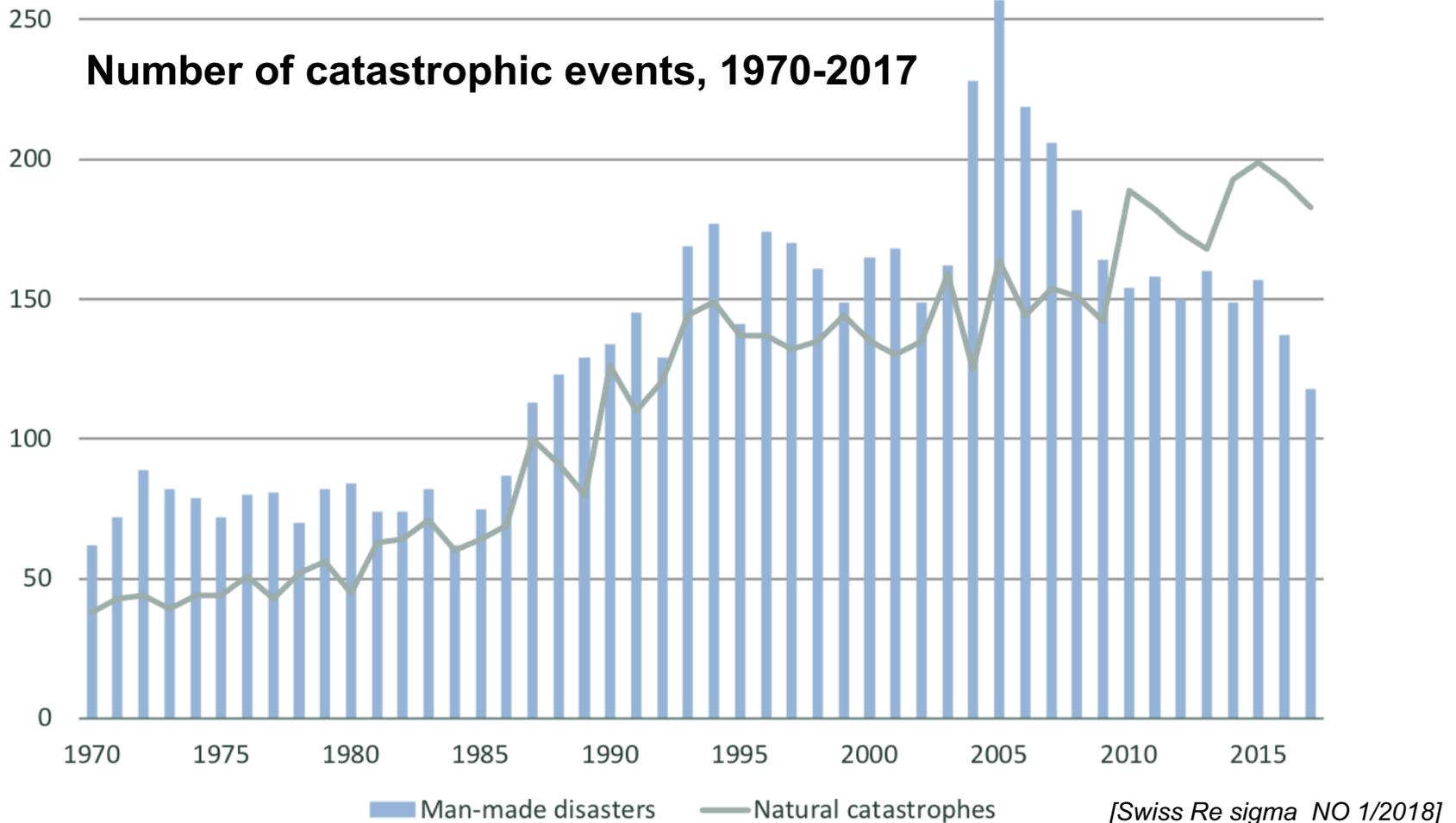
Sigma Swiss Re classifies an event as a catastrophic if it leads to:

- 90 million USD of economic loss;
- 20 dead or missing;
- 40 injured;
- 2000 homeless.



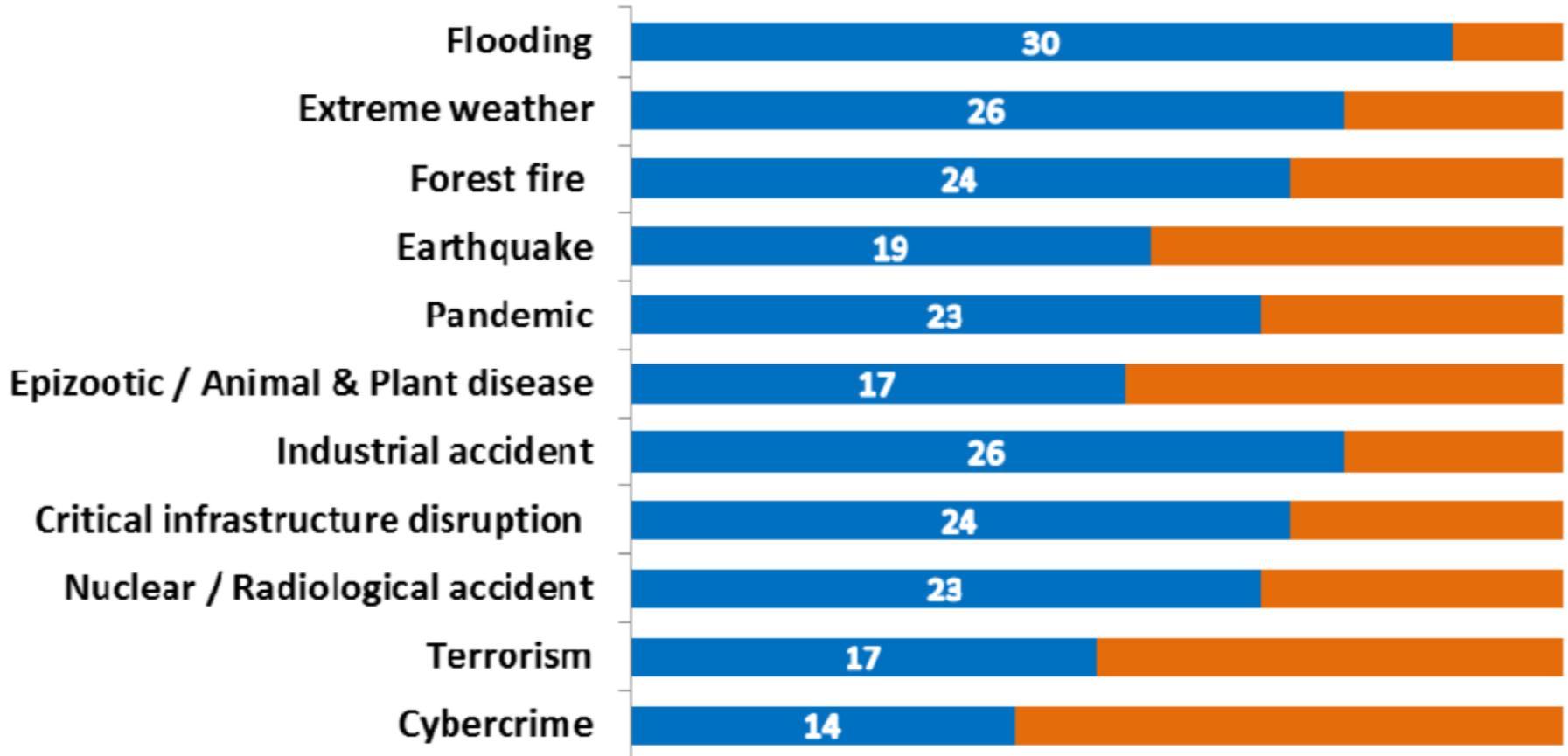
Catastrophic Events

Worldwide, the number of significant events has nearly tripled since the early 1980s.





National Risk Strategies



[European Commission report, 2017]



Space Weather Risk

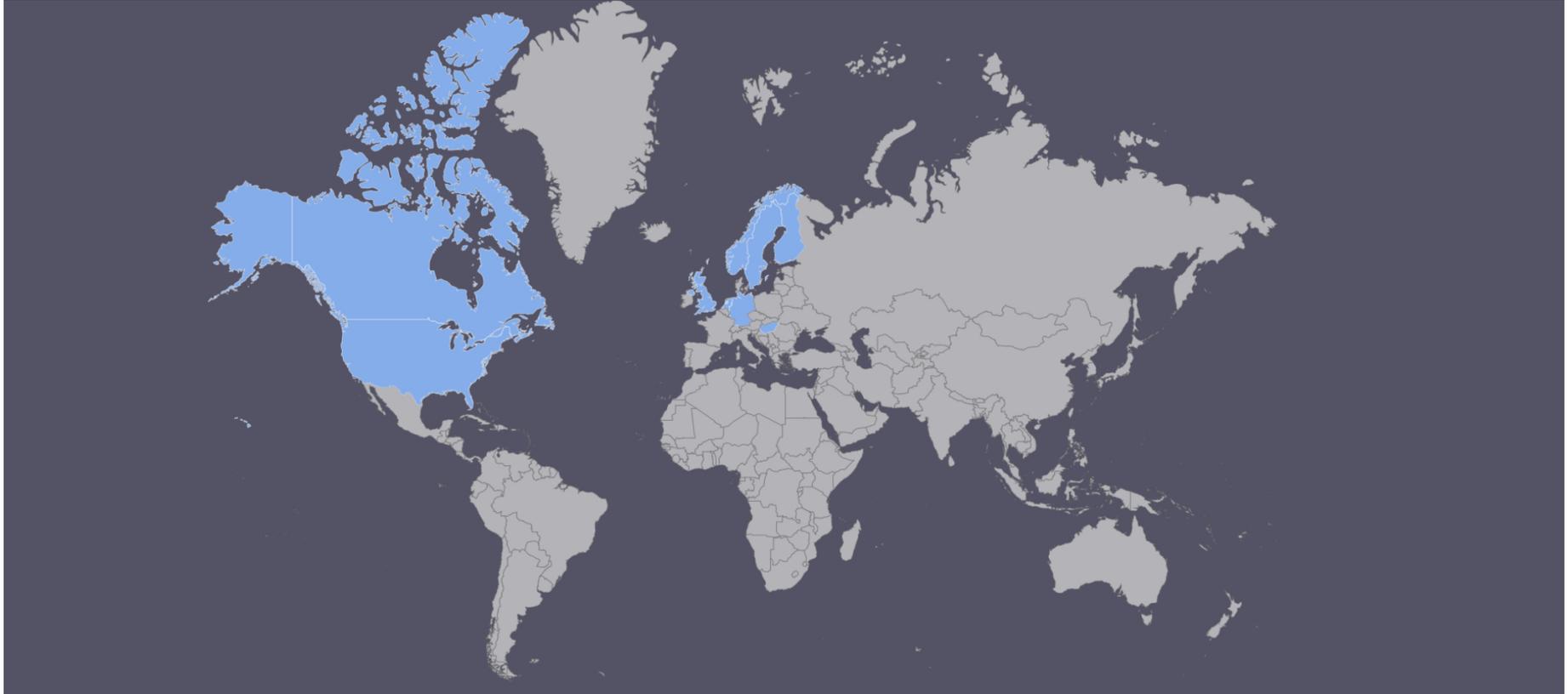


[lightwise / insurancejournal.com]

While evidence shows that space weather **is not a new hazard**, the severity of this meteorological hazard has increased with the emergence of technologies exposed to the threat.



Space Weather Risk

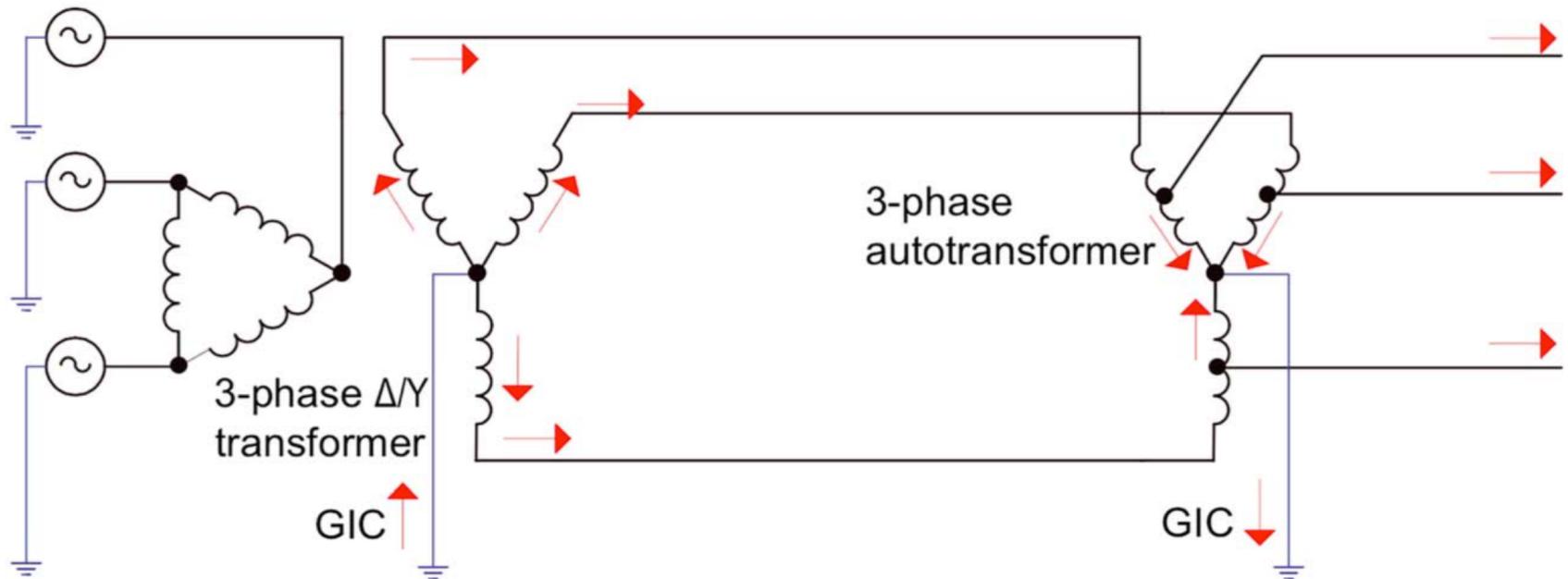


Countries who have adopted space weather risk in their national strategies:
US, CA, FI, SE, NO, UK, DE, NL, HU



Space Weather Risk

The principle of space weather impact on power grids

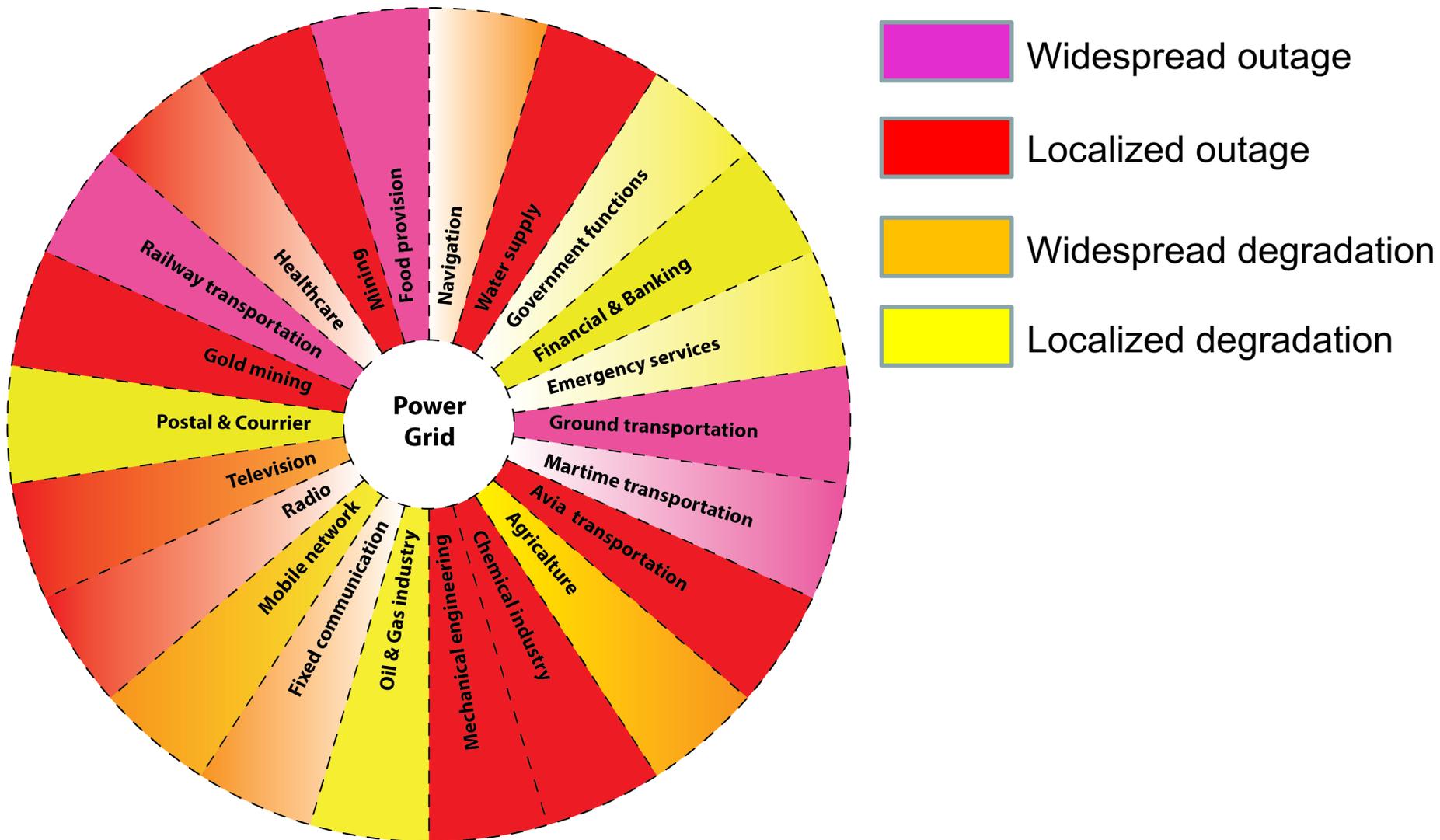


[Sokolova O. et al, AGU Space Weather 16, 2018]

GIC: Geomagnetically induced currents



Catastrophe Scenario



[Credit © Sokolova O.]



Time Frames

2-4 The propagation time for CMEs from Sun to Earth is about 2–4 days

0,75 The fastest known events exceeds 0.75 days (Schrijver et al., 2015)

0,5 Cabinet Office (2015)





Resilience

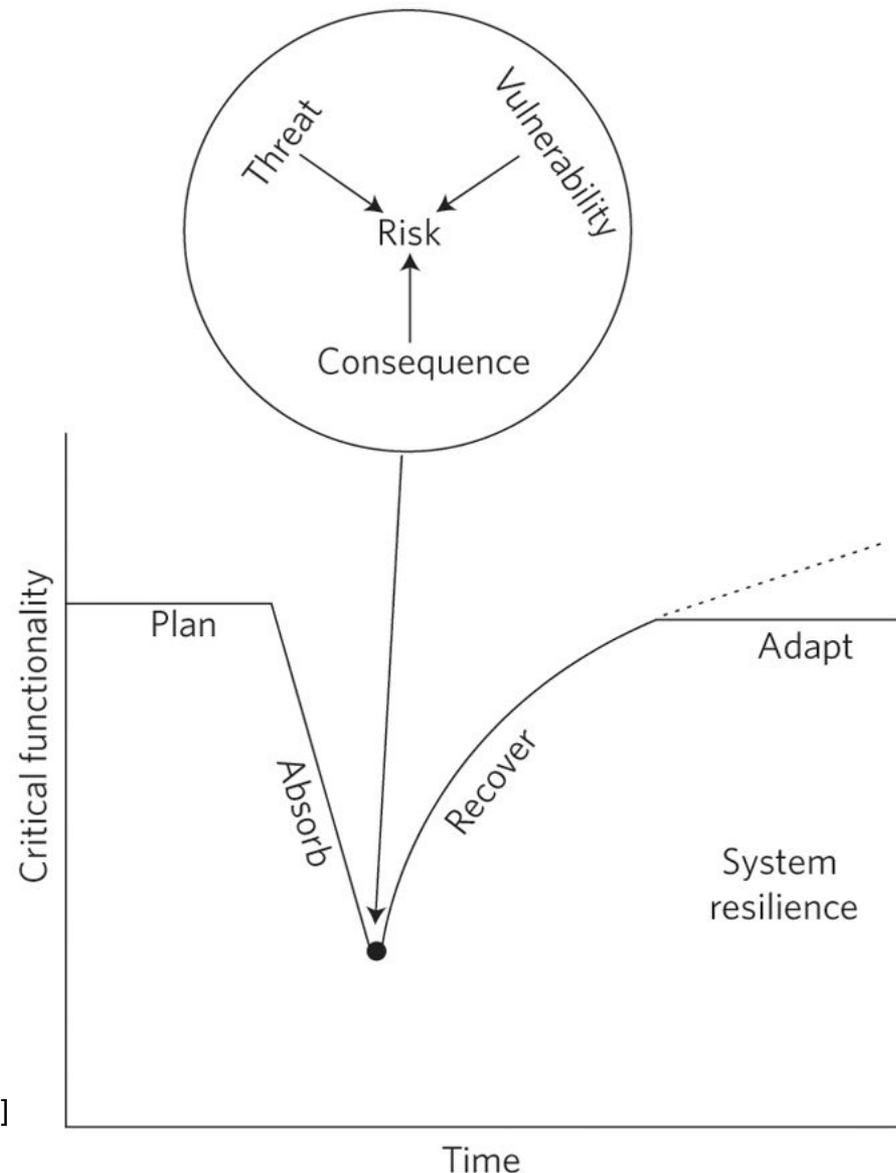
Resilience is the «magnitude of the disturbance that can be absorbed before the system changes its structure»

(Holling, 1973)

Resilience is the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events

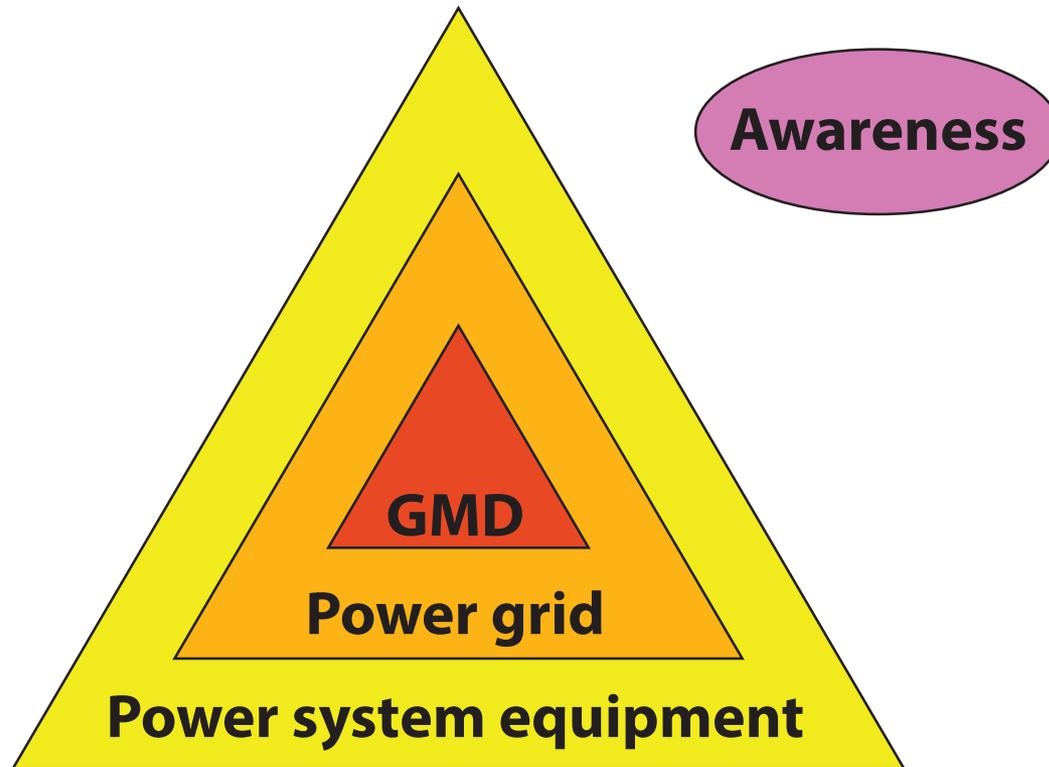
(National Academy of Sciences)

[Linkov et al., 2014]





Critical Factors



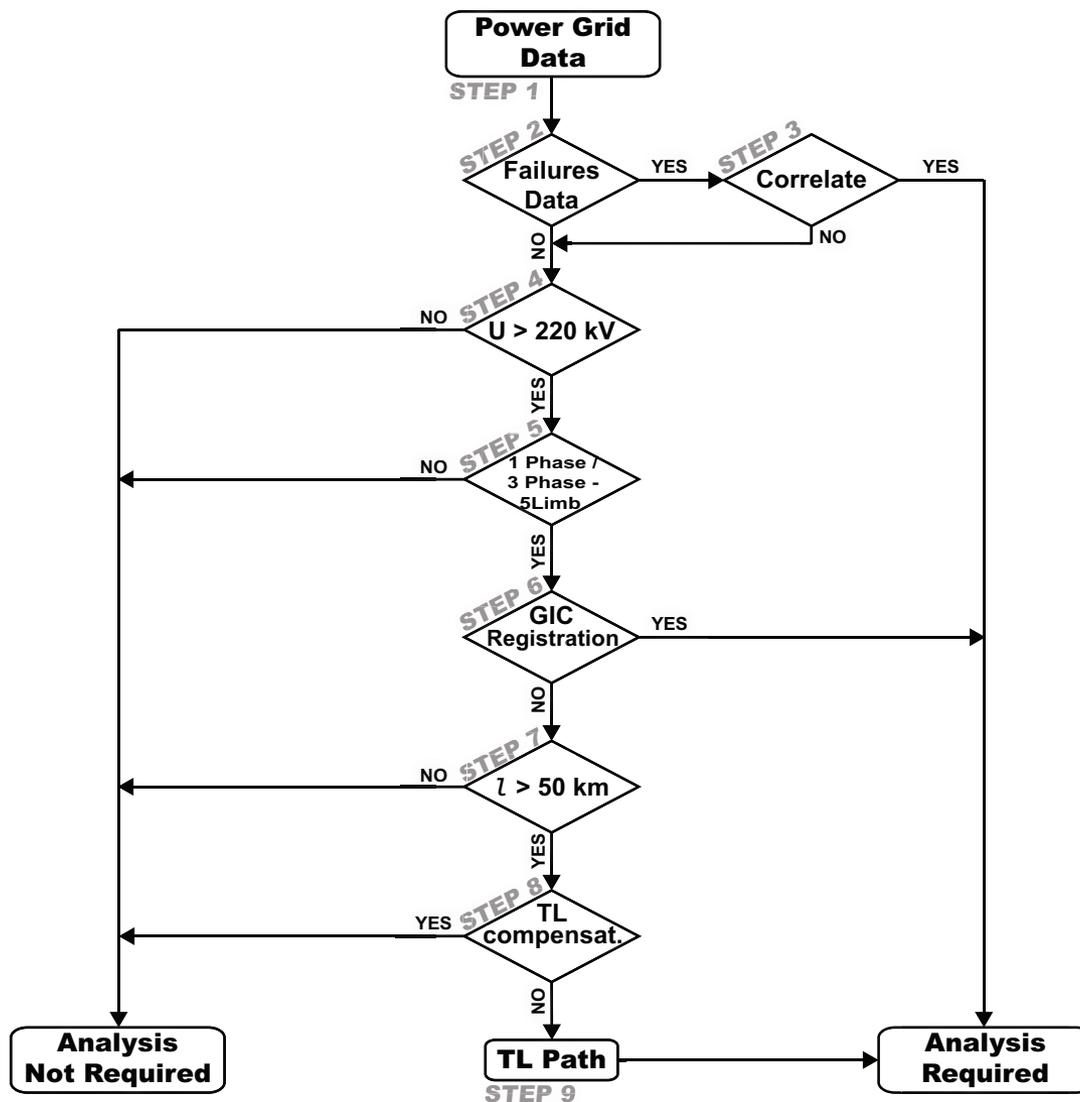
[Sokolova O. et al, AGU Space Weather 16, 2018]

It is an interdisciplinary problem!

the power grid robustness to space weather effects is determined by critical factors of different nature.



Algorithm for Power Grid Analysis



[Sokolova O. et al, AGU Space Weather 16, 2018]



Algorithm for Power Grid Analysis

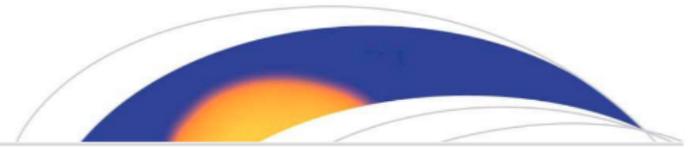




Reference Article

American Geophysical Union: AGU

AGU100 ADVANCING
EARTH AND
SPACE SCIENCE



Space Weather

RESEARCH ARTICLE

10.1029/2018SW001931

Key Points:

- Strength, duration, and impact of GMD on power grid are subject to uncertainty
- Novel algorithm for preliminary analysis of power grid's robustness to GMD is proposed and validated
- Even countries with medium and low GMD risk can benefit from preliminary evaluation

Algorithm for Analysis of Power Grid Vulnerability to Geomagnetic Disturbances

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Abstract Multiple power system equipment damage from strong geomagnetic disturbance (GMD) can significantly disrupt power grid operation. This has happened twice: in 1989, in North America and

<http://dx.doi.org/10.1029/2018SW001931>



Low Awareness Trap

Damage to reputation that results from **poorly managed critical incidents** can have **long-lasting and even permanent impacts on business.**



[National Geographic]



[theatlantic.com]

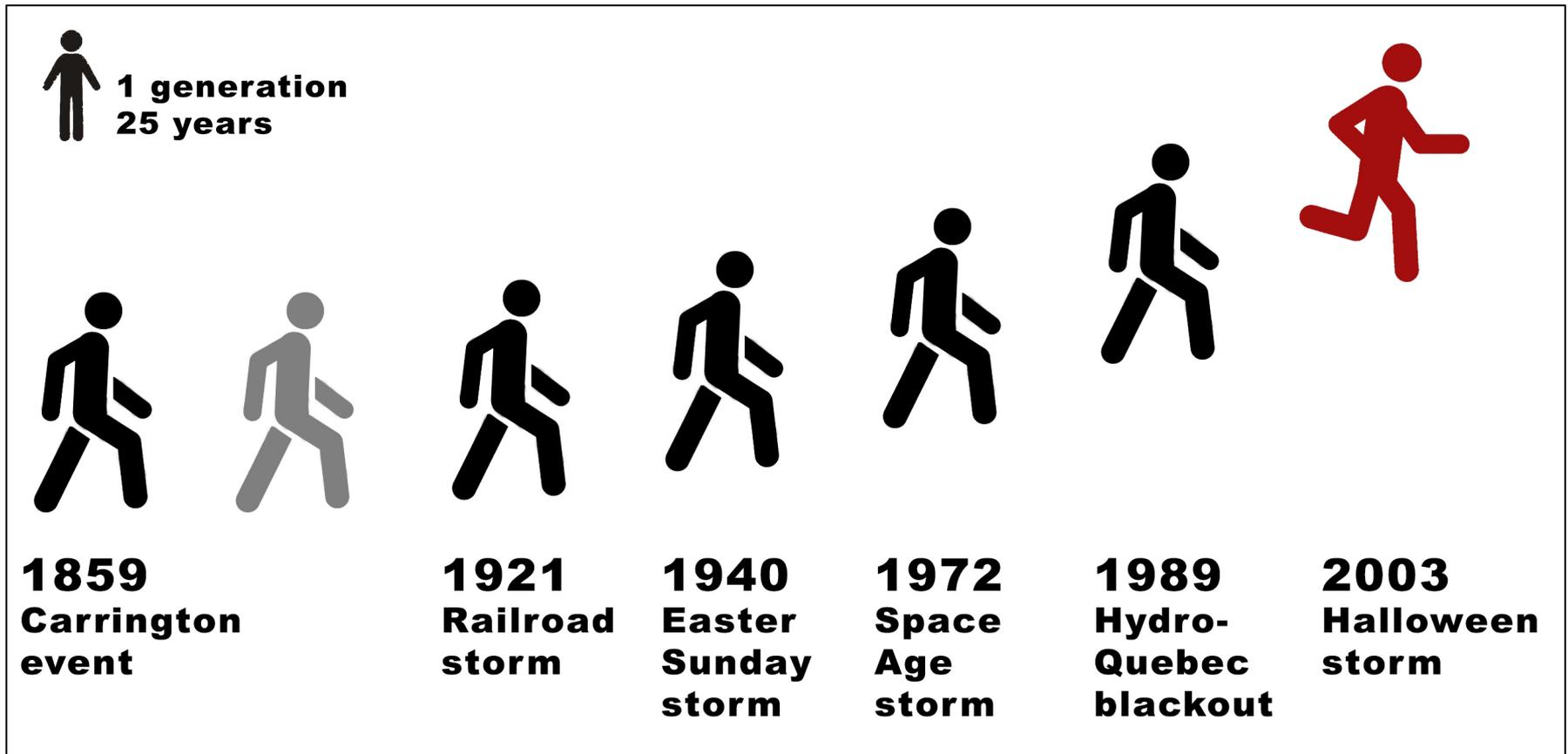


[National Geographic]



Low Awareness Trap

Registered solar storms over generations
(direct measurements)



[Credit © Sokolova O.]



Low Awareness Trap

G L  C A L

For the modern interconnected and interdependent societies **local** events have **global** effects.



Summary & Conclusion

- Rare events happen not as rare as we imagine!
- We tend not to prepare to them
- They have to and can be assessed using multi-criteria approach
- Even countries with medium and low domestic risk benefit
- We can mitigate their impact



Thank you for your attention!

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