Understanding and Managing Cascading Disasters
A Framework for Analysis

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Central Italy, January 2017: Connected Events

Rigopiano, 18 Jan. 2017

Campello, 24 Jan. 2017
Eyjafjallajökull - April 2010
Triple disaster in Japan March 2011
Cascading disasters
[crises, emergencies] are negative events that involve:-

• a primary impact (the trigger)
• chains or networks of consequences
• secondary impacts
• complex vulnerabilities interacting
• escalation points
• (usually) complex impacts upon critical infrastructure.
(a) C - cause
(b) E/C - effect
E/C - escalation points
Environmental triggers (if any)

Socio-Technological systems (macro level: e.g. globalization, technologies)

Socio-Technological systems (local/ regional level: e.g. culture, policies)

CAS and Critical Infrastructure

Impact and feedback

Source: Pescaroli & Alexander (2016)
Balancing vulnerability and resilience

- current knowledge about the concepts of vulnerability, threat and risk
- current knowledge about the concept of resilience
- human organisation in crisis situations
- gap analysis and resilience matrix
- interactions between resilience and vulnerability: theoretical model.
Intangible effects
heritage
e.g. museum -> artefacts -> restorers

Cascading escalation of secondary events

Triggering event

Direct effects:
functional nodes
- e.g. power plant failure -> lack of energy supply -> lack of water

Indirect effects:
autonomous hazards
- e.g. nuclear plant -> contamination -> CBRN training and dosimeters

Disruption of critical infrastructure

National response capacity overwhelmed

Request/offer international relief

Source: Pescaroli & Kelman 2016, JCCM
Simultaneous or successive extreme events

Background conditions amplify events (underlying risk drivers)

Climate change, Physical and statistical components

Global interdependency of human, natural and technological systems

Multiple risk assessment

Globalisation, Systems theory

Source: Pescaroli and Alexander, in review

Environmental drivers

Causality chains

Interacting Risk

Interconnected Risk

Compounding Risk

Cascading Risk

Disruption of critical infrastructure and tightly coupled organisational systems

Disruption of critical infrastructure

Tightly coupled organisational systems

Environmental drivers

Background conditions amplify events (underlying risk drivers)

Simultaneous or successive extreme events

Climate change, Physical and statistical components

Global interdependency of human, natural and technological systems

Multiple risk assessment

Globalisation, Systems theory

Source: Pescaroli and Alexander, in review
Magnitude classification of cascading incidents, crises and disasters

**Level 0 - Simple incident or major incident.**
No significant cascades or escalation points.

**Level 1 - Major incident of limited complexity.**
Simple, short cascades as secondary effects of the starting impact.

**Level 2 - Major incident or small disaster, some complex consequences.**
Limited cascade chains propagate to tertiary levels.

**Level 3 - Disaster, with complex consequences.**
Significant cascade chains with at least one escalation point.

**Level 4 - Disaster, with substantially complex consequences.**
Easily identifiable cascades with escalation points.

**Level 5 - Catastrophe, with overwhelmingly complex consequences.**
Major initial impact sets off long causal chains of cascading consequences, some of which through escalation points generate secondary causal chains.
Improving strategic level awareness of cascading risk

- from theory to practice: collaboration with London Resilience
- objectives: coordination of prevention; management and recovery of disruption
- two key areas: critical infrastructure interdependencies and power failures
- use of ANYTOWN model

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Aims of the study

- to support the actions of policy makers with better data
- to identify gaps and priorities
- to verify whether cascading risks and critical infrastructure interdependencies are sufficiently well addressed in multi-agency planning
- to increase awareness among senior stakeholders.
Preliminary results of a questionnaire survey (n=54)

- risk of cascading events perceived to be high
- could be connected to climate change
- cascading events involve significant risk of loss of life
- not sufficiently prioritised in policy and practice
- good levels of trust in contingency planning
- need to define thresholds ('tipping points') for decision making.
Mitigation

• mitigation needs integration of maps and strong inter-modal cooperation
• big questions remain about major issues (e.g. energy supply failure)
• some scepticism encountered about decision support systems (DSS)

Training

• training levels are better than expected, but need to be improved
• the best tools may be guidelines and table-top exercises.
Conclusions

• society is complex: all disasters of a certain size will involve cascades
• more investigation of operational components is needed
• in preparation: operational guidelines on cascading effects of power failures
• we need to understand how people behave in cascading crises
• inter-institutional dialogue needs to be increased
• we need to investigate more case studies.
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Special Issue:
Understanding and mitigating cascading crises in the global interconnected system
Thank you for listening!

www.ucl.ac.uk/rdr/cascading

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