



Building resilience capabilities to meet challenges induced by climate change

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I. Introduction

Climate change is identified as one of the main factors responsible for the rise of diverse natural disasters all around the world and points to a pressing need for the decarbonisation of the worldwide economy.

Natural disasters are causing severe damage affecting the lives of entire populations. In the past 30 years the number of incidents has tripled and the prediction is that this tendency will only increase.[1] Dealing with natural disasters constitutes a grand challenge for the diverse stakeholders involved in post-disaster management. First, some stakeholders (e.g., medical assistance teams, civil defence, firefighters) have to make decisions and take actions in the immediate aftermath of the disaster, that is to say, in a particularly complex context of uncertainty and urgency. The post-disaster scenario is characterised by unpredictable causal chains generated by domino effects. Second, once the crisis is over, other stakeholders (e.g., personnel of the State services, government staff) have to manage the long-term dynamics of the post-disaster recovery of the affected region. Consequently, natural disasters induced by climate change bring to the surface the issue of regional resilience. The latter involves the capacity to conserve vital processes in face of perturbations, and then to reconstruct and transform the region in a flexible manner, thus enabling learning, change, and adaptation. [2]

The pressing call for the decarbonisation of the economy is changing attitudes towards the nuclear industry. In the new context, nuclear energy appears to be a powerful contender to replace fossil fuels, or at least is becoming an unavoidable option from an energy-mix perspective, bringing to the forefront the question of «almost safe systems». The call for decarbonisation is also significantly changing other industries, such as the cement industry, called upon to replace fossil fuels. The massive use of secondary fuels instead of fossil ones becomes an urgent imperative. However, cement production sites are unprepared for such a rapid change, which makes the monitoring of their industrial processes more complex and riskier than usual. As a result, in many industries, including the nuclear and cement industries, managing safety becomes even more important. Safety management involves two forms of organisational safety: regulated and managed. While regulated safety relies on technical and procedural barriers to cope with predictable events and

is aimed at reducing uncertainty, managed safety aims to develop organisational capabilities to proactively deal with unpredictable events, and thus to deal with uncertainty. In other words, managed safety requires the development of resilience.

II. Defining resilience

In recent years the popularity of the concept of resilience has grown exponentially in the management literature aiming to address organisational capabilities to reach positive outcomes despite adversity. [3] In the case of natural disasters, adversity comes from disruptive events, which are unique, unprecedented, or even uncategorisable. In the case of nuclear power plants or other high-risk organisations, adversity refers to a context characterised by a constant exposure to potential accidents. In general, withstanding adversity relates to dealing with complex, ambiguous and uncertain situations. Because resilience is context-sensitive and multidimensional, it is defined as the capability to cope with unanticipated threats and to deal with unexpected events characteristic of complex situations. This capability depends on people's ability to make sense of what is happening around them and to develop appropriate customised responses for navigating the altered environment, [4] instead of applying pre-determined ones. Such capability refers to the concept of mindfulness characterised by focus on "the here and now" and both stable (focused) and vivid (producing rich interpretations) attention, which contribute to designing responses, which are tailored to real-time events. The development of the resilience capability involves three different stages: 1) the preparedness stage, consisting in training people to deal with uncertainty, i.e., to be mindful; 2) the proactive stage, involving the development of people's ability to be mindful and to learn from experience in order to deal with incubating threats; and 3) the reactive stage, involving the development of people's ability (a) in the short term – to manage the unpredictable causal chains immediately after the adverse event, and (b) in the long term – to learn from adverse events and to recover from disasters as well as to prepare for the future.

Notwithstanding increasing scholarly interest in the topic, many questions remain regarding the development of resilience capabilities in practice. More specifically, it remains unclear how resilience capabilities are built and how they relate to specific processes such as sensemaking, decision-making and learning. [5] As developed in parts II and III below, our Université Côte d'Azur (UCA) team is conducting research aiming at providing answers to these questions.

III. Building territorial resilience capabilities to deal with disruptive events

The UCA team is involved in two ongoing research projects on the development of regional resilience capabilities in the context of natural disasters.

The first project, IMPACT-A: Immediate Management Planning ACTion – Assessment, addresses resilience in terms of preparedness (stage 1) to cope with the unexpected in the case of disruptive events (natural disasters). Stakeholders who have to manage the event that just happened and its domino effects (unpredictable chain of causalities) have to be prepared to do it; they have to learn to be mindful, both individually and collectively. In other words, IMPACT-A addresses the link between training and mindfulness in complex situations. Its aim is both scientific and

managerial. From the scientific point of view, the objective is to provide a better understanding of the complex relationships between learning and mindfulness, which need further theoretical and empirical investigation. [6] From the managerial point of view, the objective consists in the evaluation and the improvement of the IMPACT module, in close collaboration with its designer, LCL F. Castagnola (Risks management training – Crisis management – Service Départemental d'Incendie et de Secours des Alpes Maritimes). The IMPACT module is an innovative training module, which enables individuals and groups to become resilient (mindful). It consists of an advanced training aiming at the development of cognitive flexibility and improvisation, i.e., a training that allows the participants to learn how to detach themselves from the existing interpretive schemes and procedures, to adapt to all types of events, including those related to natural disasters. In other words, the IMPACT module, which is offered in many countries all around the world, is a training in proactive resilience.

The aim of the second, PhD, project[7] is to better understand the process of building regional resilience capabilities in the post-natural disaster context. In this research, resilience is considered as the region's ability to recover from external shocks (i.e., resilience stage 3b). Due to the complexity of regional systems, building regional resilience capabilities requires inputs from many heterogeneous participants, with their diverse and complementary knowledge. These heterogeneous participants must interact and make a shared sense of the situation to collectively find innovative and lasting solutions. Even if there is a consensus that social aspects play an important role in building regional resilience capabilities, they are under-theorised in the literature. This doctoral project focuses on building regional resilience capabilities from an organisational, relational, and communicational perspective. The project is based on a comparative qualitative study of two regions devastated in October 2020 by Storm Alex (Alpes Maritimes, France). It contributes to the UCA Academy 3 FORESEE project.

IV. Building organisational resilience capabilities in high-risk contexts

The UCA team is engaged in three research projects on organisational resilience capabilities in high-risk contexts:

1) The **European Leadership for Safety** (ELSE) [8] project (see COP27 Contribution of Den Auwer et al.: Assessing the perception of nuclear risk) explores the process of the joint development of regulated and managed safety (resilience) and its underlying mechanisms. It is funded by the European Union through its Instrument for Nuclear Safety Cooperation (INSC) in cooperation with the International Atomic Energy Agency (IAEA). Its aim is to develop an innovative science-based approach to advanced education in the domain of leadership for safety, combining the most up-to-date academic knowledge and professional expertise.

2) The **Decommissioning: Management and Leadership for Safety Education** (DMaLSE) project focuses on organisational resilience capabilities at the scale of a megaproject. As many installations reach the end of their service life, governments, nuclear regulators, and operators are increasingly concerned with dismantling of nuclear power plants (NPPs). According to a recent report of the international consultancy agency, Deloitte, 56 nuclear facilities worldwide are currently in the phase of decommissioning and more than 400, including NPPs and research reactors, are expected to phase out by 2040. Decommissioning projects are confronted with a particularly high level of uncertainty due to their high complexity. They are highly complex not

only from a technical but also from an organisational and managerial perspective (i.e., in their design, planning and execution) as they involve the coordination of numerous interdisciplinary stakeholders over a very long period – typically 20 to 30 years – creating many safety challenges. Among the safety challenges, one concerns the development of organisational capabilities to manage complexity and uncertainty in megaprojects over a long period. DMAISE is in the final stage of negotiations to be funded by the European Union. Its main innovation consists in the development of a science-based approach to education on leadership and management for safety related to nuclear decommissioning. The Lead Applicant is Université Côte d'Azur and Co-Applicants are SKEMA Business School[9] and Karlsruher Institut für Technologie.

3) The **Resilience Capabilities in Dynamic Work Settings** (ReCaWS) project focuses on resilience capabilities at the scale of operational teams. It is conducted in a cement plant faced with the imperative of decarbonising its activity. The study context is the cement plant manufacturing department where operational teams operate in an unpredictable, dynamic, and complex task environment. The manufacturing process, especially its combustion stage, is not programmable or predictable. It is a complex physical phenomenon. As in all cement production sites, the complexity has increased significantly as a result of rapid and continuous changes, mainly consisting in the new and massive use of alternative fuels, which create new emergent and unpredictable chemical reactions. In this context developing resilience capabilities becomes essential. Building individual (operators') and collective (teams') mindfulness, and developing mindfulness capabilities through learning appear the most challenging. The first results of this research project provide theoretical contributions on the barriers to learning and thus on the complex links between learning and mindfulness. They also provide practical contributions on how to create the conditions that foster operators' and teams' resilience capabilities in dynamic work settings. These results have been published in a ranked journal[10]. The next step in this research project will involve a comparison between organisations operating in two different risky industries, a nuclear power plant (high-risk context) and a cement production plant (less risky context) with a specific focus on learning and mindfulness.

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