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Implementation Case Study

# Art-Science Fusion to Enhance Community-Building and Societal Resilience to Water-Related Disasters

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**Abstract** Climate change is intensifying water-related disasters in Europe, exposing critical gaps in prevention, preparedness, and public awareness. Recent flood events revealed that despite scientific warnings and EU-level monitoring systems, insufficient communication and weak "risk culture" at local levels significantly increased human losses and societal impacts. While EU policies and research programs address disaster risk, a persistent disconnect between scientific knowledge, policy implementation, and local communities limits their effectiveness. The article argues for a more integrated and inclusive approach to disaster resilience, emphasizing improved science–policy interfaces, better coordination among stakeholders, and stronger knowledge transfer to citizens. It highlights the potential of combining science with arts and cultural practices as an innovative way to enhance communication, raise awareness, and foster emotional engagement with risk. By leveraging diverse artistic expressions and digital tools, this approach can make scientific information more accessible, strengthen community participation, and support social inclusion. Ultimately, the proposed "art–science" model aims to build a stronger culture of risk awareness, improve disaster preparedness, and enhance societal resilience, aligning with EU cultural, environmental, and resilience strategies while contributing to public well-being and mental health.

**Keywords:** risk culture, societal resilience, governance, arts and sciences, climate change, water-related disasters

## 1. INTRODUCTION

The way societies respond to disasters depends heavily on the risk culture that local communities have acquired through education and/or sometimes dramatic experiences (Duca

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& Gugg, 2023). This culture is closely linked to social inclusion, societal resilience, and the level of knowledge that people can acquire from factual information (Agrawal et al., 2020). However, this information rarely reaches the local level due, on the one hand, to scientific communication that is often poorly adapted and, on the other hand, to a lack of priority given to risk culture by individuals (van der Linden et al., 2015). Using arts to improve risk awareness is an innovative way to raise public awareness and, consequently, societal resilience to disasters, by opening people's eyes and hearts to realities that are too often ignored (Davies et al., 2019). In recent years, the increase in extreme weather events has had a growing impact on towns and cities, large and small, causing serious concern within societies. Scientific research is very active in this field, linking various disciplines and sectors, but it generally neglects the citizen dimension and local authority levels (United Nations Office for Disaster Risk Reduction, 2015). This is mainly due to the difficulties in transferring knowledge that would strengthen societies' resilience to risks (Quevauviller et al., 2026). Innovative means are needed to improve communication, awareness, and education, and to strengthen disaster preparedness. The use of arts as a vehicle for citizen engagement is one such method; in particular, various artistic expressions may be used to help change the "culture of risk" associated with climate change, with a focus on vulnerable populations, especially the elderly, children, and people with disabilities.

Restoring human beings to a prominent role in managing their own resilience is an issue that has been the subject of research around the world for the past decade. This need has reached a peak with the COVID-19 crisis, and it is only recently that psychological trauma resulting from disasters has been fully integrated into EU research programmes, for example, in the "Civil Security for Society" programme (Horizon Europe). The challenge now is to find ways to reach citizens through different means of communication. One such means is to reach people on an emotional level, and arts are a very effective vehicle for achieving this, i.e., visual, performing, and literary arts (see Section 5). Growing empirical evidence within the scientific community indicates that artistic communication is a highly effective strategy for engaging individuals who have suffered in disasters and other traumatic situations. While knowledge about societal resilience is advancing, as illustrated in a recent report on a range of EU projects (Clark et al., 2025), engaging citizens and local authorities remains a major challenge that cannot be met by scientific research alone.

## 2. RISK CULTURE AND CITIZEN ENGAGEMENT

The world is increasingly facing water-related disasters, some of which are occurring with new intensity and characteristics in Europe due to climate change (European Commission, 2024). Recent dramatic flash floods, such as those that hit Belgium, Luxembourg and Germany in July 2021, and more recently Spain (particularly Valencia) in October 2024, have shown that the consequences in terms of human losses were largely due to a lack of prevention and preparedness, and above all to insufficient awareness of the risks among the population. Although scientific warnings were issued before each event through the European Flood Alert

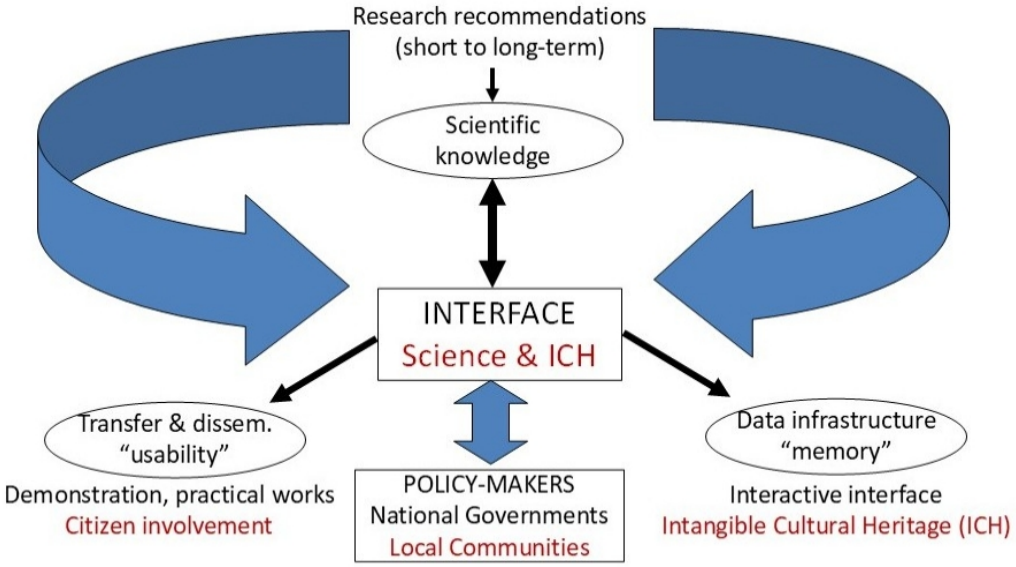
System (EFAS) and early warnings from research projects such as the Horizon Europe GOBEYOND project, they were not taken seriously enough by the local authorities, who failed to inform the population in a timely manner. This lack of knowledge transfer and 'risk culture' cost lives. In addition to the psychological trauma suffered by the population, the consequences of these tragedies continue to be felt in urban reconstruction, which must be carried out in fear of unknown risks. The lack of adequate communication at the local level has a direct impact on the resilience of society.

EU sectoral policies, e.g., the Floods Directive (European Commission, 2007) or coordination mechanisms, in particular the EU Civil Protection Mechanism (European Commission, 2013), regulate disaster prevention and response measures, but the level of public alertness and awareness in Europe is not adequate for contemporary extreme weather events, ranging from torrential rainfall to prolonged droughts. However, efforts are being made to develop "holistic" approaches to disaster preparedness, as illustrated by the EU Preparedness Union Strategy (European Union, 2025). With regard to EU research and innovation in the field of disaster risk studies, the situation is even worse. There is a significant gap between applied research results and their implementation/uptake at regional or local levels. The networking of key stakeholders, including policymakers, scientists, first responders, SMEs/industries, and civil society representatives, is actively developing through various projects and networks. Some projects face difficulties in involving citizens. In many cases, knowledge transfer fails to reach the local level—comprising both the general population and local authorities—which represents the most critical tier for building societal resilience.

Research programming within the European Union considers topics that are aimed, among others, to respond to policy and societal needs. This has been the case in water- and climate extremes-related hazards (Quevauviller, 2010, 2011) and more generally to a range of disasters in the framework of Horizon2020 and Horizon Europe programmes (Quevauviller et al., 2026). While the principle of designing research programmes that may match policy needs is well recognised, the practice may be faced by some drawbacks, e.g., research projects may be designed according to clear technical specifications which may not anticipate the outcome and orientations of political decisions regarding specific policies (e.g., which were not defined at the starting time of the projects). As a result, some research outputs fail to transition into concrete policy developments, rendering their potential to improve societal resilience unrealized. Another drawback is the insufficient coordination among different actors, which often hampers a full integration of scientific inputs from research projects into policy discussions. This is often linked to the lack of a clear "science-policy interface" mechanism (Figure 1).

Figure 1 stresses the siloed nature of science and policy (including advisory and response mechanisms), which are discipline and sector-specific. This generates hurdles for cooperation including trust dynamics, epistemic fluency, and data interoperability (Ward et al., 2026). Interactions among policy and scientific communities are indeed rarely coordinated in a systematic way and are rather functioning on *ad hoc* basis (based on links among "individuals" rather than "institutions"). On the other hand, various policy departments have different formal and informal contact points coming from numerous research and "policy" communities with

discrete interests. These communities are often also competing internally (e.g., competition within the research community, or between responsible national authorities or local risk




managers), which creates an obstacle in the pursuit of effective collaboration.

**Figure 1**. Needs of interface between science and policy (adapted from Quevauviller, 2010, and Quevauviller et al., 2026)

While this issue is obviously reflected in a wide range of disasters (natural or man-made), this article focuses on water-related disasters, such as floods, droughts, storms, and tsunamis, and on the need to find ways to strengthen the links between disaster resilience, vulnerabilities, and risks through new dynamics, including diversity and inclusion, in order to reduce vulnerabilities. This requires innovative approaches to improve communication, awareness, and education, and strengthen disaster preparedness. Arts can be innovative vectors for co-creation to address these issues by reaching different people, leveraging diversity, and practicing inclusion. The combination of arts and sciences can produce unexpected advances. Leonardo da Vinci taught us how to combine knowledge and creativity. Current advances also stem from a hybridisation of established fields through cross-fertilisation that "humanises" scientific fields. Scientific researchers share with artists a blend of imagination, creativity, emotions, and discoveries that they wish to share. Arts have often been used as a vehicle to better communicate scientific knowledge, and the role of scientific and operational actors (e.g., first responders) in risk communication may be directly linked to their ability to engage in the arts. In this context, many scientific disciplines can be considered part of the cultural and creative sectors (CCS), and there are examples of departments merging art and science in academic and entrepreneurial sectors that are not necessarily purely artistic organisations, for example, the Integrated Arts and Sciences for Disaster Reduction research group at Kyoto University in Japan.

Faced with this need to reach populations in more innovative ways, scientific initiatives seek to develop a culture of risk awareness regarding natural and technological hazards, particularly to raise awareness of disaster risks and improve preparedness (Clark et al., 2025). However, in

many cases, societies around the world are not equally well prepared to deal with disaster risks. This is an intergenerational, cross-sectoral, political, and strategic issue, and factual information about risks is essential to strengthen societies' resilience to disasters. However, this information must be presented in an understandable way! These needs are recognised not only at the scientific level, but also at the political level, as evidenced by the (non-binding) recommendations made in the above-mentioned EU Preparedness Union Strategy framework.

An innovative way to improve knowledge transfer could therefore be to tap into the artistic fibres of scientists to create communication channels that break new ground (Quevauviller, 2025). Using the arts to improve the transfer of scientific knowledge to policymakers at all levels, with an emphasis on education, awareness-raising, and disaster preparedness, is part of a "whole-of-society approach". The key to this improved communication is to evoke emotions that will pave the way for more risk awareness than, for example, scientific debates. Picasso once said (Zervos, 1935), 'The artist is a receptacle for emotions from everywhere: from the sky, from the earth, from a piece of paper, from the work of a spider.' The idea is therefore to use art's ability to open emotional doors to transfer scientific knowledge that has a direct impact on health, given that access to culture is a determining factor in psychological well-being (European Commission, 2018).

A recent interview (France Inter, January 2025) with the French Academician Erik Orsenna highlighted this link between art and science in relation to water-related risks. He said: "*First, we must understand. To understand, we must explain. To explain, we must marvel. To marvel, we must tell stories, and only then can we raise awareness. I challenge scientists by saying: just because you know something doesn't mean it's enough. On the contrary, as there are more and more alternative truths today, you must inspire people to marvel, and that's why the arts must take over from science!*"

There are numerous examples of initiatives combining art and science, particularly in the fields of art, creativity, crises, and disasters (see some examples cited in paragraph 4 of this article), disaster-related research (e.g., The Hut project[2]), exchanges between scientists and local communities through 'philosophical cafés' (e.g., the Japanese approach cited in section 5), etc. The innovation lies in combining different scientific disciplines related to hydrological disasters in order to develop new modes of communication in the field of disaster-related sciences through the ten arts (see section 5). In addition, an essential art form not classified here is the one evoked by Brazilian poet Vinicius de Moraes in the song *Samba da benção* (composed by Baden Powell) and covered by Pierre Barouh in his adaptation *Samba Saravah*: Life is the art of encounter (*A vida é a arte do encontro*). This art form is found at the crossroads of humanity and reflects the spirit of encounter essential to both art and science. This is clearly emphasised in the objectives of the new European agenda for culture, which highlights the fact that cultural participation brings people together and, beyond that, that culture is an ideal means of communicating across language barriers, empowering people, and facilitating social cohesion, including among vulnerable populations. This blend of scientific and artistic

[2] The Human-Tech Nexus – Building a safe haven to cope with climate extremes (Horizon Europe project The Hut) - https://thehut-nexus.eu/

disciplines in the service of a strengthened "culture of risk" can benefit greatly from digital tools, both in creation and dissemination. In a way, if there are "applied sciences," it is conceivable to systematically associate them with "applied arts."

## 3. ART AS A SUITABLE TOOL TO IMPLEMENT SCIENTIFIC KNOWLEDGE?

A general trend in knowledge transfer is to involve different stakeholders in the co-production of scientific knowledge, moving away from a top-down dissemination approach to participatory practices. This goes hand in hand with the fact that Community resilience is increasingly perceived as a collective capacity to adapt and learn, rather than a static outcome. In this context, this trend opens a theoretical opening: Art might become not just a communication tool but a mediating practice that would enable co-production of knowledge (Leavy, 2015). This has been recognised by first responders; for example, the French Society of Disaster Medicine (SFMC) recently produced a practical guide for citizens about how to behave in the event of crises, conflicts and disasters (Bertrand et al., 2026), which explicitly references the role of the arts in reinforcing a culture of risk. Another example, this time bottom-up, is an initiative by an art photography collective (Collectif LesAssociés, 2025) that captured images of wildfires in the South-West of France in 2022; these images were exhibited in municipalities alongside public debates regarding risk prevention and preparedness.

There are many examples of such initiatives, yet the purpose of this paper is not to make an extensive review of them; rather, it highlights that the arts may be used to enable affective ways of knowing—generating emotion as discussed below—in bridging artistic expressions and lived disaster-related experiences. This may stimulate a form of "transformative learning" supporting new human-environment relationships (Mezirow, 1991; Lawrence & Cranton, 2009; Bolden et al., 2024), and alternative knowledge systems that are too often marginalized in scientific discourses. Tensions may indeed arise between the scientific rigor and measurability and the artistic openness and ambiguity / subjectivity. Art also represents an element of public pedagogy, creating spaces for education, dialogue, and collective meaning-making and enabling knowledge exchanges across generations and cultures (Hannigan et al., 2025). It hence has great potential not only to communicate science but also to play a societal role (Heines et al., 2024).

A growing body of literature shows that participatory art has a positive impact on community cohesion and trust. It strengthens local identity and collective memory and transforms public spaces into sites of interaction and learning (Ke, 2025; Fancourt & Finn, 2019). In addition, public art may foster citizen engagement, which is a key component of resilience. This may have a direct impact on governance and decision-making, as citizens may become co-creators rather than passive recipients, thus enhancing democratic participation and policy feedback loops in a cross-disciplinary and cross-class collaboration fashion. Art may also have an impact on psychosocial resilience (Tamborrino, 2025). It provides symbolic frameworks to process trauma, supports collective meaning-making, and strengthens social bonds and shared narratives.

## 4. A NEW APPROACH

Eric Orsenna published an educational book concerning the "future of water" addressed to a large public (Orsenna, 2008). He argues that an innovative approach involves boosting enthusiasm (and wonder!) for scientific communication to raise awareness about water-related disaster prevention and preparedness among local communities in a structured way, using various forms of artistic expression. This could materialise as original artistic creations spanning the ten arts, aimed at gathering knowledge about water-related disasters and reconstruction through the collaboration of various artists, scientists, local authorities, first responders, and representatives of populations affected by climate disasters, while concurrently sharing testimonies about past events. This approach goes along with various policy priorities such as the EU Work Plan for Culture 2023-2026, the European Green Deal, the EU Preparedness Union Strategy, gender equality and social inclusion, and the digital transition. It also supports other policies in the field of disaster resilience related to anticipation and preparedness, the United Nations "Leave No One Behind" initiative (SDG 11b), and the Sendai Framework for Disaster Risk Reduction to establish a broader, human-centred approach to disaster risk management, including reducing human and other losses.

In this regard, a new approach would consist of exploring scientific and artistic disciplines as well as innovative artistic developments to enhance risk culture and societal resilience. Its objective would be to strengthen enthusiasm for scientific communication in the field of disaster awareness and preparedness by addressing local communities in a structured manner using various artistic expressions. In other words, the approach would aim to develop an innovative way of linking art and science based on original creations, with the support of digital media, to raise awareness of disaster risks and preparedness. This approach, combining art and science, would bring together different actors and representatives of vulnerable populations, thus contributing to social inclusion and societal resilience. Different art forms can be used to reach those most affected, for example, by establishing a dialogue with citizens through "philosophy cafés", allowing them to express their emotions through visual arts or music, breaking the isolation of marginalised people, including locked-down children and young adults, using digital means of expression and creation, etc. This mixed approach, which focuses on diversity and inclusion, can raise awareness, enable people to regain confidence by better understanding the risks, and, as a result, strengthen societal resilience. Overall, such an approach would contribute, through cultural activities, to the health and well-being of people affected by the effects of disasters, with a particular focus on the mental health of young people.

The idea is not new. In a spirit of promoting beauty, creativity, and inclusion as a means of improving society, the new European 'agenda for culture' emphasises the need to strengthen resilience in and through culture and calls for the development of a new model of cultural governance to address societal challenges in a holistic manner. This includes exchanging knowledge on innovative artistic and cultural approaches to addressing the climate crisis, thereby helping transform behaviours to mitigate its impacts.

This awareness of a strengthened 'culture of risk' also corresponds to several objectives of the EU Work Plan for Culture 2023-2026 (European Council, 2022), notably through the following contributions:

- Strengthen the cultural and creative sectors using digital tools and the increased creative dimension of video games, as well as the green transition.
- Strengthen cultural participation and the role of culture in society by promoting culture in EU policies and the democratic process that led to those policies.
- Unleash the power of culture by integrating it as a means of risk communication, particularly with regard to extreme weather events, and by preserving heritage (intangible and tangible) against natural and man-made disasters; and
- Strengthen the cultural dimension of the EU's external relations from a risk communication perspective.

## 5. LINKING ART AND SCIENCE

### 5.1 Broad Art Classification

Broadly speaking, a tripartite classification is commonly used in education, cultural policy, and interdisciplinary research, divided into: (1) **Visual Arts** regrouping painting, sculpture, drawing and photography, with an emphasis on spatial, material, and visual perception; (2) **Performing Arts** gathering theatre, dance, music performance, and opera, that are defined by temporality, embodiment, and co-presence; and (3) **Literary Arts** composed of poetry, prose, drama writing, based on language, narrative, and textuality. This tripartite model is often expanded in cultural policy frameworks (e.g., UNESCO-inspired classifications) to include media arts, design, and applied arts.

Historically, the idea of classifying the arts emerged in early modern philosophy, especially with Charles Batteux, who, in *Les Beaux-Arts réduits à un même principe* (1746), grouped the "fine arts" under a single principle represented by the imitation of nature. By the early 20th century, a stabilized list emerged (Table 1), namely (1) Architecture, (2) Sculpture, (3) Painting, (4) Music, (5) Poetry (or literature), and (6) Performing arts (theatre/dance). The 7$^{th}$ art, cinema, followed, having been popularized by Ricciotto Canudo in 1911. Reflecting technological shifts and the diversification of artistic media, a less standardized classification emerged: (8) Media arts / Television, (9) Comics / Graphic arts, and (10) Digital / Interactive arts (including video games). For completeness, it should be noted that in some frameworks, the tenth art refers to gastronomy—the intersection of which with natural hazards warrants a separate, dedicated paper. When investigating links among scientific and artistic disciplines, this framework allows for anchoring the work in recognized classifications and possibly using a hybrid or functional reclassification, considering arts as, e.g., translation tools, spatial interventions, participatory processes, etc.

**Table 1**. "Ten Arts" classification

| Art Form | Description | Key Modality |
|---|---|---|
| 1. Architecture | Design of built environments | Spatial/functional |
| 2. Sculpture | Three-dimensional artistic forms | Material/spatial |
| 3. Painting | Two-dimensional visual expression | Visual/pictorial |
| 4. Music | Organized sound and rhythm | Auditory/temporal |
| 5. Literature | Written and oral textual forms | Linguistic/narrative |
| 6. Performing Arts | Theatre, dance, live performance | Embodied/temporal |
| 7. Cinema | Audiovisual storytelling | Hybrid spatio-temporal |
| 8. Media Arts | Television, video, photography, broadcast media | Mass-mediated |
| 9. Comics/ Graphic Arts | Sequential visual narratives | Visual-textual hybrid |
| 10. Digital/ Interactive Arts | Video games, VR, interactive systems | Participatory/computational |

### 5.2 Examples of "Applied" Arts

As mentioned before, this article does not aim to provide an exhaustive list of "applied" arts illustrating specific situations and cases of disasters; rather, it offers a few examples that may warrant further analysis.

**Architecture**, the first art in the above classification, is a discipline that is central to our discussion because it clearly combines art and science. There have been numerous achievements in the field of disaster risk reduction, particularly in flood-prone areas or regions exposed to geological hazards. One notable example is architect Nader Khalili's 'Ecodomes', which are inexpensive earthen structures resistant to earthquakes, fires, and cyclones, and therefore particularly suitable for disaster-stricken areas. Another example is the contribution of cultural heritage to resilience strategies for improving disaster preparedness, which constitutes the primary objective of the RESILIAGE project (Tamborrino, 2025).

The links between science and the second art, **sculpture**, are multidisciplinary and historical. Leonardo da Vinci, Michelangelo, and many others demonstrated this through their anatomical representations of the body, while more recently artists such as Ernesto Neto have drawn inspiration from organic, cellular, or molecular forms. In the field of disasters, artist Doris Salcedo incorporates research materials to address memory and trauma. Herb Williams uses wax crayons to create colourful sculptures representing uncontrollable fires, hurricanes, and other disasters, addressing the effects of climate change. These forms are reminiscent of digital creations produced using 3D printing, a technology that opens up a wide universe for creating complex sculptures from digital models.

In terms of the third art, **painting**, numerous examples exist of past disasters influencing iconic historic works. These include Turner's sunsets painted in response to the 1815 eruption

of Mount Tambora—the largest known volcanic eruption— and the Great Wave off Kanagawa (circa 1829-1833) by Japanese painter Hokusai, which is widely interpreted as a warning against the risk of tsunamis. At a time when natural hazards and climate change are on the rise, art can also inform us about looming future risks. In Japan, art in general and sculpture in particular are very present. A notable example is the exhibition 'Catastrophe and the Power of Art' (2018–2019) at the Mori Art Museum in Tokyo, which shows how artists depict contemporary disasters, thereby reflecting an alternative perspective on their role. The exhibition features works responding to the 2011 earthquake in Japan, followed by the tsunami and the Fukushima nuclear accident, illustrating how Japanese artists have evoked this disaster by attempting to visually convey their feelings of helplessness and desolation. **Music**, the fourth art, is also central to representations related to science. These representations are long-standing and multidisciplinary, reflecting music's physical nature (the study of instruments and sounds), mathematical nature (the structure of compositions), neurological nature (effects on the body and mind), technological nature (creation, modelling), and social nature (impacts on culture). Recent examples illustrate artists' awareness of natural hazards. In the field of climate change, Led Zeppelin's song *When the Levee Breaks*—inspired by the great Mississippi flood of 1927—has become an anthem of resilience. Educational activities also use music as a tool for raising awareness; for example, the song *La nature est en colère* (Nature is angry) by Anny and Jean-Marc Versini. Another example of combining music and painting to foster recovery from a disaster and strengthen local communities can be seen in the community response in Suzu city after the 2024 Noto Peninsula earthquake. The annual Matsuri festival—displaying *kirikos* (beautifully painted decorative lantern floats unique to the Noto region) alongside with *taiko* (traditional Japanese drums) performances —was maintained despite the destruction resulting from the earthquake and tsunami. **Poetry, literature,** and more generally, **the art of language** are included in the fifth art, which offers a very broad field of expression for recounting, interpreting, and understanding natural hazards, while combining stories, emotions, knowledge, and actions. Art serves as a tool for bearing witness (e.g., through survivors' accounts), raising awareness (e.g., about climate risks), or questioning, for example, the place of humans in nature through philosophical or poetic texts. Literature is abundant in stories and fiction about disasters provoked by natural hazards. A classic example is Voltaire's *Candide* (1759), which ridiculed Pangloss's optimism during the devastating 1755 Lisbon earthquake and tsunami. In the 1940's, Barjavel, in his novel *Ravage* (1942) (*Ashes* in its English translation, 1943), described the chaos of a sudden energy breakdown that generated catastrophic cascading effects. Decades later, in 1973, Sakyo Komatsu depicted the collapse of Japan in the form of his suspense novel *Japan Sinks*. Interestingly, it was reading *Ravage* that sparked the idea for a research topic that led to the Horizon Europe SPARROW project[3], which aims to provide an innovative solution to strengthen societal resilience and crisis management in the face of digital failures. Another example of using the fifth art for enhancing societal resilience is the Philosophical Café's initiative. Inspired by his experiences in Paris, Professor Yoshiyuki Yama adapted this concept to share testimonies and philosophical thoughts on

[3] Sparrow – Solid Preparedness and Resilience for Robust Operations during disaster Wilderness, https://sparrowproject.eu/

disaster prevention, preparation, and recovery with local people of the Higashi-Miyoshi municipality.

The sixth art is multifaceted, combining **dance, theatre,** and the art of bodily movement, often set to music. Its links with science range from biomechanics and neuroscience to technology and mathematics. In the field of natural hazards, this art form touches the emotional realm through carefully chosen choreography and representations of stories. Dance can be inspired by natural movements, particularly those of fluids. It can be used to represent or interpret the violence, fragility or chaos generated by extreme weather events, such as storms, floods, and fires. In some cultures—including Japan, Haiti, and Indonesia—dance is an integral part of the healing rituals after a disaster, as seen in the choreographies created following the 2011 tsunami in Japan. It also serves as an educational tool to teach children about natural hazards, helping them understand survival techniques and adaptive behaviours.

Notable artistic creations include Rachid Ouramdane's choreography *Contre-nature*, which explores vulnerability and climate-induced loss through an immersive staging that combines dance, acrobatics, and visual projections. Theatre goes further by staging disasters as dramatic events, creating a tense framework between nature and culture. By representing the disaster impact, survival, and chaos, theater elicits a collective emotional response while contemplating human responsibility regarding climate change, rapid urbanisation, etc. Reflecting this approach, research projects, such as the Horizon Europe project The HuT[1], integrate theatre and performing arts as a means of expression to address extreme weather events and climate risks.

**Cinema**, the seventh art, combines narration, music, editing, and acting, capitalising on the fears and heroic acts generated by natural hazards. It merges spectacular, emotion-driven representations with cautionary tales, and very often places science in a pivotal role, helping to raise public risk awareness. There are many examples across all genres, including *Earthquake* (1974), volcanic eruptions in *Dante's Peak* (1997), tsunamis in *The Impossible* (2012), climate crisis in *The Day After Tomorrow* (2004), tornados in *Twister* (1996), etc. The scientific community is often called upon to make scenarios plausible. By doing so, cinema helps popularise scientific information among the general public, enabling a better understanding of complex processes—such as the cascading effects of tectonic movement followed by a tsunami, a disaster tragically experienced in the Sendai region in 2011. However, the medium faces distinct challenges. While it aims at education through awareness-raising and popularisation, it risks exaggeration and oversimplification. The intense emotions that engage the viewer can also induce irrational fears. Furthermore, the role of science is often called into question: while it grants a platform to experts, it leaves us with the question of whether science is ultimately serving entertainment or truth. Regardless of these tensions, cinema remains an effective educational tool for analysis, debate, and multidisciplinary creation.

The eighth art, **Media arts**, combines television, photography, and the technological capture, reproduction, and dissemination of images. The links with science alongside the commitment of artists to provide visual testimonies of natural hazards and related disasters closely mirror the cinematographic approaches mentioned above. Here again, prominent examples abound.

Richard Misrach's photo series and his book *Destroy This Memory* (2010) respond to Hurricane Katrina by capturing the *graffiti* and messages left by survivors on destroyed buildings. These images, published without captions, offer a raw and powerful testimony to the disaster. Taking a different approach, Htet T San's abstract photographic work *Natural Disasters* explores the evocative shapes and colours associated with natural hazards, offering an artistic and conceptual interpretation of the subject. Additionally, the role of art photography in documenting wildfires was demonstrated by the collective work of Collectif LesAssociés in 2025. Finally, the dedication of the younger generation is exemplified by Antoine Sottiaux, a young photographer and cineaste. Driven by his own initiative, Sottiaux traveled to Poland during the catastrophic floods of 2024 and to Spain during the devastating wildfires of 2025. His work highlights the power of images in the service of society: exposing reality to raise awareness and enhance resilience.

The ninth art traditionally refers to **comic strips and graphic novels**, and also includes digital arts (e.g., 3D digital creations) and interactive media tools. Much like the fifth and seventh arts, these mediums serve as excellent educational vehicles for recounting, explaining, and raising awareness about natural hazards, while integrating scientific knowledge. Comic strips are prolific in producing illustrated narratives of past disasters. Prominent examples exploring earthquakes include *Magnitude 9* by Jean-Marc Mathis and Thierry Murat, as well as the historic account of the *Lambesc Earthquake* by Bertorelo-Scotto and Stoffel. Volcanic eruptions are vividly depicted in works like *Pompei* by F. Santoro and *L'île au volcan* (the Volcano's Island) by F. Place. Furthermore, critical discussions on climate change impacts on viticulture and winemaking are central in *Les Ignorants* by Davodeau, etc. Finally, **digital/interactive arts** (often recognized as the tenth art) utilize scientific input to simulate disaster situations, establish disaster scenarios, and understand hazardous phenomena. By combining education with entertainment, these mediums serve as powerful tools for teaching and raising awareness, which makes them particularly effective for younger generations. Numerous examples of 'serious games' exist in the field, aimed at diverse audiences and even supporting the training of first responders. *Stop Disasters!*, an educational game developed by the United Nations (UNDDR), requires players to prevent disasters triggered by natural hazards through appropriate city planning. Similarly, *Minecraft* is another renowned game that simulates volcanic eruptions and evacuation strategies. In the realm of city-building simulators, *SimCity 4* challenges players to deal with multiple compounding disasters emphasising the importance of sustainable urban planning and climate change adaptation in critical decision-making. *Mission INONDATION* (Flood mission) is intended for schoolchildren over the age of 10, adults who live in flood-prone areas, and concerned individuals who live outside flood-prone areas. Another insightful example of interactive media used for social resilience comes from Suzu City following the 2024 earthquake and tsunami. A team of young people developed local video games featuring manga characters speaking about the disaster experience. By encouraging players to share and process their disaster experiences, this initiative intends to break the isolation of traumatised children and teenagers.

## 6. WHY IS ART NOT YET INTEGRATED INTO LARGE-SCALE RESEARCH PROJECTS?

While art is increasingly recognized within the social sciences, it remains peripheral to large-scale research. This marginalization could stem from structural, epistemological, and institutional barriers rather than a lack of relevance. First and foremost, there seems to be an epistemological mismatch regarding what constitutes "valid knowledge". While science prioritizes reproducibility, quantification, and even standardisation, artistic practices generate affective, qualitative, and often ambiguous knowledge. In other words, institutional science privileges what can be measured and compared, whereas art evokes meaning and emotion rather than metrics. Consequently, even when art is "proven useful," it often fails to meet dominant criteria of evidence, scalability, and generalizability, rendering it incommensurable with established evaluation frameworks. When looking at large-scale research projects, impacts are generally measured using Key Performance Indicators (KPIs) and cost-benefit justifications. Art contributions covering shifts in perception, trust-building, empowerment, collective imagination, etc., are difficult to quantify. This actually creates a paradox. Even in fields where qualitative change is central (e.g., resilience studies), research funding systems require numerical indicators. As a consequence, art, if present in projects, is often relegated to work packages related to, e.g., "engagement" and dissemination rather than core research. Research funding structures create silos around disciplinary categories, predefined deliverables, and technical work packages, which are not compatible with what art will produce. Added to this, barriers occur due to the difficulty of classifying art within calls for proposals, the prioritisation given to technical outputs (and related budget), and the fact that the majority of reviewers are not trained to evaluate artistic methodologies. Art is hence often underfunded in large-scale projects and instrumentalized, i.e., used in communication rather than co-production.

Resistance also exists from the artists themselves, many of whom argue that when art is reduced to a "tool," it risks losing its critical and exploratory function, and may even become instrumentalized by policy agendas. This tension underscores debates surrounding critical art and socially-engaged art. A paradox arises: while institutional research frameworks do not fully accept art as a valid form of research, artists resist being reduced to minor service providers. While art makes people think "out of the box", institutional research is generally embedded in well-defined hierarchies and ways of thinking: Scientists and engineers are seen as knowledge providers, communities are often information sources, and artists, when present, are positioned as mediators or communicators. This suggests that until art is recognized as a legitimate form of knowledge production, its role within large-scale research will remain secondary.

In terms of research implementation, the paradox is exacerbated by critical differences. On the one hand, large-scale projects operate under financial scrutiny, political accountability, and requirements for predictable outcomes (even if research may, by nature, sometimes lead to unpredictable results!). On the other hand, art introduces uncertainty, open-ended processes, and context-specific results, which clash with the need for predefined timelines, deliverables, and replicability. Another difference is linked to scale: while art is often deeply local, context-

sensitive, and relational, large-scale projects seek scalable solutions, transferable models and/or technologies, thus creating a structural mismatch.

Despite these barriers, the landscape is slowly shifting. Art-based research methodologies are increasingly recognised and are becoming the focus of university departments. A prominent example is the *Art Innovation Industry-Academia Collaboration Research Department* of the Disaster Prevention Research Institute of Kyoto University (Japan). Furthermore, the boundaries between the two fields are fluid: behind a scientist is often hidden an artist, and many artists possess a curiosity about science, as both domains are driven by creation and imagination! This leads to an expansion of art-science collaborations. Moreover, emerging policy frameworks, such as the "New European Bauhaus", integrate art, science, and society.

To conclude, art-science collaborations are in a transitional phase where discourse is ahead of institutional practice. The problem is not necessarily that art is not considered to be "proven"; rather, it is that large-scale research is built on assumptions that art fundamentally challenges. These conflicts involve measurable outputs versus experiential transformation, reproducibility versus uniqueness, control versus openness, causality versus ambiguity. What is certainly needed to move ahead is to reflect upon what transformations are required for research to integrate art as a core epistemic and operational practice.

## 7. CONCLUSIONS

This article sought to highlight the contribution of the arts as vehicles for transmitting scientific knowledge to foster greater awareness and societal resilience in the face of disaster-inducing hazards. The underlying premise is that through the arts, it is possible to evoke emotions and generate interest among populations—an outcome that would undoubtedly be more difficult to achieve through conventional scientific conferences. This conviction, which promotes art both as a catalyst for reconstruction and a vector of resilience, is increasingly shared by a growing number of scientists and first responders. It is therefore possible to envisage arts with a societal role becoming a tool for risk governance. In the classic model described by Nathan Clark (Clark, 2024), the underlying dilemma of risk governance pits the notions of control and collaboration against each other. In other words, institutional responsibility can often conflict with operational adaptability and flexibility. In the discussions on societal resilience detailed in the report cited in the first footnote of the introduction of this article, the pyramidal model of governance emphasises the importance of co-creating knowledge among public authorities, civil society, scientists, disaster response organisations, etc.

Given the wealth of knowledge that exists at the local level among citizens, first responders, and other actors, alongside the potential contribution of the arts to raising awareness of risks, it is legitimate to question traditional risk governance doctrines from the international to the local level. Reversing the decision-making pyramid, for instance, would encourage

governments and public authorities to establish governance strategies rooted in citizen knowledge using the arts as a vehicle for citizen engagement and societal resilience (Figure 2).

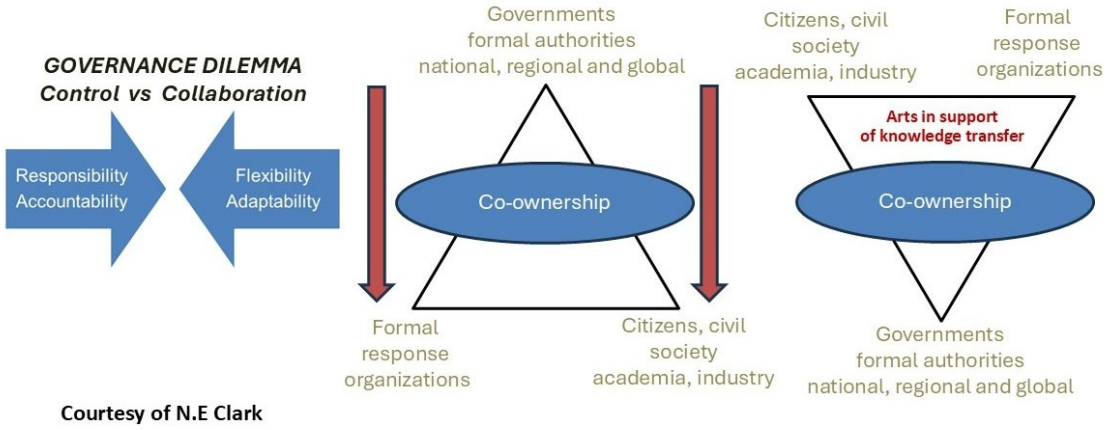



**Figure 2**. Reaching local communities for enhancing the culture of resilience, a change of paradigm? (adapted from Clark, 2024, in: Quevauviller et al., 2026)

In conclusion, while there is strong evidence for art in citizen engagement and meaning making, there is still limited work in using art as an operational means for advancing and implementing scientific knowledge on societal resilience to disasters. Further perspectives and efforts might therefore investigate the development of methodologies to translate artistic expressions into actions (related to risk awareness, preparedness, and prevention) and demonstrate measurable or observable resilience outcomes resulting from these actions. Such an evidence-based approach might result in new art-based research with operational practices in support of societal resilience.

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