Ten Promising Innovative Practices in the Field of Disaster Prevention and Planning and Their Possible Implementation in the Bulgarian Black Sea Coastal Region

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Aim of Study and Methodology

The purpose of this study is to analyse leading global policies and practices in disaster prevention and planning, as well as risk reduction ecosystems, and identify **ten potentially beneficial innovative proposals** which could be integrated into the Bulgarian Black Sea coastal region disaster management paradigm. Said policies and practices have to be in their **early research or evaluation phases** – concept, test, explorative limited piloting – and not have been systemically adopted. The study will concentrate on exemplary international cases while giving the necessary prominence to leading global countries, consortia and stakeholder collaborations in the DPP field.

A preliminary analysis will narrow the criteria and contexts, drawing some conclusions from previous research segments on already applied good policies and practices. This will help us provide indispensable requirements and conclusions as to the **conditions** under which the selected examples should be implemented – e.g. environmental sustainability, adaptability and scalability, financial soundness of the proposals, as well as legitimate potential interest for public and private stakeholders to pursue the adoption of such solutions.

Many selected practices might require **significant investment** for full operational implementation. Others will depend on an **advanced technological development** levels in both infrastructural and know-how dimensions. A substantiated analysis will provide the **necessary parameters** of advancement for the main categories of developed innovations – **technological, organisational, social or narrowly product related**. Other features will have to be further calibrated or deducted at prototyping or extended piloting stages. Proposals and their potential will then be **upgraded and adapted** to the conditions of the Black Sea Basin region and its stakeholder network.

Many **unexpected challenges** might threaten to prevail in incorporating and fully integrating scientific proposals and advanced expertise into current disaster risk reduction policies, plans, and strategies.

Necessary modifications might not be deemed beneficial to wider public and socio-economic efficiency in the long run, despite their demonstrable added value as a stand-alone solution. **Political and governance** considerations are also multifaceted and often more complex than any technical and organisational issues alone.

Still, the **main benefits of the study** will reveal the main parameters which serve to advance beyond the state of the art, achieving a synergy of **sectoral optimisation** in the regional DPP system as per **leading good practices**, as well as the potential adoption of upcoming **identified advancements and innovative breakthroughs** in the field.

The **utilised methodological approach** focuses essentially on secondary research sources. This is practically inevitable, considering the objective field of study – proposed or theoretical policy and practice examples which have potentially been tested or experimented but have not been made publicly available, massively piloted or serially implemented as proven solutions. The creative teams and promoter entities which have explored the ideas in depth are the only stakeholders which have exhaustive technical and descriptive information regarding the proposed practices.

We have analysed publications and reports in the DPP field, as well as conference presentations, along with marketable business offers and integrated solutions – by public entities, research institutes and teams, private companies or combinations of those. The resulting overview presents potentially beneficial answers to environmental, industrial, political or social challenges. International cooperation, as we will see repeatedly below, remains a defining common element and an affirmed cornerstone of global DPP excellence.

A Global Journey in Disaster Prevention and Planning: Continuous Innovation and Collaboration in Best Policy and Practice

Policy and practice are based as much on experience and empirical proof, as they are on theory and technological advancement. In DPP, administrative and political decisions may operate in apparently different domains compared to research and science, yet they are not essentially competing for identical resources, while they have the same interests in acquiring knowledge. **Scientific knowledge** is indeed becoming an integral and one of the **foundations of disaster management**. This, in turn, has already changed the role of science in the DRR and DPP fields at policy level, granting it a due and **growing prominence**.

Disaster management studies and best practices have their consequences and lasting impact on socio-economic stability and growth. However, even today, they attract considerably less competition than strictly economic fields. Even leading national and corporate initiatives and macro-regional efforts in the DPP sector stand out only relatively in terms of disaster management innovation, its efficiency and long-term benefits to early adoption. While the same advancements might receive considerably more recognition if they are dedicated to economic growth and – even – daily comforts.

As natural as that might seem to most policy makers and corporate heads, DPP has a different dimension which unfortunately gives it precedence mostly at critical times and large scale emergencies. By that intend globally relevant emergencies, a territory which stimulates **natural empathy**, **global collaboration** and common efforts to build a more stable future, with less risks and more environmental sustainability for all.

Such an inclination to ultimately consider the common good and global safety has been increasingly institutionalised and formalised over the years. It has been more than three decades since the United Nations first promoted a series of disaster risk reduction (DRR) initiatives. The UN General Assembly announced the 1990s as the International Decade for Natural Disaster Reduction (IDNDR). **1994**, in particular, saw the first global Conference on Disaster Reduction in Yokohama (and the ensuing **Yokohama Strategy** and Action Plans for a Safer World). This initiative was followed by the **2000** International Strategy for Disaster Reduction (**ISDR**) and a World Conference on Disaster Reduction, held in Kobe in **2005**. Its main output, the **Hyogo Framework** for Action emphasized national and community resilience as a focus of DPP and disaster management.

The latest DRR World Conference was held again in Japan, this time in Sendai (**2015**). The **Sendai Framework for DRR** outlined several priorities until 2030. Understanding and improving disaster risk management should equate stronger **DPP governance**, **investments in resilience** and enhanced DPP as an effective response – mainly characterised by the "**Build Back Better**" principle of recovery and reconstruction.

The Sendai Framework also promoted **global collaboration** and cross-category stakeholder partnerships as a more effective and efficient approach in tackling climate change challenges and the SDGs that have been an underlying feature of any sustainable policy over the past few years. We can appreciate the fact that a multiannual effort on behalf of practically the entire global community has stressed the importance of scientific foundation for contemporary strategies, proven effective methods and advanced technologies as an integral part of powerful policy measures targeting better DPP.

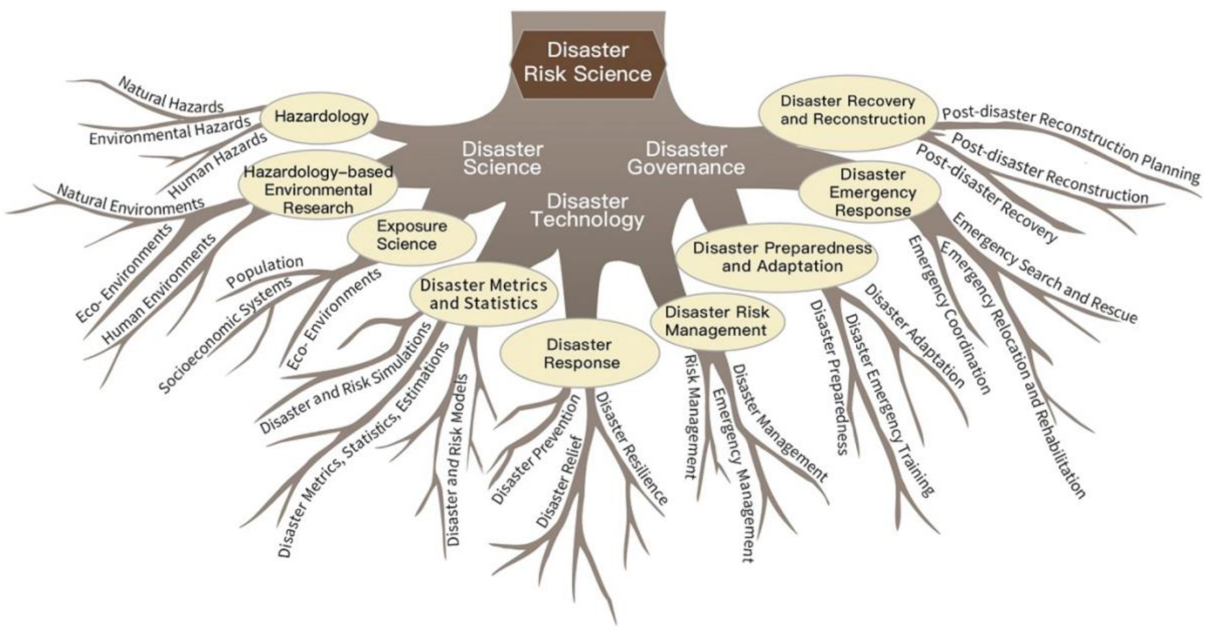
The **European Union** has also faced some of these challenges, in parallel. Member States have invested continuously in DRR science and promoted best practices and policy in DPP, most notably **risk awareness**, **disaster expertise** and **essential knowledge transfer**.

Problematic areas remain, inevitably. Discrepancies between international-level stakeholders regard their **different understanding** of priority knowledge, institutional structure (including cooperation mechanisms) and overall strategy on scientific and technological know-how for DPP. Such differences contribute to undermine systematic integration of proven applied science for DPP policies. It is the conviction of many stakeholders, however, that such divergences are to be addressed at the "top", at the governance level, as bottom-up solutions are always more pertinent to target improvements, while political and management considerations might not appreciate the added value of a tried and tested beneficial solution.

Therefore, **insisting with science** (**theoretical, applied and social**) **and technology as a way forward** has rarely been put in doubt by most DPP actors. The object of risk prevention and preparedness science is a multifaceted topical research of the entire "disaster ecosystem". That includes existing and potential hazards, geographical environment, vulnerable infrastructure and socio-economic realities. Regional specifics are traditionally examined in their interconnectedness and complexity as contributing factors rather than limiting the applicability of proposed solutions.

Advancements in DPP research, mostly applied, have been achieved over a **multi-layered disciplinary field**. Disaster science is often defined by scholars as having a structure based on the above-mentioned **three pillars**: disaster science, disaster technology, and disaster governance. Those are furthermore divided into core areas and sub-fields of explorative science and pilot proposals. Below is one of the representations of most of the essential elements of the continuously **expanding frontiers** in disaster risk science and research.

Figure 1. A framework of disaster risk science – layered disciplinary structure (source: International Journal of Disaster Risk Science, 2020)



Pursuing advancement in disaster risk science and technology is fundamentally motivated by their application in real-world developments and successful policies and practives. DPP aims to protect lives, as well as assets, besides achieving sustainable socioeconomic development. Collateral benefits to economy are not the principal aim of targeted DRR applied research. While, admittedly, various unrelated scientific and technological advancements have been replicated and adapted into relatable DPP solutions by innovative risk management stakeholders.

Ultimately, it is the active involvement of researchers and experts in applied earth sciences that has brought them to the big scene, including taking up a prominent position among UN and global disaster management initiatives. The innovations community has systematically provided expertise and technological support during the three decades of structured policies. From hazard mitigation to disaster reduction and systemic DPP approaches, innovations have been piloted into effective and beneficial tools which serve to create an integrated paradigm of DPP understanding.

Constantly evolving, the innovations ecosystem is able to address challenges from a global, macro-regional, national and local community perspective. The topics are common and collaboration is the norm. The global DPP community of stakeholders needs to cater to the entire cycle of disaster management: prevention, preparedness (and mitigation), emergency response, recovery and reconstruction.

Defining Factors and Characteristics of Leading Contemporary Practices in Disaster Prevention and Planning

Having ascertained the guiding role of science for innovative management of risks and hazards, our study looks beyond strictly technical questions – at the policy level, including **practices, plans, and ideas** in the domain of disaster risk reduction. This exploration will provide us with insights into the principal factors and elements of the leading best practices in DPP.

The **European Union** is the perfect example of the complex interdependence of **industrialised service economies** which are governed by **technocratic societal systems**. These main two dimensions provide the basis for the key concepts in modern disaster research that continue exercising their influence on actual and upcoming DPP paradigms. Considerations are also shared – between economy and policy – on relevant hazards, risks, vulnerability and resilience **needs** and **priorities**.

Given the fact that disasters occur as a result of hazards interacting with social structures, it is only natural that such needs and priorities have their social foundation. This is also the prevailing rationale of disaster management today: **the organization of society** – and therefore our ability to integrate relevant knowledge into the institutional arrangements and policies – **determines our ability** to address disaster risks and emergency management.

Even with such considerations in mind, our report can only marginally explore societal organisation and political order. That is, unless they are essentially the driving force behind an innovation which we have identified as never-before implanted yet potentially beneficial to Black Sea regional DPP systems.

Preliminary explorations in the topic have guided our approach and the accumulation of promising ideas in the field: developing **disaster risk science** is imperative to meet DPP needs and priorities. Furthermore, it is the basis for implementing the Sendai Framework for DRR and other UN and international agreements and priority policies. We will not attempt to clarify and segment niche scientific and social advancements, as many are overlapping and include different leading principles – most of all, technological innovation (see above "root system" of constantly evolving innovation). This is for applied research scholars to classify bottom-up, and for decision makers to implement based on local and national abilities and DPP capacity. Taking the gist of technology and research disciplines, we will suggest and establish a set of interdisciplinary solutions and tools which are **potentially useful** and **open to replication and scaling up**.

"**Disaster risk science**" is defined as the discipline which studies hazard mechanisms, namely disaster occurrences, dynamics modelling, spatial and temporal patterns of impacts. It also includes follow-up **emergency response** and risk **governance paradigms** of DPP systems. A cross-disciplinary field, it is different from that of Earth sciences or purely technological research. It does include sub-systems such as geology, geography, oceanology, ecology, atmospheric science and so on – on a needs basis – yet the common denominator is the basic link to disaster planning, prevention and response. Adademic functions such as geophysics, mathematics and metrics, geochemistry, including any digital Earth tools, are all instrumental to the wider vision of the research field and its applicability. Put simply, disaster risk science directs applied basic studies, theory and methodology, towards mostly **systematic and application-oriented research and development**.

Response technologies and **governance approaches** are the core of such explorations, as is their practical and sustainable integration into societal systems and the work of DPP stakeholders. A complex system of paramount importance in almost any national and macro-regional reality, DPP systems channel into an actionable mechanism what the “three pillars” (disaster science, technology and governance) have come up with in terms of **pragmatic innovation**

Expert know-how arguably plays a more vital role nowadays than experience. Constantly evolving in its own right, it allows current DPP teams to **learn from previous disasters** by identifying best practices, developing risk assessments and exploring flexible models that anticipate future patterns of natural hazards. This elevates the need **for accurate knowledge**, as much as a **shared understanding** of its topical interpretation and functional replication.

The leading factors and characteristics we are looking for are primarily related to the **perception** and **awarenes**s of the role of disaster science. This impacts particular DPP structure, functions, properties and dynamics. But it does not determine the subject matter of disaster research or the topical output – that circles around hazards, socioeconomic exposure, and the environment, mostly, as well as possible solutions to identified issues through applied innovation.

Functional exploration of disaster system **properties** alone includes their inherent and acquired interconnectedness, complexity, regional character and tendency to stand out in terms of similarities rather than differences. Research on disaster system **dynamics** refers to mechanism, processes and the current and anticipated evolution of these systems.

Fortunately, disaster risk management paradigms and DPP work receives growing **political attention**, as well as the resources it needs to function and progress. Especially in times of widely accepted series of critical global events or conditions (i.e. Covid-19 as a scenario nobody saw coming and everyone is working upon).

Many identified (potentially) beneficial solutions have to be taken as a given, with **limited time to test, pilot or setup** a satisfactory support system. Naturally, preceding DPP work bring out their effectiveness in better developed countries and trans-national cooperation platforms. When global (or leading) stakeholders meet around a solution, it provides crisis management professionals with the necessary **consensus, resources** and **support** to implement the identified innovative solutions.

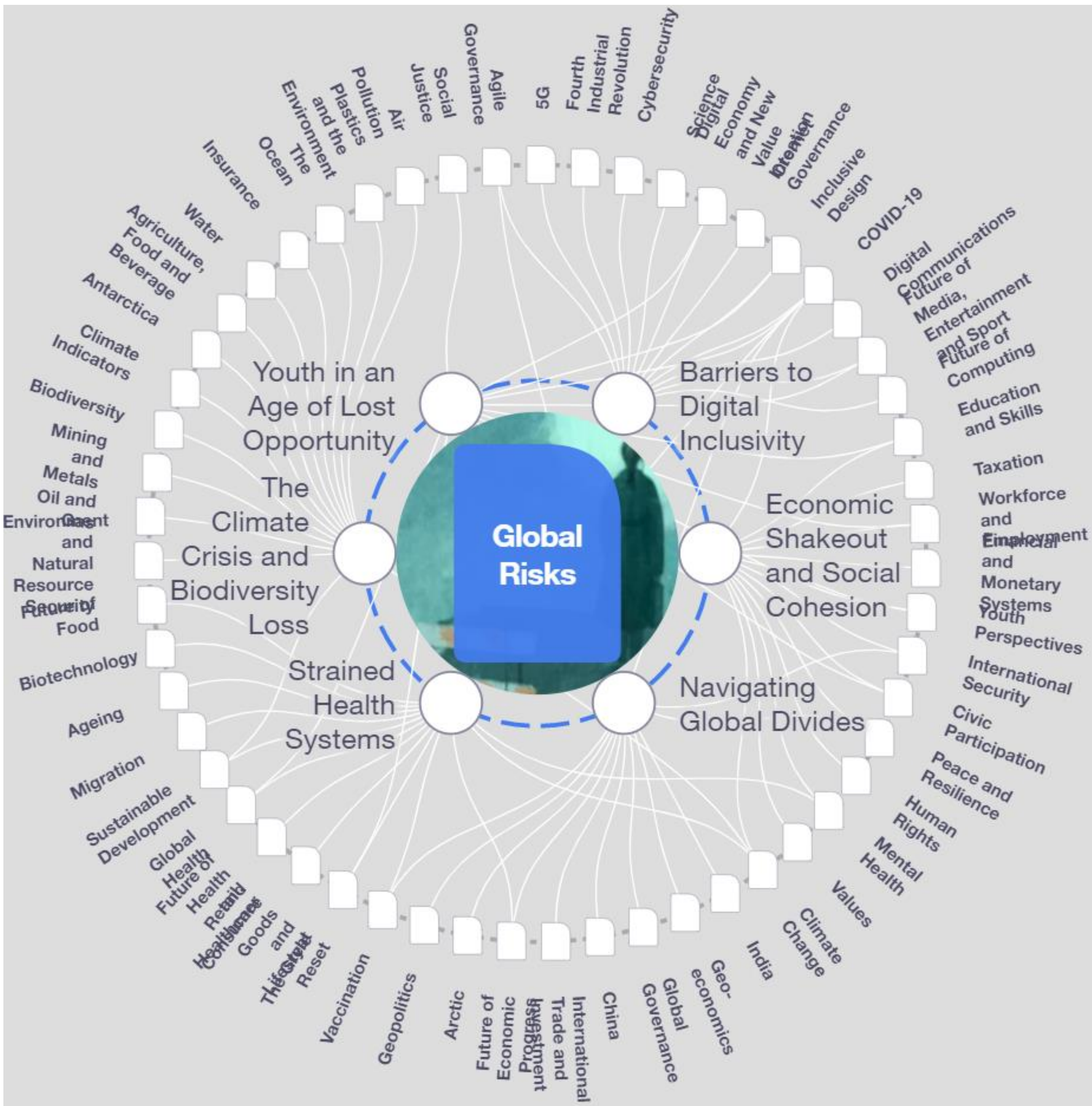
Along the process of launching an insufficiently tested solution or policy, DPP stakeholders are able to also **identify previously "invisible" gaps** and **vulnerability** issues, strategic needs and even practical shortcuts which improve their related work on closely connected DPP applications, as much as the integrity of the crisis management ecosystem. Such gaps and issues may lead to other solutions, more or less linked, with different degrees of functional or technological sophistication. **Bridging solutions to management functions** elevates the **DPP capacity** at any (territorial) level, helps replicate even unrelated beneficial practices and provides the necessary expertise to optimise both daily and strategic work in the field.

The range of potentially beneficial and replicable solutions which are to be identified and described in our study should support one or more of the following functions:

- Better management structure and integration with existing DPP tools;
- Adaptability and functional segmentation;
- Links to essential management functions and relevant regional problematics for easy replication and scalability;
- The potential to be "sold" to relevant solution operators and resource owners;
- Matching of gaps and needs to solutions, as well as complementarity with similar tools, approaches and solutions.

The World Economic Forum in **January of 2021** published its latest **Global Risks Report**. Among global drivers to risk and vulnerability, it cites **new and evolving trends** and **factors** that influence or even create contemporary risk scenarios that inevitably impact even local realities and regional ecosystems. While not entirely new, "updated" risk factors include existing **barriers to digital inclusivity**, the **pandemics'** impact on new **generations** and their **socio-economic integration**, imperfect **markets** and continuous challenges to global industry and trade, as well as the inevitable hindsight considerations on **Covid-19 handling** and global response paradigms in light of the pandemic.

Figure 2. An integrated overview of global risks (WEF, 2021)



The logical and functional **interrelation**, the inherent singular and combinational **dynamics**, the sheer **complexity** of the above palette of factors and **risk drivers** explains why selecting some of the leading potentially successful approaches, policies and practices is not an easy task. Being able to respond to one of the above is probably not sufficient to declare a solution an example of best practice, as effective as it might be in addressing that single risk factor – whether locally or on a wider territorial scale.

Precisely because of such high demands on DPP and crisis management solutions, as a complement to its Global Risks Practice, the World Economic Forum dedicates resources to **major collaborative platforms** which focus on activities that are able to address the **multifaceted challenges** of building a less vulnerable economy and society – including but not exclusively related to **climate change** issues, innovative management and dissemination of the **"Fourth Industrial Revolution"** technologies. Such macro factors are expected to shape our societies and industries of the future, and guide transformations in resulting global and regional cooperation mechanisms that address system vulnerability.

Country collaborations, industrial and research leaders, networks and DPP stakeholder organizations look towards the identification of precisely such **replicable solutions and innovative findings** – that we are after – and that improve global response capacity and our collective ability to tackle the world's greatest challenges.

Building resilience, managing risks and leveraging innovative opportunities are not separate in neither political nor scientific perspectives. An **integrated approach** has never been deemed more critical than it is now, while we still struggle to grasp with a coordinated response to a global health crisis. In an effort to look and plan beyond managing the pandemic, towards resetting systems and **rebuilding back better** our economies and societies, people and innovative solutions are at the centre of global DPP efforts.

There are some obvious and publicised examples of global cooperation, remarkable determination and impressive innovation – even and especially in times of planet-wide emergencies. Still, for the most part, countries have struggled with different aspects of internal crisis management during the pandemic, even those with well-developed DPP systems, advanced response mechanisms, high-technology infrastructure and traditionally adequate institutional funding for crisis mitigation and management. This is not the time for outlining definitive lessons but to look for **ideas, innovation** and those same **examples** of good practices and beneficial policies.

The 2021 Global Risks Report contemplates global preparedness by looking at several key areas of the crisis response mechanisms (not only directly related to COVID-19 health management but it has been rather indicative).

- Institutional authority;
- Risk financing;
- Information collection and sharing;
- Equipment (including vaccine provision and administration capacity).

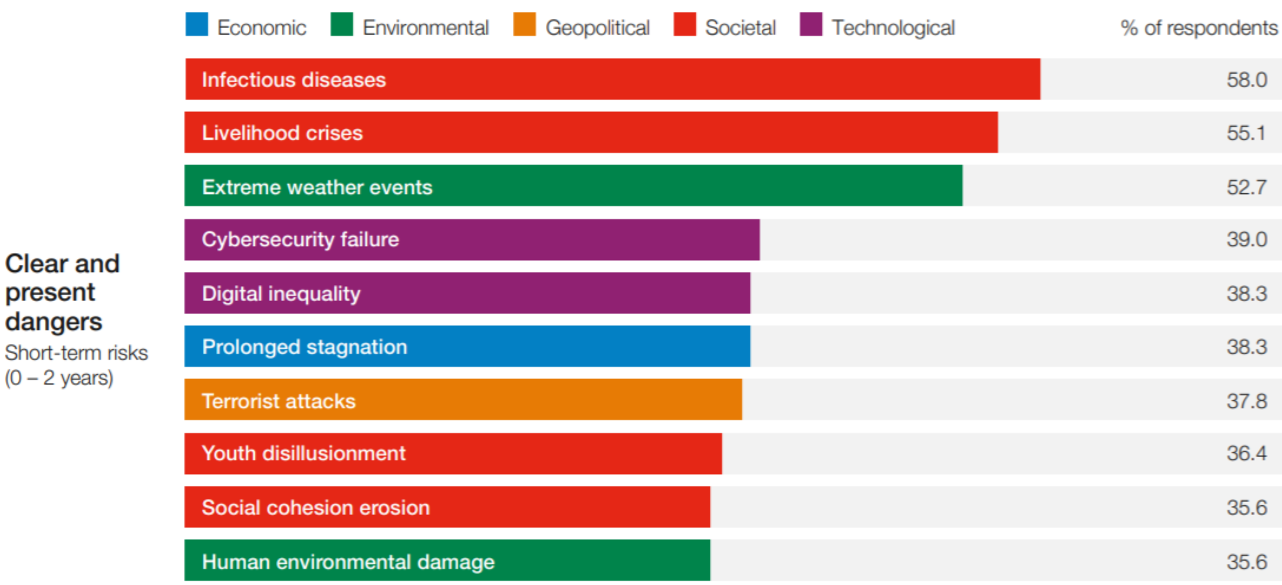
The report also explores national level responses, taking into account the diverse starting points for individual countries in terms of development, know-how and resources. This allows the survey to segment the main **public management domains** which need to be impacted by innovative and beneficial policies and practices:

- Government decision-making;
- Public communication;
- Health system capabilities;
- Societal management (e.g. lockdown handling);
- Financial assistance to vulnerable groups.

Subsequently, the “Global Risks Horizon” survey paints a much clearer picture on the parameters of **anticipated upcoming crises** and the dimensions of disaster/crisis management which need to be addressed by **promising innovative solutions**.

An integrated (and weighted) response by experts, decision makers and general population participants brings us the **shortlist of expected risks** to global vulnerability. The figure below shows the predicted leading threat factors in the short term (0-2 years from the time of writing).

Figure 3. *Clear and present dangers and short-term risks (0–2 years; WEF 2021)*



The five principal micro-groups of factors are the **Economic**, **Environmental**, **Geopolitical**, **Societal** and **Technological** threats.

We can clearly see that **technological** and **societal vulnerabilities** are rising in importance and adding to **environmental** risks as **leading risk drivers**. Promising solutions need to take into account an **integrated approach** and consider the weight of relative importance in DPP and disaster management.

Lessons from global crises and emergencies should not merely "inform" decision-makers how to better prepare for the next one. The need to enhance, support and **evolve risk management capabilities and DPP culture** has the added value of avoiding recounting efforts and planning after the latest emergency rather than **anticipating** the next one. Covid-19 – and any other global threat for that matter – offers governance opportunities to **strengthen the overall resilience** of countries, businesses and the international community, both in terms of policy and innovative practices. The WEF identifies 3 major areas:

- Formulating analytical frameworks with a **holistic and systems-based view** of risk factors and impacts;
- Investing in high-profile "**risk champions**" to encourage national leadership and international co-operation;
- Improving risk **communications** and combating **misinformation**;
- Exploring new forms of **public-private partnership** in the DPP field.

The suggested areas of improvement go a long way towards narrowing down the priority fields of promising innovative policies and practices to be highlighted and described below.

Essential Characteristics of Promising Innovative Solutions

The European Union established in 2017 its **Disaster Risk Management Knowledge Centre**. The think tank enlists experts, researchers and DPP consultants whose task is to formulate recommendations in light of namely those holistic disaster management ecosystems that we pointed out above. The importance of **emerging technologies** that have the capacity to positively impact the field and possibly change how DPP stakeholders and the society at large envisions crisis management is the one common trend which makes **technological and scientific innovation fit into preparedness, response and recovery**.

Below, we list some of the **leading principles** which almost inevitably exercise a positive impact on innovative and exemplary policies and practices in disaster preparedness, prevention and emergency management ecosystems.

Systemic Capacity to Integrate Innovation

Individual and group ability to **appreciate, internalise and integrate innovative trends and solutions** is not an easily acquired institutional trait. That is especially true for nations and governance systems which have seen their fundamental principles change relatively recently or even in the past few decades. This is the case of Bulgaria and much of South-East Europe. This is also the cases of many developing nations and macro-regions which are perennially instable and looking for their geopolitical identity.

When the recognition of the need to innovate becomes impending in a nation's hierarchy of needs, certain conditioning issues arise – for example how to integrate and support expert topical knowledge, how to invest sustainably (given limited resources) so that DRR and emergency management systems become more **relevant to present-day risks** and critical scenarios.

The challenging task of being able and organised well enough to **integrate innovation** requires certain political, managerial, institutional efficiency. It even involves a higher grade of philosophical understanding on long-term priorities when related to current needs.

Many of the challenges and vulnerabilities reported by **EU** member states with respect to the integration of scientific knowledge in disaster risk reduction plans and practices are **similar, recurring** and largely shared between macro-regions within the EU. They are, however, separated often by the above-identified institutional capacity to adopt innovation systemically, revealing **governance issues** more than DPP expert know-how shortages.

The importance of systemic capacity to metabolise proposed innovation – even and especially via **bench marking of good practices and policies** – is a defining characteristic of a nation's DPP level of efficienty. Any topical analysis of how knowledge is being transferred from a theoretical setup to a relevant policy domain should depart from the perspective that the **interface between science and policy** is shaped by a range of competing interests from multiple actors – political, business, bureaucratic, academic, civil, and so on. Expectedly, tensions that are endemic to the confrontation along the science-policy axis highlight the impact and **role of science and innovation** for policy and decision making for DPP and crisis management throughout the Union. The **necessity to reinvent policy** is rooted in its connection with research and innovations development.

Therefore, a separate research challenge addressing disaster governance paradigms should also focus on developing approaches and methods for adopting innovation and change in the field – besides and beyond traditional preparedness, adaptation, emergency response, recovery and reconstruction aspects as the fundamental functions of good DPP governance.

Disaster preparedness and **adaptation management** are closely interconnected. The former is easily comprehended when presented as capacity building for operational management of inventories, shelters, and command systems. It also includes, however, disaster response schemes, plans and standards which are increasingly in need of frequent update and upgrade. Similar considerations regard disaster response media and communications, local and national DPP campaigns and education policy. The latter factor needs additional parameters of the overall capacity to adopt and integrate innovation trends and leading DPP practices.

Evolving and **innovative emergency preparedness** and response management approaches need to cover the whole range of “anticipated” DPP and emergency command and rescue systems, technological advancements, high-tech integration and better coordination of logistics, allocation of goods and materials, as well as trans-regional collaborations in the field of defence and territorial control.

Innovative and **advanced recovery and reconstruction** management needs to be able to improve practices in rehabilitation, capacity assessment (e.g. ground safety) and innovative yet sustainable reconstruction planning. Contemporary disaster governance could be divided into administrating disaster preparedness, disaster emergency and disaster recovery and reconstruction as separate levels of DPP. Yet, they are all linked by **institutional capacity** to adopt innovative and promising advancements in the scientific and applied fields of present-day risk management.

Consequently, disaster risk science, research and innovative development contribute essentially in terms of **interdisciplinary methodological support**, as noted above when considering the multitude of its pillars, core-areas and separate research fields.

Technological Advancements Remain the Key Current Trend

Technology is a key **manifestation of applied innovation** and its utility to our daily lives, societal security and global safety. It presents countless scenarios to risk awareness, preparedness and response mechanisms. Earth's population is increasingly **tech-savvy** and adequately capable of handling **end-user equipment** – smartphones, gadgets, sensors and the like. The challenge to those who risk digital exclusion is mostly related to uneven **access to technology**, and not even advanced one.

Modern technological societies, however, the ones which present leading examples of DPP policies and practices, and those should serve as providers of model solutions in the risk management sector. Advanced socio-economic realities are also intrinsically related to the development of new types of **media and communication technologies**.

The ability to take advantage of **digital and social media** networks and communication platforms is a prominent example of essential advances in the past decade. Coupled with existing emergency institutions, facilities and operational structure, as well as proven effective disaster responses and experiences, they incrementally improve the potential of regional and national DPP systems.

The **challenges**, on the other hand, are represented by some growing concerns that **technically conceptual requirements** and **high-level technical language** that permeate risk and vulnerability assessments may end up **hindering** most of the **integrative processes** between scientific understandings of risks and the capacity of the policy domain to translate these assessments into plans and policies.

Such limitations constrain DPP stakeholders to adopt sector strategies based on idiomatic **conceptual understandings**. Moreover, this issue is not only present in the science-policy interface: even within individual scientific disciplines, there is sometimes a significant difference in the understanding of disaster and risk terminology.

The **relevance of policy makers** in translating positive technological developments (along with their requirements) into straightforward beneficial policies and practice is not to be overlooked. The above tech jargon challenge also makes it **difficult to communicate** scientific discourse to public. The complexity of the subject necessitates an appreciation of these differences and requires an ability to draw on as much **synergy** as possible **between various disciplines**.

For the most part, disaster technology developments focus on the **R&ID of disaster systems** – disaster response technologies, metrics and statistics, risk management technology, as well as technological integration.

More precisely, disaster **system metrics** include disaster **monitoring** (stationary or via remote sensing data and big data). It also encompasses **forecasting**, **early warning**, **impact estimation** (loss statistics and relative impact), disaster **modelling** (experimental, numerical and scenario modelling of mechanisms and/or impacts), **risk assessment** (quantitative and qualitative), and disaster **risk simulation**.

Disaster **response technology** includes **prevention** solutions (inventory, maps, regionalisation, planning, standards, insurance), **resilience** (structural measures, retrofitting, site improvement), and **relief** (rapid assessment, victims aid, assistance and funding, material distribution). Response mechanisms also need to have the capacity to **integrate** most or all of the above in a chain of activities.

Risk management technology covers numerous sub-segments of disaster management: **regulations**, standards, **procedures** and methods, statistical indicator systems, **logistics** and routing, online services and **automation**, **information systems**. Risk management also concerns **loss assessment**, **insurance**

and **financing**. Successful emergency management protocols have to consider online/**digital disaster management** with its related regulation, standards and necessary technologies.

In all of the above segments, **disaster and risk management technology** is repeatedly a macro segment of R&ID output and topical applications of general high-tech solutions which are adopted on a case basis – or proven repeated field engagement over the years – and remain of the innovation areas with the **highest potential for adding value** to DPP procedures and systems.

While trying to look from a strategic point of view, we still need to consider the **pragmatic side** of some exemplary applications we are to propose. Whether the right **toolbox of solutions** includes online notice boards or mobile Apps used for communicating with target communities, or a **fintech system** that facilitates cash transfers to affected groups, the practical aspects have a determining role in the anticipated rate of **adoption success**, including efficiency and effectiveness of DPP and emergency management implementation of a more far-reaching initiative.

As technology has advanced, we have continued to adopt and develop tools that contribute to the **efficiency, impact** and **tracking** of field and administrative work. This also concerns operations in the the broader DPP stakeholder base. Many institutional figures and operatives in the context of Bulgarian – and the Black Sea regional – DPP systems are not entirely accustomed to offering leading digital support to disaster management and to the public they are serving. It is true that technology and innovation are not synonymous, yet the right technology can **inspire and facilitate** new and better ways to pursue the public DPP system mission to protect citizens and the socio-economic environment from the impact from disasters.

Many of the prominent **building blocks** of DPP-related new technology and innovation revolve around **Big Data** – in this case demographic, environmental and other massive databases compiled in complex socio-economic development databases.

Accordingly, many of the **successful partnerships** across the international community, private and public DPP stakeholders and their direct link with academia, have been shaped using **data analytics** to **forecast, prevent** and **mitigate** the spread of critical events and risk factors: whether it's disease, flood damage or other hazards.

The United Nation's Office for the Coordination of Humanitarian Affairs (OCHA) is a prime example of a global agency which **compiles and exports predictive analytics** that can drive **anticipatory action** with respect to crises. All globally relevant macro-regional cooperation platforms also advocate for **early resource mobilisation** as a standard attempt to avert dire consequences.

While undoubtedly international DPP partnerships and capacity building communities do not depend on narrowly defined **digitisation** actions such as the accumulation of Big Data and predictive analytics, it is also true that this side of technological advance has been gaining the upper hand among **leading trends** in DPP policy and practice.

Many additional global initiatives are also characterised by technological innovation and integration. OCHA quotes some of the essential ones:

- **biometrics** and the provision of **digital identities** for people in need of aid;
- **blockchain** technology for supply chain tracking and for sending **digital cash**;
- the use of **drones** for disaster assessment and to deliver aid;
- **3D printing** which can dramatically shorten delivery time and cost;
- **chatbots** for communications with affected communities and segmented mass-communication.

These have all proven to be **promising innovations with great potential** and superb actual results when implemented in the majority of cases. This does not mean that we are not supposed to indicate concrete applications of one of the above technological advancements among our chosen 10 promising practices to replicate. It only means that the **context**, **scalability** and **initial exploration stages** need to be all there to consider them as valid solutions for the Black Sea coastal region and in general, under Bulgarian technological and organisational conditions.

More innovations continue emerging almost every day, with multiple applications, use cases or a single particular niche of a DPP scenario. Some might turn out to be game-changers and others will simply not work as hoped and predicted, or at least not on a scale where they can make a difference and be successfully replicated in similar contexts. Ultimately, the overwhelming majority may have developed fast, yet it needs to be **scrutinised meticulously** since innovations frequently come along with their specific new challenges and collateral risks, some notable, others still unexplored.

Implementing **emerging technologies** like **Artificial Intelligence** (AI), **Internet of Things** (IoT) and **Blockchain** can truly revolutionise the way disaster managers and decision makers acquire, analyse and act upon risk profiles, extreme events and climate change impacts. Facilitating disaster preparedness and overcoming challenges in emergency management and climate adaptation is the core objective of most innovative approaches, techniques and resources.

Whatever is already available, needs to be **systemically regulated, tested and explored** to the best possible benefits of the social good. There is an apparent need to bridge institutional and population awareness and the technology transfer gaps, bringing effectively together **demand and supply of beneficial innovation**. DPP stakeholders are increasingly placing their hopes on technological solutions and scientific advancements, in order to facilitate the integration and scale up of what has been proven as efficient and effective in the field.

There are even a number of technology development **challenges and forums**, organised by the World Bank Group, the United Nations or the European Union. Disaster management authorities and stakeholder groups appear to be rarely among the initiators of such endeavours, yet they are among the principal beneficiaries in their line of work and upwards efficiency demands. Inspiring **key technological innovators** offer unique solutions to problems in the disaster preparedness, response and resilience segments.

Public Awareness Facilitates Wide Adoption

Achieving adequate public awareness in the disaster management sector is not an easy task. It requires persistence, successful communication strategies and education campaigns among other systemic components. Once the level has been brought to an empirically satisfactory acceptance of innovation benefits, subsequent adoption of promising policies and practices is less difficult and more linear.

The wider public is **traditionally averse to rapid changes**, both in developed and developing societies and economies. Where there is insufficient information and educational levels, it is only a natural consequence of underwhelming adoption rates. The last few years – highlighted by the **Web 2.0 and 3.0** and social networking peaks – has proven that the contrary statement might also be correct, to an extent. Aversion to innovation which might be known to all (whether too easy to understand to the point where everyone feels they are experts; or too difficult to grasp where faulty theories abound) may also prove to be difficult at times, even in developed markets and societal structures. This only reminds us that **proper communication remains key** to social and systemic acceptance of any innovation forms. Anything which **requires consensus** becomes problematic, especially considering social media, excessive exposure and visibility, as well as the clash of high-level old generation decision makers and millennials.

Risk awareness among modern technological societies is intrinsically related to the development of **new types of media and communication technologies**. New media functions and roles, especially social media and its Big Data dimensions, are generating new ways for emergency professionals to communicate with the public, and vice versa.

Challenges related to **data protection** and **privacy** breaches add up to the new media's undesired potential to **curtail personal liberties** through data misuse. We have learned that not only our physically vulnerable society is susceptible to risks (i.e. pandemic); it is also subjected to digital risks such as a global "**infodemic**". The spread of misinformation and disinformation may and is repeatedly used to damage social relations, stigmatise communities or incite tensions. This adds up to the aversion to innovative policy and practice, even among educated population groups and proven professionals in their own field.

Embracing technological benefits and advancements does not mean we have to leave behind cornerstone values and societal principles. More importantly, there is currently a perceived **lack of research** that explores precisely these aspects - looking beyond technology and examining the **impact of digital transformation** on the full life cycle of disaster management, both on national level and global levels.

Integrating **interdisciplinary concepts** and considerations will leave us with a more comprehensive understanding of what is practically replicable, safely communicated and technologically possible out of selected leading research fields and applications. Methodologies would range from disaster management approaches to advanced information systems and pragmatic business management considerations. Understanding the impact and determinants of the current **digital transformation** and **technological revolution** on DPP systems globally will help us appreciate and evaluate more adequately Black Sea coastal region capacities and growth potential.

The focus on disaster management innovations, respectively, presents strong transdisciplinary characteristics. From theory to methodology, from technology to governance systems – advancements must be broadly developed from the perspectives of **science and engineering**, as well as the **humanities and social sciences**.

Ultimately disaster risk science and DPP management are a “super disciplinary group”. Researchers which are published as promoting innovation in this macro-field have, indeed, a wide knowledge and background in **Geosciences** (Geology, Geography, Atmospherics and Oceanology, Geo-mathematics and Geophysics, Geochemistry, Earth Digitisation and so on). Others are experts in **Life Sciences** (Biology, Ecology, Medicine, Pharmaceutical Science, etc.), as well as traditional Ec**onomics, Management, Statistics, Physics, Chemistry, IT** and **Technology fields**.

Communication advances require Linguistics competence, as well as History, Philosophy, Sociology, Political Science, and Legal preparation, among numerous possible academic and research qualifications.

In purely pragmatic terms, it is essential to remind us that while the majority of innovative solutions stem from scientific explorations of the **Exact Sciences**, the **Humanities** provide an indispensable key to adoption rates and social accord: Information efficiency through Communication and Education Campaigns contribute by providing the crucial vehicles of **clarity** and **consensus**.

Data-Based Decision Making Raises Solution Sustainability

As true as this is in most public governance fields, it may not appear a linear consideration in DPP and crisis management – especially provided its post-event reactionary nature, emergency needs and impulsive decisions at times. Yet, it is just as important and even more so, considering the lives and impacts at stake, to act, adopt and follow policies and practices **based on data and exhaustive information**.

Data-based **decisions, solutions and justifications** for serial piloting and implementation of DPP practices are paramount. This is no field to make experiments and empirically test solutions.

In our digitised era, data is probably the **most valuable asset**. Thanks to available technologies, **social networks** are a shorthand example of data ecosystems which can also function as data generating platforms. On the other hand, **machine learning** continually advances, creating more potential tools for solving humanity problems.

One of the most important applications of the above-mentioned technologies is in **emergency evacuation**. A comprehensive and responsive toolset that can be used in evacuation scenarios provides enhancements to fundamental disaster management practices. Multiple benefits stem from a well-developed and innovative methodology that helps first responders.

Frameworks of **decision support systems** need to eventually accumulate sufficient data amounts (and types) from different data sources, in order to provide its measurable contribution to decision making in DPP and public governance. Once again going along with the above example, analysing feeds from social media and other first responder channels provide crucial insights which can be translated into **operational recommendations and strategic information**.

Machine learning tools, on the other hand, are examples of decision support systems which **generate possible hazardous scenarios**, carry out **simulations** and present the best and alternative **decisions for optimal management** of critical events and DPP unit actions.

The most impressive implications similar methodologies are exemplified by their ability to **measure community sentiments**, generate smartly-designed **hazard scenarios** and propose the best **emergency evacuation routes** via interactive notifications and distinctly innovative features.

Further adoption of **deep learning** algorithms and **IoT** frameworks enhances data-based decision support system, providing more and more alternatives, training scenarios and management options.

In the context of the **Covid-19** pandemic little is considered as positive or beneficial. Nevertheless, lessons are important, and an encouraging aspect is tied to the fact that **data-driven decision-making** in most countries is now driving public conversations about how the world, the nation and the region should response to such extraordinary challenges. Transmission **coefficients**, growth or decrease **rates**, coverage **maps** and **curves** have essentially determined restrictions and openings, healthcare efforts as much as policy and practice. And given that this was not the case in many countries and not a typical experience, it has helped many DPP systems grow, evolve and adapt to a new digital and data-based reality.

Various **modelling and forecasting** applications are, of course, not new to disaster and humanitarian planning and preparedness. Just a couple of decades ago, however, it was mostly a process of contingency planning involving for innovative disaster managers, largely in corporate contexts of high-level humanitarian decision making. Nowadays, DPP managers use **Artificial Intelligence, Machine Learning and predictive analytics** extensively. The discipline has evolved to quickly and efficiently analyse and make decisions about how to respond to a crisis, as well as predict and mitigate a potential upcoming one.

Integrated disaster risk governance paradigms cannot remove from systemic consideration technological advancements and digital tools. When deliberating the synergy of green development and DRR, for example, successful collaborative paradigms employ predictive modelling of DRR resource allocation faced with critical issues of scarcity and efficiency. Stakeholder involvement is a resource in its own right, and it also can be planned to improve DPP use and effectiveness. The ultimate goal of data-based decision-making paradigms is to improve the efficiency and effectiveness of integrated DPP systems, often by optimising resource use.

Achieving a balance of development and safety via effective disaster risk reduction and an overall plan of sustainable development brings integrated disaster risk governance to a new and more **strategic level of efficiency**. Promoting **green development** also means planning for and avoiding a number of future risks. Being able to do it while **integrating resource distribution and data-based decisions** in the current DPP priorities and system operation is a process lauded and exemplified by both the UN and the WBG, ever since the establishment of the SDGs and around the time of the Sendai Framework.

Managing development risks is characterised by the several **instrumental goals** (as defined by WBG sustainable investment priorities in 2014):

- Coordinating the establishment of a resource-saving and environment-friendly society, the promotion of green economy, and progress toward a circular economy;
- Enhancing the administrative functions of governments at all levels, and promoting the roles of other stakeholders (entrepreneurs and households) in integrated disaster risk governance;
- Increasing integrated disaster risk governance resource utilization efficiency and effectiveness by optimising the coordination of DRR plans at different levels and sectors;
- Achieving synergies in innovative development that is coordinated, green, open, and shared, promoting the establishment of "win-win" models for all.

The establishment of **regional** integrated disaster risk **governance synergies** is not in contradiction of such **general models** and global **data-driven instrumental goals**. They have their important supportive roles in improving regional and community response capability to more localised and specific disasters.

Data-supported decision making and policy also accommodates the **importance of trans-regional and international collaboration**. It is crucial in improving DPP stakeholders' role in both national and international disaster risk governance. This **raises the collective capacity** to respond systematically in individual or global disaster events.

Collaborative efforts and initiatives build up **functional and policy relationships** between key DPP stakeholders, enhancing a system of continuous improvement and institutional adaptation; evolving operational mechanisms and **comparable best practices** even in seemingly unrelated fields such as regulation and legislation. Collaborations have proven to effectively guide the improvement of response capability in both event-based disaster management systems and global challenges.

The Impacts of Globalisation on DPP Paradigms

At the current rate of globalization, **modern disaster risks** have acquired previously unimaginable **spatial contexts**. Stronger systemic impacts and features, as well as greater uncertainty and unpredictability have stepped in more than ever before – even to the extent where data-driven decision support systems and modelling may seem to result inefficient.

Disaster risks are no longer a matter of single, one-shot events, but a new societal norm. We have entered the "risk society," and face the situation of "living with risk", as per UNISDR definitions. DPP paradigms need to establish **new emergency and risk management systems**, which is also translates to new challenges to disaster risk science and DPP research.

Emergency management systems are more or less formal in different national contexts. They play, however, an equally important part of the disaster response system and lay the foundation of local and regional disaster event response practices. Traditional emergency management systems consist of ex-ante prevention, event "coping" and ex-post recovery. They have long ago been **challenged** by multi-hazards, **disaster chains** and **compound risks**.

Disaster management science and topical research have gone a long way towards understanding and revealing how we can improve emergency management capacity against **large-scale disasters** by regrouping disaster management administrations, establishing new schemes, improving legal systems, encouraging applied science and technology applications (as part of applied R&ID). **Successful systemic answers** also include the restructuring of educational and cultural systems, the enhancement of rescue systems, an empowerment of social mobilisation and improvements in emergency resources access and distribution.

New-generation disaster management schemes, administrations, systems and response units are established to save people's lives and property from disasters **by using science, technology, planning, and management measures**.

Globally, emergency management **systems differ substantially** according to national administrative and legal systems, as well as institutional structure. Among leading economic and DPP powers, diverging examples abound.

China has adopted an emergency management paradigm of "**centralized leadership**, integrated coordination, management by category, **multi-level responsibility**, and jurisdiction management".

The **United States**, on the other hand, have been functioning in a **dual-core system** – Federal and State administration. Such a division gives prominence to Federal disaster-related agencies and emphasizes the role of responsible agencies.

Japan adopted a system of **centralized management** with the participation of local governments and **departments**.

Russia has its Ministry of Emergency Situations which takes complete responsibility for commanding and coordinating emergency situations, subsequently reporting to the President's institution.

The **European Union**, despite not being a stable transnational federation, has its similarities in handling large-scale emergencies, when n**ational governance takes precedence** over regional jurisdiction, with the exception of the largest countries by territory and industrial development (Germany, Italy, France, etc).

Despite all of the above differences, there are **common traits** to successful emergency management systems and **globalisation trends** and common challenges make them converge increasingly. Substantial crises have revealed the need for a well-structured command system, solid legal support, strong rescue teams, extensive social mobilisation, efficient joint defences and control mechanisms. These are all systemic features which are the **traditional bases** of DPP and response mechanisms.

Today's emergency management paradigms consider as **indispensable** a strong and consistent **scientific and technological support**, a **responsible social environment**, as well as timely and accurate **online information services**. Modern DPP requires substantiated advancements in all of those fields, justified by both theoretical and practical tests that identify which system could be more efficient or effective when facing particular types of emergencies.

The United Nations Office for Disaster Risk Reduction (UNDRR) has emphasized the importance of developing a strategy of "living with risk." **Interdependence** and **complementarity** between different types of disaster risks are intensifying in the era of **globalization**. The occurrence of **disaster chains** has become more frequent and evident, with more complicated mechanisms and larger scale impacts than before.

Traditional disaster risk management systems are already the ones based on quantitative measurement and assessment, as well as an array of expertise from related single disciplines. Even well prepared DPP ecosystems are facing a series of challenges stemming from multi-hazards, disaster chains, disaster compounds, and global change.

Innovative disaster risk management systems must follow the overall trend of a new "**risk society**." From a UNDRR perspective, disaster management deals with specific actions in DRR, while **DPP and disaster governance** emphasises **institutional arrangements**. The way this study presents DPP is from a standpoint of competence and jurisdiction range, overseeing but also including practical implications of policies and practices – such as the ones we aim to identify and describe.

The International Risk Governance Council (IRGC) has advocated a change **from risk management to risk governance**, integrating DRR as part of DPP and green planning and development. Holistic national and transnational approaches still have the population well-being and economic sustainability at the centre, while they also add coordinated green development, long-term prevention and integrated innovative DRR as part of DPP systemic response.

Organisational, scientific and technological innovation, as well as private-sector participation are all **horizontal supporting elements**. In an era of globalization, more comparative studies are needed to understand where disaster risk management science and policy will lead us in the long run. Current lessons are tragic but invaluable in that respect.

Integrated disaster risk governance needs to pay special attention to modern interdependence between human and environmental systems and related research. Without foregoing essential safety concerns, the **human and environmental dimensions** are almost equally visible at present and accordingly represented in **topical research**. This has raised the bar for DPP systems and current global emergency responses, having acquired the incremental responsibility of **integrated prevention** and **responsible planning**.

Select Promising Practices

The following is a list of **identified promising practices** that possess the potential to be beneficially **adopted and scaled up** in the context of the Bulgarian Black Sea coastal region DPP institutional structure and emergency management systems.

While this is merely a limited list of such promising innovations, it is representative of some of the most important trends in **socio-economic research**, **governance practices** and **technological advances**.

The illustrated cases are either in their concept or test phases, early piloting or tentative regulation efforts. None of the below solutions have been implemented on a serial scale, whether national or regional, with consistent use and visibility at the time of writing.

01 – Blockchain Capabilities for DRR and DPP Management

United States

Blockchain has been considered a **disruptive technology** on its own, based on proven techniques and applications over the past decade. While exemplary applications are mostly known to have brought us **innovative business models** and **security systems**, we will explore some concrete application scenarios from the United States. Yet, they remain largely in their theoretical or test phase, not having been adopted by a major DPP system.

Essentially, our study will explore **Blockchain technology as a paradigm** rather than a narrow single solution in DPP, as it still has almost unlimited and unexplored potential for beneficial adoption and further development.

The application of Blockchain in **safety and security** fields goes far beyond the famous cases of Bitcoin transactions and other cryptocurrencies. Indeed, Blockchain has begun to transform many business sectors and practices. From **supply chain** to marketing, commercial organisations benefit from innovative applications of this technology into account. Blockchain is viewed as a **complement** to other disruptive technologies. Along with AI and IoT, for example, Blockchain generates synergies that transform governance and business ecosystems in previously unimaginable manner.

We have provided below a shortlist of some **essential use scenarios** of Blockchain, with particular focus on **safety and security, public governance and administration** – all directly related to DPP management and potential public system vulnerabilities. The definitions come from an open source community (**Hyperledger**, an initiative of the Linux Foundation) which focuses on developing stable Blockchain frameworks, tools and libraries ready-made for public governance and enterprise deployment.

Blockchain can be used and is increasingly considered as a **viable solution** for:

- **Supply chain** and **logistics** management, leading to **resilient infrastructure**
- Preventing **cyber risks** and their cascading impacts
- Implementing Blockchain inside **Business Models capabilities** to withstand a crisis
- **Crisis Management**
- **Supply chain for vaccines** and other **critical material and services**
- **Identity tracking**
- Blockchain tracking for **communication and behaviour**
- **NGO coordination**
- **War**, guerrilla, counter-insurgency: Blockchain used to organise government response
- Blockchain as a **destabilizing technology**
- Adoption of Blockchain as a **stabilizing mechanism** in a turbulent context
- **Smart contract** and uncertainty settling
- **Perceived trust** in Blockchain is an intangible public asset
- Perceived security issues in Blockchain **raise awareness** yet prove its **reliability**
- Initial Coin Offering (**ICO**) and Security Token Offering (**STO**): **innovative ways to fund** companies and other endeavours in hard times
- Blockchain as a **disruptive innovation technology**

• Using Blockchain to **reassure people**

• **Artificial Intelligence** and Blockchain for organizations of all types

While many of the above contexts and use cases may need further clarification for uninitiated stakeholders, the essence of this revolutionary technology consists of **providing new channels of stable and secure collaboration** among **public service provide**rs, including **relief agencies**, **DPP stakeholders** and **operators**.

Blockchain can organise better, shield more efficiently and distribute resources in a secure manner. It could also alleviate some of the practical burdens that disaster survivors regularly face, such as resource distribution, location, identification, communication, and many others.

Blockchain and the future of disaster relief

Having considered the main potential applications of Blockchain as an unexplored yet **promising technological solution** in the DPP sector, we will illustrate a **more specific idea** of such an application.

After a number of seasonal **hurricanes**, the United States Federal Government and the States have been looking for more systems stability, utilities reliability and financial and operational security. After the extremely active 2017 hurricane season – with at least 6 major hurricanes out of 17 relevant storms – the estimated damages were around USD 300 billion. **IBM** was one of many organizations that stepped up to offer technological support to the Eastern Gulf Coast and other regions impacted by severe weather.

Surveying the vast array of stakeholders attempting to provide rapid, effective and reliable services, the company saw the potential value for a **Blockchain solution**. The technology itself would be ideal to help solve longstanding challenges that arise in the wake of natural disasters. Instead of organisations keeping their own separate ledgers of disaster relief and recovery activities, Blockchain might provide a single, **shared and immutable version** of all recorded steps. Such a **truthfully**

recorded track of DPP and emergency management behaviour would be distributed on dedicated networks according to stakeholder permission levels. Any efforts to alter the records would produce inconsistencies. Any mistaken data entry would produce discrepancies and require rectification.

The capacity of Blockchain to introduce "**smart contracts**" could also programmatically be exploited to **execute pre-set business rules** that govern transactions between organisations. This would **speed up** numerous processes and greatly **reduce operational risk**. Resulting platforms would be able to deliver both the **security and privacy** necessary for efficient collaboration and coordination of contract matters and operational relations across stakeholder chains.

Later on, in **2018**, teaming up with the **Texas A&M University**, IBM continued exploring the disaster recovery landscape in an attempt to build a Blockchain **proof of concept** (PoC). Working directly with survivors, the Federal Emergency Management Agency (FEMA), the Small Business Administration (SBA), private insurers, inspectors and other government officials, the researchers tried to understand their needs and challenges. They finally settled on specific DPP and emergency management issues to address.

The research team designed and built a **PoC** focused on removing many of the **procedural challenges** that survivors face in the **disaster relief** process. An important aspect was to **plan for scalability** so that public assistance stakeholders of various categories might be included in the future.

The projected use model was shaped thus: Instead of filling out and tracking multiple applications with different organizations, survivors use the PoC to **complete a single application**, control the aid they'd like to apply for and access their information, all in one place. The structural specifics of Blockchain allow for the creation of **immutable inspection reports** of damage by inspectors and local partners which then receive necessary trusted visibility, passing from initial evaluations towards repairs and overall reconstruction processes.

In this way, related DPP stakeholders are able to **follow through** in what way and how much aid has been allocated to each survivor, ensuring that due assistance is distributed fairly to impacted communities needing it on a priority-wise basis. More importantly, this reduces undue **alterations**, **external influence** and the threat of **fraudulent claims**.

Public authorities can exploit Blockchain capacities to better **visualise and track assistance distribution** and **reconstruction progress** for more accurate **planning** and **forecasting** efforts. The approach allows to identify and establish milestones, targets and requirements, as well as to compare localised gaps. Crucially, since Blockchain records are **verified by all**, the collaborative yet trusted information is now **distributed** among the spectrum of stakeholders via shared ledger resources, uniformly and at the same time. Hence, the traditional administrative and **procedural burdens**, as well as **trust issues**, especially considering the sensitive times of crises, are equally **shared** across the stakeholder spectrum. And ultimately, the impacted population is considerably **empowered** with innovative tools that enable them to participate and govern their information.

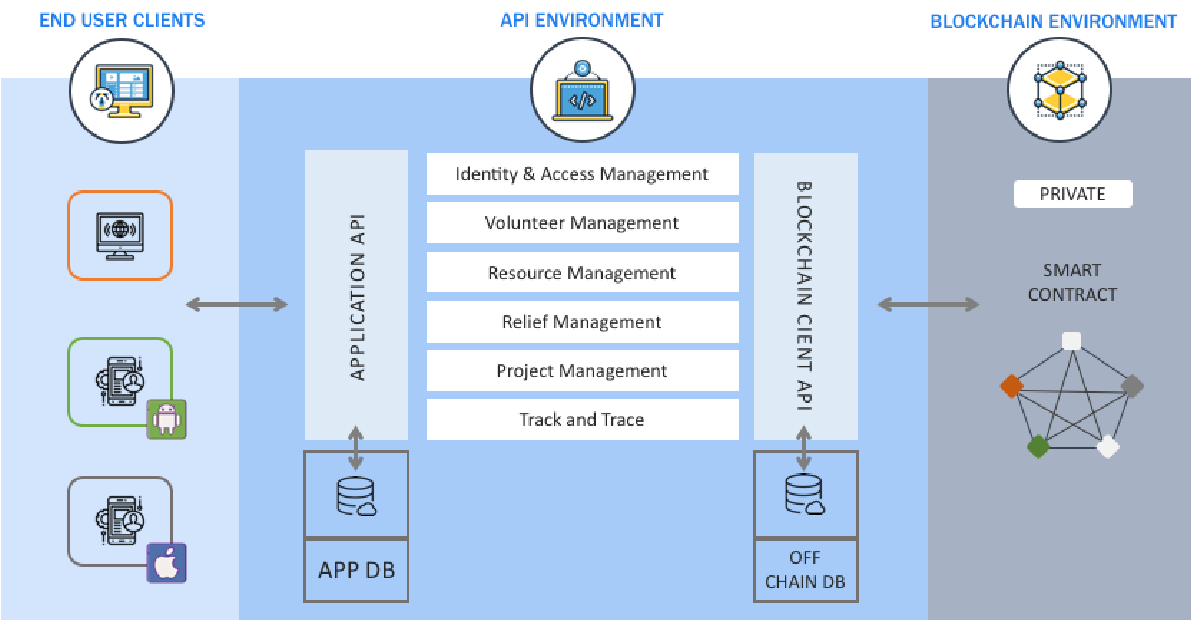
Blockchain technology has the capacity to offer shared common tasks, allowing for better collaborations. Working and preparing together an output means also responding together to feedback and maintenance. When used in the DPP sector, **coordination efforts** are always of the highest importance. Blockchain will reinforce their value, avoiding scenarios where coordination is the weakest link – and we know many disaster events where that has happened.

Administrative capacity, technical **expertise communication** chains, **fraud**, **delays** in responses, inability to **plan or react** accordingly, inefficient **resource distribution**: these are all individual and common tasks and responsibilities which are hard yet essential to coordinate in a timely and efficient manner during crisis management. Such challenges increasingly test the **bonds of trust** that uphold socio-economic realities and politically motivated efforts to improve DPP management and distribution. While the highest added value Blockchain provides is namely in the coordinated and shared contribution and trustworthiness of processes that use it.

This is also essential when planning response mechanisms and building up the DPP ecosystem. Blockchain brings along its inherent **trust** and **transparency** qualities, provides the ability to control how we **collectively prepare** and **respond** to challenging events. Implementing information systems, communications channels, record ledgers and resource distribution methods along the lines of the above proposal is **cost effective** and **not** excessively **difficult** to carry out. The Black Sea coastal area and its local and regional authorities and DPP stakeholders have much to benefit from a similar solution as the one outlined.

The figure below represents graphically the basic and most essential resource distribution methods and channels which could be implemented via Blockchain.

Figure 4. *Blockchain resource management in DPP contexts (www.hyperledger.org)*



In an attempt to narrow down the application scenarios, we present a schematic outlook of the **key challenges during disaster relief efforts** which would benefit from the technological innovation advancement presented by Blockchain infrastructure:

- Lack of **trust**, **transparency** and **auditability** of the relief efforts to ensure resources are used for the intended purposes and in an efficient manner;

- Slow and difficult **registration** process for volunteers and external relief partners;
- Lack of **coordination** across organizations;
- Often, although not always, lack of **single channel** or **process** for **donors** and **agencies**
- Difficult **collection** and **distribution** efforts leading to **duplication** of efforts and waste
- Missing or **improper recording** of activities and transactions associated with the relief efforts

The response which Blockchain infrastructure provides is ingrained in its essence. The application scenarios above closely match the potential of provided solutions, and – from the point of view of **enterprise architecture** – disaster management and relief efforts rely mostly on **collaboration and coordination** between various stakeholders, meeting diverse demands and exchanging diverse goods, resources and services.

Even when not considered "broken", classical supply chain may be optimised if not fixed. This improves local progress and overall **DPP efficiency**. And ***e*ffective emergency management** requires namely **rapid and coordinated action** among multiple parties.

Therefore, while not entirely unheard of in the DPP sector, our study has determined that implementing a Blockchain infrastructural solution would be ideal to **optimise and coordinate Black Sea regional DPP ecosystem efficiency**. A non-exhaustive list of challenges to be addressed is provided with the possibility to **scale up** and **select components and processes** which will be channelled through the innovative Blockchain public-private system architecture:

- Creating a **common platform:** Blockchain brings **collaboration** and **coordination** among all stakeholders involved in relief effort by having a single, trusted ledger.
- Recording and managing **immutable data:** Once data is recorded, it cannot be easily changed, creating an **audit trail** and **trusted system** for collection and distribution of goods and services.

- **Secure sharing & management:** Documents and personally identifiable information can be securely managed and shared between **need-to-know parties**. This enables compliance with any EU and national **privacy regulations** across different regional and jurisdiction competences.
- Optimising **demand reporting:** Demand (needs) from different areas can be recorded on a single network by trusted participants and met by different agencies. This can **avoid duplication** and waste.
- **Improve trust** via third party verification**:** Disaster needs can be verified by third parties to increase trust.
- Acquiring of improving **tracking and visibility:** Inventory of supplies can be tracked from receipt into the warehouses until delivery to the end receiver. This improves transparency and **facilitates logistics**, leading to **faster respon**ses and avoidance of duplication of efforts across relief organizations and DPP managers.
- Dedicating due **attention to volunteer effort:** Volunteer time and contribution can be captured, tracked, reimbursed and audited. **Incentives**, even if just recognition, can lead to more **community engagement**.
- Planning for **future tokenization:** Potential future digital tokenization and setting up explorative links to stable digital coin can be used to incentivise some of the volunteers and local community to contribute more actively

02 – Communications Simulation Deck

United States

Within the last few years, **social media** has become the **go-to communication channel** choice of large population groups when in need to obtain information. However, one of the issues for emergency managers is how an **agency can test** how it would **use social media in an emergency**.

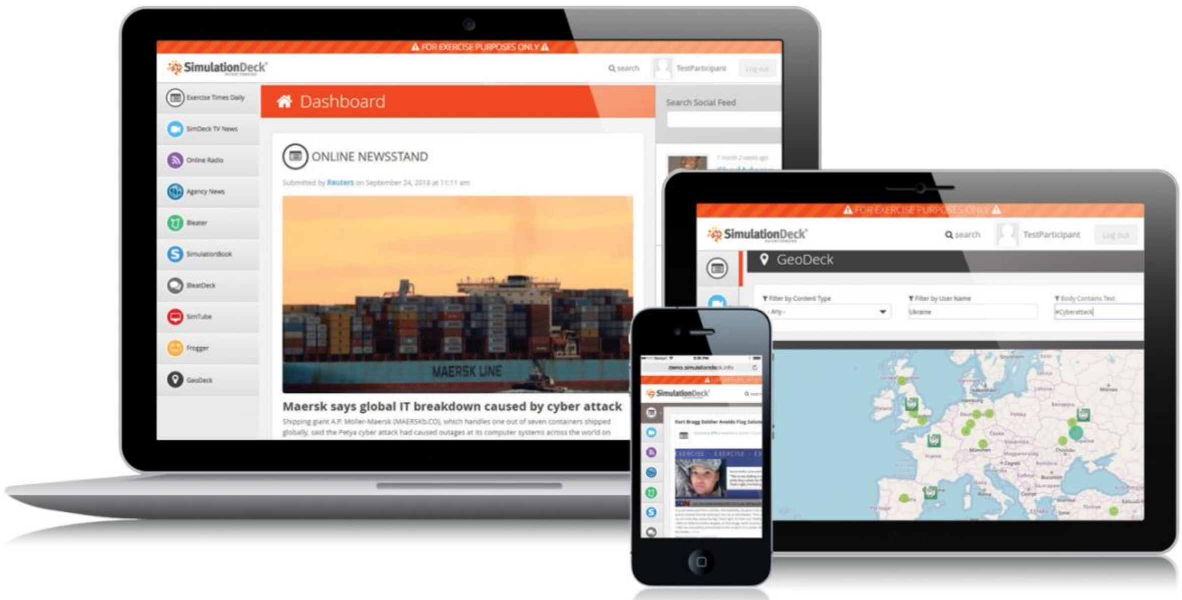
Issuing updates on Facebook (or tweeting), even when preceded and followed by the words “test” or “drill”, is likely confuse people and possibly **start rumours**. The latter can hardly be stopped on a short notice, once the incorrect information starts to spread. Emergency management consulting firm **Nusura** Inc. is seeking to provide a way for agencies to test their social media and **public outreach practices** through the use of its training tool, named **SimulationDeck**.

The secure **Web portal replicates** online communication tools, including popular social networking sites like **Facebook** and **Twitter**, as well as agency **websites and blogs**. Nusura is basing its applied research efforts on actual personnel experiences from the public information sector (some key staff have been involved previously with FEMA in public affairs management). The goal is to help **communication experts** and **DPP actors train** on disseminating. The result should be their ability to provide **timely, accurate and coordinated public information** in relation to emergencies (whether before, during or after)

After both observing and carrying out numerous topical exercises, the company observed a certain pattern which was common to most pilot and preparation campaigns in the field of DPP communication. Communication messages as a **public information function** was not being **tested in a realistic way**. Communication and risk prevention experts pointed out to the **growing role of mock media**. Moreover, public information tests, where available and a practice, were **not addressing responses and reactions** but composing one-way scenarios and dedicating time and training on the message itself – mostly unrelated to an actual handling of even a small emergency.

As a result, the company (Nusura) created **SimulationDeck** to **mimic what happens online** and **in the media** during an emergency. The Web portal has tested with **nine websites**: SimulationBook includes **Facebook's** core features; Bleater simulates **Twitter**; blogging platform **Frogger**; **YouTube** lookalike EweTube; **agency** news; **incident** information; Exercise **Times Daily**, a Web-based newspaper that features **live reader comments**; SimDeck News, a **Web-based TV** station; and KEXN **Radio**.

Figure 5*. SimulationDeck is projected for browser and App availability.*



SimulationDeck does **not require special software**, so it can work on any platform or Internet-connected device. One person working in the simulation cell during an exercise could **act as 10 people**. For example, one staff member could file a newspaper article, then post on the agency's website and then act at the governor's press secretary and announce a surprise press conference. As **events evolve rapidly**, any simulation player may generate an enormous number of "injects". This reflects the public's ability to type and send messages all the same time.

The tool has so far been successfully **tested** at an US Army field training exercise that had about 9,000 service members and civilians from the military, as well as Federal and State agencies. Army officials appreciated the importance of practicing all forms of communication, while public relation experts stressed the role of social media as it has becomes increasingly popular and practically indispensable.

Social media a major means of information source and a way to send out messages for a large portion of contemporary society. Public authority and DPP managers and staff need to allow for adequate topical training, in order to understand how it affects events, DPP management and where it leads communication. With the elevated relevance of emergency management actors, they have the moral obligation to understand the complex information environment which has evolved from **traditional media** to the **mass-participation media** that people are using now, i.e. social media – and the way the **two realities interact**.

Past attempts to create a multifunctional media training tool were not so far-reaching. Examples include **milBook**, a professional networking site similar to Facebook that was developed by the U.S. Defense Department. However, it was one-sided as it was designed with the needs of the user in mind and not vice versa.

SimulationDeck offers a more realistic feel of **multi-layered communication**. It incorporates traditional (albeit **digital) media** with **social media** during exercises. It also allows for **topic tracking** on microblogging sites, with **search features** allowing a cross-media functionality. While not a definitive solution, this particular tool is a perfect example of an innovative practice which will certainly benefit Black Sea region DPP preparation, management and response capacity.

03 – Data Mining Decision Support System

Luxembourg – United States

We have already analysed the importance of Big Data collection, mining, handling and elaboration in today's digitised world. Security, safety and stability mechanisms relying on advanced socio-economic processes to optimise population governance have appreciated the importance – and the dangers – of **Big Data as a powerful innovation** area. Commercial operators and global technological giants have already been exploiting some of its essential inherent values.

Our study also brought up and treated extensively the challenges that timely and efficient DPP management could overcome with a more intensive employment of **decision support systems based on concrete data**.

An applied research team from the Luxembourg Institute of Science and Technology (**LIST**) has investigated potential application scenarios of Big Data decision support systems for **public systems management**, including DPP ecosystems and emergency preparedness.

The proposed decision support system, which is an intelligent, automated and user-friendly application, is composed of **three main phases**. The first phase is the **information extraction tool**, which will turn data into information. The second phase is the virtual experiment based **scenario generation tool**, which will provide all possible hazardous scenarios and responses based on current and possible situations. Finally, the third phase is the **web-based optimisation tool** to make **decisions**.

Phase 1: Information Extraction Tool

This tool extracts the most accurate and reliable knowledge from different **data sources** such as **social media platforms** and **cyber security firewalls** with different data structures. Artificial intelligence and **Machine Learning** algorithms support the development of a decent environment in terms of **data mining** and data analysis.

The most important outputs of this phase are **physical, environmental, physiological and sentimental metrics** in shapes of numerical and categorical factors. They are quantified and established as indicators throughout follow-up stages and simulations. Such factors allow the tool and its users to ponder the concepts of **deterministic and probabilistic measurements**.

As it is illustrated in the below figure, the Information Extraction Tool itself has a structure which is composed of **4 distinct stages**:

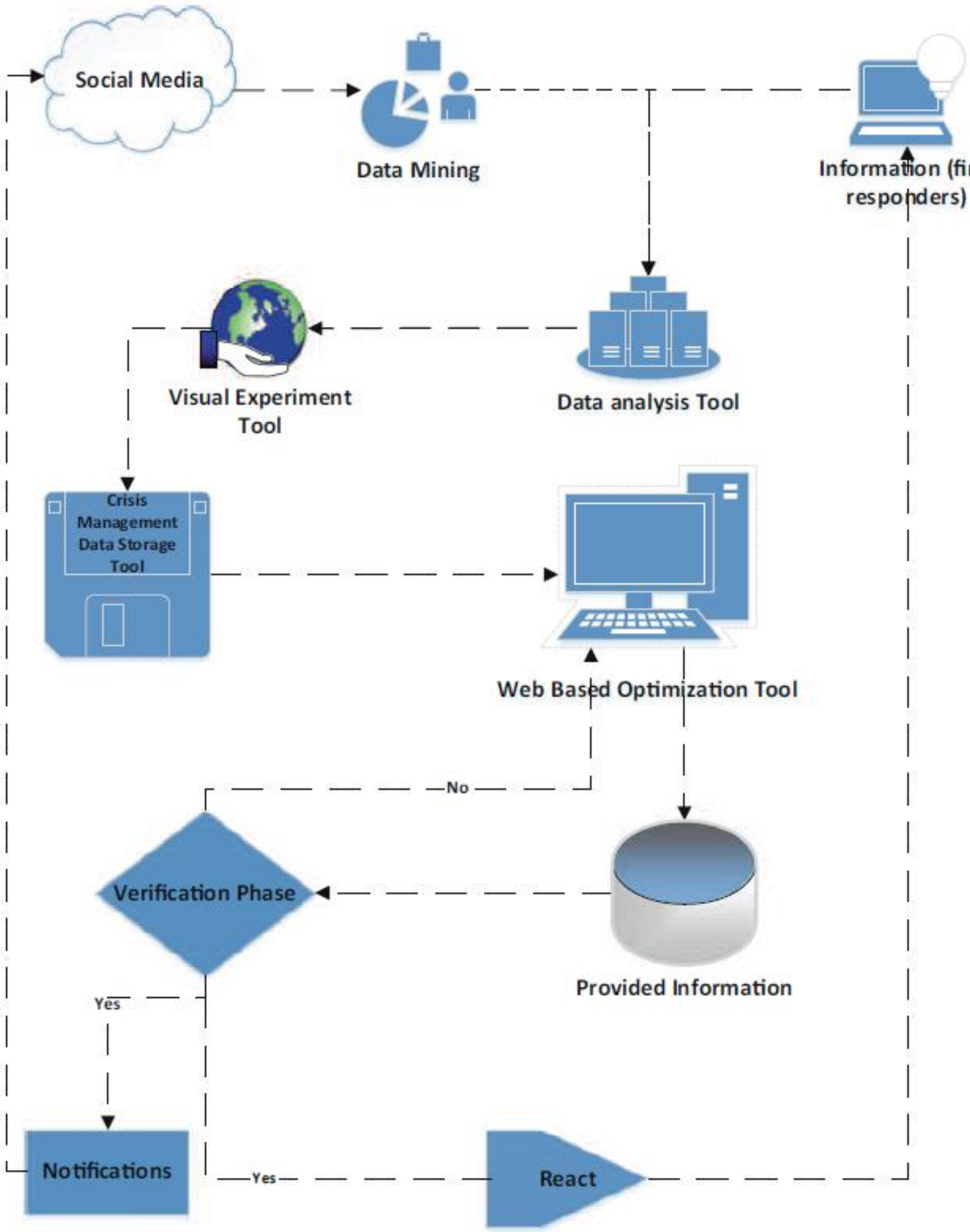
- The first stage identifies the **major social media platforms**, like Twitter, Facebook, Instagram, Google+, Snapchat, etc. Although they are largely known, the platforms evolve continuously and their relevance for the public service management function varies (whether it is DPP or other).

- **Data mining** is the second stage, which uses the Machine Learning based **text mining**, **image mining** and **video mining algorithms** to realize the creation of data, its streaming, and aggregation. It handles raw data through cleaning, categorising, clustering, and visualising.

- The third stage is to **identify the direct, clean and concrete information** obtained from all first responders, tele communication providers, standards and guidelines. This, for example, is the case of quantified equipment of hospitals, fire stations, rescue and research teams, police, army, online maps and weather conditions among others.

- The fourth stage of the information extraction tool is the essential data analytics stage, which handles **descriptive, predictive and prescriptive analytics** to produce **inputs** for the **scenario generation and optimisation phases**. This last sub-stage of the tool understands the **disaster type**, identifies the **metrics**, spots the **location**, understands the **demographics**, measures the **data legitimacy**, identifies **risks**, identifies **attach surfaces**, diagnoses **reasons** for fault and infers **weaknesses**, predicts the future **possibilities**, and measures **sentiments** of people thanks to the Artificial Intelligence innovations.

Figure 6*. Proposed technological framework of the Data Mining decision support system*



Phase 2: Virtual Experiment-Based Scenario Generation Tool

This second tool upgrades previous work and aims to produce **expected causalities**, expected **evacuation time** for infrastructures, expected **system disabilities** and to **forecast urgent needs** and **mappings** of disaster situations.

The tool **generates** different types of **scenarios** and **simulates** them in shapes of different **risk/threat combinations** and **vulnerability parameters** – among those are natural hazards, terrorist attacks, cyber-attacks, infrastructural shortages, different numbers of inhabitants, daytime, night-time situations and many more. The outputs of this phase are stocked in the disaster management data **storage tool** which is using file systems and programming models in alignment with the optimization phase.

Phase 3: Web-Based Optimisation Tool

This last phase is also composed of **four** different interconnected **stages**:

Stage 1, which is a **web-based optimization tool**, is composed of mathematical **modelling-based solvers** of challenges such as routing problems, scheduling problems and resource assignment problems.

Stage 2 is the collection and categorisation of provided information by the optimiser tool and covers the tasks listed below:

• Supports the first responders, people, and disaster managers with **classified materials** – for example, facility and plant plans and other critical information on a need-to-know basis;

• Plans the best **routes and assignments**, according to logistic parameters, schedules and other related information;

• Provides **simulation results** like **3D maps** of smoke spreading, fire spreading, flood spreading, can be used to **identify the best evacuation plan**;

• Optimises response operations by using the **spatial distribution** of trapped people / attackers / terrorists, **predictions** of evacuation times and options, number of casualties, lists of **critical points** and locations and critical information of potentially damaged or burned down assets.

Stage 3 is a **Verification tool**: it validates or modifies the provided information by reviewing the emergency management fundamentals and sending the relief messages. This tool is an **interface** that is under the supervision of **human expert** to facilitate and guarantee the accuracy of processes and pass down (and up) coordinated decision making and shared responsibilities.

Stage 4 of this phase is the **React tool**: it triggers the cyber security module in case of any **cyber-attack** the duty of the react tool is feeding back the system with factors to be used by **scenario generation tool**.

Essentially, this last Phase 3 is able to generate as much useful information, support tools and materials for feeding social media that it serves as a **support platform for communication strategists** as well. This would include types and amount of information to be shared and/or secured by blockchain technology, enhancing the viral ability of social media by sharing techniques – including simplified instructions (plan, photo, video and comments) for trapped people – as well as providing necessary information for access to emergency services (e.g. internet or emergency calls made possible even without a SIM card).

The applied research solution proposed by the LIST team of scientists is entirely based on **technology, digital infrastructure and computing** capacities, as per their specifications. It could be implemented safely and without altering too much the institutional structure of the Black Sea regional DPP, yet would yield a number of **benefits to decision makers, operators and the public at large**.

04 – Automated Wildfire Protection Systems

United States

According to the United States network of National Centres for Environmental Information (NOAA), in 2017 alone, between January and April there were roughly **53 thousand wildfires** which burned over 2.4 million acres in the country. This was the most wildfire activity since 2000 and prompted both institutions and applied research teams to seek a solution to address some of the perceived territorial and infrastructural vulnerabilities.

The proposed solution is an innovative **fire extinguishing system** linking a **tower-sensor-sprinkler** component chain, which is intended for installation in areas endangered by wildfires (forest or field).

As devastating as wildfires can be, the innovative **Roof Soaker** system proposes a solution that would give property owners an advanced and effective way to respond to the threat. A patent is in place for this yet-to-be-manufactured system. It has been rated well by FEMA and has received positive initial feedback by different DPP stakeholders as well. The Federal Agency has has placed it in its Innovative Solutions category in Emergency Management solutions, particularly related to fire safety and construction standards.

The Roof Soaker has an **infrared tower** foreseen that detects wildfires up to **70** kilometres away and **alerts** both property owners and emergency responders. Following initial detection and system triggering, the installation relies on a rather simple structure of pipes filled with water or fire retardant liquid that can be sprayed over an area of **10 metres around** the structure. Well-placed **roof soakers** can ease some of the strain of detecting and dealing with wildfires for emergency responders.

The **problem solved** by the automated fire protection technology relates to the ability to keep buildings and homeowners away from **dangerous attempts to protect** roofs and surrounding spaces by watering or other activity during a wildfire. It also provides people adequate **time to evacuate** their property while knowing they are taking all precautions to keep their property protected.

It gives emergency responders the advantage to concentrate on the priority fire fronts and the evolution paths in which less homes or assets would be lost. The technology can help save millions in home repair and replacement costs, as well as help lower insurance premiums and provide peace of mind.

How exactly does the technology solve the problem? Sprinklers are preferably used to wet down an area. This results in combustible buildings and landscaping being much less likely to ignite due to flying embers and intense heat from a nearby fire. The soaked structure and landscape releases moisture into the air, this lowers the ambient temperature and **increases the humidity** in the immediate area. These effects extend some high distances above ground level. The result is that the advancing wildfire will tend to be deflected by the less supported environmental pockets and pass by areas protected by the proposed solution.

The **competitive advantage** of the innovative system is in its own particular patented **fasteners**. It is desirable to have a **fire suppressant** device capable of being mounted on the roof of a building that is maintenance free after installation, which can be installed under roofing materials. Furthermore it is desirable to have a device that does not require any penetration being made in the roofing material.

The roof soaker is equipped with an **automatic backup generator** for power outages, and the **water source is not limited** to a pool, pond, well, or a water storage tank. The roof soaker is equipped with a **security panel** that controls the **infrared camera** on the tower which will alert structure owners via their computers and smartphones; as well as alerting emergency responders of the situation.

Figure 7*. Schematic illustration of the Automated Fire Protection system*

While this is a simplified illustration of the proposed solution, it has been **patented** in the United States, although **never** piloted or **implemented** on a large scale as a public protection solution and part of the institutional DPP system.

It has received very positive feedback and results in testing phases, including from US Federal agencies, as quoted above. We are certain that implementing the solution in areas which are difficult to reach or manage along the Black Sea coastal line, yet present consistent fire vulnerabilities, would bring long-term benefits to decreasing fire vulnerability, the protection of people and assets.

05 - Intellistreets

United States

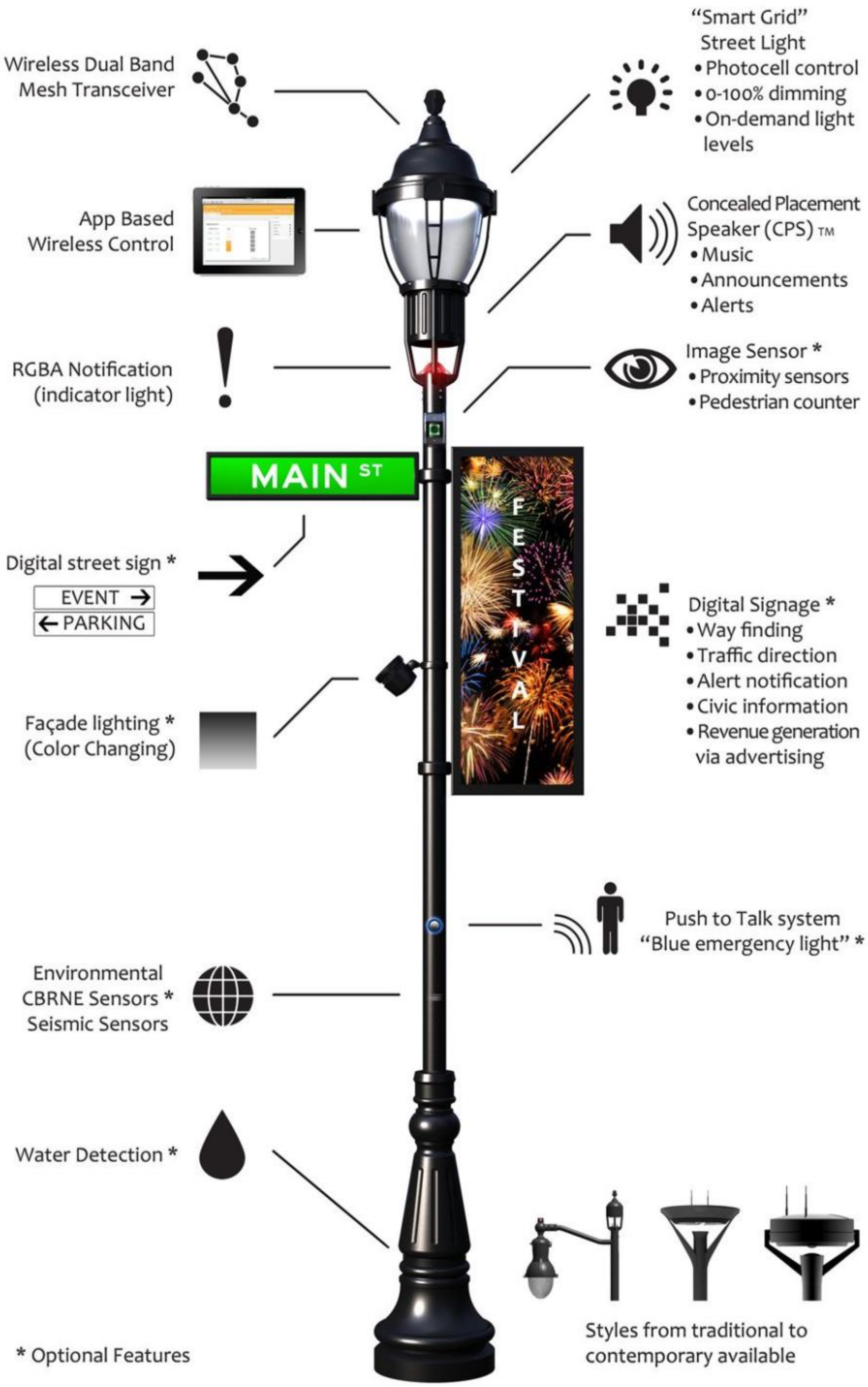
Once again from the United States, we have identified a solution which is advanced, intelligent and could detect, warn, inform and help manage a number of urban threats and disaster risks. An emerging technology that **outfits streetlight poles** with wireless technology to provide emergency alerting, urban security and public safety functions as well as energy conservation.

The system was invented as a response to the chaos created at street level during some notable terrorist attacks cases, as well as following similar and related **urban emergencies**. The company bears the same name as its proposed solution – **Intellistreets**. It proposes to **retrofit existing streetlights** – if a community is not ready or able to purchase brand-new, high-tech poles. While the features vary depending on an area's needs, they can include:

- **emergency alerts**
- **digital signage**
- **hazardous environment alerts**
- **two-way audio**
- **vehicle impact detection**
- **pedestrian counter.**

Existing serial functionalities – such as wi-fi transmitters – and other smart features could also be added on and integrated in the multi-level metrics system.

Figure 8. *Illustrative scheme of Intellistreet functionalities and essential options*


Wireless Dual Band Mesh Transceiver
App Based Wireless Control
RGBA Notification (indicator light)
MAIN ST
Digital street sign *
EVENT
PARKING
Façade lighting * (Color Changing)
Environmental CBRNE Sensors * Seismic Sensors
Water Detection *
* Optional Features
"Smart Grid" Street Light
• Photocell control
• 0-100% dimming
• On-demand light levels
Concealed Placement Speaker (CPS) TM
• Music
• Announcements
• Alerts
Image Sensor *
• Proximity sensors
• Pedestrian counter
FESTIVAL
Digital Signage *
• Way finding
• Traffic direction
• Alert notification
• Civic information
• Revenue generation via advertising
Push to Talk system "Blue emergency light" *
Styles from traditional to contemporary available

Though street lamps may seem like an unlikely tool for emergency management and response, the innovative design of Intellistreets lamps gives seemingly ordinary lighting a powerful **new layer of functionality**. These street lamps are equipped with **environmental sensors** that detect hazards like rising **water levels**, strong **winds**, high **temperatures**, and lethal **gas**. They are also equipped with 180-degree **cameras** that offer a real-time look at pedestrian traffic and developing situations.

Lampposts could detect a number of critical indicators which are pre-set and ordinarily monitored by more complex infrastructure. They can even **display evacuation routes** to help citizens and visitors safely leave an area.

Emergency management teams can use these Intellistreets lamps to **respond to threats** and **communicate essential information** to citizens in the area. The lamps illuminate in four different colours, so area management can use them to indicate warnings, danger, or the safest escape route. Concealed speakers make it easier to make critical public announcements and a double-sided LED banner can display alerts.

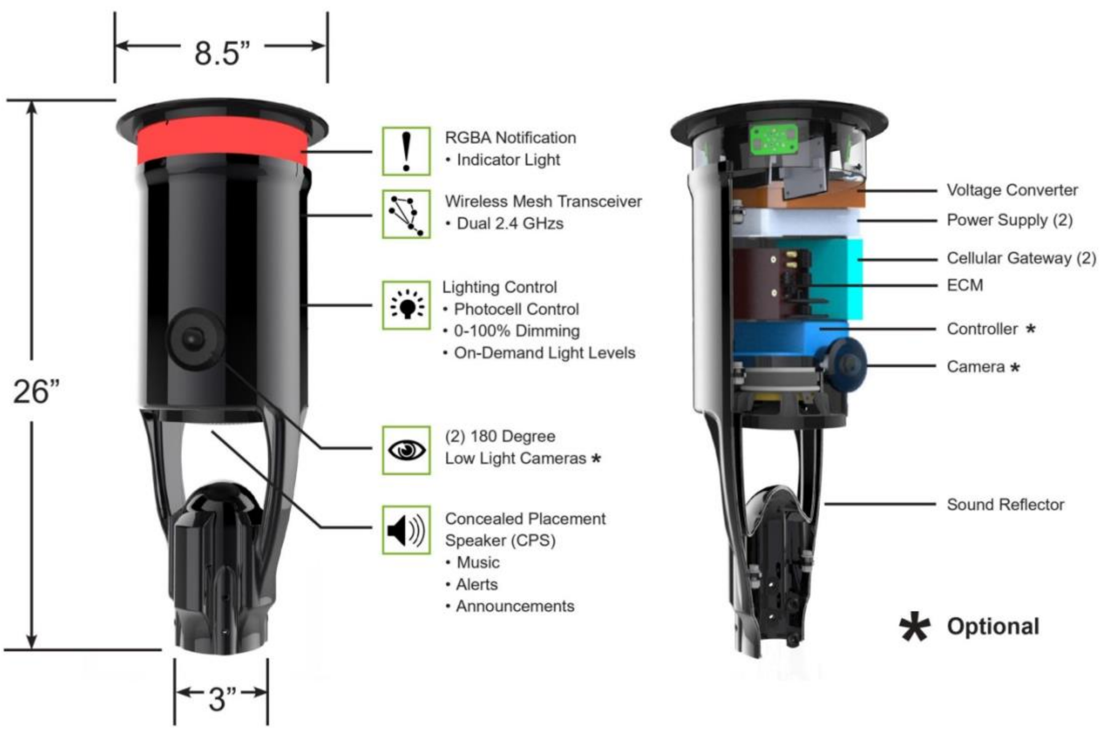
More importantly, with these powerful street lamps in place, emergency responders could gather **essential information about threats** and communicate with citizens at the street level before they're able to arrive on the scene.

At its heart, the technology consists of a dual **radio mesh wireless system** that has **embedded microprocessors**, which allow for information gathering, such as analysis of what a streetlight is hearing, seeing, smelling, etc. This is a method known as **edge processing** – an innovative combination of aggregation, data manipulation, bandwidth reduction and other computing processes **directly** on an **Internet-of-Things (IoT) device**, including in this case a collection of **sensors** into a system. The idea is to put basic computation as close as possible to the physical system, making the IoT device as "**smart**" as possible at the tip of the very piece of infrastructure.

Its advantages are related to the possibility to provide first responders with real field information – interpreted into human language or graphics – that comes right from the site instead of analytics that happen through backhaul technology and processors.

Accessed via a **Web-based system**, operators and first responders can receive an alert when an environmental factor triggers the system. Because the technology is built into each streetlight, a government representative can take action **from a remote location** to make pedestrians aware of a situation. The company provides the example of outfitting streetlight poles with water sensors in an area that has flooding or water main issues. A streetlight with the built-in intelligence would activate a warning light when water reaches a certain depth, e.g. being detected above the curb. Other streetlights in the area that have the technology would begin to flash, warning traffic to slow down.

***Figure 9**. Alternatives: fitting sensors and edge computing into short street-light poles.*



The Intellistreets audio features also increase public safety in a two-way fashion. Emergency blue light buttons allow people to **signal** for help, and speakers provide a way for government officials to **make announcements** or **issue emergency alerts**. Digital signs can display standard information, such as civic **announcements**, and then be **updated** with crucial information like an evacuation route when necessary. The system could feature built-in signage and announcements for standard situations that allow a public safety representative to click a button on the Web-based system to start audio alerts or change what is currently shown on the digital signs. An example is to provide a tablet to **local patrol vehicles** so officers can easily update the messaging when needed.

The technology is not widespread yet, but is being **tested** at the Sony Pictures premises in Culver City, California where digital signs provide departure routes during weekly evacuation exercises. Additional **demonstration** pieces of Intellistreets were installed in Michigan last year for a limited testing round. Although local government officials are not using the system's **"high-tech" tools**, they consider the majority of the features to be largely beneficial.

The proposal has a much more far-reaching potential and could easily be **implemented gradually** in certain priority areas in **dense urban settings** along the Black Sea coastal region.

06 – CrowdTasker

Austria

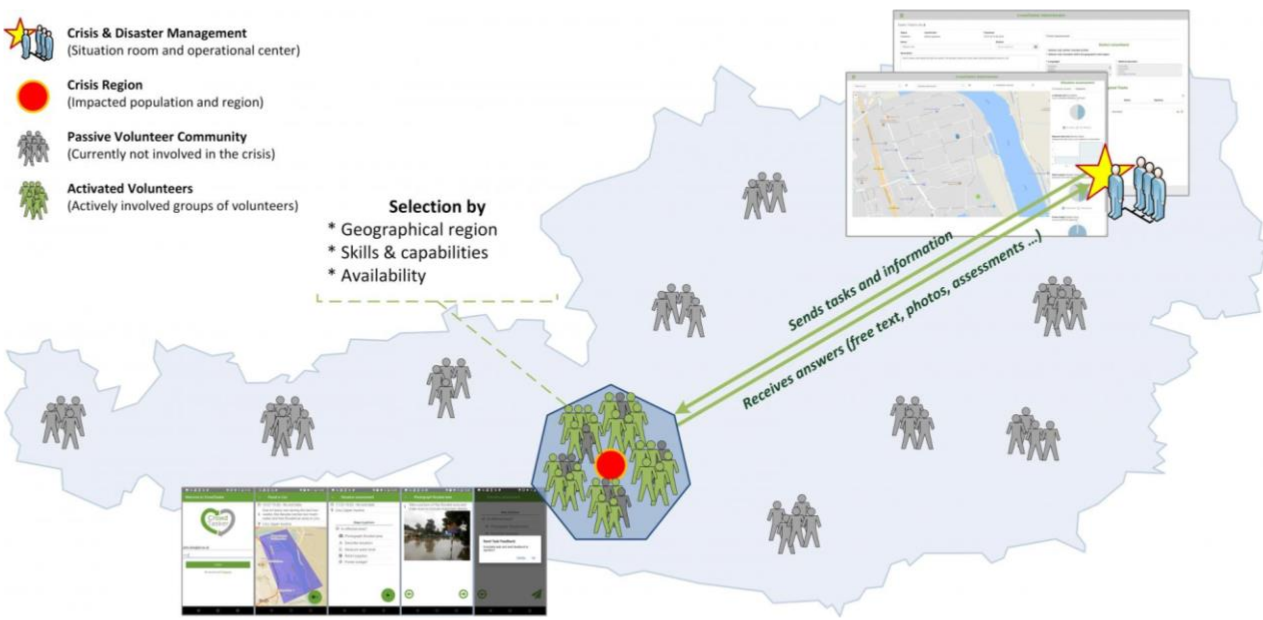
The Austrian Institute of Technology (AIT) has experienced and ambitious applied research teams. They have developed a potentially revolutionary solution named **CrowdTasker**. It enables crisis managers to **instruct large numbers of non-institutional** (either spontaneous or pre-registered) participants and volunteers with **customizable tasks**, **contextual information**, **warnings and alerts**, as well as to **crowdsource information** from them.

The received feedback is evaluated and visualised, as it provides crisis managers with a detailed overview of the situation, which is used in turn to trigger adequate **disaster relief services**.

When working with volunteers – or **even regular field workers** – that are already at a disaster site CrowdTasker allows the crisis managers to:

- Dramatically reduce the time and effort needed to **exchange information** with these volunteers;
- **Differentiate** between the volunteers based on their profiles (e.g. **skills, health**) and **positions**
- Address the people that potentially **possess local knowledge**;
- Distribute and alleviate the **workload** for emergency and response organisations.

Figure 10*. Schematic representation of CrowtTasker communication via segmentation*



The **supported use cases** are numerous. The project team that developed the solution provides some specific and pragmatic examples which have demonstrable added value to DPP management and structural efficiency.

Addressing spontaneous volunteers – CrowdTasker supports volunteer managers and incident commanders by offering a lightweight mode of **registration** and low barrier to entry for spontaneous volunteers that are not officially affiliated with an organisation.

Registration of volunteers is implemented as self-service **sign-up** via the **smartphone** application. Volunteers can create an account easily, by providing an email address and password. Later, they can provide information about their **skills** via a profile page. This information may also be vetted and validated by volunteer managers to provide an indication of trust in the **volunteer's profile**.

Alternatively, volunteers can use the **social media interface** of CrowdTasker (provided via **chatbots**) as initial means of signing up with an even lower barrier to entry. By starting a conversation with the CrowdTasker chatbot, they can sign up to receive **information and tasks** and provide profile information, similar as in the smartphone application, but in an environment that they already use and are familiar with.

Interacting with existing informal volunteers groups – Spontaneous volunteers often use social media as infrastructure for self-organisation and managing their participation as a group. Social media networks have an especially low barrier to entry, as many people are already familiar with their use and mode of operation. Therefore, social media represents an attractive channel for guiding efforts of spontaneous volunteers.

CrowdTaskers **community module** offers volunteer managers an interface with self-organised groups that is easily established by **adding the CrowdTasker chatbot** to the group. Subsequently, the group can receive information about the ongoing efforts. They can also **share perceived needs** of their own through the chatbot, enabling information exchange and **coordination** with emergency organisations and other groups.

The CrowdTaskers community module visualizes this data exchange for volunteer managers and allows for easy ways to **comment or offer support**. This allows volunteer managers to interact with groups that would otherwise not participate in information exchange via dedicated volunteer platforms.

Due to the nature of information exchange (i.e., with groups, rather than individual, registered volunteers), this functionality is intended to **share perceived issues** on a more **abstract level** than in the core crowd tasking workflow. For example, on group may observe (or even form in response to) a blocked road and attempt to clear it; because they need help, they submit this info via the chatbot in their existing **Telegram** group as "Clear Road X" – something that a volunteer manager or other groups can react to (in the form of comments or by pledging support). This type of interaction requires more **self-determined action** on the end of the recipient than the tasks distributed via the CrowdTasker smartphone application.

Distributing warnings and alerts to registered users (alerting) – CrowdTasker can provide real-time warnings, information and guidelines to the public. Recipients can be selected and segmented based on their location to warn them of hazards in certain areas or provide guidance once they enter a pre-defined area. Warnings and alerts can also be restricted to users with specific skills.

For example, pre-registered volunteers can be informed of an approaching storm or flood and given **explanations on how to prepare** and how to **react** when a crisis occurs.

Assigning tasks and requesting specific reports – Volunteers using CrowdTasker can be instructed to report the situation on the field, e.g. for initial damage assessment in a particular area. To achieve this, the incident commander can create tasks that consist of multiple steps (similar to survey forms) to ask specific questions about an incident. Each step consists of a step description, and possible answers (multiple or single choice, numeric, image, etc.).

Reporting can be **restricted** to a certain area and to users with specific skills. All task reports are **located** and displayed on an **interactive map** for the incident commander to provide help task planning and prioritisation.

Crowdsourcing field reports (observations) from solution users – The incident commander can allow the volunteers that use CrowdTasker to **send reports** on newly observed incidents in the field. This differs from the use case "Request specific Reports". The incident commander will get new information about **unknown incidents**. The report is triggered by the volunteer on its own in contrary to the "Request specific Reports" Use case where the incident commander already knows about an incident and wants to ask the volunteers specific questions about a situation.

Once again, reporting can be restricted to a certain area and to users with specific skills. All reports are located and displayed on an **interactive map** for the incident commander, helping to improve task planning and prioritisation.

Conducting just-in-time micro-training – CrowdTasker allows the responsible organisations to micro-train the solution users "just in time" and on a "need-to-know basis", while taking into account their geographic position and profile (e.g. existing skills).

For example, pre-registered volunteers can be informed of an approaching storm or flood and given explanations on how to prepare and how to react if and when the crisis occurs. Volunteers with **special skills** can be given **different information** from those that do not have such skills and a response form can be used to control if the volunteers have understood the information.

***Figure 11**. Dividing tasks, training and instructions according to location, skills or profile*

This solution, also based on accessible and affordable hardware technology, could be implemented on a systemic basis among DPP stakeholders in the Black Sea coastal area. It would raise significantly communication, coordination and understanding among field operators, as well as their managers.

07 – City Management Portal

France

Thales Group is a French multinational company that designs and builds electrical systems, as well as services for the aerospace, defence, transportation and security markets.

Within the framework of a European collaboration project, it has proposed its dedicated **City management portal**, specially designed for **routine management** of city operations as well as **large-scale events** and **crisis situations**.

It would be extremely useful to a wide array of public service actors, security and safety stakeholders and DPP managers and policy makers: Municipal departments and agencies, transport operators, event organisers and many more. They could simultaneously can share information securely, from different places, as well as organise tasks and coordinate their operations in **easy-to-use collaborative workspaces**.

Public operators and DPP managers would have immediate access to a reliable, multi-source information base, including **action plans**, secure **documents** and on-the-spot information from citizens and agency **field staff**. The **smart map** display has clear symbology overlays and colour-coding, as it provides up-to-date and comprehensive **city-wide overview** of the situation, making it easier to monitor operations and make timely, well-informed decisions.

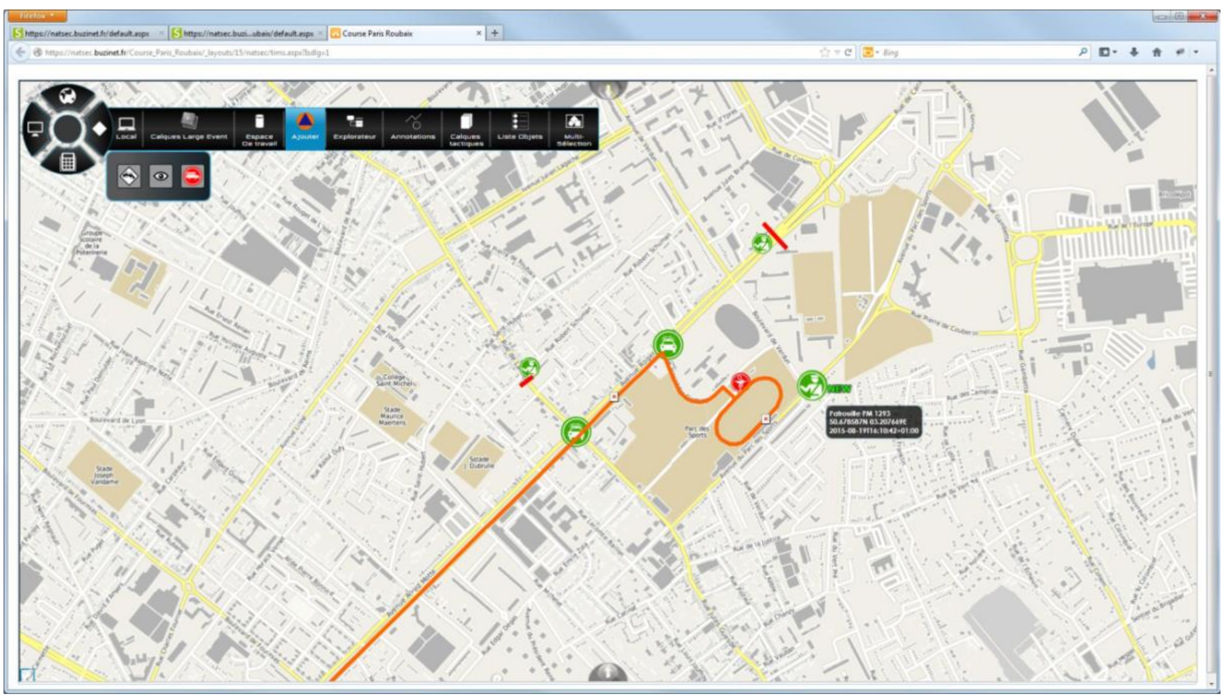
The collaborative platform also supports new tools created by operators themselves. For example, situation **reports**, best practice **guidelines**, task sheets and **checklists**, exercise, **scenarios**, and many more. These resources could help anticipate incidents ahead of time and manage unexpected critical situations.

Several use cases are suggested by the solution provider as exemplary applications of the platform:

Manage a sport event – Various entities are involved in the management of big sport events. This may complicate communication and resource distribution, both in real time and in terms of planning. The City Management Portal enables the manager of the event ensure that all stakeholders have the same information at all times.

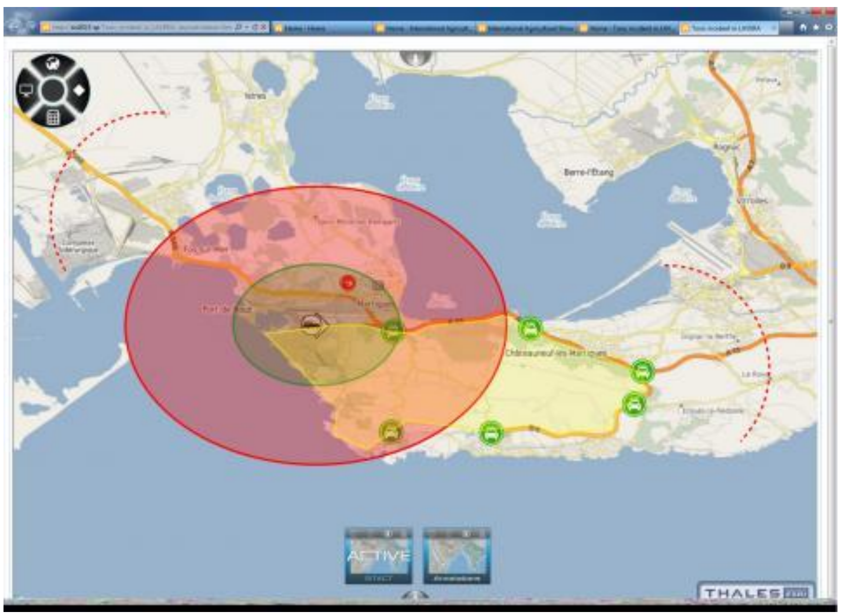
It covers the **planning phase** with its content management system. It also provides the **common operating picture** during the event, as well as **topical data** which would be valuable both generally for event management, as well as segmented by potential scenarios, in order to build post-event reports and analyses.

Figure 12. *A screenshot of the proposed City-Management portal (Event management)*



Management of chemical hazards – A common situational awareness is shared between all DPP stakeholders through an access to a common tool in the cloud. The map of the affected area is shared where resources, hazards, points of interest are displayed. All stakeholders can add their own data. Portal functionality also allows for a shared Electronic Content Management system to be included. These would enlist pre-set response plans and procedures, as well as modifiable reaction types, routes, etc.

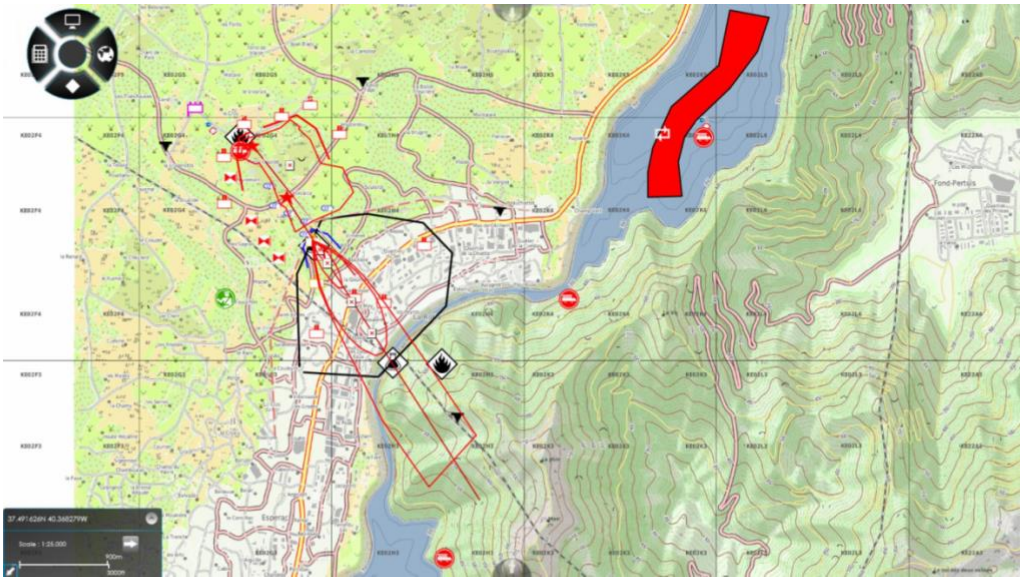
Figure 13. A screenshot of a disaster localisation, reaction and management



Such a system would allow for a series of **crisis management functions** to be optimised and coordinated much better:

- Provide decision support
- Maintain shared situational awareness
- Disseminate a Common Operating Picture (COP) and assessments
- Develop and sustain COP and related procedures
- Collect information from deployed sources

Figure 14. Optimising route for fire response – hazmat interaction mapping



08 – I-React: Crowdsourcing Emergency Management Data

EU collaboration (Italy-led)

I-REACT is a European project which has been developed in EU-wide collaboration over three years. Leg by the Italian LINKS Foundation, it has attempted to propose an innovative approach to integrating emergency management data coming from **multiple sources**. The focus is mainly on citizen-provided data and feedback, via **social media** and **crowdsourcing**, although the system allows for a variety of information types and sources.

The collaboration included 20 partners from 9 European countries and had set out to boost the interaction between research, public sector and business in the field of DPP. Ultimately, the aim was to provide globally relevant DPP solutions to vulnerabilities in the modern digital socio-economic system.

The project lead, LINKS, is a merger of two distinguished research and innovation institutions: ISMB (Istituto Superiore Mario Boella), focusing on ICT, and SiTI (Istituto Superiore sui Sistemi Territoriali per l'Innovazione), focusing on Territorial Systems and Smart Cities, with personnel and know-how support from the Polytechnic University of Torino.

I-REACT solutions aim to **enable faster information elaboration**, allowing citizens, civil protection services and policymakers to effectively **prevent and react against disasters**.

The partnership initiative explored applied research projects and processes that might not only improve specific solution implementation but could potentially offer an **entirely new approach to current DPP models**.

Considering the strain on local DPP governance models, the partnership focused on responses which contemporary society might provide to some vulnerabilities that are the result of climate change – e.g. floods, wildfires and other extreme weather events. DPP systems have to deal with more frequent and intense critical scenarios, posing a challenge for entire risk management systems.

I-REACT has develop an integrated solution which works by gathering, elaborating and modelling of data coming multiple and **structurally diverse sources**. Examples would include existing and updated information from European monitoring systems, earth observations, historical information and weather forecasts. All subsets are then combined with data gathered by new technological developments created within I-REACT. These include a **mobile app** and a **social media analysis tool** to account for real-time **crowdsourced information**. Moreover, the integration of **drones** improve mapping precision and quality, **wearables** to improve positioning, as much as **augmented reality glasses** facilitate reporting and information visualisation by first responders.

Integrating all types of datasets under one platform, I-REACT is able to **empower stakeholders** in the disaster prevention, planning and management. Citizens are involved in **reporting first-hand** information, policymakers are supported in the **decision making** process, and first responders are thus equipped with essential **tools for early warning** and **response**.

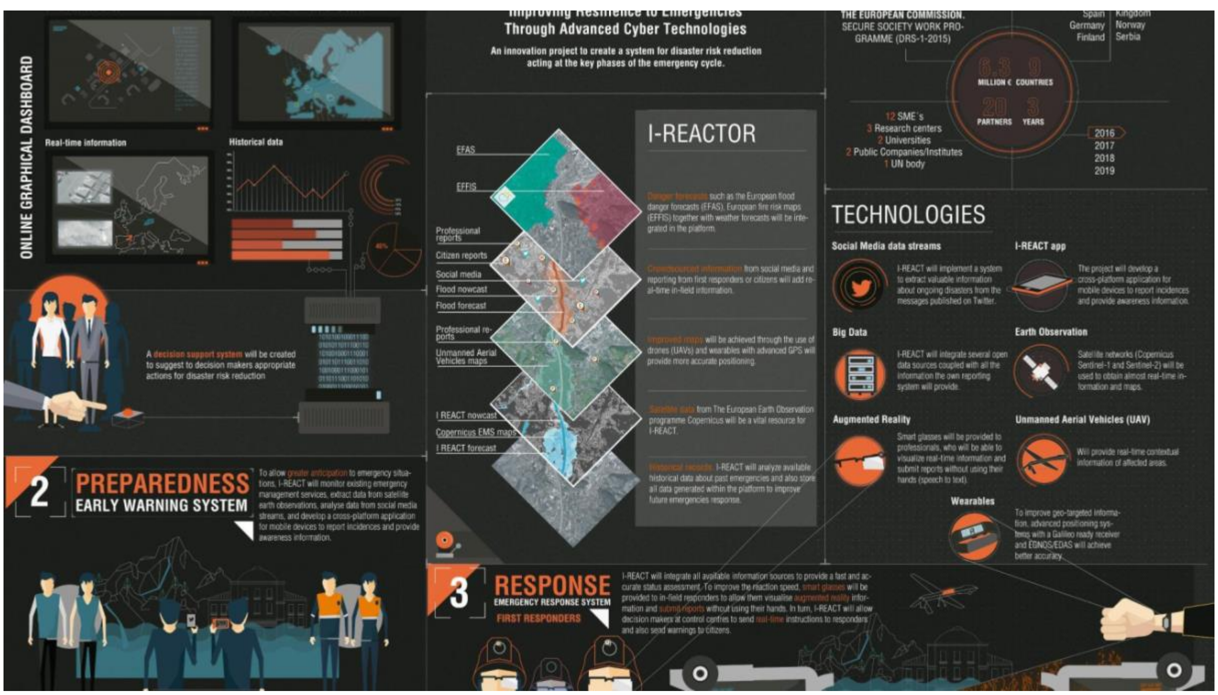
Despite not having been implemented on a serial or public scale, the I-React output solutions aim to provide a European-scale contribution to a more secure and resilient society. It is applicable to practically any hazard, response mechanism or preparedness procedure.

The **illustrative use case** which is provided by the solution developers includes precisely the mechanism of **data integration from dissimilar sources**. The I-React platform is able to integrate and elaborate information from EU and national monitoring systems, real-time observation sensors and IoT devices and third-party forecasts. The mobile App is linked to social media feeds, drone imagery and participating staff wearable devices (the latter two improve positioning). First-rate reporting and visualisation is segmented by user type and current operational or management needs.

The leading relevant **crisis management functions** it covers include:

- Establishing and sharing detailed Common Operating Picture (COP)
- Collecting focused and general information from deployed sources
- Survey or/and investigate the affected area

Figure 15. *Screenshot from the I-React integrated platform*



09 – Big Data Reference Architecture for Emergency Management

Spain – Italy

This innovative proposal is development by the Polytechnic Universities of **Madrid** and **Turin**. It explores the Big Data Reference Architecture as defined and presented by the United States "National Institute of Standards and Technology" (NIST; resulting architecture framework is referred to as **NIST Big Data Reference Architecture or NBDRA**).

The potential for improving efficiency and effectiveness of emergency management based on Big Data systems has been mentioned above. In light of applied scientific proposals by the Spanish and Italian teams (and based on the US foundation of Big Data architecture), the NBDRA has shown more than promising potential to support an **advanced Big-data-based decision system**.

An upgrade of the NBDRA architecture is shown in the figure below, as it has been constructed inductively based on the analysis of existing literature and subsequent analysis (classified according to the CommonKADS task hierarchy, as reported by its creators).

The proposed reference architecture aims at developing a shared understanding of the **applications of Big data for emergency management**. This reference architecture can be used for **knowledge management** by collecting and organizing best practices and for its practical implementation.

Data providers introduce information feeds in the system. Consequently, the proposed reference architecture extends previous taxonomies and includes ICT systems that provide information to the Big data system. Potential data providers have been classified as:

• **Digital sensors**: data collected passively through the use of digital services (e.g., mobile phones, web searches).

• **Physical sensors**: sensors (e.g., satellite, wireless sensor networks and geospatial) focused on remote sensing of changes in human activity.

• **Social media and news media**: the information published on the Internet (e.g., blogs, Twitter) can be traced as social sensors of people's opinions and intents. Especially relevant is geo-located social media.

• **Open data**: open information provided by governments (e.g., census, statistics) and organizations (e.g., Wikipedia).

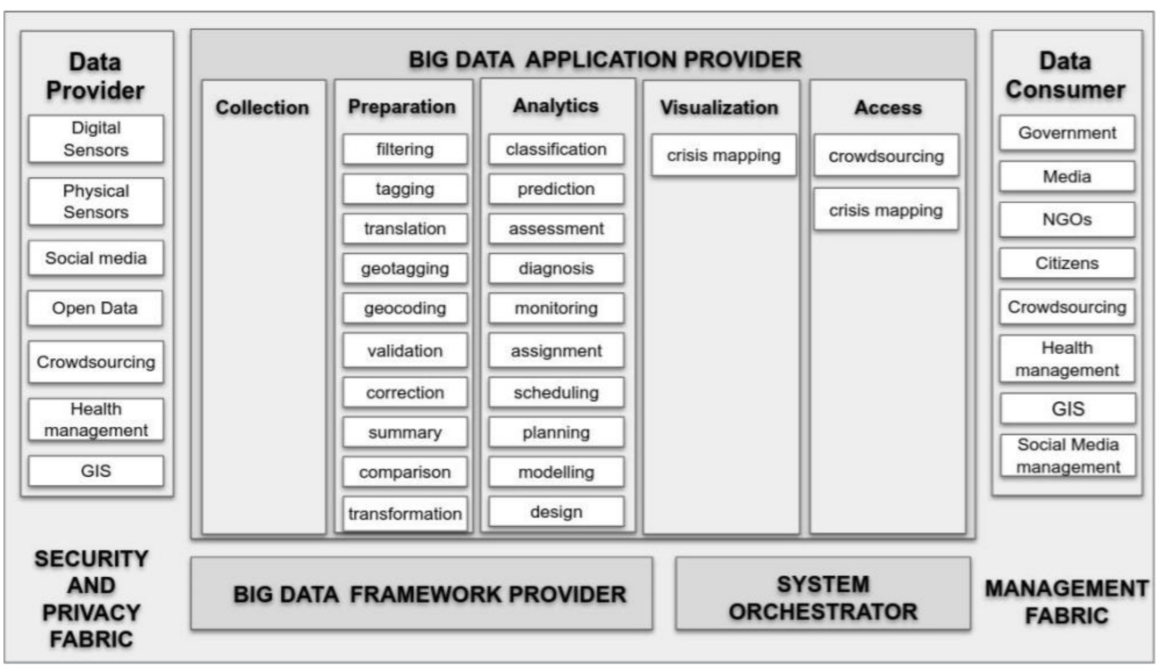
• **Crowdsourcing**: information produced actively by users in order to report information about a disaster (e.g., mobile phone reporting tool, emergency map).

• **Health Information Management Systems**: health information for managing the disaster, mainly related to patients and hospital management systems.

• **GIS**: geographical information provided by various GIS systems.

Below is a simplified representation of the proposed Big-data aggregation and elaboration architecture.

Figure 16. *Advanced Big Data Framework Architecture for Emergency Management (based upon the NBDRA and its upgrades)*



The original NBDRA provides a definition of an open reference architecture representing Big data systems. It is already intended to support data engineers, data scientists, and data architects, as well as software developers, and decision-makers to develop **interoperable big data solutions**.

Such reference architecture is organised around **five major roles** and **two fabric roles**. The five NBDRA roles are: **data provider**, **data consumer**, **big data application provider**, big data **framework provider**, and **system orchestrator**. The two fabric roles are management, and security/privacy. These two fabrics are instrumental and provide services to the above five main roles.

The five processing activities within the big data application provider have been further **detailed for emergency management**. The collection activity uses standard big data collection techniques for accessing data providers and persisting data in the big data framework provider. Depending on the disaster phase, the system orchestrator should **configure access to data providers** and the security and privacy fabric components to follow the established requirements and data policies.

The main specificity of the innovative **disaster management** relevance is the **integration with crowd-working software**. The preparation activity comprises data cleansing, standardization, validation, and enrichment. The proposed framework includes a list of **micro tasks** derived essentially from the literature review: filtering, tagging, translation, geocoding, geotagging, validation to check the veracity or data correctness, correction, summarization and comparison.

Many of these tasks can be done using **crowdsourcing** or **automation methods**. Automation techniques are used for **filtering and classifying images** and the classification is validated using crowdsourcing.

The analytics activity aims at **extracting knowledge** from the ingested data. Analytic tasks have been organised based on the "CommonKADS task library", since it already provides a general **framework for classifying** the potential uses of big data analytics.

This framework distinguishes two general **task types**: analytical and synthetic tasks. **Analytical tasks** produce a characterization of the system and are subdivided into prediction, classification, diagnosis, assessment, and monitoring. **Synthetic tasks** construct a description of the system and are subdivided into assignment, scheduling, planning, modelling, and design.

This categorisation has been used for **classifying uses of big data** according to core capabilities as defined in the US National Response Framework (NRF). These relate to the different phases of disaster management: **mitigation**, **preparedness**, **response** and **recovery**.

Table 1. *Big Data tasks for preparedness phase (Iglesias et al, MDPI Open Access Journal)*

NRF Capability	Task	Example
Planning	Prediction	Ambulance demand forecast based on weather conditions and datasets from hospitals
Public information and warning	Communicate	Use of social media to communicate that vaccine against H1N1 influenza was available
Operational Coordination	Assessment	Recommendation of using operational analytics to coordinate emergency response across Federal, State, and local agencies
Intelligence and Information Sharing	Collection	Usage of big data and open data integration mechanisms for improving information sharing from central to local governments and NGOs during preparedness in Taiwan

During the **pre-disaster stage**, Big data analytics can contribute to **building resilient infrastructures and communities**, both in mitigation and preparedness activities. As shown in *Table 2*, during the mitigation phase, big data technologies can help in reducing the impact of disasters by providing a long term **hazards data collection system**.

Big data analytics can therefore be used for risk **assessment**, in order to understand vulnerabilities to threats and hazards, and develop **plans and strategies** to manage them. In addition, **monitoring and prediction analytic tasks** are also relevant, since they can help decision makers to prioritize risks and make informed decisions. Regarding preparedness activities, big data technologies can improve **decision making** in planning, coordination and information activities.

***Table 2**. Big Data tasks for mitigation phase (Iglesias et al, MDPI Open Access Journal)*

NRF Capability	Task	Example
Planning	Assessment	Simulation modelling of eruptive processes for identifying eruption scenarios for emergency planning in at Vesuvius, Italy
Public information and warning	Communication, Prediction	Big Data analytics for predicting extreme flood risks and create awareness in the community to mitigate its effects
Operational Coordination	Schedule	Develop scheduling plans of power supply based on disaster trends and reserves of emergency supply
Community resilience	Assessment	Use of big data technologies to integrate physical, social, economic, and environmental dimensions to assess neighbourhood resilience
Long-term vulnerability reduction	Assessment	Harvesting big data from residential buildings for assessment on climate change policies
Risk and Disaster Resilient Assessment	Assessment	Geospatial zonation of seismic site effects in Seoul
Threats and hazards identification	Monitoring	Monitoring social media and crowdsourcing data for early identification of urban flooding

During the **disaster stage**, big data technologies can provide **real-time decision support** for disaster management, since they can manage the variety, volumes, and velocity of the available data sources.

The main purpose of analytic tasks is providing real-time assessment. In fact, the integration of big data has radically **transformed** the **decision-making** process that previously was based only (or mostly) on historical data and empirical experience. Instead, now organizations can make more informed decisions and adapt their strategy when the situation changes.

Big data analytics can provide assessments for improving decision making in a wide **range of activities**, such as analysis of social media for emergency planning, rescue team coordination and triage. In addition, analytic tasks can provide new insights, since they can detect hidden **patterns that enable decision makers** to gain a deeper understanding of the situation. Monitoring activities can benefit from the integration of heterogeneous sources and help in detecting trends and patterns to **foresee potential issues**.

Additionally, big data technology can not only **improve situational awareness**, but prediction analytic tasks can enable moving **from hindsight to foresight**, and anticipate the consequences of the current situation.

Finally, during a **disaster aftermath**, big data technologies can contribute to monitor its **recovery status**, and provide assessment to evaluate the socio-economic consequences and recovery efforts. Visualization capabilities present processed data to data consumers. The proposed reference architecture includes the capability to **generate crisis maps** since they are among the most popular and successful visualization mechanisms for crowd data. They provide an overview of the emergency situation and include **layers** for organising the information (e.g. incidents, safety and security hotspots and parameters).

The access activity manages **communication** and interaction with data consumers. For disaster management, specific attention should be paid to the communication with crowdsourcing tools, and with visual analytics tools such as crisis mapping ones.

Ultimately, data consumers use the resulting output of the proposed big data system for the **entire disaster management cycle**. Data consumers of the Big Data System for Emergency Management are various and potentially more groups at the same time. As defined by the research team of the propose architecture, they are:

- **Government-level**: governmental partners responsible for disaster management.
- **Media**: mass media communication that contributed to information distribution and sharing during the emergency cycle.
- **NGOs**: participating in the emergency as first responders.
- **Citizens**: citizens affected or non-affected by the emergency.
- **Crowdsourcing**: digital humanitarian organizations participating proactively in emergency management.

• **Health information management systems**: health systems that can use the big data insights for their decision making processes.

• **GIS**: systems that can aggregate GIS information from the big data system.

• **Social media management**: social media management tools that can use big data insights for improving information sharing impact.

It is worth pointing out that many of the **user groups** are also closely **linked** to the **data sources**, since they could provide and consume the outputs of the big data system. The proposed reference architecture enables the integration of various additional **automation** (big data-based) and **crowdsourcing** resources.

The essential **components** of a **Big Data System** for emergency management are inductively based on **emergency management experiences**. The research team has proposed NBDRA as a generic framework for describing Big Data systems but has adapted it to the **DPP-specific** domain. The **distinctive element** of the proposal is the integration of **crowdsourcing** that enables the design and execution of **hybrid data** pipelines for emergency management.

Big Data analytics platforms will likely be increasingly integrated with crowdsourcing systems. It is essential to **monitor best practices** and to **identify open models** for such solutions. The proposed reference architecture is exemplary in providing a common framework for Big Data systems in the disaster domain. It has the potential to improve **organisational efficiency and DPP management** in both its coordination mechanisms and decision-making paradigms.

10 – Social Media Analysis Platform + Rumour debunking Tool

France and Austria

Another prominent example of a promising solution in the DPP sector comes from the **Thales** Group which we already introduced with its City Management Portal (see Practice 7). This time, it collaborates with the Austrian Institute of Technology (**AIT**) – one of the country's largest research and technology organisations. AIT provides expertise in "key infrastructure issues of the future".

Under the Driver Project, the two entities have developed separate yet complementing solutions to a common challenge in the DPP management field. The **Social Media Analysis Platform** (**SMAP**) shares functionalities and its instrumental purpose with the **Rumor Debunking Tool**. Both solutions enable DPP stakeholders to find and access relevant crisis management information and feedback within in Social Media platforms.

Social Media (as found in sites, microblogs and Apps) contain information which can contribute to situation assessment in a crucial manner. Socially relevant information can concern the **incident** itself, its **impact** or the **needs** of the population affected by the crisis. When trying to take Social Media into account, Crisis Managers face a major challenge due to the **high volume** of information. **SMAP** supports this process by **automating** the collection process, and offering **mining tools** based on content analysis, time and geography.

Crowd sourcing is a major functional trait of SMAP, providing added value in comparison to traditional media information systems. SMAP can be used to detect **incident related information** published by private persons, directly exposed to or directly witnessing the crisis and providing (on purpose or not) information which could be useful to the crisis manager to successfully manage the emergency or evolving event.

In the potentially relevant application cases which the solution creators describe, SMAP can work as mostly with pre-registered or pre-identified **volunteers**. Their social network accounts (e.g. Twitter, Instagram and Facebook) would be known in advance. However, the system could accommodate and benefit from contributions by **spontaneous users** and volunteers.

The most relevant **crisis management functions** which could be supported and improved with the proposed platform include:

- Crowd-sourcing facilitation
- Conducting systematic monitoring and data collection
- Rumour detection and debunking
- Conduct systematic monitoring and data collection on social digital media
- Setting up data analysis as decision making support

During a critical event, SMAP is able to detect the **initial stages of rumour generation** and social network messages propagating false information. This may regard the nature, origin or management of the crisis but are all likely to have an impact on the efficiency of disaster management. SMAP can help **detect, understand** and analyse the rumour contents, as well as **identify** the community within the social network (e.g. Twitter) where it is initiated and/or spreading.

Such a systemic support could help **fight rumours** and/or **fake information** which is propagated through publicly relevant messages. Considering the importance of social network platforms and means to modern urban societies, those may be equally important – if not more than – traditional digital mass media.

More importantly, the SMAP platform offers targeted support in terms of an informed and efficient **crisis communication methodology**. The below figure represents a screenshot of SMAP – we can see the intent to build a user-friendly tool which could support the functions of DPP managers.

Figure 17. *Graphic outlook of the Social Media Analysis Platform*

The **Rumor Debunker** is a tool which has been developed almost simultaneously with the above Social Media Analysis Platform, in close collaboration and is targeting mostly similar features of DPP management and operations. Although it is more narrowly defined in its technical subject **- rumours and false news** among social media message streams – it offers a largely **comparable solution** for internet news analytics to that of the SMAP. Therefore, we will present them as a pair of innovative solutions which may go a long way towards solving this **increasingly relevant challenge** that crisis management teams are facing.

The Rumour Debunker is developed to counteract both **misinformation** and **disinformation** campaigns. It is able to promote such capability and integrate it into functionally diverse campaigns, efficiently tackle its subject matter while facing crises on a large scale and even protracted manmade disasters.

Rumor Debunker covers all phases of crisis management by preparing reliable data sets of media communication for unexpected events.

By pointing out actual trends, Rumor Debunker allows crisis and disaster managers to **discover relevant information** from internet news the field of which is under their operational responsibility. The tool offers a few main features to integrated DPP:

- A solution to **debunk deception** and rumors in social media;
- A platform to be used to get an insight on how **media data** is **presented** and **perceived** in digital media and
- A new approach to analysing and **evaluating relevant information** and network communication in crisis situations, including:
    - **motivation** behind disinformation campaigns or
    - **first source** and **multiplicator** sources of false news propagation.

The RD tool has provided a couple of **example usage cases**, explained below.

1. Continuous media monitoring (aim: verifying quality)

A typical problem which is addressed in the first usage use is that the internet provides a quantity and variety of information. **Human evaluation is limited** in its scale and resources in evaluating whether a particular news piece, source or information dataset is true or not, while the Rumor Debunker could face such task tirelessly ad crawl until it reaches the truth.

AIT provides the **illustrative example** of a **flood** event in Austria. If someone posts on social media that cholera bacteria is found in the water – which was not true – there would normally be a dramatic **increase in methods** observable for fake production.

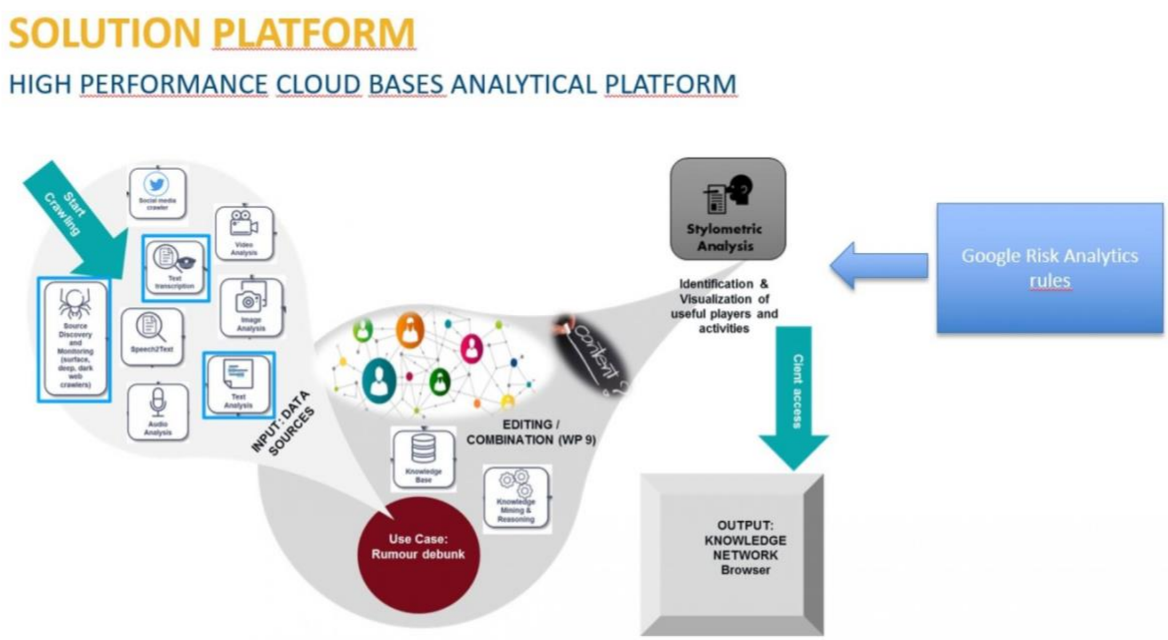
It is very easy to overlook whole parts of the internet communication, relevant for a specific crisis if these are manmade. Such **traditional media** monitoring methods do not have a proper grade of

saturation for strategic communication. Automated methods have proven to be much more effective. However, the combination of **automated tools and human intelligence** remains the most effective is, and as such it is employed in Rumor Debunker.

By building up and providing access to a **quality checked news data set** for the relevant operational information space, the Rumour Debunker platform shows **news**, **marked** with the value of the **compound index**. As such, the news can be valued according to their **reliability**.

Based on the data set of such classified news messages, users of the Rumour Debunker platform get an insight and impression on whether particular news pieces are the target of a hyper-personalised **disinformation campaign**. This possibility is expected to become more important for crisis and disaster management. Therefore, the user might even be **warned** in the future, if necessary, as part of the continuous media monitoring.

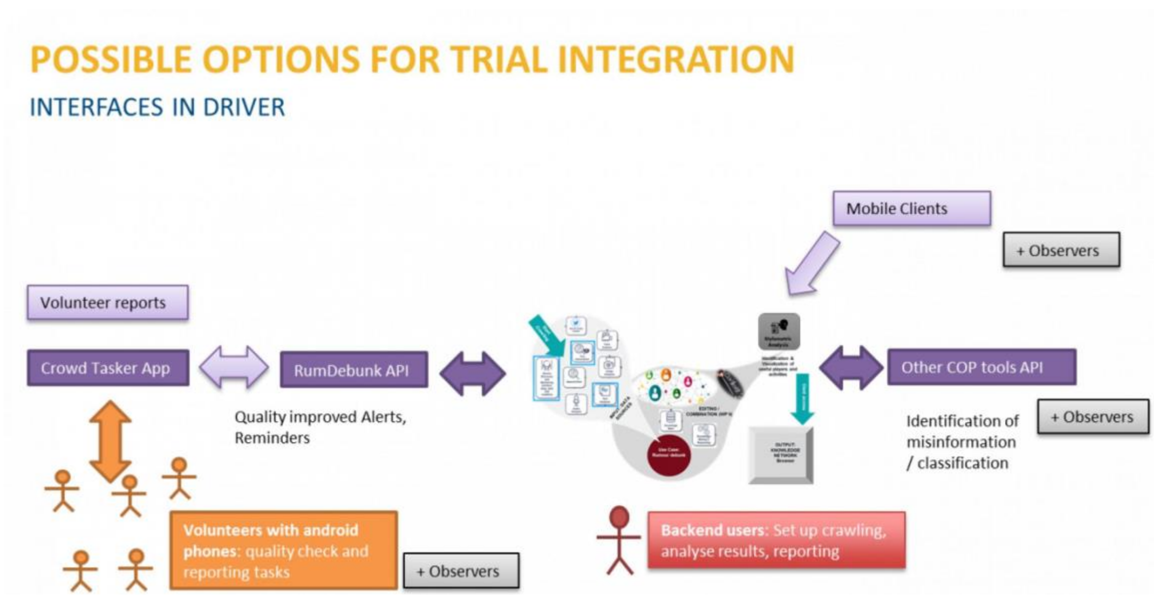
Figure 18. *Rumor Debunker platform structure*



Relevant **crisis management functions** which are supported include:

- Setting up dissemination and information sharing campaigns;
- Conducting information analysis and evaluation;
- Defining information management procedures;
- Providing decision support;
- Supporting informed decision making.

Figure 19. *Possible scenarios of integration of Rumor Debunker in the wider digital decision making DPP support*



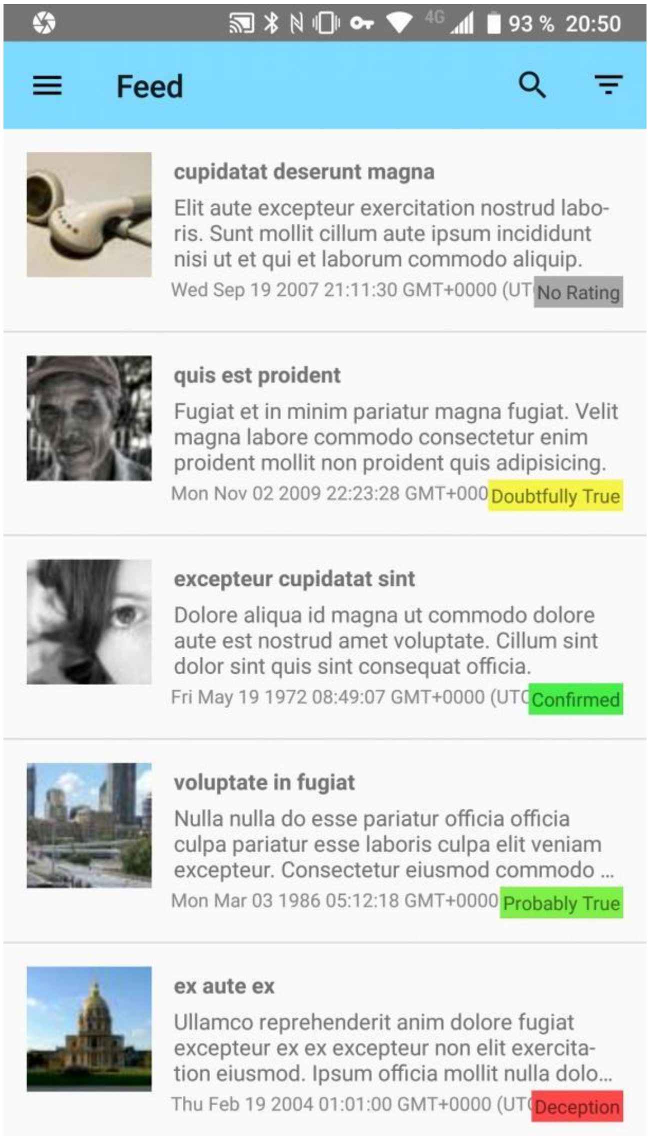
2. Media observation during a crisis

AIT has also suggested a second potential use case which is considered highly beneficial by its developers. For **network-centric** communication in **crisis decision making** (CDM), it is very important to gather reliable open source information. Relevant sources of misinformation and disinformation should quickly be identified to enable an efficient counter-reaction.

Social media is an important **facilitator** and a distributor of very **sensitive public reactions**. Continuously evolving communication rules in new media channels have created new realities in possible and actual crisis situations. Traditional journalists lost their role as a gateway in crisis communication. With social media in place, crisis **communication is always network centric**. It needs crisis and disaster managers to use those communication tools which keep up with the pace of innovation.

DPP managers should also understand the basic process of **creating and propagating disinformation**. If the first publisher might have a specific interest in publishing the information, the publisher with the highest **multiplicator rate** is responsible for spreading the disinformation. For strategic network communication in crisis situations, it is very important to know the **motivation** behind disinformation campaigns, as well as the first source and the multiplicator sources, so that they can be addressed appropriately and effectively. Put simply, by tracking the sources of specific news, back to their origin, the structure behind the disinformation campaign becomes visible.

Figure 20. *Colour coded news pieces according to their "truthfulness" compound index*



Relevant **crisis management functions** which are supported include:

- Setting up data analysis;
- Developing communications and information management systems;
- Setting up dissemination and information sharing campaigns;
- Setting up dissemination and information sharing between stakeholders;
- Conducting information analysis and evaluation.

An Overview of Prominent Disruptive Technologies Featured among Identified Innovations

Having identified beforehand the **main global trends and technologies** which influence the creation and implementation of promising and exemplary policies and practices, we had a clearer idea as to the direction in which such solutions should have been sought. Particular research fields and technology advancements have been standing out and influencing DPP and crisis management for a number of years.

The above ten practices have their concrete and extended use scenarios and conditions. Some are widely applicable, others more targeted. They have all provided us with additional **insights** into the more **influential current research topics and technological innovation fields** which define contemporary disaster risk reduction, prevention, planning and management.

Undoubtedly, technological advancement and innovation are creating new opportunities for enhancing disaster resiliency and risk reduction. Developments in **disruptive technologies** – such as Artificial Intelligence (**AI**), **Blockchain**, the Internet of Things (**IoT**) and **Big Data** – add up to continuous innovations in traditional technological fields. **Robotics** and **drone** technology are also transforming many fields directly related to disaster risk reduction and management. The rapid spread of supporting digital infrastructure and devices, especially wireless broadband networks, smartphones and **cloud computing**, has ultimately created the foundation for comprehensive application of disruptive technologies for disaster management.

As we have seen in the above illustrative examples of promising practices, disruptive technologies can spread critical **information** more quickly, improve understanding of the **causes** of disasters, enhance **early warning** systems, **assess** damage in new ways and add to the **knowledge base** of the social behaviours and economic impacts in the event of a crisis. Consequently, since situational awareness is improving with such tools, the DPP community has a clearer understanding of the extent of impacts and where to prioritise **resources**.

At the same time, the very pace, scope and impact of these technologies varies considerably. While the use of **drones** and **IoT** is increasing, experience is gained and costs fall; and while **social media** are playing a central role in everyday lives and understandably also during disasters – many theoretical and perceived use scenarios for Big Data, robotics and AI remain **largely experimental**. Then there is the middle ground: hybrid digital technologies such as crowdsourcing (e.g. for map details) is increasingly used by leading DPP stakeholders, while the general public does not appreciate its potential to support disaster management.

Probably a note aside should be dedicated to **Artificial Intelligence**, as it is growing in importance while still confounded to more specialised uses. **Disaster resilience** is an area ripe for the use of AI technologies. A number of governments (i.e. US and EU), companies and universities are using AI regularly for this kind of tasks. Admittedly, most efforts are still considered in the early stages of accumulating experience and preparing to enlarge benefits to DPP at a somewhat later stage. However, AI technologies could **already help** governments more quickly and efficiently **identify risks, predict disasters** and **assess damage** during and after an event. Additionally, when we speak about **Machine Learning**, it is a merely more **advanced data analysis method** which allows for greater **automation** – yet it is still a branch of AI, even more advanced.

Recognizing the benefits of AI for disaster resilience in nations and macro-regions at risk of natural disasters is important, in order to reach out to leading global stakeholders, if and where the local DPP capacity and experts are not sufficiently prepared to exploit AI in this direction.

For new tech to exercise large scale beneficial impacts on DPP, some more time and consistent **investments in research and skills** are needed. **Traditional technologies**, though not "disruptive" by definition, continue to play a crucial role in DPP and crisis management. They are also benefitting from **digitisation** and **hybrid technology** deployment. Satellite imagery and seismometers remain important methods for detecting, monitoring and accessing disasters, and old-fashioned text messaging still has a wide reach in public communications.

The important aspect for new and traditional technology to consider is its **usefulness** to national and local governments, assistance agencies, the private sector, research communities and civil groups. Whatever has been proven, even theoretically, to be able to **maximise benefits** from some of the opportunities identified in this paper, could add up to the usage case scenarios and synergetic effects.

The importance of **regulation**, **training, scaling** and **building partnerships** goes in that direction – aiming to explore usability scenarios and new technology applications of both old and new approaches. This should help **disruptive technologies** achieve **wider impact** before, during, and after disasters with the potential to significantly reduce loss of life, assets and uphold recovery efforts.

A non-exhaustive list of new and disruptive technologies which DPP managers and stakeholders should explore further in an attempt to boost preparedness, recovery and relief capacities include:

- Drones (air and underwater)
- Big Data
- Internet of Things (e.g. devices, sensors, wearables)
- Artificial Intelligence (including Machine Learning)
- Robots
- Blockchain
- Social Media Networks
- Crowdsourcing (including crowdfunding)
- Latest generation smartphones

Conclusions

This analytic study has explored the **trends and conditions** which produce leading new policies and practices in disaster preparedness and planning, and accordingly the main **common features** of such exemplary solutions. It has also, subsequently, attempted to clarify and put in perspective the perceived requirements for their implementation, scalability and ultimate capacity to be beneficial to the Black Sea coastal region DPP ecosystem.

One of the most important conclusions to make is the attempt to understand how to make the **best use** of the above-identified practices, approaches and technologies. In what way are they **promising** to the subject region and its socio-economic, technological and governance realities?

Much like their inherent high qualities and replicable benefits, the key determinant remains in pursuing such practices with the necessary preparation and conviction, providing the required resource quality, support mechanisms and well-defined requisites for scalability. The need for **increased application of innovation and technology** for disaster risk reduction, prevention and planning has never been greater in order to foster new development and implementation of more effective **evidence-based approaches**.

Important DPP initiatives have been under development for the past couple of decades. Other improvements and new methods, further beyond conventional and traditional methodologies are already being explored, especially those related to serious underlying causes such as **climate change**, **poverty**, **urbanisation**, population density, and environmental degradation.

The Sendai Framework for Disaster Risk Reduction encourages better access and **support for innovation and technology,** as much as increased investments in DRR and DPP, aiming to develop new innovations that are both **cost effective** and **beneficial** when applied in replicable and all-round disaster management phases: preparedness, mitigation, response and recovery.

Strong **collaboration** remains paramount between DPP stakeholders on a transnational scale, such as government, academia, NGOs, and the private sector. A collaborative approach is crucial to **concept development** as much as it is to **application** of technology and innovations.

The output of this study has resulted in a brief **catalogue of select promising practices.** It might be enriched by actually implemented solutions and current lessons, including global emergency response to pandemic conditions and the resulting need to collaborate even more closely.

The proposed solutions will aid to shape a pattern of conditional analyses which serve to **identify further opportunities** to broaden and deepen the cooperation between DPP and DRR actors. Addressing specific protection needs and vulnerabilities brings up collateral questions and leads to explorative studies in more or less connected topical advancements in theory and practice. Building resilience in the face of a series of global challenges has taught DPP stakeholders to learn to **develop protocols** and recommendations, as well as to meticulously preserve those same **lessons** learned and external know-how – to be able to shape a better future in **DPP capacity-building, policies and guidelines**.

We expect more and more promising practices and innovative approaches to be increasingly related to **climate change**, **inclusion** (i.e. social, digital, etc.) and **response capacity**; as well as **pandemic vulnerabilities**, people **displacements** and **financial instability**. Building and maintaining fundamental yet flexible DPP capacity is a prerequisite in being able to replicate successfully the identified best practices – as much as the next generation of solutions that will follow them.

The ability to broaden and deepen **multi-stakeholder engagement** and offer a general societal approach to critical DPP issues may do the difference where resources and current capacity does not allow for a smooth scale-up.

Finally, we will quote a selection of the recommendations provided by the International Telecommunications Union, the United Nations specialised ICT agency. They regard the conditions which would render optimal and **maximise disruptive technology benefits**:

- Systemisation and standardisation are needed to improve the application of technology interventions. **Open standards** will help lower **costs**, ensure **interoperability** and enhance **scaling**. Standardization also extends to Big Data use, currently often shrouded in “opaqueness”. Clear and transparent **sharing protocols** should be implemented, including application programming interfaces. For **social media**, standardised **hashtags** should be employed to **reduce confusion** and magnify impacts.

- Reach of digital technologies must be factored into **disaster management strategies**. In respect to **communications** among DPP stakeholders, this includes considering **purpose** and **audience**. While Twitter has proven useful in crisis situations, its **penetration** is relatively **low** among the general public. It should also be considered that some people may not want to use proprietary platforms for a number of reasons. Therefore, relying on **only one method** may not reach all intended recipients.

- A **global repository** featuring information on how **digital technologies** are being applied for disaster management would **raise awareness** and **understanding**. Hundreds of applications of disruptive technology are underway around the world, but experiences are often buried in news articles and research reports. An information base would be **useful for identifying** digital interventions that have **worked** – with case uses, contexts and supporting material. This will also highlight relevance for different country circumstances and disaster types.

- **Partnerships** between the public, private and academic sectors are critical for understanding and applying DPP digital technologies. The majority of **disruptive technology** uses is being developed by the **private sector**; it also controls significant amounts of personal information in **Big Data** sets, which are immensely useful for DPP. Still, most relevant topical research is being undertaken by the academic community.

- **Scaling up** disruptive technologies for DPP is essential to achieve widespread impact and **lower deployment costs**. To date, many interventions have remained in their **test** or **pilot phases**. Establishing **identification protocols** for relevant **use cases**, followed by **fast-track scaling** mechanisms should be useful. Given the vast potential of disruptive technologies for DPP, there is a need to **nurture innovation**. Examples from the start-up world are relevant where **incubators, labs, competitions** and **venture capital** are used to discover, mentor and scale up promising innovations.

- **Training** is indispensable for the DPP community to understand how to properly and responsibly **deploy** new and **emerging digital technologies** in crisis settings. User-friendly **manuals** need to be developed for different technologies. **Exchanges** would be useful for DPP personnel to gain experience using **new tools**.

- **Legal complexities** of applied technological research and DPP interventions need to be understood. This is fairly straightforward in respect to specific regulations, such as registration and regulation of drones, but still unclear regarding **data protection and privacy**. Uncertainty surrounds the latter as to its effect on technological development – promotes or inhibits. Moreover, Big Data may eventually be forthcoming, but in present disaster scenarios support is needed instantly. Hence, it is essential to have **data access** and **sharing protocols** in place **beforehand**. The DPP community has developed **codes of conduct** in certain areas that can help when laws are vague.

- Adequate **capacity remains fundamental** for asset planning and **deploying** relevant **digital technologies**. Even those tech solutions that show great **potential** (e.g. the above ten) require the ability to **plan**, **manage** and **operate**, indispensable for their success. DPP agents do not need to be experts in digital technologies, but they do need to understand enough about them – and keep an open mind – to be able to develop **deployment mechanisms**. Disaster agencies might also consider creating a **chief technologist** post to better understand how to apply disruptive technologies.

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