Improving Damage assessments to Enhance cost-benefit Analyses

Deliverable C.5: Recommendations and suggestions for the harmonisation process between forensics and compensation purposes for Europe

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Contributions
Authors: Scira Menoni, Daniela Molinari, Martin Dolan
Contributors: Rosa Mata, Rafael Prades, Nicola Berni, Claudia Pandolfo

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1. A framework to manage post disaster damage data

In an article that has been recently published and which is one of the result of the IDEA project (Menoni et al., 2016) we have suggested that any reporting system corresponds to a structure framing damage to a community and its built environment in a rather specific way. We went as far as calling such framework as a damage model that is, in fact, the representation of the damage that has occurred and that inevitably entails some aspects of simplification and interpretation. We will never stress enough that being "precise" in the sense of totally embracing the "reality" of the damage is "a chimera" as suggested by Handmer (2003).

Object of analysis	Sub-sectors and characterization	Scale	Aspects	Type of damage	Tool/data
Event		local/regional	hazard		regional/Research Centres/ River Basin authorities/other
People (victims, evacuated)		local	loss	direct and indirect	Regional Authorities and interviews
Lifelines	Water and sewerage	regional	loss and functionality	direct and indirect	Regional Authority, lifelines providers
	Waste				
	Power				
	Telecommunication				
	Gas				
	Transportation				
Public facilities	Different types of facilities	provincial/ regional	loss and functionality	direct and indirect	Regional, provincial and local authorities
Agricolture	infrastructures	regional/large scale	loss	direct	Regional/associations/ others
	crops and animals				
	soil				
Industrial plants	Different types of plants	local	vulnerability and loss	direct and indirect	Local authorities, Regional authorities, direct surveys
Residential buildings		local	vulnerability and loss	direct and indirect	Local authorities, direct surveys
Cultural heritage	May be services, residences, open spaces	local	vulnerability and loss	direct and indirect	Local authorities, specific authorities
Natural environment		local/regional	loss	direct and indirect	Regional authorities, Parks, others

Table 1. Example of sectors and sub-sectors to be considered in the case of damage due to floods

However, there are some key aspects of damage that should be accounted for in an enhanced system and specifically: the need to take a systemic perspective, according to which all systems and sectors need to be considered, as depending on the specific event, they may be differently affected. Sectors

that we have considered as relevant are reported in table 1. They have served as the basis for the reporting that has been developed after the two flood events in the Umbria Region in 2012 and 2013. The second crucial aspect is related to the need to consider appropriate scales of evaluation. We can speak about sectors, such as residential, business or services at the city or larger levels; however within each sector, locally we will address individual items and sectors' individual components. The scale at which the analysis is performed is crucial to identify what qualifies as a damage, for whom within what areas. It is clear in fact that what constitutes a damage for a given community, for example in terms of lost jobs, can become a gain for others where jobs are increased due to the shift of customers from the affected region to the neighboring one. Without a clear definition of the territorial ambits within which one is carrying out a damage analysis the latter may fail intersecting relevant flows and processes.

The third crucial aspect regard the time scale. Not all damages become evident the day after a fast onset event; some become evident only after a certain time; indirect damages can be evaluated in their entirety only after longer time. This means that any damage assessment has a clear time-stamp that needs to be made explicit and there is not damage assessment in absolute terms without reference to the exact time when it has been performed.

2. What we have learned from the analysis of the compensation process

We have analysed the compensation process in the three countries of the project partners, that is the UK, Spain and Italy. Clearly they do not cover all possibilities in Europe, yet they represent quite different systems that reveal a rather large possibility of conditions regarding how compensation is organized and accessed. Synthetically it can be said that the UK is an example of a private driven process, where the insurance sector takes the lead when it comes to compensation after major events with the public sector, that is different segments of the State, including regional and local authorities responsible for complementing the compensation covered by insurance. Yet, even though the system is driven by private insurance, the State has an important even crucial role as negotiator of insurance and insurability conditions and provides the factual basis for a general coverage. The Spanish system makes rather large recourse to insurance, in that private owned goods and businesses are covered by insurance, that, though, is publicly managed, that is an emanation of the State even though it works at the conditions of a regular insurance. Furthermore the State and the Regions compensate for the damage to public items that are nor insured. The Italian system is at the other extreme: a system that has been managed primarily through public compensation of damage, derived from the State budget, in the past creating also large debt or making recourse to special taxes, and to a rather limited extent to private insurance. Yet, in the last years there has been an increase in insurance penetration also in

Italy, along with the financial crisis that has substantially diminished the capacity and especially the faith that the State will be always be there to compensate for whatever damage provoked by extreme events.

Despite the large differences in the structure of the compensation system in the three countries, there are some important similarities that cannot be neglected:

a. The most important being the problems that have been encountered in terms of financial sustainability of the system itself. Certainly the Italian system is the least sustainable especially in a crisis situation, however also the UK proved to be problematic and leading to an important reform such as the Flood-Re new Scheme. The sustainability issue has partly to do with the fact that costs associated to extreme events are rising, but also with the fact that the distribution of losses and compensation burden in the society does not always reflect equity and justice considerations.
b. The intervention of the public, that is of the State is always crucial, even in the most private oriented framework such as the UK. This is because the State has the capacity to intervene both to implement structural measures that often require very large investments that are usually considered as a public duty, and to enforce land use and buildings regulations, that can substantially diminish the exposure and vulnerability of assets at risk.
c. In all cases there is an important distinction between small and large events. Large events such as the Lorca earthquake in Spain in 2011 and the Gloucestershire flood in the UK in 2007 always trigger important public expenditure and donors activity more than smaller events. Somehow it seems that large events trigger some extraordinary conditions that justify also expenditure out of the usual box.

Apart from those differences it is generally true that insurance and the State have different ways of deciding and supporting with data and surveys damage compensation. Insurance has a codified protocol, according to which after an event there is a claim that will be opened by the affected owner to which a form of control either by surveyor or loss adjuster in the most complicated cases will follow to determine the final amount of compensation. In the case the State is the refunder a double process is expected: on the one hand there will be some administration (generally but not exclusively the municipality) that is responsible for collecting damage data and dispatching it to higher authorities.

At the other end of the thread there is the State that allocates a certain amount given an initial (and after some time corrected) overall estimation of the amount needed. The State driven process has undergone significant changes in the last years, with increasing attention to reporting and standardization systems to obtain a better estimate of the damage and consequently of the needed amount of money.

As will be discussed in the next section, there has been an increasing call for more standardized reporting of damage in the last years, driven both by national governments and by the European Commission through the application forms to apply to the Solidarity Fund.

Object of analysis	Sub-sectors and characterization	Source of compensation	Responsibility for data collection
Event			Public authority that may be supported by rsearch institutes
People (victims, evacuated)		Prevalence of public funding; prevalence of private insurance; mix of the two	Civil Protection Authorities
Lifelines	Water and sewerage	Mainly private insurance with public subsidies	Lifelines owners and service providers
	Waste		
	Power		
	Telecommunication		
	Gas		
	Transportation		
Public facilities	Different types of facilities	Prevalence of public funding with some insured items	Services owners and providers; municipal and/or regional authorities
Agricolture	infrastructures	Insurance subsidized by public	Directorate of Agricolture (Regional level) and Ministry of Agricolture
	crops and animals		
	soil		
Industrial plants	Different types of plants	Prevalence of public funding; prevalence of private insurance; mix of the two	Loss adjusters; private owners, public administrations
Residential buildings		Prevalence of public funding; prevalence of private insurance; mix of the two	Municipalities and civil protection authorities; insurance companies
Cultural heritage	May be services, residences, open spaces	Sources of compensation as for pertinent sectors plus additional funding from public bodies, donors	As for the pertinent sector plus Ministry or regional authorities for cultural herigate with special provisions
Natural environment		Public compensation when available, donors	Public an private owners or managers of parks, oasis. Health and Environmental Ministries and authorities in case of contamination

Table 2. Compensation sources for different sectors. The table is general without reference to a specific situation.

An important aspect that emerges when a comprehensive report of damage needs to be prepared, is the fact that different agencies and authorities, even within the same State or regional administration, are responsible for collecting the data, given their mandate. So for example the Ministry of Agriculture is responsible for damage to the agricultural sector, private, public or semi-private lifelines companies are responsible for the damage to their own infrastructures, municipalities and civil protection

authorities generally collect the data related to damage to residential buildings and to businesses. Nevertheless in many examples even in the same country, damage to business was treated separately by another Directorate responsible for economic development as in the case of the Umbria Region after the 2012 flood.

This rather mixed situation is further complicated by the fact that even the source of compensation, and therefore the procedures and the process to be followed are not necessarily the same neither for the same assets, nor in the same country as the situation may well change from one even to the other from one asset to the other.

Table 2. exemplifies this concept. As it can be seen, a public asset such as a water system that is generally run by a public company may be compensated by an insurance company, in case the system is insured. In other situations, the water company is asking for public compensation in case the system is not insured.

At the same time a private asset, like a business can be compensated by insurance or (in case the national law permits this) by State aid or compensation.

Another key point that needs to be stressed is that data collected by different authorities, agencies, and stakeholders does not always perfectly match data requirements for compensation. In fact, stakeholders that need to intervene on their own asset collect data for repairing damage and restoring their dwelling, business, service. If they want to qualify for compensation they need then to provide certification and proof of both the damage that has occurred and the effectuated intervention if they had already when documents are asked for by public or other administration.

There is then another category of stakeholders, such as for example municipalities that collect data both to ask for compensation of their own assets and as service providers for their citizens. Municipalities collect data from private owners and then arrange them in the format required to ask for compensation at higher levels of government.

This situation that is quite common, albeit not so linear nor straightforward, creates a situation where some stakeholders collect data to i. account for the damage that they have suffered; ii. to carry out repair and recovery interventions. The data they collect and the format in which they collect them may or may not match the requirements set by authorities for compensation. As it can be seen in all examples provided for the three countries, even though there is a general framework that is followed, each event triggers some extra or special rules that need to be complied with and require some rearrangement of the data that have been collected. In fact, at least in Spain and Italy in a very clear cut way, requests of documentation and certification of damage and losses is asked in decrees that associate to the declaration of a given state of emergency funds for compensation. In the decrees the subjects and the items that qualify for public compensation, sometimes in large detail, is provided and therefore the data need to be provided accordingly to be entitled for compensation. This is a very

crucial point. Different legislation ask for different ways and format of presenting information on damaged assets and losses, however the various stakeholders collect data for repair needs in almost the same way everywhere, as the needed data depend on the type of item that has been damaged and on the type of damage that can be provoked by a certain hazard on a certain item. We found that there may be a slight discrepancy between the way damage data are collected for repair purposes and for compensation as for the letter one needs to respond to legislative requirements that change overtime, that change between one event and another and which are also subject to political and economic choices regarding what can qualify for compensation and what cannot in a given event.

3. The rising pressure to develop standardized and more effective reporting for compensation

In the last years, partially as a consequence of the economic crisis and partially resulting from a different attitude of governments towards natural calamities restoration, implying larger responsibilities on local affected communities and shrinking intervention of the State, there has been a growing pressure to: i. provide more evidence base for the refunding requests; ii. standardize the format in which data is provided to governments to ask for compensation. This trend is visible also at higher scale, by international organisations, both governmental and NGOs. Larger accountability for public and donors' expenditure equals the requirement to be more transparent about damage. At the international level, one may recall the Post Disaster Needs Assessment (PDNA, see Wergerdt and Mark, 2010) methodology, resulting from a coordinated effort among the World Bank, the UN and the European Commission. The methodology, especially in one of its components, the Damage and Losses Assessment (DALA), addresses the issue of developing a cross sector analysis of the damage, quantifying and describing losses suffered by residential houses, economic activities, environmental assets, lifelines.

At the European level, the European Solidarity Fund mechanism has its own application form, that ask for rather aggregated information regarding the affected sectors.

At national levels, each country as we have seen even from our small sample, is acting differently. In Italy in the last years the National Department of Civil Protection issued a number of decrees with specific requests in terms of reporting and annexed compiled forms for residential buildings and for businesses. It has been a learning by doing process as the Department has upgraded its requests after each event since 2010 or so, also taking into consideration what it had chosen as "best" or "good" practices.

3.1. Compensation by the European Solidarity Fund

The European solidarity Fund (EUSF) was set up under the Council Regulation (EC) No 2012/2002 of 11 November 2002 and Regulation (EU) No 661/2014 of the European Parliament and of the Council of 15 May 2014 amending Council Regulation (EC) No 2012/2002. The EUSF is intended to provide assistance in the event of a major natural disaster with serious repercussions for living conditions, the natural environment or the economy in one or more regions of a Member State or of a country applying for accession.

- State applying and contact person
- date of first damage caused by the disaster
- nature of the disaster (e.g. earthquake, flooding, storm, forest fire, drought)
- brief description of the disaster and of the emergency measures taken
- impact of the disaster on the population, the economy and the environment
- area/regions affected - map(s) of the disaster stricken area/region(s)
- total direct damage estimate (description and financial table), distinguishing between public and private damage and breakdown by sectors: infrastructure (water/waste water, transport, energy, telecom, etc.), businesses, agriculture and forestry, private homes and assets, cultural heritage, provisional accommodation, cost of emergency services, other (as appropriate)
- percentage of Gross National Income (GNI) or regional GDP represented by the damage
- description of the method(s) used to assess the damage
- estimated eligible costs, breakdown among EUSF categories: Restoration to working order of infrastructure and plant, temporary accommodation and rescue services, securing of preventing infrastructure and measures of protection of cultural heritage, Cleaning up of disaster stricken area/natural zones
- share of "eligible" cost in relation to total direct damage amount
- other EU funding
- other non-EU funding including insurance
- short description of the implementation of Union legislation on disaster risk prevention and management related to the nature of the disaster.

Table 3. Information required to apply for the Solidarity fund

Member States can apply for the EUSF if direct damages due to the natural disaster exceed EUR 3 billion (2011 prices) or more than 0.6% of the gross national income of the beneficiary State. Nonetheless, when disasters have a regional extension (i.e. a NUTS2 region extension), Member States can apply for the fund if direct damages exceed 1.5% of that region's gross domestic product (GDP).
Costs eligible for funding regard:

- the immediate restoration to working order of infrastructure and plants providing energy, drinking water, waste water disposal, telecommunications, transport, healthcare and education;
- the provision of temporary accommodation and the funding of rescue services, in order to meet the needs of the population affected;
- the immediate consolidation of preventive infrastructure and protection of cultural heritage sites;
- the cleaning-up of disaster-stricken areas, including natural zones.

Request for funding must be submitted to the EU Commission by the beneficiary State within 12 weeks (84 days) after the first effects of the disaster become clear. Although it is always the national authority that submit the request, the latter is prepared by Regions in the case of regional disasters.
The EU Commission defined a specific form for applying to the EUSF that can be download from the EU Commission website. The form requires the information represented in Table 3.

3.2. The role of the Solidarity Fund within the case studies of the Idea project

3.2.1. Italy

In order for the National Authority to apply for the EUSF, in Italy specific guidelines have been issued to support Regions in collecting and reporting all data required by the EU Commission. These guidelines are not described here in detail as, in fact, Regions are required to supply all the information above listed. No suggestions are supplied in the guidelines on how Regions must collect data for the reporting.

3.2.2. UK

The UK received about £110m from the EU to help repair damage caused by heavy floods in England.
The EU Solidarity Fund (EUSF) was established in November 2002 to provide financial assistance in the aftermath of major disasters in Member States and pre-accession countries, which cannot be covered by the regular EC Budget. Under the provisions governing the EUSF up to EUR 1 billion can be provided in a given budget year to fund uninsurable costs including emergency relief and reconstruction operations, above that provided for in the EU's spending plans for the period 2007 to 2013, which are known as the Financial Perspective.

Before a Member State can apply for support from the Fund, the total amount of damages incurred in a major disaster must exceed a certain amount. The EUSF's eligibility threshold for what are termed "National Level Disasters" is for all damages, insurable and uninsurable damage to exceed EUR 3 billion (2002 prices) or 0.6% of the affected country's Gross National Income (GNI) in order to qualify for assistance, whichever is the lower.

The assistance from the EUSF is apportioned progressively such that the portion of the damage exceeding the 0.6% GNI threshold gives rise to aid amounting to 6% of total direct damage while the rate is 2.5% for the total direct damage under the threshold. The aid provided - were the thresholds met - would only be a small proportion of the total aid required. Between 2002 and 2005, member States have received from the Fund between 2.5% and 5% of the total damage suffered - so if the UK's total damage is £2.5bn, we might expect between £62.5 million and £125 million.

Any funding received has to be spent within one year of receipt. If the UK receives any money from the Fund, then it will be required to report on what that money has been used for. If not all the money received is spent, then it will have to be returned to the Commission. Likewise, if the expenses for which the Fund is asked to support turn out to be less than we estimated, then any excess payment will have to be reimbursed to the Commission.

3.2.3. Spain (back from the C2 deliverable)

Several mechanisms were activated in the EU to support the recovery efforts after the Lorca Earthquake. The EUSF (European Union Solidarity Fund) disbursed 21M€ distributed among different administrations and Ministries in Spain (Ministry of Public Works and Ttransport, Ministry of Defence, CARM, Lorca City Council); The European Investment Bank (EIB) gave a 185M€ loan to the CARM to cover costs mainly related with local infrastructures; European Regional Development Fund (ERDF) contributed with 14M€ co-financing recovery of local infrastructures related to economic activities.

4. The need to consider a data collection process that is multipurpose

In the already quoted article by Menoni et al. (2016) we stated that developing a damage model responds to the need to encompass different visions and interpretation of damage by multiple stakeholders and to provide the basis for a different uses, ranging from compensation to improving risk modelling to forensic investigation to cost benefit analysis. This is even less trivial, as it requires that the damage data collection process becomes a more shared and agreed upon socially constructed process. In such a process, each stakeholder provides some of its data and concedes something of its “privacy” regarding owned data in favor of a wider understanding of mutually interacting damage and losses and of the context in which damage has occurred.

In the context of the Idea project we have performed several meetings and two workshops with both private and public stakeholders to understand what is their level of acceptance of the need to be more transparent and open with their damage data and regarding the opportunities that are offered by having the large picture of what happens in a complex event. We may say that there have been advancements with respect to the past but we are certainly not there yet as far as some actors in particular are concerned (i.e. critical infrastructures and lifelines services providers).

Within the Idea project we have also explored what does it actually mean that data collected for compensation can be complemented to address other purposes, in particular improved risk modelling capacity (this can be found in Deliverables D1 → D4) and forensic investigation (this can be found in Deliverables B1→ B4) and also in this deliverable in the following paragraphs.

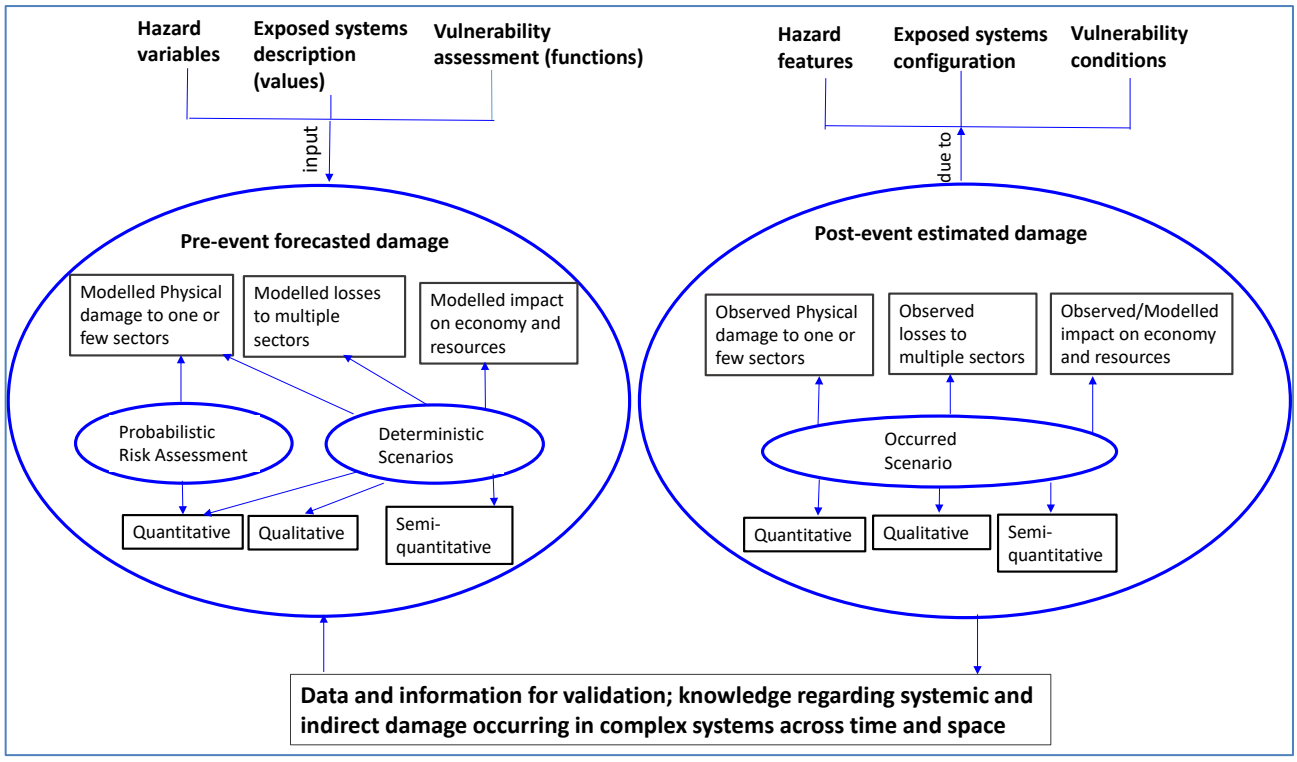

Figure 1. Link between pre- and post-disaster damage assessments (source: made by S. Menoni and forthcoming in Menoni S., C. Bonadonna, M. Garcia, R. Schwarze, Recording Disaster Losses for improving risk modelling, in JRC, DRKMC, Disaster Knowledge First Report)

As for the first, better loss and damage assessment can be of use to improve current risk modelling capacities, starting from the modelling of direct physical damage to the representation of systemic and ripple effects throughout complex systems. Increasingly, organizations and agencies in charge of risk prevention at different levels and in different phases of the so called “disaster cycle” but also private companies such as insurance and reinsurance, are using risk scenarios in the attempt to forecast and

get clues about what may happen as a consequence of an extreme event in territories they are managing or for which they are providing insurance or any other service.

As illustrated already in DEL.B_1 on forensic methodological aspects, the PERC (Post Event Review Capability) is a methodology that has been launched in 2013 by the Zurich's Flood Resilience Alliance – as part of the Zurich's social corporate responsibility program - to elicit lessons learnt from flood disasters. It can be considered a forensic investigation in its need to measure to what extent the so called 5C: physical, financial, human, social and natural capital are capable (or not) to sustain the 4R, that is the four levels of resilience that are recognized in robustness, redundancy, resourcefulness, rapidity. It has similarities with the Forin project (Risk, 2011) in that it is aimed at supporting policies and providing tools for a community awareness of risks and indicate ways to reducing them in the future. The methodology is qualitative, in that in order to assess the 5C one has to go through a checklist of questions that help to characterize each community. It is also stated in the Perc Manual that the assessment is best carried out with the involvement of concerned communities and stakeholders similarly to the Forin initiative.
It is interesting to note that a body that is an emanation of an insurer has decided to develop such a method. Certainly one possible answer lies in the need insurers feel very strongly today to raise the awareness of risk by their clients and also to improve their resilience and response capacity. We have encountered similar concerns also by other insurers that have been involved in the IDEA project meetings (in particular Aviva and Unipol): there has been a shift in the more recent years from a neutral attitude towards customers, as the relationship basically ends with the payment of premium and eventually with compensation after a disaster, towards a more participatory approach, in which insurance companies are encouraging risk avoidance behaviours and assisting their clients after a disaster so as to minimize both direct and indirect damages. Recent insurance policies are changing accordingly, as the customer is increasingly involved in risk taking decisions, considering the levels up to which he can insure his/her own good, the possible accompanying measure she/she can take in order to minimize the effects of an event in case it occurs, with the help of the insurer.
It must also be said that even though for compensation purposes until now sophisticated types of analyses were not required, this may change in the future as the justification of exposed costs will be increasingly a pre-requisite to access funding.

Box 1. The PERC methodology developed by Zurich

Post disaster data can help in understanding and assessing the complexity of scenarios, especially in areas where critical infrastructures, key production assets, diverse communities are exposed and vulnerable to different extent to individual or multiple threats. Improving the overall capacity to include complexity in modelled scenarios, in risk assessments will support better mitigation and prevention strategies and will also permit to better tailor such measures to the specific contexts that show different responses to similar hazard stressors.
As for forensic investigation, better damage data are necessary to better understand how hazard, exposure, vulnerability and other important factors that are considered in risk management, such as coping and adaptation capacity, resilience, play in a real event to produce a certain level of damage. Of course we are not in the condition yet to perform a perfect quantitative analysis in this respect,

however we have shown that in depth analysis of real events can provide significant insight into the causes and to the drivers of risk. Post disaster damage analysis is so important that some insurance company have developed their own methodology for forensic investigation (see Perc of Zurich). In the meantime, as suggested in Figure 1, the two activities of risk assessment and forensic are linked one to the other. Improved understanding of risk factors as playing in real events may change and improve the way we consider such factors in pre-event forecasts.

5. Linking the double needs of collecting data for damage compensation and forensic investigation

As discussed in Deliverable B.1, forensic investigation requires the development of complete event scenarios describing damage occurred to the different exposed sectors and the dynamic of the event in terms of phenomena and actions adopted to deal with the emergency. Damage data collection is then at the base of any forensic analysis.

In order for the (damage) data collected according to the present procedures to be fully exploitable for forensic investigation, it is important to improve current procedures for data collection and reporting so that:

- A better description and characterisation of damaged items is performed. This implies also to pre-define possible categories of affected items (e.g. for the road network: highway, regional road, municipal road, bridge, tunnel, underpass, etc.). The objective is allowing a better understanding of the physical vulnerability of damaged items.
- A better description and characterisation of damage is performed. This implies also to pre-define possible types of damage (e.g. for the road network: debris accumulation, collapse of retaining walls, flooding, interruption, etc.). The objective is allowing a better understanding of both the physical vulnerability of damaged items and other forms of vulnerability (e.g. organisational, systemic).
- A better description and characterisation of actions is performed. This implies also to pre-define possible types of action (e.g. for the road network: removal of debris, partial interruption, use of alternative path, precautionary interruption, use limited to emergency activities). The objective is allowing a better identification of the different factors that may increase or reduce damage.
- Geo-localisation of affected items is done. Having geo-referenced data is key to visualize the spatial distribution of damage as well as of influencing factors, and then to investigate whether spatial patterns exist.
- Information on indirect damage is collected. Information on indirect damage is not collected now or it is collected in a much unstructured way (e.g. in the description of the damage). Still, indirect

damage represents an important share of the total damage and its knowledge is key to develop complete event scenarios. Lots of information can be collected on indirect damage with minor additional efforts (e.g. for the road networks: days of interruption, users affected, inaccessible services, etc.) and should be included in present forms for data collection.

It is important to stress that most of required improvement regard a better structuring of already collected information rather than collecting new data. This has been carefully taken into account in the development of the IS.

6. How forensic investigation can be used to improve compensation for businesses

As can be seen from the case study in Task B, a forensic approach is valuable in that it can offer great insight into both the real damage to a business and into the underlying and often unseen causes that lead to that damage. This is a valuable tool for insurance companies in trying to understand their overall exposure to risk and in assessing the damage associated with floods or other catastrophic events where many claims are made at the same time. It can also be useful for public bodies in establishing the same issues and for planning flood management strategies and administering funds. It can be beneficial to businesses of all sizes if a database of forensic cases were to be configured which could produce reports on the risk associated with different business types. These and other possible benefits are outlined here to provide an overview of the potential improvements that such an approach could imply for flood risk management.

A fundamental component of the IDEA Project was the development of a methodology for a forensic disaster investigation which is designed to identify the root causes of disaster damage as a means of improving cost-benefit analysis and compensation following disaster events. This study proposes ways in which this methodology can be applied in insurance premium setting and in the claim process. This methodology may be applied in order to facilitate more speedy assessment of damage and in accurately and rapidly calculating claims payments to business in relation to business interruption and to building damage. It can also be important in understanding the systemic risk faced by insurance companies and public bodies.

6.1. Understanding Risk

The forensic investigation is a way to extract the maximum value from damage data, to extract any possible lesson that can be drawn from a specific event. In this sense it is of course connected to risk assessment. In fact, the forensic investigation is related to one single scenario, the scenario that has actually occurred with respect to the many others that could have happened with different conditions

of the hazard, time of impact, conditions of exposure, response capacity. In an article that has been prepared for an AGU series book in course of publication we have suggested that: “In the field of natural hazards, scenario modelling has been used as an alternative to probabilistic risk assessment, by addressing the impact a deterministic hazard input (be it an earthquake, a flood or a landslide) may have in a given area.

Scenarios, are used to explore alternative futures, given different conditions of critical determinant variables on the general behaviour of the studied systems, and given alternative sets of decisions and interventions that can be taken to change intentionally the path of an unwanted likely future. In general, the scenario approach is taken to describe what the future may look like, given a strong stress in the environment, like that produced by a natural hazard”. Even though scenarios are projected into the future, knowledge about how past events evolved is necessary to produce them. Before the event occurrence, the damage is estimated on the basis of information regarding the hazards existing in the area of concern, the exposed assets and the vulnerability of both assets and communities. After the event occurrence, instead, the damage is a “known” factor, shapes the scenario that has actually occurred and which can be analyzed so as to identify how and to what extent the risk factors of hazard, exposure and vulnerability had actually concurred to produce the observed levels of damage.

An economic risk-based approach should be adopted which provides incentives for insurance and reinsurance undertakings to properly measure and manage their risks. Harmonisation should be increased by providing specific rules for the valuation of assets and liabilities, including technical provisions. The improvements in understanding indirect and systemic risks that a forensic approach can provide would certainly help insurance companies to achieve this. As stated by a leading scholar, the assumption is that better the data would allow a more sophisticated approach to flood insurance but that depends on many things other than just the collection of data. Using it and interpreting it correctly are two separate things. Just collecting that data and having a database won't do much but improvements in the analysis of that data are also essential.

6.2. Improved Data

Any analysis is only as good as the data available and so is the case with forensic investigation. Any improvement in compensation processes must begin with improved data collection. As illustrated in Task A of the IDEA Project, data collection within the UK is hindered by disconnection, misalignment of data collection processes, differing data needs, different storage systems and data protection issues between stakeholders. For forensic investigation to be implemented successfully, the first step is to address some of the issues with data collection and sharing so that a publically accessible database is available that can be used by a wide variety of stakeholders for different purposes.

A leading UK insurance company operate one system of data input. Since the company was formed by many different companies over many years, they have a lot of legacy systems and are now moving to one large system for underwriting which has a claims function so both teams can see the other system. Any exclusions on a property can be seen by claims. They do use a separate system for claims in which they collect data on construction type, property level data. Improved collection and use of data would certainly help in standardising and streamlining internal processes.

6.3. A Public Database

The creation of a public database could certainly help policy holders to better understand, firstly, their risk and thus the best type of cover and premium and, secondly, the true costs of damage to business resulting from both direct and indirect impacts. As discussed in Task A, a shared database could be established that is fed into by local authorities, emergency services, infrastructure companies, and other public agencies such as the EA, before during and after flood events, with data on various characteristics of damage agreed upon by all stakeholders.

Such a database with reliable data collected in a systematic way, sharing responsibilities, and done collaboratively would have the advantage of both improving the quality and availability of data and also reducing the data collection resources needed by each organisation. In terms of how such a resource could benefit the insurance processes, a database of this sort could collate an enormous amount of data that could then be used to establish forensic case studies, offering great insight into vulnerabilities, underlying causes, indirect damages and overall exposure that are currently not fully understood. This would benefit all stakeholders including businesses, insurance companies and government agencies and local authorities.

Having this information publically available could rectify the perceived knowledge imbalance that exists between customer and insurance company, with the insurance company currently having an enormous advantage in understanding the risk that their customers face. It would allow public agencies to better understand the areas to focus funding on in order to improve flood risk management strategies. If such a database and a forensic methodology were to reveal that the largest amount of damage was caused by business interruption as a result of a failure in the water treatment network, then this could be identified as a much more beneficial area to direct funding than towards providing property level protection for example.

6.4. Business Evaluation Checklist

A Business Resilience Checklist for planning business continuity strategies already exists and is made available by the Business Emergency Resilience Group. This is a checklist that is produced online by way of asking a series of questions which assesses how prepared a business is for emergencies. A

report is produced based on the answers provided which can assist a business in preparing a continuity plan and protecting against flooding.

A forensic methodology coupled with a large publically available and collaborative database could be used to provide individualised assessments of risk for businesses based on the characteristics defined in Task D. This checklist could also assist in the valuation of their business when taking out an insurance premium. It was noted by both insurance company representatives and business owners that the valuation of a business at the premium setting stage can be difficult as small businesses are often unaware of areas of vulnerability such as supply chains. This can result in undervaluation which can result in issues when a claim is then made in the event of a flood. Better understanding of the real value of a business would benefit the business owner and the insurance company who both want to see any insured business return to normal operations as quickly as possible.

However, it must be noted that with brokers being heavily involved in this process, this process is often done on behalf of the business and therefore the benefits may not be realised. This could be an alternative tool made available by insurance companies as a way of allowing businesses to buy cover directly.

6.5. Damage Checklist

An incredibly useful tool for businesses to be able to assess the damage caused by a hazard event would be to have a checklist that could be used to guide them through calculating the various elements of damage that they may have suffered. This checklist could be tailored for different types of business based on the key aspects of a business that influence their resilience and/or vulnerabilities as shown in Task D of the IDEA Project. Having input the various characteristics of their business, a checklist could illustrate to the business owner the various possible direct and indirect damages that may have occurred, based on a database of historical events. This database could be built up from the input from stakeholders identified in Task A which include local authorities, emergency services, the Environment Agency, infrastructure companies and other businesses.

It would offer support to businesses during the often psychologically challenging times of repair when debates with loss adjusters can increase stress and be resource intensive.

7. The transition phase

The publication of the quoted article by Menoni et al. (2016) has been time and labour consuming, because from one review to another we have also changed the way we were considering the different aspects and challenges of post-disaster data collection. In one of the reviews to which we responded and changed accordingly the article, it was suggested that a multipurpose reporting or damage model

requires a strong IT support to be implemented. We strongly agreed with this point that is developed in deliverables E1→ E5. In the latter we suggest though that developing such a tool is not a simple "technical application" as the concept and the overall methodology are not totally clear. We think to have achieved significant steps forward with the IDEA project, however much has still to be done in practice to operationalize all the steps and the results of the project. We have understood that it is not by chance if a coordinated tool and procedure for post-disaster data collection is not available yet. There are many reasons, for this and they need to be addressed one by one if we want to substantially advance. In fact, the problem is not of developing an IT tool to ease data collection and storage. What is needed is to develop a complete set of conceptualized framework for each sector and sub-sector that requires damage data collection and analysis. In fact the most difficult thing is to envisage the types of queries that will be requested to fulfill a variety of reporting requests and in the meantime to support forensic investigation and enhanced risk modelling or cost benefit analysis.

In the workshop that was carried out in Milan on the 28th of November it became clear for example that even though we generally speak of "lifelines" as a sector, in fact rather different assets and underlying organizational and systemic arrangements are in place for each distinct lifeline. So conceptualization needs to be carried out by sector and sub-sector. Ideally, such process requires tests and iterative interviews with stakeholders from each sector in order to achieve a satisfactory conceptualization that will lead to the development of the relative database, interfaces and applications.

We deem that once covered for one or two sectors, the process becomes easier and perhaps a bit shorter, but a timeline of two to three years can be required to actually engineer such a tool, particularly if an Agile methodology, that is one involving in the design the users, has tobe pursued. What can be done in the meantime?

Together with the two civil protection authorities that are involved in the project, the Catalunya and the Umbria Region, we think that the transition phase can be managed by agreeing on protocols and procedures for data collection with stakeholders. Structuring and rationalization of comprehensive data collection systematization of storage can be done "manually" while appropriate IT tools are being developed. In the meantime the rationalization of the process and its application to real cases can provide important insights to the digitalization and computerization as it has been the case all along the project. Manipulation and analysis of the data gathered after the events in the Umbria Region in particular permitted to fine tune damage data collection forms and to develop procedures to be agreed upon and implemented jointly by the Regional Civil Protection Department and by researchers of the Politecnico di Milano.

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