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The Impact of Natural Disasters: Simplified Procedures and Open Problems

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1. Introduction

A *natural hazard* is a geophysical, atmospheric or hydrological event (e.g., earthquake, landslide, tsunami, windstorm, flood or drought) that has the potential to cause harm or loss, while a *natural disaster* is the occurrence of an extreme hazardous event that impacts on communities causing damage, disruption and casualties, and leaving the affected communities unable to function normally without outside assistance (Twig, 2007).

The definition of *natural disaster impact* (NDI) can change according to both the aim of the study and the scientist assessing it. It can be defined as constituting the *direct*, *indirect* and *intangible* losses caused on environment and society by a natural disaster (Swiss Re, 1998).

Direct losses include physical effects such as destruction and changes that reduce the functionality of an individual or structure. Damages to people (death/injury), buildings, their contents, and vehicles are included, as are clean-up and disposal costs.

Indirect losses affect society by disrupting or damaging utility services and local businesses. Loss of revenue; increase in cost; expenses connected to the provision of assistance, lodging, and drinking water; and costs associated with the need to drive longer distances because of blocked roads are included.

Intangible losses include psychological impairments caused by both direct and intangible losses that individuals personally suffer during the disaster.

The *Natural Disaster Impact Assessment* (NDIA) is crucial in helping individuals to estimate replacement costs and to conduct cost-benefit analyses in allotting resources to prevent and mitigate the consequences of damage (UNEP-ECLAC, 2000).

A general NDIA procedure has not yet been developed; several approaches are available in literature and their applicability depends on the accessibility of damage data.

Possible end users of NDIA include the following (Lindell & Prater, 2003):

1. Governments, with an interest in estimating direct losses to report to taxpayers and to identify segments of the community that have been (or might be) disproportionately affected
2. Community leaders, who may need to use loss data after a disaster strikes to determine if external assistance is necessary and, if so, how much.

3. Planners, who can develop damage predictions to assess the effects of alternative hazard adjustments. Knowing both the expected losses and the extent to which those losses could be reduced makes it possible to implement cost-effective mitigation strategies.
4. Insurers, who need data on the maximum losses in their portfolios to guarantee their solvency or even to undertake additional measures to alleviate the risk that they would face in case of a disaster (i.e., the use of catastrophe bonds which are risk-linked securities that transfer a specified set of risks from a sponsor to investors) (Noy & Nualsri, 2011).

Data availability and reliability, especially for old events, represent constraints in the NDIA context because of several issues of very different type:

1. Data availability, for current events, depends on the time at which data gathering started. It is impossible to decide a priori when data have to be gathered: it primarily depends on the type of phenomenon causing the disaster and its magnitude, and secondly on the scope of the assessment (for example, the assessment should not be delayed as there is an urgent need to elicit support from the international community) (ECLAC, 2003).
2. Long-term losses must sometimes be determined over a period of years. Slow landslides, for example, can cause damage over long periods. Intangible damage like disaster-related stress also requires years to be detected (Bland et al., 1996).
3. In most countries, there are no agencies responsible for gathering damage data. Damage caused by severest events can be mined from international databases, while data on less severe events can be obtained by means of specific historical studies.
4. Data on property damage can depreciate the value of property, thus they would not be available or not completely reliable (Highland, 2003).
5. For some type of disasters, as landslides or floods, the costs of damages to structures such as roads are often merged with maintenance costs and are therefore not labelled as damage. In addition, when heavy rains trigger both landslides and floods (Petrucci & Polemio, 2009), it is difficult to separate landslide damage from flood damage.
6. Developing countries have an incentive to exaggerate damage to receive higher amounts of international assistance; thus, in these cases, data may not be entirely reliable (Toya & Skidmore, 2007).

This chapter starts with a panoramic of the different approaches reported in the literature to assess the impact of natural disasters, and then presents some simplified approaches to perform a relative and comparative assessment of the impact caused by phenomena as landslides and floods triggered by heavy rainfall during events defined as Damaging Hydrogeological Events. Finally, some indices to assess the relative impact of landslides are presented.

2. A review of impact assessment literature

To identify recent literature concerning NDIA, a search was made using Google Scholar, a technical search engine that search across articles, theses, books and abstracts, from academic publishers, professional societies, online repositories, universities, international organizations and other web sites (Petrucci & Llasat, in press). According to their focus, the selected articles were sorted in three groups described in the next sub-sections.

2.1 Short-medium-term effects directly involving people and goods affected by a disaster

The articles included in this group employ the simplest approach: the impact is expressed by the list of damaged elements and neither monetary figures nor other assessment are performed (Ngecu & Ichang'i, 1999; Whitworth et al., 2006; Bilgehan & Kilic, 2008). Frequently used impact indicators include numbers of victims and damage to buildings, roads and agriculture. In these studies, damage data are obtained by state agencies or even collected by directly asking people involved in the disaster. Both the number of victims and the percentage of people affected are used to compare the impact of a disaster on various communities (Msilimba, 2010) or that of disasters that have occurred in different time and places. Some of these articles focus on damage to people, analysing the circumstances leading to loss of life and assessing them in relation to vulnerability factors (e.g., age, race, and gender) (Jonkman et al., 2009).

2.2 Medium- and long-term socio-economic effects

In these articles, after individuating the affected population and the pre-disaster situation, the researchers isolated effects on social sectors (the population, housing, health and education), service infrastructure (drinking water and sewage, communications, electricity and power), and production sectors (agriculture, industry and trade) in order to measure the disaster's impact on the macroeconomic indicators during a period of one to two years after the disaster (ECLAC, 1991).

Natural disasters are seen as a function of a specific *natural process* and *economic activity* (Raschky, 2008). The indicators used to detect the impact on national economies include a) long-term recovery businesses (Webb et al., 2002); b) changes in flow variables such as annual agricultural output (Patwardhan & Sharma, 2005); c) variations in fiscal pressure (Noy & Nualsri, 2011); and d) effects on the labour market (Belasen & Polachek, 2007; Zissimopoulos & Karoly, 2010).

The value of human life can be tentatively assessed using two approaches that assign different values to people in different income groups or in countries at different stages of development (AusAID, 2005):

1. The human capital approach involves calculating the average expected future income that the deceased would have generated assuming that he (or she) had achieved normal life expectancy.
2. In the willingness to pay (WTP) approach, surveys assess how much an individual is willing to pay to reduce the risk of death. Even environmental damage can be assessed using the WTP approach, either by asking people to state a WTP amount or by inferring this amount based on costs incurred for environmental services (Dosi, 2001).

Economically, disasters can act as a barrier to development, increasing poverty and having a small but significant negative effect on economic growth (Raschky, 2008). This effect can return a society to the level of human development it had achieved two years prior to the disaster (Rodriguez-Oreggia et al., 2010). Indirect societal effects such as decreases in productivity in people affected by disaster can influence economic growth (Popp, 2006). Human capital can be *directly* affected by these disasters through death or injury and *indirectly* affected when damage to schools decreases human capital accumulation (in poor countries, decreasing school

attendance rates caused by reductions in family expenses can occur). Even demographic effects such as migration have been detected (Smith & McCarty, 1996).

Nevertheless, natural disaster can also produce positive effects. Disasters can create *Schumpeterian creative destruction* (Cuaresma et al., 2004), especially if there are injections of funds for assistance and/or reconstruction. They can represent an opportunity to update capital stock and improve an economy, thereby producing a long-term positive effect on the growth of the Gross Domestic Product (GDP) (Skidmore & Toya, 2002). Activities in the construction sector may reactivate the economy, and the demand for construction materials may generate windfall profits (ECLAC, 1991). Outside the disaster area, income increases can accrue for owners of commodities whose price is inflated by disaster-induced shortages (CACND, 1999). For instance, in the case of drought, when agricultural production decreases, farmers in affected areas experience the negative effects of the disaster, and the price of agricultural products increases. Then, farmers outside affected area, who are experiencing normal production, will reap the benefits of these higher prices (Wilhite et al., 2007). Even ways of thinking and acting can be modified by major disasters, resulting in personal and community growth (Birkmann et al., 2008).

Disasters are more costly for developing countries: as economies develop, there are fewer disaster-related deaths and damages/GDP (Toya & Skidmore, 2007). Nevertheless, increasing wealth causes relatively higher losses in high-income nations (Raskly, 2008). Increases in income increase the private demand for safety; higher income enables individuals (and countries) to employ additional, costly precautionary measures. Nevertheless, in countries that experience a concentration of assets that is larger than the counter-measures put in place, the income-vulnerability relationship can be inverted, especially in the case of disasters related to behavioural choices such as floods and landslides.

Disasters in South, Southeast, and East Asia are more costly than those occurring in the Middle East and Latin America. These results might be tied to the higher population density of Asian countries. Small island developing states are severely impacted by such events (Meheux et al., 2007): the number of victims and affected individuals and the degree of damage are twice as large on average as in any other region (Noy, 2009).

Normalization procedures are used to assess what the magnitude of economic losses over time would be if a past disaster took place today. It seems that societal change and economic development are the principal factors responsible for the increasing losses from natural disasters to date (Pielke et al., 2008; Barredo, 2009; 2010). For weather-related disasters, Bouwer (2011) pointed out no trends in losses - corrected for increases in population and capital at risk - that could be attributed to anthropogenic climate change.

2.3 Short-to-long-term physical and physiological effects on people

These articles focus on natural disasters and their effects on people's health from either a physical or a psychological point of view. Pre- and post-disaster conditions were compared in these studies to detect the onset of diseases and/or the worsening of pre-existing illness, and to assess if and when disaster-related symptoms appear/disappear. The data collection processes mainly involved standardized questionnaires used to collect self-reported information on symptoms quantified using numerical scores (Catapano et al., 2001; Cao et al., 2003) that could measure the disaster's impact.



Fig. 1. Damage caused to roads by landslides and floods in Calabria.

The risk of developing physical and/or psychiatric disorders is related to the extent of the losses suffered (Cao et al., 2003), and it is greater in families that have lost a family member in a disaster (Lindell & Prater, 2003), have experienced evacuation, or have worse finances (Bland et al., 1996). This probability can also be increased by a lack of information on the probability that the event will re-occur (Catapano et al., 2001). Two sub-sets of articles were isolated that focused on *psychological* and *physical* effects, respectively.

2.3.1 Psychological effects

According to the *Conservation Resource Model*, people try to protect resources such as objects (housing, possessions, etc.), social roles (employment, marriages, etc.), energy (time and monetary investments), and personal characteristics (e.g., self-confidence). The threatened or actual loss of these resources as caused by a natural disaster leads to psychological distress (O'Neill et al., 1999). Frequently observed conditions such as minor emotional disorders seldom come to the attention of psychiatrists but may negatively affect social relationships and work performance. Commonly detected symptoms are fatigue (Lutgendorf et al., 1995), tics, and cognitive experiences such as confusion, impaired concentration, and attention deficit disorder. *Emotional* signs such as anxiety, depression, and grief, as well as *behavioural effects* such as sleep and appetite changes and substance abuse, were also reported (Lindell & Prater, 2003). Even effects on suicide rates were detected: earthquake victims (people who had lost family members residing with them, were injured, or experienced property loss) were 1.46 times more likely than non-victims to commit suicide (Chou et al., 2003).

All these effects can be mild and transitory or can lead to *Post Traumatic Stress Disorder* (PTSD). The mental states of victims can include three stages (Sadeghi & Ahmadi, 2008): a) an *immediate reaction* involving distressing symptoms accompanying adaptive stress; b) the *post-immediate phase*, which includes symptoms of maladaptive stress (confusion, agitation, and occasionally neurotic or psychotic reactions); and c) the *long-term sequel* phase, which involves a return to normal health or the onset of PTSD, which can sometimes yield a *chronic phase* that involves personality changes. These surveys make it possible to monitor the most fragile segments of the population, including people with pre-existing mental illness, racial and ethnic minorities, and children, in which symptoms may differ depending on age (Lazarus et al., 2002; Overstreet et al., 2011). Gender differences arise as well: for instance, after an earthquake, women report greater emotional distress and mental health problems than do men (Norris et al., 2002), but the occurrence of addiction disorders among women is much lower (Montazeri et al., 2005).

2.3.2 Physical effects

Physical effects encompass symptoms affecting people who have not been directly involved in a disaster. The deterioration of hygiene, housing, and basic services can induce the outbreak of diseases such as *leptospirosis* (AusAID, 2005) or increase the risk of morbidity and mortality caused by communicable diseases (Waring & Brown, 2005). In developing countries, for instance, contagious and non-contagious diseases are reported during the first weeks after floods. Moreover, in some environments, even the incidence of snake bites can increase (Shajaat Ali, 2007).

Disaster-related stress can have several secondary impacts on human health, such as effects on the human immune system (Solomon et al., 1997), diabetes (Ramachandran et al., 2006; Fonseca et al., 2009), and gastro duodenal ulcers (Suzuki et al., 1997). Also increases in serum leptin levels have been detected in subjects with PTSD, which explains the hyper-vigilance of people who have faced danger and uncertainty (Liao et al., 2004). In addition, after major earthquakes, the number of patients with Acute Myocardial Infarction (AMI) has been reported to increase 3.5-fold, and the part of women with AMI seems significantly greater than in the years preceding the disaster (Suzuki et al., 1997).

3. The impact of Damaging Hydro-geological Events (DHEs)

This paragraph focuses on climate-related damaging phenomena as landslides, floods, urban flooding, and storm surges which occur during periods of bad weather conditions, lasting from one to a few days, and characterised by intense rainfall and sometimes strong winds. These periods can be defined as Damaging Hydro-geological Events (DHEs) (Petrucci & Polemio 2003, 2009), and their impact can be assessed as the sum of the damage caused by all the damaging phenomena triggered through a selected DHE.

3.1 Data collection

Data on damage caused by DHEs which occur currently can be obtained from different agencies (civil protection, public works offices, etc.) or even by on-site surveys (interviews with people involved or local administrators). On the contrary, dealing with events that occurred in the past, for which no direct surveys can be performed, historical data have to be found. The availability of historical data changes from one country to another and over time, and it is related to event severity. Actually, information concerning older events is less plentiful than information pertaining to newer events and the greatest amount of data usually exists for the most severe events, whereas less severe cases are rarely mentioned. Historical data can be gathered mainly from non-technical sources (books, newspapers, etc.), and then phenomena are described by non-specialist observers, which often focus on the effects (damage) more than on their causes (landslides, floods and so on).

In Italy, for example, there is no public authority that systematically collects data on damage caused by DHEs. These data can eventually be found in several offices, but none of these offices focus exclusively on collecting them. Moreover, each office stores documents in its archive by using organization criteria that are designed according to the needs of the office itself and not planned for public use. In addition, the archives of some type of offices, as i.e. fire brigades and hospitals, which can contain data on damage to both people and properties, cannot be accessed because of laws ensuring the privacy of citizens. Other requests for both aid and damage reimbursement are usually sent to civil protection offices, but we mustn't presume that these requests are systematically collected, and, this usually happens only for recently occurred phenomena; it is more difficult to find documents concerning damage that occurred several decades ago. Several authors gathered data from press archives (Cuesta et al. 1999, Devoli et al. 2007). Daily newspapers ensure continuity in information flow and, by-passing problems related to privacy, report detailed descriptions of human injuries, supply the age, sex, and names of the people involved and details of the causes of death or prognosis of injuries. However, this information source presents some disadvantages that must be clearly understood.

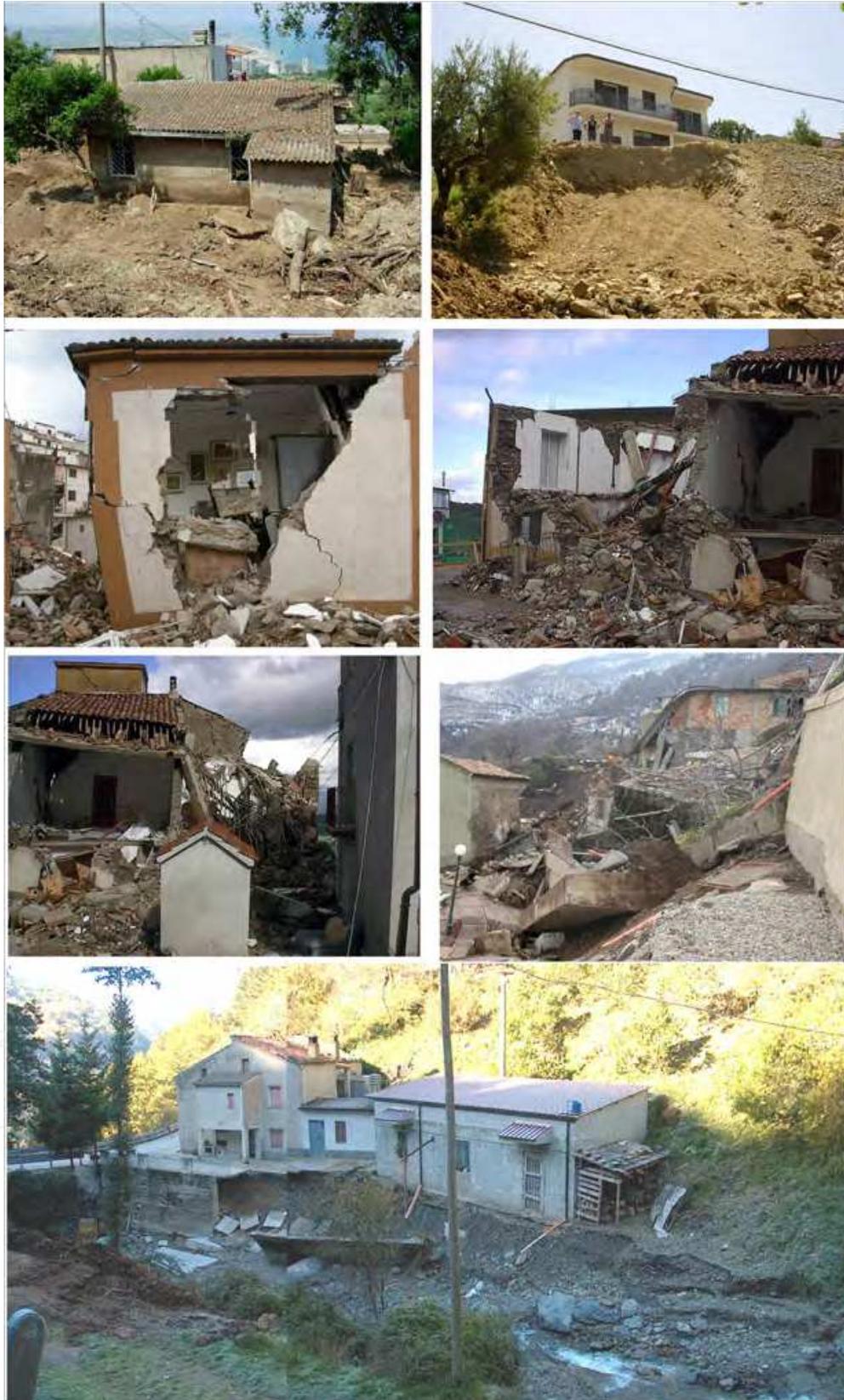


Fig. 2. Damage to houses caused by landslides and floods in Calabria.

1. The language of newspapers is not technical, so the articles must be carefully analysed to correctly classify the described phenomena. It is necessary to understand the reporter's perspective and familiarity with phenomena: adjectives to describe the size of a landslide, for example, must be assessed with caution because they are strongly affected by previous experience of the reporter with landslides.
2. Local newspapers are more detailed than national ones: until some decades ago, news coming from regions far from the editorial unit was only related to severe events, and thus, only the local newspaper allows a complete screening of both major and minor events occurred in a selected time-frame.
3. Articles tend to focus on damage, so details on phenomena can be scarce and must be inferred. Similarly, quantitative data on triggers (i.e., rain or wind intensity) are not provided, because newspaper articles focus more on the effects and less on their causes.
4. The articles must be checked in order to avoid duplication: often, newspapers report a damaging phenomenon in several editions (at least until major damage has been repaired). Also the number of victims must be carefully checked: newspapers may provide changing figures until the end of rescue operations.

Despite these disadvantages, especially in countries where there are no public authorities collecting these data, newspapers can be used as proxy data to establish a catalogue of damaging situations that can provide an indicator of the social impact of DHEs. In Italy, a systematic collection of data mined from newspapers was organised in an on-line database named AVI (<http://sici.irpi.cnr.it/>), and the use of newspaper data or, more recently, of internet-sourced news is a common practice to gather data (Kirschbaum et al., 2009).

3.2 Approaches to the assessment of damage caused by DHEs

The record of damage caused by DHEs in a selected region during a certain study period can be obtained by means of the systematic analysis of daily newspapers. Then, the damage caused by these DHEs can be assessed by various criteria, and the events can be classified according to their damage severity. In this way, data can be used for different types of analyses, as for example: a) the study of triggering rainfall thresholds, b) the comparisons between the severity of DHEs occurred in a selected area through the time, to understand if climatic change can modify their impact, and c) the comparisons between the severity of DHEs occurred in the same places but in different periods, to verify if and how the development of urbanised sectors can affect their impact.

The approaches to assess the impact of DHEs can be more or less complex; nevertheless, their applicability depends firstly on data availability and secondly on the scale of the study. The simplest damage classification, which can be applied at both local and regional scale, can be performed establishing *a priori* three damage levels (Petrucci & Versace, 2000):

1. **Level 1: high damage.** At least one of the following circumstances occurs:
 - breaking of bridges
 - damage to main roads and railway lines
 - serious blocking of roads and railways lines
 - damage to major life-lines
 - collapse of buildings
 - flooding of vast areas of land with great damage to agriculture
 - occurrence of victims and casualties

2. **Level 2: medium damage.** The circumstances of Level 1 do not occur but at least one of the following does:
 - some building rendered unusable
 - landslides and/or flooding that affect road and railways though with limited effects and brief duration
 - damage to secondary life-lines
 - flooding of limited areas of land with serious damage to agriculture
3. **Level 3: low damage.** The circumstances of Levels 1 and 2 do not occur and just one of the following happens:
 - damage to agriculture OR
 - flooding of inhabited areas OR
 - damage to life-lines

To perform an in depth analysis, further steps can be done, by defining some descriptive indices that can be used to summarize the effects of a DHE.

3.2.1 Index of Damaged Area (IDA)

This index represents the relative size of the area affected by floods or landslides during a DHE, and it is assessed in reference to small administrative units of the disaster region. In Italy, for example, we relate this index to the municipalities of a selected region.

The IDA is obtained by summing the area of municipalities hit during the DHE (S) and dividing the obtained value by the area of the regional surface (R).

$$IDA \text{ (Index of Damaged Area)} = S / R \times 100 \quad (1)$$

S is greater than the area truly affected, but this simplification is necessary to by-pass the impossibility of precisely delimiting areas actually hit, because of the low technical level which can characterise historical data. IDA represents the percentage of a region's area affected during each DHE; based on IDA, the DHEs that affected a region can be classified as:

$$\text{Local DHE} = IDA < 2.5\%$$

$$\text{Wide DHE} = IDA: 2.5 \div 10\%$$

$$\text{Regional DHE} = IDA > 10\%$$

3.2.2 Local Damage Index (LDI) and Local Damage Index Density (LDI_d)

The Local Damage Index is the sum of damage D_i caused in a municipality by the i phenomena that occurred there, and it is based on the concept that damage is the product of the value of damaged element and the level of loss that it suffered (Varnes & IAEG, 1984):

$$LDI = \sum D_i \quad (2)$$

Where:

$$D_i \text{ (Damage)} = V_i \times L_i \quad (3)$$

V_i is the *value of the damaged element*, ranging from 1 to 10 in an arbitrary scale (Figure 3), and L_i is the *level of loss* suffered, a measure of the percentage of loss affecting the element during the event, that can be High=L1 (1), Medium=L2 (0.5), or Low=L3 (0.25) (Petrucci et al. 2003).

By dividing the LDI by the municipal area, we can obtain an index that represents the density of damage in each of the hit municipalities:

$$LDId \text{ (Local Damage Index Density)} = LDI / \text{Municipality area} \quad (4)$$

Obtained values can be sorted into a number of classes. For each event, a regional map of municipalities classified according to the LDId can summarise the regional pattern of damage, thus allowing use of a geographical analysis of the pattern of damage density pattern which can be used, i.e., to identify more intensely affected regional sectors. Moreover, by comparing LDI to the return period of rainfall which triggered the damaging phenomena, the proneness of an area to be damaged by DHEs can be classified as (Petrucci & Pasqua, 2008):

- **High**, if rainfall of low return periods causes severe damage.
- **Medium**, if return period of rainfall and induced damage show equal levels of exceptionality.
- **Low**, if rainfall having a high return period induces damage of low level.

4. The impact of mass movements

Mass movements, defined as the movements of masses of soil, rock, debris, or mud, usually occur because of the pull of gravity, and are a source of great concern because they can impact numerous victims and cause severe damage. Although many types of mass movements are included in the general term “landslide,” the more restrictive use of the term refers only to mass movements where there is a distinct zone of weakness that separates the slide material from more stable underlying material (USGS, 2009).

Only a low percentage (12%) of the articles analysed to perform the review presented in the paragraph 2 concern landslides. This low attention to landslides impact depends on two factors: a) if compared to earthquakes or hurricanes, landslides could be classified as minor disasters; b) landslides can be secondary consequence of major disasters such as earthquakes. Nonetheless, both the assessment of damage after landslides occurrence, and the appraisal of damage that could be caused by future landslides have practical usefulness.

Immediately after an event that triggered several landslides, a rapid relative damage assessment allows for the sorting of phenomena according to their relative impact, upon this assessment priorities for structural remediation can be set and the costs and benefits derived from the implementation of different defensive measures can be assessed.

On the other hand, pre-event assessment of the potential impacts of future mass movements can provide information to planners, who must evaluate the consequences of alternative hazard mitigation measures. If the landslide inventory of an area has been conducted, a “consequence analysis” can identify potential outcomes arising from the activation of each mapped landslide. In addition, estimating the potential damage from each landslide can enable preparedness and improve the capacity of governmental agencies to cope with the emergency phases.

5. The Support Analysis Framework

The Support Analysis Framework is a spread sheet used to appraise damage caused by past mass movements or to assess the probable damage related to future phenomena (Petrucci & Gullà, 2009, 2010). The SAF was organised on the basis of historical damage data available in the Historical Archive of CNR-IRPI of Cosenza which have been partially published (Petrucci & Versace, 2005, 2007; Petrucci et al., 2009).

Type	Sub-Type	Vi			Level 1 (1)	Level 2 (0.5)	Level 3 (0.25)
		Bridge	Tunnel	Roadway			
Road network	Highway	10	10	8	Prolonged traffic interruption due to road breakage	Temporary traffic interruption due to road breakage	Effects on road without traffic interruption
	State road	8	8	6			
	County road	6	6	4			
	Municipal road	5	5	3			
	Mule-track			1			
Railway network	State railway	10	10	8			
	Regional railway	8	8	6			
	Service railway	5	5	3			
Type	Sub-Type	Vi			Level 1 (1)	Level 2 (0.5)	Level 3 (0.25)
Housing areas				10	Building collapse	Building evacuation	Effects not involving evacuation
Public buildings	Hospital			10			
	City hall			10			
	School			10			
	Barracks			10			
	Fire station			10			
	Church			10			
	Airport			10			
	Cemetery			5	Collapse of a lot of construction	Collapse of some construction	Effects without collapses
Services networks	Electricity line			5	Prolonged service interruption in large areas	Temporary service interruption in large areas	Temporary service interruption in small areas
	Telephone line			5			
	Drainage system			5			
	Aqueduct			5			
Productive activities	Agriculture			4	Interruption of production and loss of productive system	Interruption of production and loss of products	Limited loss of products
	Farming			4			
	Commerce/business			5			
	Fishing			4			
	Industry			8			
Tourist and sport resorts	Hotel			10	Interruption of activity and loss of productive structure	Temporary interruption of activity	Effects without interruption of activity
	Campground			4			
	Bathing beach			2			
	Sport resorts			8			
Port equipment	Wharf			8	Collapse	Loss of efficiency	Effects not involving loss of efficiency
	Seafront			3			
	Breakwater			1			
Hydraulic works	Check dam			4	Collapse	Loss of efficiency	Effects not involving loss of efficiency
	Embankment			5			
	Retaining wall			6			
	Dam			10			

Fig. 3. Types and sub-types of damaged elements. For each type and sub-type, the value considered for damage assessment is V_i . The multiplying factors for assessing the Local Damage Index are 1, 0.5 and 0.25 for levels 1, 2 and 3, respectively.

The aim of the SAF is to convert (historical) data of landslide damage into numerical indices describing: direct damage, defined by the effects on 6 types of elements (*Buildings, Roads, Railways, Productive Activities, Network services, People*), indirect damage, defined by the actions aiming to reinstate pre-landslide conditions, and intangible damage, defining psychological consequences caused to people by the landslide.

In dealing with an approach designed for historical damage data, the SAF does not require on-site surveys: damaged elements and levels of loss are obtained by analysing the available descriptive data. For this reason, the SAF can be filled by non-specialists who should simply be trained on the procedure to mine landslide damage data from historical documents.

5.1 Identification and direct damage sections

For each landslide, a SAF must be completed to obtain numerical indices representing its impact. The first part of the SAF is the identification section (**A**), which accounts for:

- location of the landslide (province, municipality, place name, coordinates) and map of the landslide area (if not available in analysed documents, we can roughly trace it on a topographic map with the available information);
- time of activation (year-month-day/s);
- document(s) from which data have been obtained (original title or type of document if no title is available);
- reliability of the document(s) from which data have been collected (ranging from low to high, according to the type of document and the skill of the author).

The part of the SAF assessing direct damage is made up of 6 sections (B to G) and it is divided into two parts: the elements (on the left side of the chart) and the levels of loss (on the right) (Figure 4). Each element is characterised by its value, set on an arbitrary scale (red numbers). The levels of loss (black numbers), are set as: L4: complete loss; L3: high loss; L2: medium loss; or L1: low loss. Depending on the section, these levels have different meanings, but they always reflect the aforementioned levels of loss.

In the working version of the SAF, the yellow cells are empty: by typing the letter x in a cell describing an element and another one in the cell of the suffered level of loss, formulas implemented in hidden columns multiply these two values to obtain dl , which is the contribution to damage of the line l . All the dl values are used to assess both direct and total damage indices.

The elements used for direct damage assessment are organised in the following sections:

- **Section B: Buildings.** Buildings are classified as public or private. For public buildings, according to the social function, the strategic coordination role in emergency management and the number of people who can be inside during night and day, a unique value was set (city hall =1; barracks =1; hospital =1; school =0.75; church =0.75). For private buildings, two criteria were introduced to identify their value: the number of buildings (1 building; 2-10 buildings; >10 buildings), and whether they are inhabited, temporarily inhabited or uninhabited. The level of loss can be selected from: L4 (collapsed), L3 (unusable due to structural damage), L2 (unusable due to loss of functionality), and L1 (habitable with light damage). In this section, the loss of furnishing inside or outside the buildings is also included and classified according to the number of buildings involved (1 building; 2-10 buildings; >10 buildings).

- **Section C: Roads.** Roads are classified into five types according to relevance, traffic flow, and possible restoration costs: highway, state road, county road, municipal road and country road. Except for country roads, which are characterised by a simple structure, the damage can affect one or more of the following sub-elements: bridge, tunnel and roadway. Then, except for country roads, the value depends on the damaged sub-element(s). According to the degree and duration of inefficiency, the levels of loss were set as follows: L4: road breakage causing traffic interruption for months; L3: road breakage causing traffic interruption for days; L2: temporary interruption without breakage; L1: light damage without traffic interruption.
- **Section D: Railways.** According to the relevance and the traffic flow, we divided railways into state and regional railways. The value depends on the damaged sub-element(s), and the level of loss can be selected from: L4: railway breakage causing traffic interruption for months; L3: railway breakage causing traffic interruption for days; L2: temporary interruption without breakage; and L1: light damage without traffic interruption.
- **Section E: Productive activities.** These are divided into five types: industrial, commercial, handicraft, tourism and farming. The levels of loss were set as: L4: interruption of production and loss of productive system; L3: interruption of production and loss of products; L2: loss of products; and L1: light damage without loss of products.
- **Section F: Network services.** This category is divided into five types: gas pipeline, electric line, telephone line, aqueduct, and drainage system. The levels of loss were set according to the duration of the inefficiency and the extent of the suffering area (L4: prolonged service interruption of large areas; L3: temporary service interruption of large areas; L2: local and temporary inefficiencies; and L1: light damage without inefficiencies).
- **Section G: People.** Damage to people is described by the occurrence of four conditions: victims; badly hurt; light physical damage; and temporary shock conditions. The levels of loss were set according to the number of people concerned (>60 people; 60-30 people; 30-10 people; <10 people).

5.2 Indirect damage sections

The indirect damage analysis process includes two sections, H and I (Figure 5). Section H describes actions concerning the dislocation of people, for which the levels of loss are set according to the number of people involved (>60 people; 60-30 people; 30-10 people; <10 people). Section I accounts for the cost of remedial works, and the interruption and/or delay of economic activities caused by the mass movement. In this case, the level of loss depends on an appraisal of the economic cost of these works, sorted into four nominal intervals (>100,000 €; 100,000-20,000 €; 20,000-10,000 €; <10,000 €).

As for direct damage sections, the numbers in Figure 5 are hidden in the operating version of the SAF, because the yellow cells must be filled in. For each action, we have to select only one of the four levels of loss, by typing the letter x into the relative cell: in this way, the hidden value is placed in the correspondent d_i cell. All of the d_i values are used to assess both indirect and total damage indices.

Direct damage sections											
Sections	Elements			Levels of loss				d_i			
B	Buildings	Public buildings			L4	L3	L2	L1			
		City Hall			1	1	0.75	0.5	0.25	d_{B1}	
		Barracks			1	1	0.75	0.5	0.25	d_{B2}	
		Hospital			1	1	0.75	0.5	0.25	d_{B3}	
		School			0.75	1	0.75	0.5	0.25	d_{B4}	
		Church			0.75	1	0.75	0.5	0.25	d_{B5}	
		Private houses	Inhabited	Temporarily inhabited	Uninhabited	Levels of loss					
		1 Building		0.75	0.5	0.25	1	0.75	0.5	0.25	d_{B6}
				0.75	0.5	0.25	1	0.75	0.5	0.25	d_{B7}
				0.75	0.5	0.25	1	0.75	0.5	0.25	d_{B8}
				0.75	0.5	0.25	1	0.75	0.5	0.25	d_{B9}
		2+10 Buildings		1	0.75	0.5	1	0.75	0.5	0.25	d_{B10}
				1	0.75	0.5	1	0.75	0.5	0.25	d_{B11}
				1	0.75	0.5	1	0.75	0.5	0.25	d_{B12}
		>10 Buildings		1	1	0.75	1	0.75	0.5	0.25	d_{B13}
				1	1	0.75	1	0.75	0.5	0.25	d_{B14}
				1	1	0.75	1	0.75	0.5	0.25	d_{B15}
				1	1	0.75	1	0.75	0.5	0.25	d_{B16}
		Loss of furnishings and assets	1 Building			0.25	1	0.75	0.5	0.25	d_{B18}
			2-10 Buildings			0.5	1	0.75	0.5	0.25	d_{B19}
			>10 Buildings			0.75	1	0.75	0.5	0.25	d_{B20}
		Loss of assets outside the buildings (i.e. cars)	1 Building			0.25	1	0.75	0.5	0.25	d_{B21}
			2-10 Buildings			0.5	1	0.75	0.5	0.25	d_{B22}
>10 Buildings			0.75	1	0.75	0.5	0.25	d_{B23}			
C	Roads	Highway	Bridge	1	1	0.75	0.5	0.25	d_{C1}		
			Tunnel	1	1	0.75	0.5	0.25	d_{C2}		
			Roadway	1	1	0.75	0.5	0.25	d_{C3}		
		State road	Bridge	1	1	0.75	0.5	0.25	d_{C4}		
			Tunnel	0.75	1	0.75	0.5	0.25	d_{C5}		
			Roadway	0.75	1	0.75	0.5	0.25	d_{C6}		
		County road	Bridge	1	1	0.75	0.5	0.25	d_{C7}		
			Tunnel	0.75	1	0.75	0.5	0.25	d_{C8}		
			Roadway	0.25	1	0.75	0.5	0.25	d_{C9}		
		Municipal road	Bridge	0.75	1	0.75	0.5	0.25	d_{C10}		
			Tunnel	0.5	1	0.75	0.5	0.25	d_{C11}		
			Roadway	0.25	1	0.75	0.5	0.25	d_{C12}		
		Country road	Roadway	0.25	1	0.75	0.5	0.25	d_{C13}		
D	Railways	State railway	Bridge	1	1	0.75	0.5	0.25	d_{D1}		
			Tunnel	1	1	0.75	0.5	0.25	d_{D2}		
			Roadway	0.75	1	0.75	0.5	0.25	d_{D3}		
		Regional railway	Bridge	1	1	0.75	0.5	0.25	d_{D4}		
			Tunnel	0.75	1	0.75	0.5	0.25	d_{D5}		
			Roadway	0.5	1	0.75	0.5	0.25	d_{D6}		
E	Productive activities	Industrial			1	1	0.75	0.5	0.25	d_{E1}	
		Commercial			0.75	1	0.75	0.5	0.25	d_{E2}	
		Handicraft			0.5	1	0.75	0.5	0.25	d_{E3}	
		Tourism			0.75	1	0.75	0.5	0.25	d_{E4}	
		Farming			0.25	1	0.75	0.5	0.25	d_{E5}	
F	Networks services	Gas pipeline			1	1	0.75	0.5	0.25	d_{F1}	
		Electric line			1	1	0.75	0.5	0.25	d_{F2}	
		Telephone line			0.5	1	0.75	0.5	0.25	d_{F3}	
		Aqueduct			0.75	1	0.75	0.5	0.25	d_{F4}	
		Drainage system			0.5	1	0.75	0.5	0.25	d_{F5}	
G	People				>60 P	60-30 P	30-10 P	<10 P			
		Victims			1	1	0.75	0.5	0.25	d_{G1}	
		Badly hurt			1	1	0.75	0.5	0.25	d_{G2}	
		Light physical damage			0.5	1	0.75	0.5	0.25	d_{G3}	
		Temporary shock conditions			0.25	1	0.75	0.5	0.25	d_{G4}	

Fig. 4. Sections of the SAF assessing direct damage. The black numbers are the relative values of the elements. The levels of loss (red numbers) are set as follows: L4: complete loss; L3: high loss; L2: medium loss; L1: low loss. P stands for People.

Indirect damage sections						
S	Actions	Levels of loss				dl
		L4	L3	L2	L1	
		>60 people	60<people<30	30<people<10	<10 people	
H	Lodging for prolonged periods (>30days)	1	0.75	0.5	0.25	dl _{H1}
	Lodging for short periods (<30days)	0.75	0.5	0.25	0.25	dl _{H2}
	Arrangement of foodstuffs and basic necessities for displaced people	0.25	0.25	0.25	0.25	dl _{H3}
	Set up of sanitary conditions for displaced people	0.25	0.25	0.25	0.25	dl _{H4}
S	Actions	Levels of loss				dl
		L4	L3	L2	L1	
		>100,000€	100,000 ÷ 20,000 €	20,000 ÷ 10,000 €	<10,000 €	
I	Removal of debris in order to re-enable circulation	1	0.75	0.5	0.25	dl _{I1}
	Remedial works aiming to re-establish safety conditions for people (retaining walls, removal of unstable rock blocks)	1	0.75	0.5	0.25	dl _{I2}
	Studies, surveys and monitoring aiming to organise plans for emergency management and recovering	1	0.75	0.5	0.25	dl _{I3}
	Emergency works on unstable buildings	1	0.75	0.5	0.25	dl _{I4}
	Construction of new housing	1	0.75	0.5	0.25	dl _{I5}
	Opening of alternative roads to by-pass damaged areas	1	0.75	0.5	0.25	dl _{I6}
	Economic loss due to the decrease of traffic	1	0.75	0.5	0.25	dl _{I7}
Intangible damage section						
S	Actions	Levels of loss				dl
		L4	L3	L2	L1	
		>60 people	60<people<30	30<people<10	<10 people	
L	Psychological effects due to the prolonged condition of displaced people	0.75	0.5	0.25	0.25	dl _{L1}
	Psychological effects due to the temporary condition of displaced people	0.5	0.25	0.25	0.25	dl _{L2}
	Problems due to the delay of public transportation in the damaged area	0.5	0.25	0.25	0.25	dl _{L3}

Fig. 5. Sections of the SAF assessing the indirect (**H** and **I**) and intangible (**L**) damage. Basing on the combination of the action to be undertaken and the number of people involved (**H** and **L**) or the cost of the action (**I**), a value grid has been defined.

5.3 Intangible damage section

The intangible damage, assessed in section L, takes into account the psychological consequences affecting people who live in the damaged area. The levels of loss are set according to the number of people involved (>60 people; 60-30 people; 30-10 people; <10 people) (Figure 5). For each line of the indirect damage sections, by selecting a single level of loss, the appropriate numerical value is inserted in the corresponding cell of d_i . All of the d_i values are used to assess both intangible and total damage indices.

5.4 Assessment of damage indices

The values of d_i obtained from the lines of the SAF are converted into damage indices by means of the simple calculations summarised below. For each section, i.e., for the generic section i , we calculate the Damage of the Section i (D_{Si}) using equation 5:

$$D_{Si} = \sum dl \quad (5)$$

where d_i is the damage contribution of each of the n lines of section L .

For each section, the maximum value of D_{Si} ($MaxD_{Si}$) is calculated based on the occurrence of damage to all of the listed elements that are supposed to suffer the highest level of loss. Next, D_{Si} is normalised to $MaxD_{Si}$ to obtain the Normalised Damage of Section i (ND_{Si}), as in equation 6:

$$ND_{Si} = D_{Si} / MaxD_{Si} \quad (6)$$

To obtain the Index of Damage of Section i (ID_{Si}), the values of ND_{Si} are classified as follows: D4: very high damage ($1 < D4 \leq 0.75$); D3: high damage ($0.75 < D3 \leq 0.5$); D2: medium damage ($0.5 < D2 \leq 0.25$); or D1: low damage ($D1 < 0.25$).

The Normalised DIrect Damage ($N.DI.D$) is obtained using equation 7:

$$N.DI.D. = \sum ND_{Si} / 32.5 \quad (7)$$

where the value 32.5, which is used to normalise the result, is the maximum ND_{Si} that can be obtained by summing the D_{Si} of all of the direct damage sections. The calculation is extended to all of the sections of direct damage, from B to G. The value of $N.DI.D.$ is converted into the Index of DIrect Damage ($I.DI.D.$) by classifying it into one of the four classes listed above (D4, D3, D2, or D1). The Normalised INdirect Damage ($N.I.D.$) is calculated using equation 8: the sum is from $i=H$ to $i=I$ and 9.25 is the maximum indirect damage that SAF can assess. The Index of INdirect Damage ($I.I.D.$) is obtained by classifying the result according to the above-mentioned four classes.

$$N.I.D. = \sum D_{Si} / 9.25 \quad (8)$$

Similarly, the Normalised INtangible Damage ($N.IN.D.$) can be assessed using equation 9, in which L is the intangible damage section and 1.75 is the maximum sum of D_{Si} of the L section. The Index of INtangible Damage ($I.IN.D.$) is determined by classifying the value obtained from equation 9.

$$N.IN.D. = \sum D_{Si} / 1.75 \quad (9)$$

The Normalised Total Damage (*N.T.D.*) is calculated using equation 10 (the sum is from $i=B$ to L), and the Index of Total Damage (*I.T.D.*) is obtained by classifying the value obtained from equation 10. In equation 10, 43.5 is the maximum value of total damage that can be assessed using the SAF.

$$N.T.D. = \sum DS_i / 43.5 \quad (10)$$

Following the described procedure, the SAF allows to convert damage descriptions into numerical indices expressing – in a relative manner – the direct, indirect, and intangible damage. The procedure was tested in Calabria, on both historical landslides (Petrucci & Gullà, 2009, 2010) and more recent events (Petrucci et al., 2010).



Fig. 6. Damage caused to cars by DHEs in Calabria.

It must be pointed out that the procedure is based on a relative scale of values and not on monetary costs. Then it can be used for a) current events for which monetary assessments are not (or not yet) available, and for B) past landslides for which monetary assessments of costs are quite impossible to obtain. In both these situations, the SAF represents the *minimum amount of information* that can be used to define the impact caused by different landslides in order to perform impact comparisons.

6. Conclusion

The chapter showed a panoramic view of the assessment of the impact of natural disasters as presented in the scholarly literature. The numerous experiences of damage assessment performed in different economic frameworks show that developing countries are more strongly hit than developed ones: as economies develop, there are fewer disaster-related deaths and damages/GDP. Nevertheless, increasing wealth causes relatively higher losses in high-income nations. Increases in income increase the private demand for safety; higher income enables countries to employ additional, costly precautionary measures. Yet, in countries with a concentration of assets that is larger than the counter-measures, the income-vulnerability relationship can be inverted, especially in the case of disasters related to behavioural choices such as floods and landslides.

Two major constraints obstruct the assessment of the impact of disasters: the first is the lack of shared assessment methodologies. In the different literature sectors, several approaches are available, but, as far as academic research are restricted to the detailed discussion of one particular impact, or impacts in a single sector, the result is a somewhat fragmented coverage of impacts. On the other hand, conveying all the different assessments in a single methodological approach is objectively an extremely complicated task which can be handled exclusively by multidisciplinary staffs, having all the skills to cope with a multifaceted task as disasters impact assessment.

The second problem is related to data availability. It is impossible to decide a priori the most opportune time to gather data and to undertake impact assessment, as it will depend on the type of phenomenon causing the disaster, its magnitude and scope of the assessment. In addition, continuous data gathering also once the emergency phase has passed ensures detection of long-term effects, as either economic impacts or psychological consequences on people affected.

On the contrary, dealing with the impact of phenomena occurred in the past, data gathering becomes very complicated: both the amount of data available and their level of detail can be low and cannot be significantly increased, even by further research. In these cases, simplified approaches can be used to perform relative assessments based on a minimum amount of information. These approaches aim to supply quantitative indices expressing the impact of different disasters in order to make them comparable even if they occurred both at different time and in different areas.

Specifically for landslides, a structured approach aiming to collect data and transforming them into relative damage indices is presented. This approach can be used for a) current events for which monetary assessments are not (or not yet) available, and B) past landslides for which monetary assessments of costs are quite impossible to obtain. In both these

situations, the approach focuses on the minimum amount of information that can be used to define the impact caused by different landslides in order to perform impact comparisons. It must be understood when using this approach that one is dealing with relative assessments and their reliability strictly depends on the reliability of the data employed.

7. References

- AusAID (Australian Agency for International Development) (2005). Economic impact of natural disasters on development in the Pacific, Volume 2: Economic Assessment Tools, http://www.ausaid.gov.au/publications/pdf/impact_pacific_tools.pdf, 2005, last access: June 2010
- Barredo, J.I. (2009). Normalised flood losses in Europe: 1970–2006. *Natural Hazards and Earth System Sciences*, Vol. 9, pp. 97–104
- Barredo, J.I. (2010). No upward trend in normalised windstorm losses in Europe: 1970–2008, *Natural Hazards and Earth System Sciences*, Vol. 10, pp. 97–104
- Bilgehan, R. & Kilic, R.K. (2008). The landslides threatening Tasova town (Central Anatolia, Turkey) and their environmental impacts. *Environm. Geology*, Vol. 55, pp. 179–190
- Birkmann, J., Buckle, P., Jaeger, J., Pelling, M., Setiadi, N., Garschagen, M., Fernando, N. & Kropp, J. (2008). Extreme events and disasters: a window of opportunity for change? Analysis of organizational, institutional and political changes, formal and informal responses after mega-disasters. *Natural Hazards*, Vol. 55 (3), pp. 637–655
- Bland, S.H., O’Leary, E., Farinero, E., Jossa, F. & Trevisan, M. (1996). Long-term psychological effects of natural disasters, *Psychosomatic Medicine*, Vol. 58, pp. 18–24
- Bouwer, L.M. (2011). Have disaster losses increased due to anthropogenic climate change? *American Meteorological Society*, Jan 2011, pp. 39–46
- CACND (Committee on Assessing Costs of Natural Disasters) (1999). The impacts of natural disasters: a framework for loss estimation. *The National Academy Press*, 80 pp.
- Cao, H., McFarlane A.C. & Klimidis, S. (2003). Prevalence of psychiatric disorder following the 1988 Yun Nan (China) earthquake: the first 5-month. *Soc. Psychiatry Psychiatr. Epidemiol.*, Vol. 38, pp. 204–212
- Catapano, F., Malafrente, R., Lepre, F., Cozzolino, P., Arnone, R., Lorenzo, E., Tartaglia, G., Storace, F., Magliano, L. & Maj, M. (2001). Psychological consequences of the 1998 landslide in Sarno, Italy: a community study. *Acta Psychiatr. Scand.*, Vol. 104, pp. 438–442
- Chou, Y.J., Huang, N., Lee, C.H., Tsai, S.L., Tsay, J.H., Chen, L.S. & Chou, P. (2003). Suicides after the 1999 Taiwan earthquake. *Inter. Jour. of Epidemiology*, Vol. 32, pp. 1007–1014
- Cuaresma, J.C., Hlouskova, J. & Obersteiner, M., (2004). Natural disasters as creative destruction: evidence from developing countries, <http://www3.interscience.wiley.com/cgi-bin/fulltext/119397853/PDFSTART>, last accessed: June 2010.
- Cuesta, M.J.D., Sanchez, M.J., & Garcia, A.R. (1999). Press archives as temporal records of landslides in the North of Spain: relationships between rainfall and instability slope events. *Geomorphology*, Vol. 30, pp. 125–132
- Devoli, G., Morales, A., & Høeg, K. (2007). Historical landslides in Nicaragua-collection and analysis of data. *Landslides*, Vol. 4, pp. 5–18

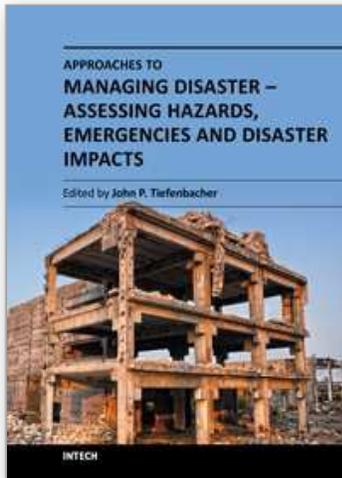
- Dosi, C. (2001). Environmental values, valuation methods and natural disaster damage assessment, Medio Ambiente y Desarrollo, CEPAL, United Nations, Santiago, Chile, 62pp.
- ECLAC (Economic Commission for Latin America and the Caribbean's) (1991). Manual for estimating the socio-economic effects of Natural disasters. <http://www.eclac.org>.
- ECLAC (Economic Commission for Latin America and the Caribbean's) (2003). Handbook for estimating the socio-economic and environmental effects of natural disasters, Section two: Social Aspects, Housing and human settlements, [http://www.preventionweb.net/files/1099_Vol2\[1\].pdf](http://www.preventionweb.net/files/1099_Vol2[1].pdf), 2003, last access: June 2010.
- Fonseca, V.A., Smith, H., Kuhadiya, N., Leger, S.M., Yau, C.L., Reynolds, K., Shi, L., Mcduffie, R.H., Thethi, T. & John-Kalarickal, J. (2009). Impact of a natural disaster on diabetes: exacerbation of disparities and long-term consequences, *Diabetes Care*, Vol. 32, pp. 1632-1638
- Highland, L.M. (2003). An account of preliminary landslide damage and losses resulting from the February 28, 2001, Nisqually, Washington, Earthquake. USGS Open-File rep.03-211.
- Jonkman, S.N., Maaskant, B., Boyd, E. & Levitan, M.L. (2009). Loss of life caused by the flooding of New Orleans after hurricane Katrina: analysis of the relationship between flood characteristics and mortality. *Risk Analysis*, Vol. 29 (5), pp. 676-698
- Kirschbaum, D.B., Adler, R., Hong, Y., Hill, S. & Lerner-Lam, A. (2009). A global landslide catalog for hazard applications: method, results, and limitations. *Natural Hazards*, Vol. 52 (3), pp. 561-575
- Lazarus, P.J., Jimerson, S.R. & Brock, S.E. (2002). Responding to natural disasters: helping children and families information for school crisis teams. www.nasponline.org. last accessed: June 2011.
- Liao, S.C., Lee, M.B., Lee, Y.J. & Huang, T.S. (2004). Hyperleptinemia in subjects with persistent partial Posttraumatic Stress Disorder after a major earthquake. *Psychosomatic Medicine*, Vol. 66, pp. 23-28
- Lindell, M.K. & Prater, C.S. (2003). Assessing community impacts of natural disasters. *Nat. Haz. Rev.* Vol. 4(4), pp. 176-185
- Lutgendorf, S.K., Antoni, M.H., Ironson, G., Fletcher, M.A., Penedo, F., Baum, A., Schnelderman, N., & Klimas, N. (1995). Physical symptoms of chronic fatigue syndrome are exacerbated by the stress of hurricane Andrew. *Psychosomatic Medicine*. Vol. 57, pp.310-323
- Meheux, K., Howes, D.D. & Lloyd, K. (2007). Natural hazard impacts in small island developing states: A review of current knowledge and future research needs. *Natural Hazards*, Vol. 40, pp. 429-446
- Montazeri, A., Baradaran, H., Omidvari, S., Azin, S.A., Ebadi, M., Garmaroudi, G., Harirchi, A.M. & Shariati, M. (2005). Psychological distress among Bam earthquake survivors in Iran: a population-based study. *BMC Public Health*, Vol. 5(4), pp. 1-6
- Msilimba, G.G. (2010). The socioeconomic and environmental effects of the 2003 landslides in the Rumphu and Ntcheu Districts (Malawi). *Natural Hazards*, Vol. 53, pp. 347-360
- Ngecu, W.M. & Ichang'I, D.W. (1999). The environmental impact of landslides on the population living on the eastern foot slopes of the Aberdare ranges in Kenya: a case study of Maringa Village landslide. *Environmental Geology*, Vol. 38, pp. 259-264

- Norris, F.H., Friedman, M.J., Watson, P.J., Byrne, C.M., Diaz, E. & Kaniasty, K. (2002). 60,000 disaster victims speak: Part I. An empirical review of the empirical literature, 1981–2001. *Psychiatry*, Vol. 65(3), pp. 207-239
- Noy, I. & Nualsri, A. (2011). Fiscal storms: public spending and revenues in the aftermath of natural disasters. *Environment and Development Economics*, Vol. 16, pp. 113–128
- Noy, I. (2009). The macroeconomic consequences of disasters. *Journal of Development Economics*, Vol. 88, pp. 221–231
- O’Neill, H.K., Blake, A.E., Bussman, M.D. & Strandberg, D.K. (1999). Psychological distress during the Red River flood: predictive utility of the conservation of Resource Model. *Applied Behavioural Science Review*, Vol. 7(2), pp. 159-169
- Overstreet, S., Salloum, A., Burch, B. & West, J. (2011). Challenges Associated with Childhood Exposure to Severe Natural Disasters: Research Review and Clinical Implications. *Journal of Child & Adolescent Trauma*, Vol. 4, pp. 52–68
- Patwardhan, A. & Sharma, U. (2005). Improving the methodology for assessing natural hazard impacts. *Global Planet. Change*, Vol. 47, pp. 253–265
- Petrucci, O. & Gullà, G. (2009) A Support Analysis Framework for mass movement damage assessment: applications to case studies in Calabria (Italy). *Natural Hazards and Earth System Sciences*, Vol. 9, pp. 315–326
- Petrucci, O. & Gullà, G. (2010). A simplified method for landslide damage scenario assessment based on historical data. *Natural Hazards*, Vol. 52(3), pp. 539-560
- Petrucci, O. & Llasat, M.C. (in press). Impact of disasters in Mediterranean regions: an overview in the framework of the HYMEX project. Proceedings of the Second World Landslide Forum, Rome, Italy, October 3-7, 2011
- Petrucci, O. & Pasqua, A.A. (2008). The study of past Damaging Hydrogeological Events for damage susceptibility zonation. *Natural Hazards and Earth System Sciences*, Vol. 8, pp. 881–892
- Petrucci, O. & Polemio, M. (2003). The use of historical data for the characterisation of multiple damaging hydrogeological events. *Natural Hazards and Earth System Sciences*, Vol. 3, pp. 17-30
- Petrucci, O. & Polemio, M. (2009). The role of meteorological and climatic conditions in the occurrence of damaging hydro-geologic events in Southern Italy. *Natural Hazards and Earth System Sciences*, Vol. 9, pp. 105-118
- Petrucci, O. & Versace, P. (2000). Conoscere il passato per prevedere il futuro. *DPC (Dipartimento Protezione Civile) Informa*, Vol. 29, pp. 25-26
- Petrucci, O. & Versace, P. (2005). Frane e alluvioni in provincia di Cosenza agli inizi del ‘900: ricerche storiche nella documentazione del Genio Civile. I Quaderno dell’Osservatorio di Documentazione del Dipartimento di Difesa del Suolo (UNICAL). Editoriale Bios, Cosenza, 172pp. Available on Google Books, ISBN 88-7740-391-8
- Petrucci, O. & Versace, P. (2007). Frane e alluvioni in provincia di Cosenza tra il 1930 e il 1950: ricerche storiche nella documentazione del Genio Civile. II Quaderno dell’Osservatorio di Documentazione del Dipartimento di Difesa del Suolo (UNICAL) Pubbl. GNDCI N. 2913, Nuova Bios, Cosenza, 247pp. Available on Google Books, ISBN 978-88-6093-029

- Petrucci, O., Pasqua, A.A., & Gullà, G. (2010). Landslide damage assessment using the Support Analysis Framework (SAF): the 2009 landsliding event in Calabria (Italy). *ADGEO*, Vol. 26, pp. 13-17
- Petrucci, O., Versace, P. & Pasqua, A.A. (2009). *Frane e alluvioni in provincia di Cosenza fra il 1951 ed il 1960: ricerche storiche nella documentazione del Genio Civile*. III Quaderno dell'Osservatorio di Documentazione del Dipartimento di Difesa del Suolo (UNICAL), Rubbettino, Soveria Mannelli (CZ), 316 pp. Available on Google Books, ISBN 978-88-95172-05-7
- Pielke, R.A. Jr., Gratz, J., Landsea, C.W., Collins, D., Saunders, M.A. & Musulin, R. (2008). Normalized hurricane damage in the United States: 1900-2005. *Nat. Haz. Rev.* Vol., 9(1), pp. 29-42
- Popp, A. (2006). The effect of natural hazard on long run growth, Major themes in economy, <http://www.cba.uni.edu/economics/themes/popp.pdf>, 2006, last access: June 2010
- Ramachandran, A., Snehalatha, C., Yamuna, A., Bhaskar, A.D., Simon, M., Vijay, V. & Shobhana, R. (2006). Stress and undetected hyperglycemia in Southern Indian coastal population affected by tsunamis. *JAPI*, Vol. 54, pp. 109-112
- Raschky, P.A. (2008). Institutions and the losses from natural disasters. *Natural Hazards and Earth System Sciences*, Vol. 8, 627-634
- Rodriguez-Oreggia, E., De la Fuente, A., De la Torre, R., Moreno, E. & Rodriguez, C. (2010). The impact of natural disasters on human development and poverty at the municipal level in Mexico. CID Working Paper No. 43, 34pp.
- Sadeghi, N. & Ahmadi, M.H. (2008). Mental health preparedness for natural disasters in Iran. *Natural Hazards*, Vol. 44, pp. 243-252
- Shajaat Ali, A.M. (2007). September 2004 flood event in SW Bangladesh: a study of its nature, causes, and human perception and adjustments to a new hazard. *Natural Hazards*, Vol. 40, pp. 89-111
- Skidmore, M. & Toya, H. (2002). Do Natural Disasters Promote Long-Run Growth? *Economic Inquiry*, Oxford Univ. Press. 40, 4, 664-687.
- Smith, S. & McCarty, C. (1996). Demographic effects of natural disasters: a case study of hurricane Andrew. *Demography*, Vol. 33(2), pp. 265-275
- Solomon, G.F., Segerstrom, S.C., Grohr, P., Kemeny, M. & Fahey, J. (1997). Shaking up immunity: psychological and immunologic changes after a natural disaster. *Psychosomatic Medicine*, Vol. 59, pp. 114-127
- Suzuki, S., Sakamoto, S., Koide, M., Fujita, H., Sakuramoto, H., Kuroda, T., Kintaka, T. & Matsuo, T. (1997). Hanshin-Awaji earthquake as a trigger for acute myocardial infarction. *Amer. Heart Jour.*, Vol. 134, (5)1, pp. 974-977
- Swiss Re (1998). *Floods-an insurable risk?*, Zurich, 48 p.
- Toya, H. & Skidmore, M. (2007). Economic development and the impacts of natural disasters. *Economics Letters*, Vol. 94, pp. 20-25
- Twigg, J. (2007). Tools for Mainstreaming Disaster Risk Reduction, Social Impact Assessment. International Federation of Red Cross and Red Crescent Societies Provention Consortium. http://www.proventionconsortium.org/mainstreaming_tools (latest access June 2011)

- UNEP-ECLAC (2000): Panorama of the environmental impact of recent natural disasters in Latin America and the Caribbean, <http://www.gdrc.org/uem/disasters/disenvi/Panorama-Envi-Impact.pdf>. last accessed: June 2010.
- USGS (2009). <http://pubs.usgs.gov/fs/2004/3072/fs-2004-3072.html>
- Varnes, D.J., IAEG-Commission on Landslides (1984) Landslide Hazard zonation – a review of principles and practice, UNESCO, Paris, 63 pp.
- Waring, S.C. & Brown, B.J. (2005). The threat of communicable diseases following natural disasters: a public health response. *Disaster Management Response*, Vol. 3, pp. 41-7
- Webb, G.R., Tierney, K.J. & Dahlhamer, J.M. (2002). Predicting long-term business recovery from disaster: a comparison of the Loma Prieta earthquake and Hurricane Andrew. *Environ. Haz.*, Vol. 4, pp. 45-58
- Whitworth, M.R.Z., Griffiths, J.S. & Lee, E.M. (2006). Evaluating risk in a rural environment; a case study; Sorbas, SE Spain, IAEG2006 Paper No. 535: 1-6.
- Wilhite, D.A., Svoboda, M.D. & Hayes, M.J. (2007) Understanding the complex impacts of drought: A key to enhancing drought mitigation and preparedness. *Water Res. Man.*, Vol. 21, pp. 763-774
- Zissimopoulos, J. & Karoly, L.A. (2010). Employment and self-employment in the wake of hurricane Katrina. *Demography*, Vol. 47(2), pp. 345-367

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