UNIVERSITA' POLITECNICA DELLE MARCHE

Department of Life and Environmental Sciences

Doctorate of Science

Curriculum in Civil and Environmental Protection

XXXI cycle

Methodologies and tools for collecting, recording and sharing flood data information and associated damages and losses.

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Acknowledgments

The present study have been sponsored by Università Politecnica delle Marche and Cima Research Foundation and was made in collaboration with the Regional Civil Protection of Marche Region which I would like to thank for their support.

I am grateful to Paolo Principi, Francesca Sini and Marco Massabò for the data, the comments, the suggestions and their positivity during my PhD. Among being great professors they are also, on my opinion, great human beings.

I would like to thank all the persons that provide necessary data, comments and support for this study: Cesarina Santinelli (Regional Civil Protection of Marche Region), Gianni Fermanelli (Agriculture sector in Marche Region), Paola Melonaro (Regional Civil Protection of Marche Region), Carlo Troisi (Piedmont Region), Veronica Casertelli (National Civil Protection Department), Emilio De Francesco (National Civil Protection Department) and Barabara Lastoria (ISPRA).

I am grateful to all the persons that work in the Functional Centre of Regional Civil Protection of Marche Region and Giovanna Sandroni for all their help and positivity.

A special thanks go to my friends and family who believed and supported me during the PhD.

And last but not least I want to thank my son Aron.

P.S. The final version of this document have been produced under durable high magnitude earthquakes.

1 Introduction

Numerous studies shows that in the last decades the damages and costs of climate related disasters are rising [(Wallemacq & House, 2018), (Sendai Framework for Disaster Risk Reduction 2015-2030, 2015), (Mapping the impacts of natural hazards and technological accidents in Europe, 2010)]. The damages of climate related disasters are also expected to rise due to climate changes (Global warming of 1.5°C, 2018). Especially the UN Office for Disaster Risk Reduction recently released the report "Economic Losses, Poverty & Disasters 1998-2017" which shows that during the period 1998-2017, disaster-hit countries reported direct economic losses of US$ 2,908 billion of which climate-related disasters accounted for 77% of the total. The reports shows also that climate-related disasters are the most frequent with 91% of major events recorded for the period with floods representing 43.4% of the total.

An interrogation of EM-DAT database, one of the most famous and longevity databases, for the period 1900 till 2018 comprehending all continents data, shows that the number of disaster have an increasing trend over the years (Figure 1).

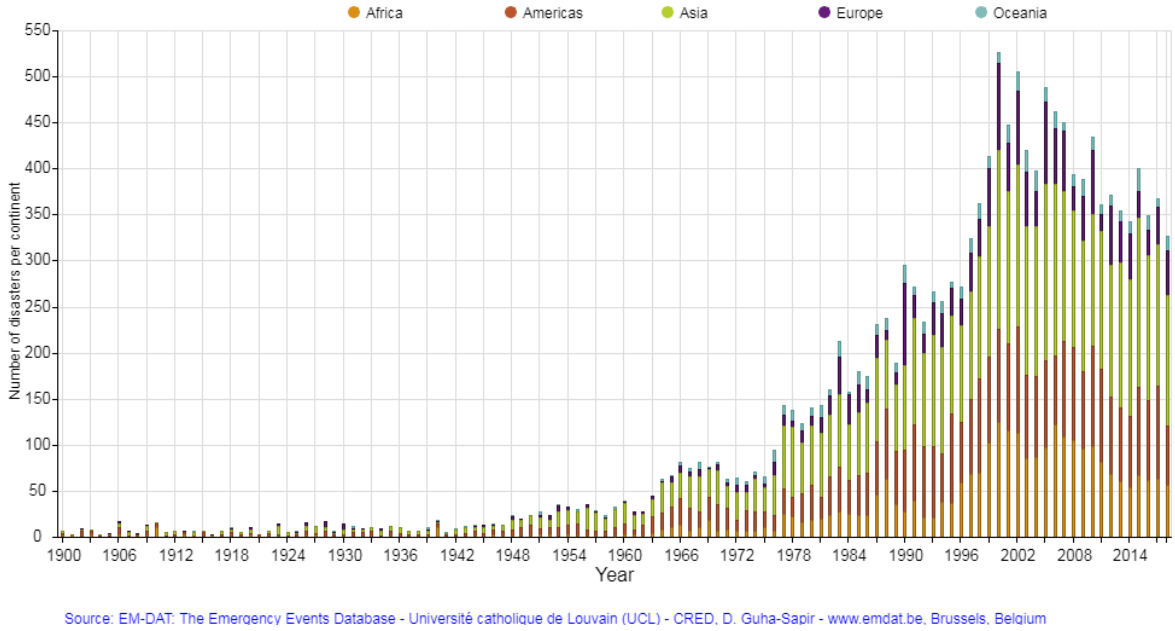


Figure 1. EM-DAT database, number of disasters for the period 1900-2018.

All the previous data shows that the disaster risk is increasing. Many can be the causes as the land use change, increased exposure in hazard prone areas, climate change, higher amount of data available through the years etc..

Many international organizations (UN Office for Disaster Risk Reduction – UNDRR, former UNISDR, Joint Research Centre, Sigma Reinsurance) have underlined the importance of gathering and recording disaster loss data.

The disaster loss data can be very useful because as essential evidence for sound policy-making and evaluating progress in reducing disaster risks (De Groeve, Poljansek, Ehrlich, & Chorbane, Current status and Best Practices for Disaster Loss Data recording in EU Member States, 2014). With increased understanding of the disaster trends and their impacts, better prevention, mitigation and preparedness measures can be planned to reduce the impact of disasters on the communities.

As stated by the National Research Council in March 1999 “Until relatively accurate estimates are available, the true economic losses in natural disasters will remain poorly understood and the benefits of disaster mitigation activities only imprecisely evaluated”.

This study is mainly focused on the damage and loss data after flood events. It start with contextualising the work with different international, European and national level frameworks, documents, directives and databases. After an overview of the state of the art of the topic, a comparison is made between FloodCat (Italian national database for floods) and some selected international, European and national level frameworks, documents, directives and databases in order to see how much FloodCat is in line with similar initiatives in the DRR field.

The state of emergency in Italy have been investigated in a holistic manner starting from Alerting Procedures to the Declaration of the State of Emergency and State of Natural Calamity till the damage compensation by the state administration. The implementation of FloodCat system in Marche Region as a pilot region for FloodCat test, use, improvement and optimisation have been described in detail. An event case study (May 2014) have been analysed from the point of view of damage data. And finally an effort have been made to apply economic damage estimation to FloodCat records.

The research objective on damage data is very important in the flood risk management community. This research integrate/harmonize existing monitoring tools into the FloodCat database.

In the common goal of reducing the risk of forthcoming disasters, legislation, initiatives, documents and frameworks at both European and international level have been produced during the last decades to find common targets and set milestones for the coming horizon.

In the following paragraphs are listed the main directives and international initiatives that are relevant for this doctoral study. This comprehend the European Union Flood Directive, the Joint Research Centre’s guidances on disaster losses, the Sendai Framework for Disaster Risk Reduction 2015-2030, the Sustainable Development Goals and the INSPIRE Directive.

1.1 European Union Flood Directive – EUFD

Floods are a threat to human health, cultural heritage, the economy and the environment. With the Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks (hereinafter Flood Directive), the EU establishes a framework for assessing, mapping and planning for the reduction of the risk of floods in Europe ((Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks).

Although floods are natural phenomena that cannot be fully prevented, human activity is increasing their likelihood and impact. The risk of flooding and the scale of damage will increase in the future, as a result of climate change, inappropriate river management, construction in flood risk areas and the increase in people and property in these areas.

Considering that most of the river basins in Europe are shared between countries, action is more effective at the EU level, since this allows better risk assessment and the coordination of measures taken by the EU countries.

The Flood Directive aims to establish a framework for measures to reduce the risk of floods in the EU by assessing the risk of flooding in river basins and coastal regions, mapping out areas that are prone to significant floods and drawing up flood-risk management plans based on close cooperation between the EU countries.

The main purpose of this Directive is to reduce the potential negative consequences on human health, the environment, cultural heritage and economic activity.

The path outlined in the Directive includes a series of implementation stages, each characterized by specific obligations and deadlines, which defines as the final goal the preparation of the Plan of Flood Risk Management (PGRA). This path takes place within a management cycle that is renewed through an iterative process with periodicity equal to 6 years.

Into each management cycle is expected to be implemented at the level of Unit of Management the following products: preliminary flood risk assessment (PFRA), areas with potential significant flood risks (APSFR), flood hazard maps and flood risk maps (FHM & FRM) and, as mentioned, the flood risk management plans (FRMP) (Figure 2).

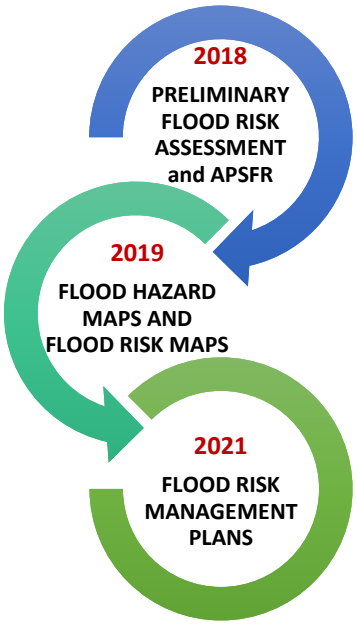


Figure 2. The phases of the Floods Directive and the deadlines for the second management cycle.

PFRA

The Directive requires EU countries to assess the risk of flooding in coastal regions and river basins by collecting information on those areas, such as past flood history and maps showing borders, land use and topography, and determining the likelihood of future significant floods and their consequences. First published by 22 December 2011, these assessments will be reviewed by 22 December 2018 and then reviewed every 6 years thereafter.

FHM & FRM

EU countries must also produce maps that identify areas prone to significant flood risks and indicate scenarios (based on high, medium or low probability) of a flood occurring there. First published by 22 December 2013, these maps must be reviewed every 6 years.

FRMP

EU countries must also establish flood-risk management plans that are coordinated at the level of the river basin or coastal districts. These plans establish objectives for the management of flood risks, focusing mainly on prevention (e.g. avoiding construction in areas that may flood), protection (measures to reduce the likelihood of floods in a specific place) and preparedness (informing the public about flood risks and what do to in the event of flooding). These plans must be completed by 22 December 2015 and are also to be reviewed every 6 years.

Both the flood-risk maps and the management plans are coordinated with the water framework directive (WFD). The implementation of the WFD, this directive and other water-related directives is guided by the common implementation strategy, which also aims to integrate water policies with other policies in the EU, such as agriculture, transport or research and regional development.

1.2 Joint Research Centre-JRC guidance on disaster losses

The Joint Research Centre – JRC is the European Commission's science and knowledge service. Over the past years JRC produced some reports focused on the thematic of disaster data.

In 2013, in a study commissioned by Directorate General Humanitarian Aid and Civil Protection of the European Commission, the JRC formulates technical recommendations for a European approach to standardize loss databases (De Groeve, Poljansek, & Ehrlich, Recording Disaster Losses, 2013). This study proposed some technical requirements that are based mostly on existing standards, best practices and approaches found in literature, international and national organisations and academic institutions. The requirements cover very detailed recording (at asset level) as well as coarse scale recording taking into account also EU legislation.

In 2014 JRC produced another report which was an overview of the state of the art for recording disaster loss data in European Union member states (De Groeve, Poljansek, Ehrlich, & Corbane, Current status and Best Practices for Disaster Loss Data recording in EU Member States, 2014). It summarize the contribution of experts from 15 EU Member States. Through a comparative analysis was shown that methodologies for disaster loss data collection and recording in Europe are heterogeneous and that the available loss databases vary in their level of completeness and detail. In addition, IT systems vary in purpose, complexity and openness. This makes difficult the aggregation of loss data at the EU level.

Another JRC report of 2015 (De Groeve, Corbane, & Ehlrich, 2015) proposes a minimum set of loss indicators that should be part of any operational disaster loss database at EU level. This would allow a homogeneous data collection this way the data would be comparable between different countries and would provide a generic standard format for sharing damage and loss data.

JRC produced in 2018 the technical report “Loss database architecture for disaster risk management” (Ríos Díaz & Marín Ferrer, 2018). The report studied disaster loss data recording across the EU and shows that there are hardly any comparable disaster damage and loss data: differences exist in the methods of data recording as well as in the governance approaches to managing the data. The lack of standards for damage and loss data collection and recording represents the main challenge for data sharing and comparing, especially for cross-border cooperation within the EU. The report proposes a common structure of a generic database able to accommodate and properly record the required particularities of a vast variety of events triggered by any kind of hazard.

One of the reasons for having a multi-hazard database is so that Member States could have an overview of common data, structured per hazard, to facilitate the identification of weaknesses at national level and the establishment of well-informed priorities in order to reduce the current level of risk.

The loss database for disaster risk management should be based on the following pillars:

- be compliant with the diverse directives and initiatives;
- be able to collect and aggregate data to report to the Sendai Framework;
- contribute to the preparation of the National Risk Assessments – NRA;
- contribute to monitor the SDG;
- be Inspire compliant.

1.3 Sendai Framework for Disaster Risk Reduction 2015-2030

The United Nations to date have organized three World Conferences on Disaster Risk Reduction (WCDRR) that focus on disaster and climate risk management in the context of sustainable development. The three World Conferences have been hosted by Japan: in Yokohama in 1994, in Kobe in 2005 and in Sendai in 2015. Requested by the UN General Assembly, the United Nations Office for Disaster Risk Reduction (UNISDR) served as the coordinating body for the Second and Third UN World Conference on Disaster Reduction in 2005 and 2015 ((UN Office for Disaster Risk Reduction, n.d.).

Previous conference outcomes include the ‘‘Hyogo Framework for Action 2005 – 2015” and the Yokohama Strategy and Plan of Action for a Safer World in 1994 while the Third UN World conference adopted the Sendai Framework for Disaster Risk Reduction 2015-2030.

The Sendai Framework is a 15-year, voluntary, non-binding agreement which aims the following outcome: “The substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries.”

To support the assessment of global progress in achieving the outcome and goal of the Sendai Framework, seven global targets have been agreed (Simplified chart of the Sendai Framework for Disaster Risk Reduction 2015-2030) (Figure 3):

1. Substantially reduce global disaster mortality by 2030, aiming to lower average per 100,000 global mortality rate in the decade 2020-2030 compared to the period 2005-2015;
2. Substantially reduce the number of affected people globally by 2030, aiming to lower average global figure per 100,000 in the decade 2020 - 2030 compared to the period 2005-2015;
3. Reduce direct disaster economic loss in relation to global gross domestic product (GDP) by 2030;
4. Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030;
5. Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020;
6. Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of this Framework by 2030;
7. Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to the people by 2030.

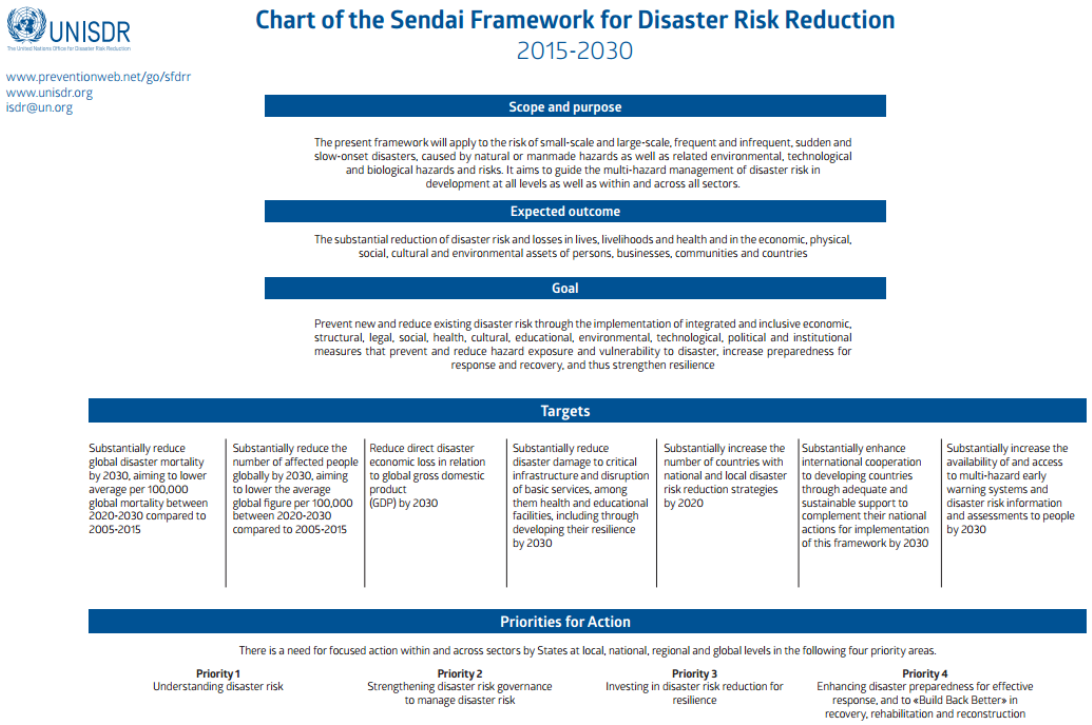


Figure 3. Simplified chart of the Sendai Framework for Disaster Risk Reduction 2015-2030.

In Figure 4 are shown the 4 priorities for action with supporting rationale, and 13 guiding principles of the Sendai Framework (Full chart of the Sendai Framework for Disaster Risk Reduction 2015-2030).

Priority 1. Understanding disaster risk

Disaster risk management should be based on an understanding of disaster risk in all its dimensions of vulnerability, capacity, exposure of persons and assets, hazard characteristics and the environment. Such knowledge can be used for risk assessment, prevention, mitigation, preparedness and response.

Priority 2. Strengthening disaster risk governance to manage disaster risk

Disaster risk governance at the national, regional and global levels is very important for prevention, mitigation, preparedness, response, recovery, and rehabilitation. It fosters collaboration and partnership.

Priority 3. Investing in disaster risk reduction for resilience

Public and private investment in disaster risk prevention and reduction through structural and non-structural measures are essential to enhance the economic, social, health and cultural resilience of persons, communities, countries and their assets, as well as the environment.

Priority 4. Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation and reconstruction

The growth of disaster risk means there is a need to strengthen disaster preparedness for response, take action in anticipation of events, and ensure capacities are in place for effective response and recovery at all levels. The recovery, rehabilitation and reconstruction phase is a critical opportunity

to build back better, including through integrating disaster risk reduction into development measures.

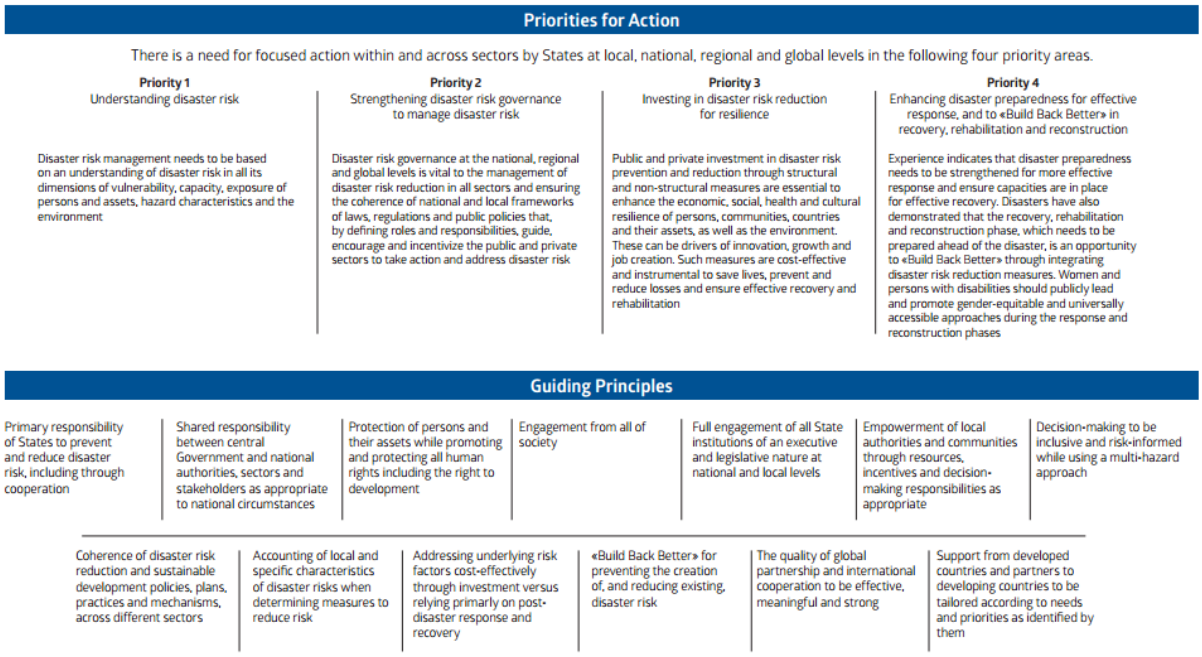


Figure 4. The priorities for action and guiding principles of the Sendai Framework.

As indicated in paragraph 50 of the Sendai Framework for Disaster Risk Reduction, the WCDRR conference recommended that the UN General Assembly establish an open-ended intergovernmental expert working group – OIEWG, comprised of experts nominated by States, and supported by the United Nations Office for Disaster Risk Reduction (UNDRR), with involvement of relevant stakeholders, for the development of a set of possible indicators and terminology to measure global progress in the implementation of Sendai Framework in coherence with the work of the inter-agency and expert group on sustainable development indicators (Resolution adopted by the General Assembly on 2 February 2017, 2017).

The report (Report of the open-ended intergovernmental expert working group on indicators and terminology relating to disaster risk reduction, 2016) outlines the OIEWG's recommended indicators for the seven global targets of the Sendai Framework for Disaster Risk Reduction 2015-2030, the follow-up to and operationalization of the indicators, and recommended terminology relating to disaster risk reduction. Were recommended 38 main indicators required to measure the 7 Global targets.

Were produced some other documents to help on the implementation of the Sendai Framework for Disaster Risk Reduction 2015-2030, the new global instrument to manage disaster risk:

- "**Reading the Sendai Framework for Disaster Risk Reduction 2015 – 2030**" offer a reading of the Sendai Framework because the final text was not necessarily suited to explicitly contain all the details, explanations and rationales (Reading the Sendai Framework for Disaster Risk Reduction 2015 – 2030, 2015);

- "**Words into Action**" is a guidance material on specific areas and issues because the implementation of the Sendai Framework require the adoption of policies, strategies and plans and the further review and development of normative instruments at local, national,

regional and global levels as well as quality standards and practical guidelines (Words Into Action, n.d.).

1.4 Sustainable Development Goals

In 2015 all United Nations Member States adopted the 2030 Agenda for Sustainable Development is a plan of action for people, planet and prosperity. The 17 Sustainable Development Goals and 169 targets which we are announcing today demonstrate the scale and ambition of this new universal Agenda. They seek to build on the Millennium Development Goals and complete what these did not achieve. The Goals and targets will stimulate action over the next fifteen years in areas of critical importance for humanity and the planet: people, planet, prosperity, peace and partnership. The SDGs build on decades of work by countries and the UN starting in 1992, at the Earth Summit in Rio de Janeiro, Brazil where more than 178 countries adopted Agenda 21.

At the 2030 Agenda for Sustainable Development heart are the 17 Sustainable Development Goals (SDGs), which are an urgent call for action by all countries - developed and developing - in a global partnership (Figure 5). They recognize that ending poverty and other deprivations must go hand-in-hand with strategies that improve health and education, reduce inequality, and spur economic growth – all while tackling climate change and working to preserve our oceans and forests.

The SDGs and the Sendai Framework were adopted in the same year, in 25-27 September and 14-18 March respectively.

Figure 5. SDG logo and 17 individual icons.

Following in Table 1 are listed the 17 SDGs.

Table 1. 17 SDGs icons and short description.

Icon	Short description	Targets	Indicators
	End poverty in all its forms everywhere	7	12
	End hunger, achieve food security and improved nutrition and promote sustainable agriculture	8	14
	Ensure healthy lives and promote well-being for all at all ages	13	26
	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	10	11
	Achieve gender equality and empower all women and girls	9	14
	Ensure availability and sustainable management of water and sanitation for all	8	11
	Ensure access to affordable, reliable, sustainable and modern energy for all	5	6
	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	12	17
	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	8	12
	Reduce inequality within and among countries	10	11
	Make cities and human settlements inclusive, safe, resilient and sustainable	10	15

	Ensure sustainable consumption and production patterns	11	13
	Take urgent action to combat climate change and its impacts	5	8
	Conserve and sustainably use the oceans, seas and marine resources for sustainable development	10	10
	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	12	14
	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels	12	23
	Strengthen the means of implementation and revitalize the global partnership for sustainable development	19	25
 Total	17 Goals	169 Targets	242 Indicators

Each SDG have some targets and each target have one or more indicators. For example SDG1 has as first target (1.1) “By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than $1.25 a day”. This target can be measured with the indicator (1.1.1) “Proportion of population below the international poverty line, by sex, age, employment status and geographical location (urban/rural)”.

The Sustainable Development Goals Report is submitted every year to the High-level Political Forum (HLFP), drawing on data collected and reported by country on an annual basis. The first Sendai Framework Progress Report is expected in 2019 and will exceptionally cover trends in implementation for the two biennial cycles 2015-2016 and 2017-2018. In 2019, reporting on progress in achieving the SDG targets related to disaster risk reduction and in implementing the

Sendai Framework, will be shared at the High-level Political Forum and Sixth Global Platform for Disaster Risk Reduction respectively.

There is some overlap across the two agendas. Monitoring of the Sendai Framework is intended to complement monitoring of 11 SDG indicators shown in Figure 6 and listed in Table 2 (The Sendai Framework and the SDGs, 2019).

Figure 6. Linkages between the Global Target Indicators and the Targets of the Sustainable Development Goals.

Table 2. SDG indicators and corresponding Sendai Framework indicators.

SDG indicators		Sendai Framework indicators
Goal 1. End poverty in all its forms everywhere		
1.5.1	Number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population	A1 and B1
1.5.2	Direct economic loss attributed to disasters in relation to global gross domestic product (GDP)	C1
1.5.3	Number of countries that adopt and implement national disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015-2030	E1
1.5.4	Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with national disaster risk reduction strategies	E2
Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable		
11.5.1	Number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population	A1 and B1
11.5.2	Direct economic loss in relation to global GDP, damage to critical infrastructure and number of disruptions to basic services, attributed to disasters	C1, D1, D5

11.b.1	Number of countries that adopt and implement national disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015-2030	E1
11.b.2	Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with national disaster risk reduction strategies	E2
Goal 13. Take urgent action to combat climate change and its impacts		
13.1.1	Number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population	A1 and B1
13.1.2	Number of countries that adopt and implement national disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015-2030	E1
13.1.3	Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with national disaster risk reduction strategies	E2

1.5 INSPIRE

The purpose of the directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 is to lay down general rules aimed at the establishment of the Infrastructure for Spatial Information in the European Community (hereinafter referred to as INSPIRE), for the purposes of Community environmental policies and policies or activities which may have an impact on the environment (Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)).

There are three KEY TERMS of the directive INSPIRE:

Infrastructure for spatial information: covers metadata, spatial data sets and spatial data services; network services and technologies; agreements on sharing, access and use; and coordination and monitoring mechanisms, processes and procedures.

Metadata: information describing spatial data sets and spatial data services, making it possible to discover, inventory and use them.

Spatial data: any data with direct or indirect reference to a specific location or geographical area, such as addresses, transport networks, elevation and land use.

Each EU State must implement its own national Spatial Data Infrastructure, coordinating those of the sub-national level. Each national Spatial Data Infrastructure will constitute a "node" of the European infrastructure, and will have to provide geographical data, metadata and services:

- geographical data: these are those indicated in the annexes to the directive, divided into categories; the first in order of priority will be: coordinate systems, geographic grid systems, geographical names (toponyms), administrative units, addresses, cadastral parcels, transport networks, hydrography, protected sites;
- metadata: they must concern both data and services;
- services (art. 11): means web services and computer applications that search for available data (through their metadata, eg. Catalogue Service), for consultation (eg. Web Map Service), for downloading data copies (eg. Web Feature Service), for conversion (eg. Coordinate Transformation), as well as services to call other services (service chain).

The rules to establish the Spatial Data Infrastructure in the various countries of the European Union are called Implementing Rules and are aimed at the interoperability of services and the harmonization of geographical information in Europe. They are documents that refer to technical standards and specifications, and are also defined starting from the experiences of infrastructures of spatial data already realized.

The INSPIRE Directive has been incorporated into Italian law by the legislative decree of 27 January 2010, n. 32 with which the national infrastructure for spatial information and environmental monitoring was established in Italy, as a node of the community infrastructure (DECRETO LEGISLATIVO 27 gennaio 2010 , n. 32, 2010).

The Ministry of Environment and Land and Sea Protection is the competent authority for the implementation of Legislative Decree no. 32/10 and the Ministry has set up the National Contact Point for the INSPIRE Directive.

As for the National Geoportal (www.pcn.minEnvironment.it), the art. 8 of Legislative Decree 32/2010 establishes that (Geoportale Nazionale, n.d.):

• the National Geoportal allows public and private stakeholders to be aware of the availability of spatial and environmental information;

• the National Geoportal is an access point for the purposes of the INSPIRE Directive, at national level.

Datasets in scope of INSPIRE are those which come under one or more of the 34 spatial data themes in Table 3.

Table 3. INSPIRE spatial data themes.

Annex 1	1. Addresses 2. Administrative units 3. Cadastral parcels 4. Coordinate reference systems 5. Geographical grid systems 6. Geographical names 7. Hydrography 8. Protected sites 9. Transport networks
Annex 2	10. Elevation 11. Geology 12. Land cover 13. Orthoimagery
Annex 3	14. Agricultural and aquaculture facilities 15. Area management/restriction/regulation zones & reporting units 16. Atmospheric conditions 17. Bio-geographical regions 18. Buildings 19. Energy Resources 20. Environmental monitoring Facilities 21. Habitats and biotopes 22. Human health and safety 23. Land use 24. Meteorological geographical features 25. Mineral Resources 26. Natural risk zones

	27. Oceanographic geographical features 28. Population distribution and demography 29. Production and industrial facilities 30. Sea regions 31. Soil 32. Species distribution 33. Statistical units 34. Utility and governmental services

2 Overview of databases and similarities

At global level exist different databases that record disasters. Some are hazard specific like the National Oceanic and Atmospheric Administration – NOAA Global Historical Tsunami Database, Earthquake databases held by different organizations at different levels [European-Mediterranean Seismological Centre (EMSC), the USGS Earthquake Hazards Program], European past floods — European Environment Agency, Nuclear Data Service – International Atomic Energy Agency – IAEA, Global Landslide Catalogue (GLC) - NASA's Data Portal etc. Some other databases are multi-hazard like EM-DAT of the Centre for Research on the Epidemiology of Disasters (CRED), the Canadian Disaster Database, NatCatSERVICE of Munich Re, DesInventar of UNDRR (former UNISDR) etc.. Some databases are focused on natural disasters some on technological disasters and some on both type of disasters. Some databases have some threshold criteria for entries as EM-DAT while others like DesInventar do not have a threshold value for entries. The databases have different structures and different fields for the record, there is a lot of heterogeneity in different aspects. The geographical level of data collection and recording also is different, there are also databases at country level, regional level etc.. Following are described some of the most significant databases.

2.1 EM-DAT

In 1988, the Centre for Research on the Epidemiology of Disasters (CRED) launched the Emergency Events Database (EM-DAT). The main objective of the database is to serve the purposes of humanitarian action at national and international levels. The initiative aims to rationalise decision making for disaster preparedness, as well as provide an objective base for vulnerability assessment and priority setting. EM-DAT contains essential core data on the occurrence and effects of over 22,000 mass disasters in the world from 1900 to the present day. The database is compiled from various sources, including UN agencies, non-governmental organisations, insurance companies, research institutes and press agencies. EM-DAT distinguishes between two generic categories for disasters: natural and technological (Emergency Events database - EM-DAT, n.d.).

For a disaster to be entered into the database at least one of the following criteria must be fulfilled:

- Ten (10) or more people reported killed;
- Hundred (100) or more people reported affected;
- Declaration of a state of emergency;
- Call for international assistance.

2.2 NatCatSERVICE

The NatCatSERVICE is a global database of natural catastrophe (“nat cat”) data. Since 1974, Munich Re (Reinsurance Company) has been systematically recording information on nat cat loss events from around the world. The database entries begin with the historic eruption of Mount Vesuvius in AD 79. However, data deemed suitable for systematic and analytical evaluation on a worldwide scale are available from 1980 onwards. It contains 18,169 relevant natural loss events worldwide during the period 1980 – 2018. The database provides comprehensive, reliable and professional data on insured, economic and human losses caused by any kind of natural hazard (NatCatSERVICE, n.d.).

2.3 SHELDUS

Spatial Hazard Events and Losses Database for the United States– SHELDUS™ is a county-level hazard data set for the U.S. and covers natural hazards such thunderstorms, hurricanes, floods, wildfires, and tornados as well as perils such as flash floods, heavy rainfall, etc. The database contains information on the date of an event, affected location (county and state) and the direct losses caused by the event (property and crop losses, injuries, and fatalities) from 1960 to present. With the release of Version 15.2, the database now also includes insured crop losses (indemnity

payments). Insured crop losses cover the period from January 1989 to present (Spatial Hazard Events and Losses Database for the United States – SHELDUS, n.d.).

2.4 CDD

The Canadian Disaster Database (CDD) contains detailed disaster information on more than 1000 natural, technological and conflict events (excluding war) that have happened since 1900 at home or abroad and that have directly affected Canadians. The CDD tracks "significant disaster events" which conform to the Emergency Management Framework for Canada definition of a "disaster" and meet one or more of the following criteria:

- 10 or more people killed;
- 100 or more people affected/injured/infected/evacuated or homeless;
- an appeal for national/international assistance;
- historical significance;
- significant damage/interruption of normal processes such that the community affected cannot recover on its own.

The database describes where and when a disaster occurred, the number of injuries, evacuations, and fatalities, as well as a rough estimate of the costs. As much as possible, the CDD contains primary data that is valid, current and supported by reliable and traceable sources, including federal institutions, provincial/territorial governments, non-governmental organizations and media sources. Data is updated and reviewed on a semi-annual basis (Department of Public Safety and Emergency Preparedness [CA], n.d.).

2.5 DesInventar Sendai

DesInventar Sendai is a new version of the well-tested, widely used software that implements all the Indicators and data required for the Monitoring of Targets A to D of the Sendai Framework for Disaster Risk Reduction, which correspond to parallel Sustainable Development Goals (SDG's) indicators from Goals 1, 11 and 13. Among many other new features, it also allows for the definition and use of Sendai Framework metadata to describe several indicators and allow a finer disaggregation of data (DesInventar Sendai, n.d.).

The DesInventar methodology includes a software product with two main components: the Administration and Data Entry module and the Analysis module. The Administration and Data Entry module is a relational and structural database through which the database is fed by filling in predefined fields (space and temporal data, types of events and causes, sources) and by both direct and indirect effects (deaths, houses, infrastructure, economic sectors). The Analysis module allows access to the database by queries that may include relations among the diverse variables of effects, types of events, causes, sites, dates, etc. This module allows at the same time to represent those queries with tables, graphics and thematic maps.

The United Nations Office for Disaster Risk Reduction – UNDRR (former UNISDR), is the host and main sponsor of the development and world-wide dissemination of DesInventar, especially in Asia, Africa and Oceania.

2.6 Global Active Archive of Large Flood Events

The Global Active Archive of Large Flood Events of the Dartmouth Flood Observatory, University of Colorado have information derived from news, governmental, instrumental, and remote sensing sources. The archive is "active" because current events are added immediately.

Each entry in the table and related "area affected" map outline represents a discrete flood event. However, repeat flooding in some regions is a complex phenomenon and may require a compromise

between aggregating and dividing such events. The listing is comprehensive and global in scope. Deaths and displaced estimates for tropical storms are totals from all causes, but tropical storms without significant river flooding are not included. The Archive includes: events from 1985-present.

2.7 Catalogue AVI

In 1989 the Minister of Civil Protection of Italy requested the National Research Council (CNR), Group for Hydrogeological Disasters Prevention (GNDCI), to compile an inventory of sites historically affected by landslides and floods in Italy, for the period 1918-1990. The inventory, completed between 1991 and 1992, and the update, carried out in 1995 and 1996, produced a large archive of historical information on mass-movements and floods in Italy for the period 1918-1994. The information was mainly found in journals/newspapers, expert interviews, books, published and unpublished technical and scientific reports. Were produced also maps of the sites affected by mass-movements and inundation (The AVI Project, n.d.).

Most of the information was digitised and stored into a computer database. The database currently contains more than 25,000 records, subdivided into more than 45 relational tables. The digital archive can be accessed directly at the GNDCI information system sites at wwwdb.gndci.cnr.it. A version of the database for the distribution to the public is also available.

In spite of the limitations due to the complexity of the Italian territory, the different awareness of the impact of landslides and floods on the territory, and the limited resources available for the inventory and its maintenance, the result of the inventory represents the most comprehensive source of information on mass-movements and floods for this century ever prepared for Italy and one of the few in the world.

2.8 FloodCat

FloodCat (Flood Catalogue) is a reserved access web-GIS platform that acts as a national catalogue of alluvial events available to Competent Authorities - CA for the implementation of the Flood Directive in Italy. This platform, accessible at www.mydewetra.org, is owned by the Department of Civil Protection (DPC) and was created for the IT part by CIMA Research Foundation. The contents and structure of the current version of FloodCat (3.0) have been edited by the DPC in collaboration with the Italian Institute for Environmental Protection and Research (Notes on FloodCat, 2018). FloodCat is the most used database during this PhD and it will be described following in more detail than other databases above. FloodCat serves to implement the first step of the Flood Directive, the PFRA and to report through simple export to the European Union.

2.9 FloodCat system

FloodCat is defined according the EU floods directive, the document “Technical support in relation to the implementation of the Floods Directive (2007/60/CE) – A user guide to the floods reporting schemas”, the Guidance Document No. 29 of EC of 2013 and have also been made changes after the previous document have been updated and after tests started in some pilot Regions of Italy, one of which Marche Region (this will be discussed in following chapters). However, taking into account the specific needs of the country and the characteristics of some databases already available at national and regional level, various additions have been made with respect to the data structure defined in the context of “EC reporting”, which allow the preservation of the considerable amount of additional information available.

As briefly explained above, in Chapter 0, FloodCat serves to implement the first step of the Flood Directive in Italy, the PFRA. Here it will be explained in more detail the structure of the database. The FloodCat structure is based on three main objects called "Event", "Phenomenon" and "Damage". Each event may have one or more phenomenon, each phenomenon may have one or more damages. Figure 7 represents the hierarchy of the FloodCat database and the fields of each tab where are specified those that are obligatory.

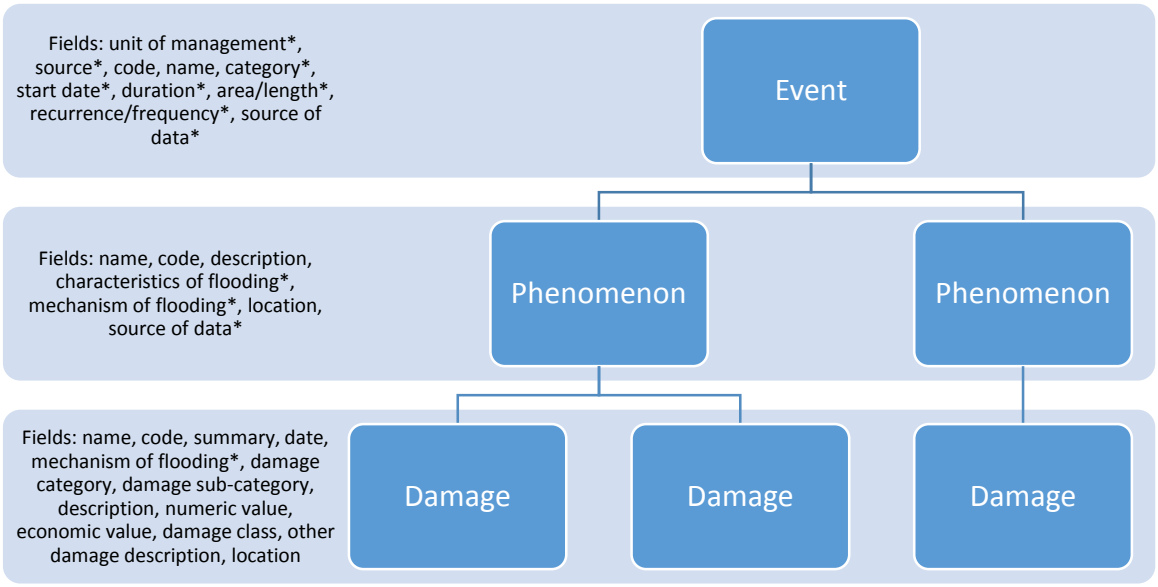


Figure 7. Hierarchy of FloodCat system and fields of each tab in the left.
**obligatory fields*

During data entry, the first object that needs to be defined is the Event (Figure 8), characterized by a single origin (source) (eg. fluvial, pluvial, marine) and a single Unit of Management - UoM. This implies that if, for example, a given area has suffered a flood of fluvial and marine origin, the classification will have to take place as if the events were two; the same applies if this area belongs to two UoMs. The Event tab, which summarizes the general characteristics of the flood, is not directly associated a geographical location on the map. For further details on the fields of the tab Event please consult ISPRA Notes (Notes on FloodCat, 2018).

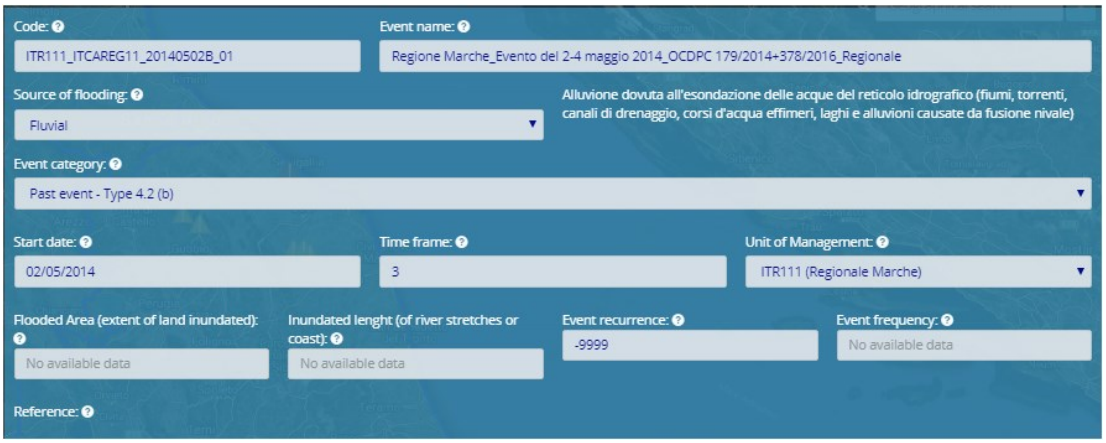


Figure 8. Screenshot of the Event tab. April 2019 update.

The Phenomena (Figure 9) represent the characterization of the dynamics of the Event in terms of Mechanism (for example, overcoming the containment capacity in the riverbed, overcoming the containment capacity of the defence works), Characteristics (eg., flash flood, debris flow, flood from snow fusion), localization of the flood to which the impacts are associated. Multiple Phenomena may be associated with a single Event. Only one Characteristic and one or more Mechanisms are associated with each phenomenon. Each Mechanism can be associated with one or more Damages. For further details on the fields of the tab Phenomena please consult ISPRA Notes (Notes on FloodCat, 2018).

Figure 9. Screenshot of the Phenomenon tab and localization map. April 2019 update.

Damage represents the description of the impact on the exposed elements that are classified by one or more categories (eg. civil buildings, industrial plants) and related sub-categories (eg. single-family houses, IPPC plants)(Figure 10). Geolocation is also provided, through georeferenced graphic elements such as points, lines, polygons, contained in special shapefiles. For further details on the fields of the tab Damage, on categories and subcategories please consult ISPRA Notes (Notes on FloodCat, 2018).

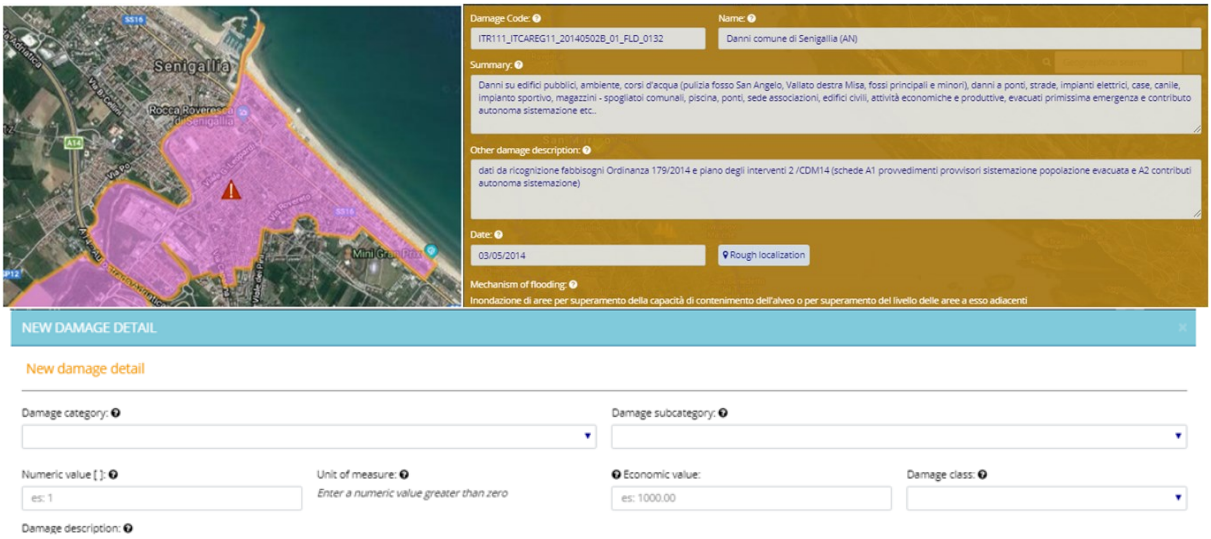


Figure 10. Screenshot of the Damage tab and localization map. April 2019 update.

In summary, in FloodCat spatial information is collected in relation to:

- event dynamics (flooded area) - are associated with the Phenomenon tab;
- impacts - they are associated with the Damage tab (eg. location of the point or of a section where a bank breakage occurred, location of a damaged building).

In FloodCat it is possible to insert an alluvial event by associating it with macro-framing characteristics and then to characterize it by performing a sort of downscaling, distinguishing mechanisms and characteristics in the different flooded areas and impacts on the territory in terms of damage to the exposed.

The following subchapters are an effort to compare FloodCat with some of the initiatives and databases described earlier.

2.9.1 FloodCat vs. JRC

FloodCat is compliant to the Flood Directive and have been updated also taking into account the JRC's "Guidance for recording and sharing disaster damage and loss data" (De Groeve, Corbane, & Ehlrich, 2015) as well as the indicators proposed in the Sendai Framework. For these reasons FloodCat has been identified as a reference for data collection in the case of flood events and is also already a good candidate to take on board when considering a multi-hazard database schema (Ríos Díaz & Marín Ferrer, 2018).

To be noted that the JRC's report of 2018 (Ríos Díaz & Marín Ferrer, 2018) do not contain a description of the fields for the proposed loss database (while FloodCat have detailed description) so the following effort to compare the fields with FloodCat will try to match them at best of the possibilities.

Table 4 shows how the different fields proposed in JRC's 2018 report match the fields of FloodCat.

In the JRC report of 2018 (Ríos Díaz & Marín Ferrer, 2018) (hereinafter in this paragraph will be referred as JRC) have been proposed to use for the loss database for disaster risk management three

pieces of a triage: the events, the assets and the damages. This is similar with the structure of FloodCat database that contain three main tabs: event, phenomenon and damage.

The event table of JRC would be linked with some associated tables:

- table with metadata information;
- coping capacity table;
- table with hazard specific information.

In FloodCat the event and phenomenon table comprehend many of the fields contained in the event table of JRC and the associated tables with the exception of the following fields of JRC proposed database:

- Event/update_date;
- Event/pedigree;
- Event/Metadata/status;
- Event/Coping capacity/coping capacity index;
- Event/Flood Hazard specific information/rainfall height;
- Event/Flood Hazard specific information/rainfall duration;
- Event/Flood Hazard specific information/water depth.

JRC in the case of floods proposed for the tab event 27 fields which correspond to 20 of the fields of the tabs Event and Phenomenon of FloodCat. While FloodCat have 15 fields (of the two above mentioned tabs) not required by JRC proposal, which would be 9 if we do not consider the phenomenon tab's references. We can say that for the Event part of the proposed JRC's database, FloodCat comprehend the proposed fields by 74%.

The second part of the triage proposed by JRC is the Assets table that would contain all the information about different assets and its main source of information would be fed with the date from the cadastre in order to have an up-to-date version of the buildings, land and infrastructure. For this JRC's table it is very difficult to find similitudes with FloodCat because FloodCat do not include any pre-event data. The only direct comparable field is the event ID field. The Assets table have many associated tables for some of which are specified which are the fields while for others no (Figure 11): Economic table, Cultural heritage table, Environmental table, People table, Prices table and Asset Localization table.

The third part of the triage proposed by JRC is the Damage table that would contain the percentage of damage of an asset. In the JRC report are represented in figures 4 and 5 two tables of damages which have not the same fields, so for the comparison will be taken as reference the Damage table reported in the big schema of figure 5 (same as Figure 11 of this document).

So in conclusion we can say that the data of the proposed database of JRC contained in the table Event are very similar to those contained in the tabs Event and Phenomenon of FloodCat while the data contained in the tables Assets and Damage are hardly comparable with the tab Damage of FloodCat as they are conceptualized very differently. The Damage tab of FloodCat can be seen as an intersection/combination of the tables Assets (and associated tables) and Damages (and associated tables) of JRC's proposal. Because of the different conceptualization behind (data on the assets pre-event of JRC and only post damage data of FloodCat) and because of the many associated tables, their relative connection and fields not explained in detail as in FloodCat the comparison is just an effort to match heterogeneous methodologies. FloodCat comprehend the proposed fields of the Event part of the proposed JRC's database by 74%.

Table 4. Comparison FloodCat and JRC proposed database.

FloodCat	JRC 2018 report
Tab/field of the tab	Event
Event tab/Code	(Identification Data) event ID
Event tab/Start date	start_date
Event tab/Time frame	duration/end_date
Event tab/Name of Flood Event	denomination
Event tab/Event category	type_of_event
-	update_date
deducted from Event tab/Unit of Management	(International Organisation for Standardisation) ISO_country_name
ISPRA Notes, USER manual	methodology
-	pedigree[1]
	Event metadata (AT)*
Event tab/Code	generated number (like a GLIDE number)
Event tab/Reference/Name	URL
Event tab/Reference/Title	title
-	status
	Coping capacity (AT)*
deducted from Event tab/Unit of Management	ISO country code
deducted from Event tab/Unit of Management	country name
-	coping capacity index
	Flood Hazard specific information (AT)*
Event tab/Source of Flooding	source of flooding
Event tab/Unit of Management	unit of management
Event tab/Flooded Area (extent of land inundated)	flooded area/affected area
Event tab/Inundated length (of river stretches or coast)	inundated length
Event tab/Event frequency	frequency
Event tab/Event recurrence	recurrence
-	rainfall height
-	rainfall duration
Phenomenon tab/Characteristic of flooding	characteristics of flooding
Phenomenon tab/Mechanism of flooding	mechanism of flooding
-	water depth
Event tab/Reference/Type	-
Event tab/Reference/Subject	-
Event tab/Reference/Bookmark	-
Event tab/Reference/Author	-
Phenomenon tab/Name	-
Phenomenon tab/Phenomenon Code	-
Phenomenon tab/Surface Water Body	-
Phenomenon tab/Description	-
Phenomenon tab/Localization	-
Phenomenon tab/Reference/Type	-
Phenomenon tab/Reference/Name	-
Phenomenon tab/Reference/Title	-
Phenomenon tab/Reference/Subject	-
Phenomenon tab/Reference/Bookmark	-
Phenomenon tab/Reference/Author	-
	Asset
-	asset ID
-	asset name
Damage tab/Description Damage tab/Other Damage Description	asset description
Damage tab/Numeric value	asset value
Damage tab/Localization	asset location ID (asset localization table AT*)
-	asset owner ID

[1] A score which is correlated to the quality, accuracy, reliability, uncertainty of data collection and recording process.

-	asset economic ID
Similar to Damage tab/Category Environment	asset environmental ID
Similar to Damage tab/Category Cultural Heritage, Landscapes	asset heritage ID
Event tab/Code	event ID
	Damage
Damage tab/Code	Damage ID
Damage tab/Class	Type (%) Damage
Damage tab/Category Damage tab/Subcategory	Asset ID
Automatic as each Damage is under an Event tab	Event ID
Damage tab/Numeric value	Value
-	Item ID
Damage tab/Name	-
Damage tab/Summary	-
Damage tab/Date	-
Damage tab/Mechanism of flooding	
Damage tab/Economic value	Combination of the JRC's tables of Asset, Value, Damage, Market Price as in Figure 11

*AT = Associated table, linked with main tables

Table colour legend:

- FloodCat Event tab
- FloodCat Phenomenon tab
- FloodCat Damage tab
- Other FloodCat or JRC
- Main table in JRC
- Associated table in JRC

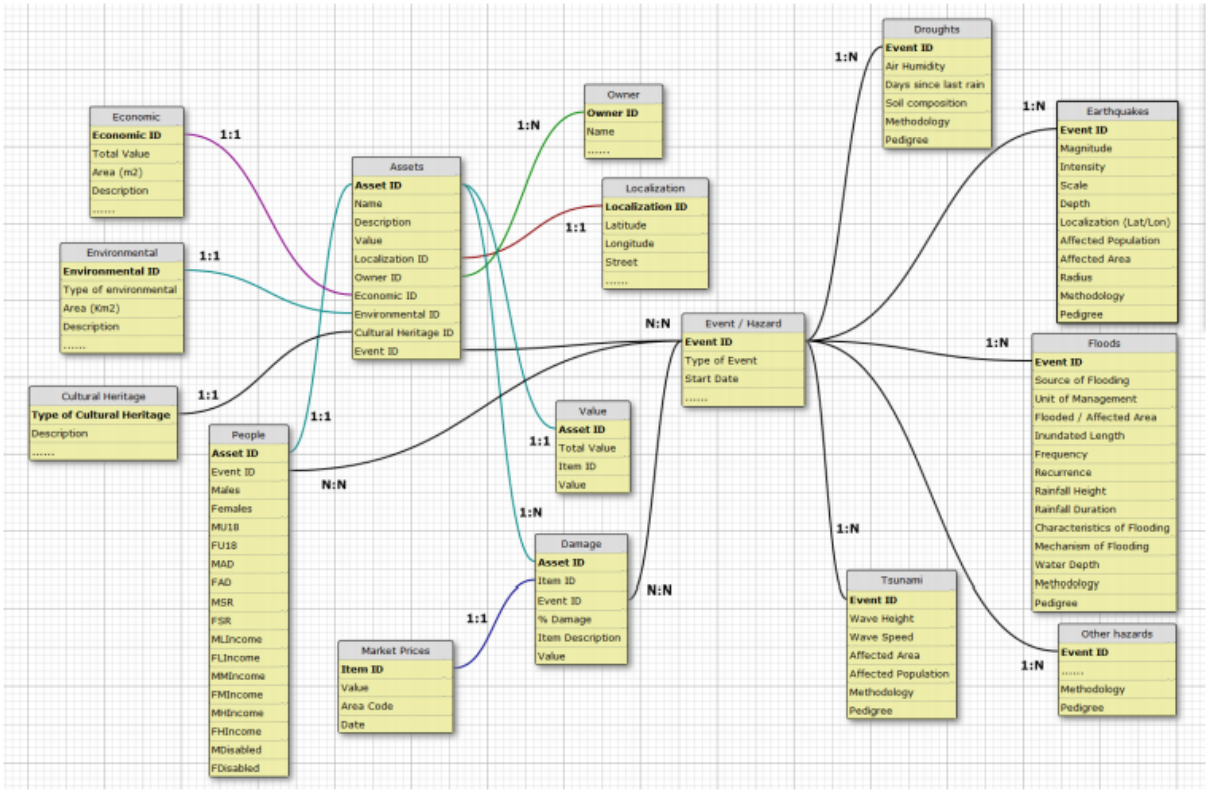


Figure 11. Diagram of the loss database architecture, JRC 2018.

2.9.2 FloodCat vs. Sendai indicators

A set of 38 indicators was identified to measure global progress in the implementation of the Sendai Framework for Disaster Risk Reduction. The indicators will measure progress in achieving the global targets of the Sendai Framework, and determine global trends in the reduction of risk and losses (Sendai Framework Indicators, n.d.).

Table 5 is an effort to compare the FloodCat fields with the Sendai indicators. The Global Targets E, F and G cannot be compared with FloodCat as they deal with number of nations, international cooperation and early warning. As the Sendai indicators are mainly numbers or economic loss express in a monetary value than the only tab of FloodCat with which they can be compared is the Damage tab of FloodCat. The Sendai indicators that require the indicator to be report per 100,000 people of population can be deducted by knowing the number of population of Italy from the Institute of Statistics INSTAT, at the required moment/for the year desired. Also the Global GDP can be found from the World Bank data.

The Global Target A can be measured with FloodCat's numeric value of deaths and missing. Global Target B, B2 indicator can be measured with the numeric values of the subcategories "Damage to population-Injured" and "Damage to human health-From pollution or contamination" of FloodCat. While the indicators B3, B4 and B5 can be roughly measured with the subcategory "Evacuated" of FloodCat because there is no other Subcategory which better fits this indicators, though the subcategory "Evacuated" would probably be an underestimation of the indicators B3, B4 and B5. The Global Target C that aim to measure the economic loss, can be fully measured with the field Economic value of different FloodCat categories as listed in Table 5. The only Category of FloodCat which seems not to be present in Global Target C is "Environment". The Global Target D, the indicators D1, D2, D3 and D4 can be measured with data contained in FloodCat, while it remain difficult to understand if the indicators D5, 6, 7 and 8 can be measured with FloodCat as this

indicators refer not to damage or destruction of different infrastructures and services but refer to interruption and in the effort made to compare with FloodCat fields, the fields would result the same as for the indicators D1, 2, 3 and 4 because FloodCat do not have fields that directly consider interruption.

As a conclusion it would be appropriate to say that all the Sendai indicators of the Global Targets A, B, C and D can be measured or in a few cases roughly measured using FloodCat.

Table 5. Comparison FloodCat and Sendai indicators A, B, C and D.

FloodCat	Sendai indicators
	Global target A Substantially reduce global disaster mortality by 2030, aiming to lower average per 100,000 global mortality between 2020-2030 compared with 2005-2015
Category: Population/Human health Subcategories: Damage to population-Deaths+Missing Field: Numeric value	A-1 (compound) Number of deaths and missing persons attributed to disasters, per 100,000 population
Category: Population/Human health Subcategory: Damage to population-Deaths Field: Numeric value	A-2 Number of deaths attributed to disasters, per 100,000 population
Category: Population/Human health Subcategory: Damage to population-Missing Field: Numeric value	A-3 Number of missing persons attributed to disasters, per 100,000 population
	Global target B Substantially reduce the number of affected people globally by 2030, aiming to lower the average global figure per 100,000 between 2020-2030 compared with 2005-2015
Category: Population/Human health Subcategory: Damage to population-Injured+Evacuated + Subcategory: Damage to human health-From pollution or contamination Field: Numeric value	B-1 (compound) Number of directly affected people attributed to disasters, per 100,000 population
Category: Population/Human health Subcategory: Damage to population-Injured + Subcategory: Damage to human health-From pollution or contamination Field: Numeric value	B-2 Number of injured or ill people attributed to disasters, per 100,000 population
Category: Population/Human health Subcategory: Damage to population-Evacuated Field: Numeric value	B-3 Number of people whose damaged dwellings were attributed to disasters
	B-4 Number of people whose destroyed dwellings were attributed to disasters
	B-5

	Number of people whose livelihoods were disrupted or destroyed, attributed to disasters
	Global target C Reduce direct disaster economic loss in relation to global gross domestic product (GDP) by 2030
Sum of the following 5 table rows Field: Economic value	C-1 (compound) Direct economic loss attributed to disasters in relation to global gross domestic product
Category: Agriculture, Zootechnics, Fisheries, Mines Field: Economic value	C-2 Direct agricultural loss attributed to disasters
Categories: Economic Activities Trade, Industry, Crafts, Construction Sectors+Economic Activities Recreational Tourist Sector[2] Field: Economic value	C-3 Direct economic loss to all other damaged or destroyed productive assets attributed to disasters
Category: Private Buildings and Goods Subcategories: Public / Private Buildings for Residential Use+ Goods Contained in Private Buildings Field: Economic value	C-4 Direct economic loss in the housing sector attributed to disasters
Categories[3],[4]: Hydraulic Works+ Technological and Service Infrastructures+ Communication and Transport Infrastructures+ Public Interest Structures/Services Field: Economic value	C-5 Direct economic loss resulting from damaged or destroyed critical infrastructure attributed to disasters
Category: Cultural Heritage, Landscapes Subcategories: Archaeological Heritage/Sites+ Historical And Architectural Heritage/Sites+ Worship Buildings/Places+ Libraries+ Museums+ Monuments+ Works of Art Field: Economic value	C-6 Direct economic loss to cultural heritage damaged or destroyed attributed to disasters
	Global target D Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030
Sum of the following 3 table rows Field: Numeric value	D-1 (compound) Damage to critical infrastructure attributed to disasters

[2] As by Wikipedia classification of productive assets https://it.wikipedia.org/wiki/Categoria:Attivit%C3%A0_produttive .

[3] Based on Garzanti definition of Infrastructure https://www.garzantilinguistica.it/ricerca/?q=infrastruttura .

[4] The decision regarding those elements of critical infrastructure (C5 Sendai Indicator) is left to the Member States and described in the accompanying metadata.

Category: Public Interest Structure/Services Subcategories: Structure/Services for Health Care – Hospitals + Structure/Services for Health-Care Homes, Home for the Elderly, Disabled, etc. Field: Numeric value	D-2 Number of destroyed or damaged health facilities attributed to disasters
Category: Public Interest Structure/Services Subcategory: Structures/Services for Education - Nursery/School/University Field: Numeric value	D-3 Number of destroyed or damaged educational facilities attributed to disasters
Categories: Hydraulic Works+ Technological and Service Infrastructures+ Communication and Transport Infrastructures+ Public Interest Structures/Services except the subcategories mentioned in the two above table rows Field: Numeric value	D-4 Number of other destroyed or damaged critical infrastructure units and facilities attributed to disasters
Sum of the following 3 table rows Field: Numeric value	D-5 (compound) Number of disruptions to basic services attributed to disasters
Category: Public Interest Structure/Services Subcategory: Structures/Services for Education - Nursery/School/University Field: Numeric value	D-6 Number of disruptions to educational services attributed to disasters
Category: Public Interest Structure/Services Subcategories: Structure/Services for Health Care – Hospitals + Structure/Services for Health-Care Homes, Home for the Elderly, Disabled, etc. Field: Numeric value	D-7 Number of disruptions to health services attributed to disasters
Categories: Hydraulic Works+ Technological and Service Infrastructures+ Communication and Transport Infrastructures+ Public Interest Structures/Services except the subcategories mentioned in the two above table rows Field: Numeric value[5]	D-8 Number of disruptions to other basic services attributed to disasters

2.9.3 FloodCat vs. SDG

The 2030 Agenda for Sustainable Development have at its heart the 17 Sustainable Development Goals (SDGs), 169 Targets and 242 Indicators. As SDG indicators are many, only the SDG that match or roughly match with FloodCat will be shown on Table 6. The data of SDG required for 100,000 people can be reported by knowing from INSTAT the updated number of population. GDP data of the country can be found from World Bank.

[5] The decision regarding those elements of basic services to be included in the calculation will be left to the Member States and described in the accompanying metadata.

SDG2-SDG10, SDG12, SDG14-SDG17 have no similarities in FloodCat. Only the SDG1, SDG11 and SDG13 have few indicators that match with FloodCat. Some SDG are repeated in different targets (1.5, 11.5, 13.1 and 1.5, 11.5) and the only two matches in FloodCat are the field numeric value for the whole category Population/Human Health and the filed economic value for whole categories.

Certainly better data to match the SDG indicators can be found not in FloodCat but in the National Statistical Institute – INSTAT, in the Ministries and World Bank data.

Table 6. Comparison FloodCat and SDG indicators.

FloodCat	SDG indicators
Category: Population/Human Health Field: Numeric value	SDG1/1.5/1.5.1 Number of deaths, missing persons and persons affected by disaster per 100,000 people
	SDG11/11.5/11.5.1 Number of deaths, missing persons and persons affected by disaster per 100,000 people
	SDG13/13.1/13.1.1 Number of deaths, missing persons and persons affected by disaster per 100,000 people
All FloodCat Categories Field: Economic value	SDG1/1.5/1.5.2 Direct disaster economic loss in relation to global gross domestic product (GDP)a
	SDG11/11.5/11.5.2 Direct disaster economic loss in relation to global GDP, including disaster damage to critical infrastructure and disruption of basic services

2.9.4 FloodCat vs. AVI

The AVI catalogue is an inventory of areas affected by landslides and floods in Italy. For the part dedicated to floods, FloodCat can be seen as a successor of AVI catalogue. In fact the flood data contained in AVI have been used to fill FloodCat but there is no public data to show how the different fields were combined and the organisations contacted did not give any information. However by using public data of AVI, especially by selecting the Census card number 7200023 that contains many information on damages it was possible to make a comparison on the fields of AVI and FloodCat (Table 7). Although the structure of the database is not similar as FloodCat is conceptualized in a hierarchic manner in three tabs while AVI have census card numbered that contain all the information on the event, phenomena and damages, except for the localization that is reported in some thematic cartography when there is the information on localization. Without taking into consideration the structure of the database but only focusing on the fields contained in both databases we can say that the two databases are very similar. Although FloodCat have some fields that cannot be found on AVI for the flood part. The main fields missing in in AVI are the inundated length, event frequency and recurrence, the characteristics and mechanism of flooding, the numeric value of damages ex. number of houses etc. except for the number of people. Also seems that two categories, “Economic Activities Recreational Touristic Sector” and “Cultural Heritage, Landscapes”, are not represented in AVI. Considering all the fields of FloodCat they match with the fields of AVI by nearly 70%.

Table 7. Comparison FloodCat vs. AVI.[6]

FloodCat	AVI
Event tab/Code	Census card number
Phenomenon tab/Phenomenon Code	
Damage tab/Code	
	Administrative information
Damage tab/Approximate location	Region
	Province
	Municipality
	ISTAT Code
	Mountain Community
	Location
	ISTAT Code
	General information on the event
Event tab/Start date	Date
Damage tab/Date	
-	Physiographic environment
Event tab/Time frame	Duration of the event, number of days
Event tab/Flooded Area (extent of land inundated)	Surface
Damage tab/Approximate location	Affected locations
Phenomenon tab/Description	Notes
Damage tab/Description	
Damage tab/Other Damage Description	
Damage tab/Summary	
-	Basin/s
Phenomenon tab/Surface Water Body	Water streams
	Cartographic information
Phenomenon tab/Localization	IGM classification
	Technical cartography
Event tab/Source of Flooding	Triggering causes
	Hydrological information
-	example height of water in a certain location
	Damage information
Damage tab/Category Agriculture, Zootechny, Fisheries, Mines	Agriculture
	Livestock
Damage tab/Category Communication and Transport Infrastructures (ex. Bridges)	Goods - Public Interest Structures
Damage tab/Category Hydraulic Works	
Damage tab/Category Technological and Service Infrastructures	
Damage tab/Category Technological and Service Infrastructures	Goods - Network infrastructures
Damage tab/Category Private Buildings And Goods	Goods - Civil Buildings
Damage tab/Category Communication and Transport Infrastructures	Goods - Communication Infrastructures

[6] The information on AVI catalogue were extracted from the tabs found online as there were no answer to our request from Centro Nazionale Ricerche-CNR. Especially was used the tab N. 7200023 because seems to have many information.

<table>
<tr><td colspan="3"></td><td></td></tr>
<tr><td colspan="3">Damage tab/Category Economic Activities Trade Sector,
Industry, Crafts, Building</td><td>Goods - Industrial buildings</td></tr>
<tr><td colspan="3">Damage tab/Category Public Interest Structures/Services</td><td>Goods - Public buildings</td></tr>
<tr><td rowspan="3">Damage tab/Numeric value</td><td rowspan="3">Damage tab/Category Population/Human Health</td><td>Subcategory: Damage to the population - Deaths</td><td rowspan="3">People:
-Deaths
-Homeless
-Evacuees</td></tr>
<tr><td>-</td></tr>
<tr><td>Subcategory: Damage to the population – Evacuees</td></tr>
<tr><td colspan="3">-</td><td>Land use:
- Infrastructures (Existing)
- Settlements (Present)</td></tr>
<tr><td colspan="3">Damage tab/Class</td><td>Damage to goods the part in brackets of the entity of damage</td></tr>
<tr><td colspan="3">Damage tab/Economic value</td><td>Monetary valuations</td></tr>
<tr><td colspan="3">Damage tab/Category Environment</td><td>Indirect effects</td></tr>
<tr><td colspan="3">Damage tab/Other Damage Description</td><td>Notes on damages and provisions</td></tr>
<tr><td colspan="3">-</td><td>Emergency</td></tr>
<tr><td colspan="3"></td><td>Available documents</td></tr>
<tr><td colspan="3">Event tab/Reference</td><td rowspan="2">Documents/There is a monographic report:
Documents/Bibliography/Reference no.
Documents/Bibliography/Author
Documents/Bibliography/Title
Documents/Bibliography/Contained in
Documents/Bibliography/Volume
Documents/Bibliography/Number
Documents/Bibliography/City
Documents/Bibliography/Year
Documents/Bibliography/Gender
Documents/Bibliography/ISBN or ISSN
Documents/Bibliography/Body
Documents/Bibliography/Pages
Documents/Bibliography/Boards
Documents/Bibliography/Attachments
Documents/Bibliography/Scale</td></tr>
<tr><td colspan="3">Phenomenon tab/Reference</td></tr>
<tr><td colspan="3">-</td><td>AVI census sheets</td></tr>
<tr><td colspan="3">-</td><td>Census information/Operational unit (Operational unit, detector, Date of compilation)</td></tr>
<tr><td colspan="3">-</td><td>Census information/Expertise (Census carried out by, Entry made by,</td></tr>
</table>

	Area of expertise, Newspapers consulted)
Event tab/Unit of Management	-
Event tab/Name of Flood Event	-
Event tab/Event category	-
Event tab/Inundated length (of river stretches or coast)	-
Event tab/Event frequency	-
Event tab/Event recurrence	-
Phenomenon tab/Name	-
Phenomenon tab/Characteristic of flooding	-
Phenomenon tab/Mechanism of flooding	-
Damage tab/Name	-
Damage tab/Code	-
Damage tab/Numeric value (except for people)	-
Damage tab/Mechanism of flooding	-
Damage tab/Category Economic Activities Recreational Touristic Sector	not found
Damage tab/Category Cultural Heritage, Landscapes	not found

Table colour legend:

FloodCat Event tab

FloodCat Phenomenon tab

FloodCat Damage tab

2.9.5 FloodCat vs. INSPIRE

In order to compare FloodCat with INSPIRE the datasets that will be considered are those of the spatial theme "Natural Risk Zones". The document "INSPIRE Data Specification on Natural Risk Zones – Technical Guidelines" contains the data specification on INSPIRE Annex III spatial data theme 12, Natural Risk Zones (INSPIRE Data Specification on Natural Risk Zones – Technical Guidelines). Natural Risk Zones are defined as areas where natural hazards are coincident with populated areas and/or areas of particular environmental/ cultural or economic value. The domain of the Natural Risk Zones data specification is potentially very large, it encompasses hazards from floods to geomagnetic storms, and exposed elements from buildings to designated environmental features. The data and information that is included in the INSPIRE data specification take as a starting point the existence of the delineation of a hazard area. The approach taken to model Natural Risk Zones is generic in its treatment of each of hazard, exposure, vulnerability and risk. Flood risk is significantly more precisely defined than other hazards, due in part to the development of the Floods Directive (2007/60/EC - FD) and collaboration with the relevant (FD) expert group. Natural Risk Zones also involve significant engagement with other thematic areas from INSPIRE. There are 4 key spatial object types that are modelled: Hazard area, Observed event, Risk zone and Exposed element.

Although the data specifications took into account the Flood Directive, domain specific terms of 2007/60/EC (flood directive) and of Data Specification Natural Risk Zones are not necessarily identical because the Natural Risk Zones thematic working group – TWG NZ has to cover many categories of hazards and respectively risks.

To illustrate how the terms/contents that are used in Floods Directive (2007/60/EC) are addressed in the core feature types model for NZ or related with other INSPIRE themes TWG NZ provided the overview of Table 8.

Table 8. Correspondence between Flood Directive and INSPIRE Directive.

FD terminology	NZ terminology	Other Inspire theme(s) / TWG(s)
UoM – Unit of Management Units of management may be individual river basins and/or certain coastal areas, and may be entirely within national borders or may be part of an international unit of management or international river basin district.	-	Area management, Hydrography
Flood Location Location of past significant floods or where potential future significant floods could occur, could be a town or other area that was flooded, or stretches of rivers /coastal areas	HazardArea and/or RiskZone	Hydrography, Administrative Units etc.
SpecificArea locality, river basin, sub-basin and/or coastal area or other areas associated with article 4	-	Hydrography, Administrative Units, Area Management
AreasOfFloodRisk Areas with potential significant flood risk (APSFR), can be indicated as entire or stretches of river/coastal areas, areas, polygons, entire river basins.	HazardArea and/or RiskZone	Hydrography
TypeOfFlood	SpecificRiskOrHazardType	
TypeOfPotentialConsequences	TypeOfExposedElements	Production and Industrial Facilities, Protected Sites, Hydrography, Land Use, Human Health and Safety, Transport Networks, Buildings etc
Recurrence	LikelihoodOfOccurence	
Frequency	LikelihoodOfOccurence	
Fatalities	LevelOfHazard	
Degree_TotalDamageHumanHealth	LevelOfHazard	
Degree_TotalDamageXYZ	LevelOfHazard	

The Flood Directive is compliant with the INSPIRE Directive because comprehend the contents of the NZ and other Inspire themes.

3 Emergency management in Italy

3.1 Alerting procedures[7]

In order to describe the whole emergency cycle in a holistic way below are described the alerting procedures that precede emergencies.

An effective warning system that reduces the meteorological and hydro-geological risk is based on a minimum of 4 assumptions:

1. At first a valid hydrometeorological monitoring system and a valid meteorological forecast and then hydrogeological-hydraulic forecast, that indicates the probable scenarios of hazard and that allows to carry out a subsequent assessment of the risks induced by that hazard;[8]

2. An adequate system of procedures that will then effectively trigger actions to contrast these risks. This must be established internally in the civil protection plans, which every municipality must have. The plans must be updated frequently and must be known by stakeholders. This is regulated by law;

3. An effective communication system that quickly reaches all the Authorities at the various levels and which must activate the enforcement actions (for example: closing a bridge, closing a school, arranging the closure of an access to a place exposed to risk etc.) and that also informs Citizens of the impending risks so that they can protect themselves;

4. Continuous training, which must be carried out at all levels, to grow a "Culture of Risk" in people. Training to be implemented primarily in schools, but also through the thousands of other methods now possible through the web, social networks, and in places where the population lives and/or meets, in the workplace and so on. The citizen trained and informed is the citizen who knows how to protect himself and the others.

The alert system in Italy is federal, between state and regions. It is based on a first phase of definition of Criticality Scenarios (or risk), through the use of colour codes, and then on a second phase of implementation of contrast actions (National alert system, 2019).

3.2 Bulletin, warning and alert

First let's clarify the differences between the terms bulletin, warning and alert (see Figure 12). The documents emitted by the Functional Centre are bulletins and warnings while the alert is something that belongs to the civil protection because the Functional Centre may not be inside the regional civil protection.

Each Italian Region and Autonym Province have one Functional Centre with the duty to monitor and to make previsions of meteorological and hydrogeological hazards and their effects (Network of Functional Centres , 2019). In the case of Marche Region the Functional Centre is under the Civil Protection structure.

The alert is the document with which the Civil Protection inform the whole system (governmental structures, volunteer organizations, media, citizens etc.) and states what is expected (that can be inferred from the bulletins/notices of the Functional Centre) and what is recommended to do.

[7] http://www.regione.marche.it/Regione-Utile/Protezione-Civile/Previsione-e-Monitoraggio/Procedure-di-Allertamento

[8] Hazard and Risk are different.

Nowadays with the new procedures[9] it exist the "warning message" that the civil protection does. In the cases when the bulletin predicts ordinary, moderate or higher criticality, than is emitted the civil protection "warning message". The warning message is emitted also in case of weather warning issued for snowfall, strong wind or storm surges and with the new procedures, in case of avalanche criticality.

The bulletin is issued if the criticality is ordinary or absent and a warning is given if the criticality is moderate or high.

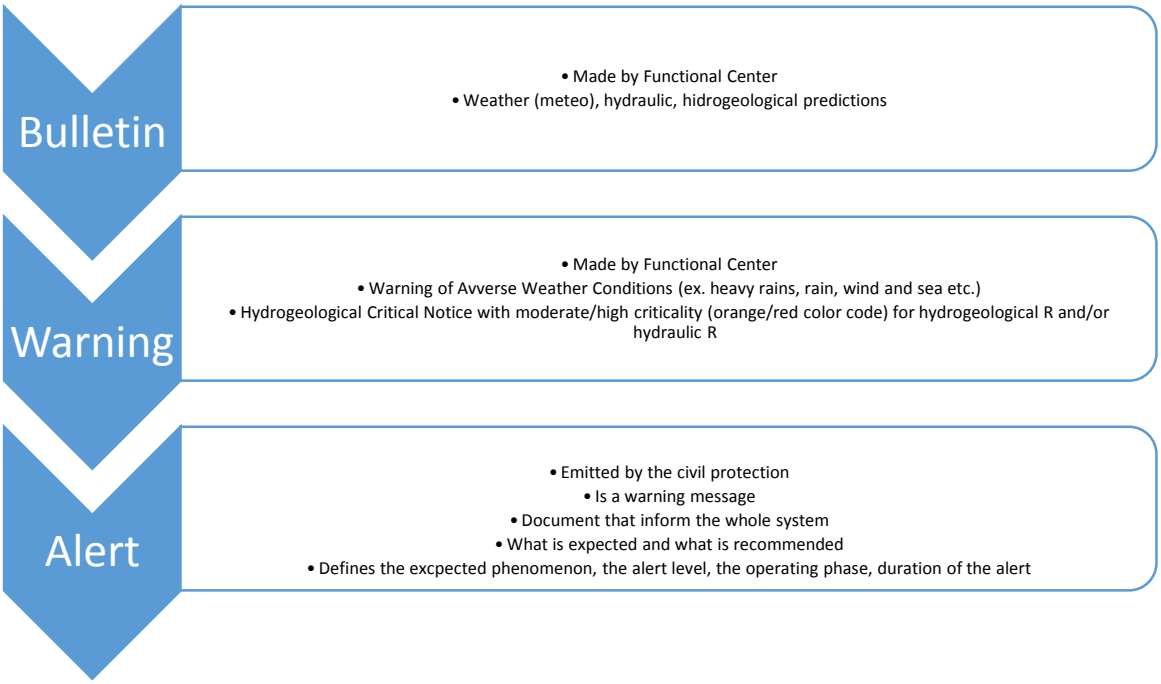


Figure 12. Bulletin, warning and alert.

3.3 Criticality and code colours

There are three types of criticalities considered in civil protection for the whole national territory:

- Hydraulic criticality – describes the possibility of flooding of the largest rivers for which can be made predictions of event evolution;
- Hydrogeological criticality – include landslides and the possibility of flooding of the minor hydrographic network (ex. ditches, small rivers) for which can't be made predictions of event evolution;
- Hydrogeological criticality for thunderstorms – risk deriving from meteorological phenomena characterized by high forecast uncertainty in terms of location, timing and intensity (ex. intense and short-term rainfall, wind/tornado, thunderstorms, hail) ((Event scenarios, 2019).
- Avalanche criticality;

For the purposes of forecasting and preventing hydrogeological and hydraulic risk, the hydrographic basins have been divided and/or aggregated into alert zones, which are homogeneous territorial

[9] After the National Department issued operational provisions in February 2016, the Regions issued new procedures.

areas for the expected hydro-geological and hydraulic effects, following adverse weather events (Figure 13).

For each alert zone have been identified some possible precursors, or indicators, of the possible occurrence of instability phenomena and have been determined the critical values (eg an intense precipitation capable of causing landslides), in order to construct a reference threshold system. To this system of thresholds corresponds the risk scenarios, divided into levels of growing criticality: ordinary (eg localized landslides, flooding of underpasses, sewer regurgitation, but also critical localized phenomena such as sudden floods and rapid flows); moderate (eg flooding and activation of landslides and flows in critical geological contexts); high (extensive floods and widespread landslides).

On the basis of the criticality levels, an alert is issued. The different alert levels represent the codified phases of activation of the structures that involve the implementation of risk prevention actions and emergency management (Forecasting activities , 2019).

The relationship between the critical levels assessed by the Functional Centre and the different alert levels is established, univocally and independently, by the Regions, and is adopted in specific procedures (Alert levels, 2019).

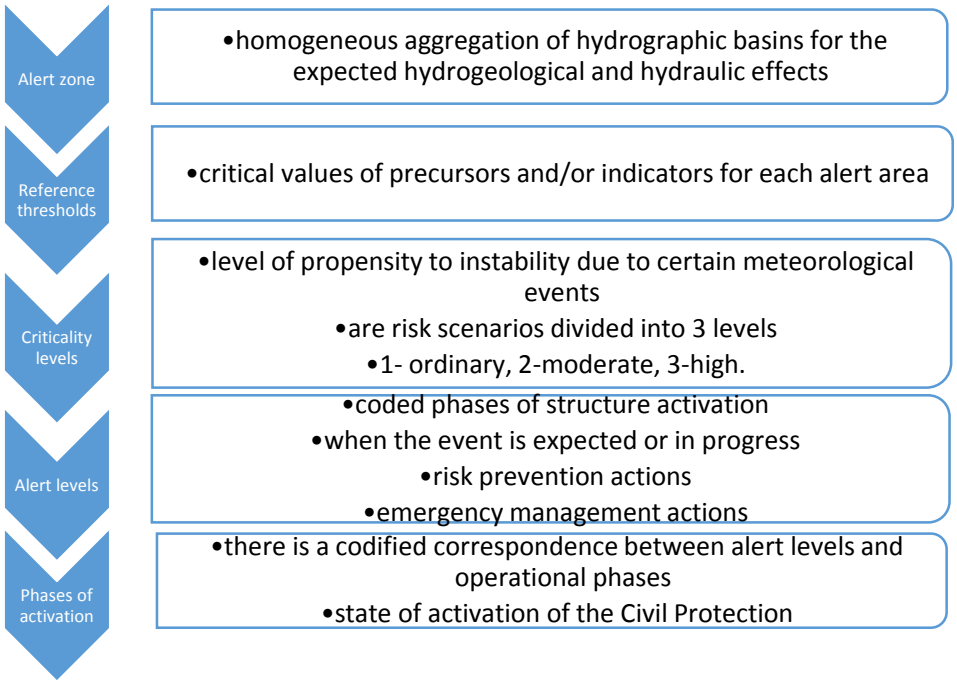


Figure 13. Alert procedure.

In the Marche Region[10] there are 6 alert zones (Alert zones Marche Region, 2019) for each one the level of hydraulic criticality, hydrogeological criticality and hydrogeological criticality for thunderstorms is foreseen. Four levels of criticality are defined: to each level of criticality is assigned an alert level.

[10] Starting from 3 April 2017, the update of the alert procedures for the hydrogeological and hydraulic weather risk of the Marche Region is in force (DPGR 160 of 19 December 2016 and DPGR 63 of 20 March 2017 and DPGR 302 of 8 November 2018).

For Marche the levels of criticality, with the associated alert levels, are:

- Absence of foreseeable significant phenomena (No Alert);
- Ordinary Criticality (Yellow Alert);
- Moderate Criticality (Orange Alert);
- High Criticality (Red Alert).

The definition of the event scenario and the possible effects and damages associated with each level of criticality/alert are reported in the Scenario table (Event scenario, 2019).

Table 9 reports a summary of bulletin and notice at Marche Region. The activity is not limited to the forecast phase, but when there is no criticality and no meteorological warning there is a monitoring phase of the ongoing situation, with the communication to the administrations in case of threshold exceedance.

Table 9. Bulletin and notice.

	Meteorological	Hydrogeological and hydraulic
Bulletin	The meteorological surveillance bulletin reports, for each hydrogeological alert area, the forecasts of different parameters, also based on adjectival thresholds	The bulletin of hydrogeological and hydraulic criticality is the document which defines, for each of the alert zones, the level of criticality assigned and the corresponding alert level.
Notice	Warning of adverse weather conditions for: rain, wind, snow, sea.	Hydrogeological Criticality Notice with criticality xxx (color code xx) for R x Eg. Notice of Hydrogeological Criticality with moderate criticality (orange color code) for hydrogeological R and hydraulic R

3.4 State of Emergency in Italy

In Italy disasters are classified, for civil protection purposes, in three different types. For each event, according to extension, intensity and response capacity of civil protection, there are the corresponding levels of civil protection that will take the lead and the coordination of interventions: type A (municipal level), type B (provincial and regional) and type C (national). There is a refund only in case of an extraordinary event in which is declared the state of emergency.

The state of emergency may be declared "imminent" and not just "at the occurrence" of natural disasters, or relating to action of man that by intensity and extension must be tackled with immediate intervention with extraordinary powers and means (example Pope visit in Loreto, province of Ancona, Italy) (Decree Law no. 59 of 15 May 2012, converted into Law no. 100 of 12 July 2012).

With the Decree Law no. 59 of 15 May 2012, changes the definition of type C events as “Natural disasters or related to human activities that because of their intensity and extent should, with immediate intervention, be tackled using extraordinary powers and means to be deployed during limited and pre-defined periods of time”. The timelines are set out in this way for the use of

extraordinary means and powers to meet emergency needs.[11]

For "type C" events the Council of Ministers declares the state of emergency, upon proposal of the Prime Minister, or, by mandate, with the portfolio of a Minister or the Secretary of State at the Presidency of the Council of Ministers of the Council Secretary. The request may also come from the President of the relevant Region, which however needs to agree with the procedure. Up until the entry into force of Decree. 59/2012, converted into Law n. 100/2012[12], the declaration of a state of emergency was carried out through a decree of the President of the Council of Ministers. Now is a resolution of the Council of Ministers.

The duration of the state of emergency - as established by art. 10 of Law no. 119 of October 15, 2013 - cannot exceed 180 days and can be extended up to an additional 180 days, with a further decision of the Council of Ministers.[13]

3.5 The Civil Protection Code: what changes

Since 2 January 2018, the National Service has been governed by the Civil Protection Code (Legislative Decree no. 1 of 2 January 2018).[14]

The Code was created with the aim of simplifying the provisions of civil protection, enclosing them in a single text easy to read. To meet this objective, each article clearly explains the rules it replaces and in the two final articles (Articles 47 and 48) also offers a coordination of regulatory references and the complete list of all the rules that through the Code are repealed.

The reform reaffirms a model of polycentric National Service. Also for this reason, the Code has been written in a different way than other norms and has been elaborated by a drafting group composed of representatives of the Civil Protection Department, Regions, Municipalities, Ministries and Civil Protection Volunteers.

The first proposal to reorder the legislation on civil protection is therefore the result of the work of a mixed group thus influencing the whole approach of the Code, which stems from an open discussion on critical issues and strengths of the previous legislation on the subject.

Why the need for a reorganization of civil protection? From the first law of the Minister of Public Works, which in 1926 regulated the theme of the "civil protection" coordination, up to the law 225/1992, instituted by the National Service, norms and modifications follow the historical trend and the emergencies of the Country. The will to reform the civil protection regulations comes 25 year after the implementation of the law 225/1992, which has already been modified. Further variations and integrations of civil protection, stratified over time, passing through many bodies of legislation and all these factors made the reading of the legislation on the subject very difficult. The new Code aims at simplification. Today, the world is complex and the legislation on civil protection must take into account this complexity. It will manage risk forecasting, prevention and mitigation, but also the

[11] Decree Law no. 59 of 15 May 2012, converted into Law no. 100 of 12 July 2012: urgent provisions for the reorganization of civil protection
http://www.protezionecivile.gov.it/jcms/it/view_prov.wp?contentId=LEG34388
[12] Before the changes introduced by Law 100/2012 the delegated Commissioner was the delegated of Government and not of the Head of Department of Civil Protection.
[13] States of emergency http://www.protezionecivile.gov.it/jcms/en/stati_di_emergenza.wp?request_locale=en
[14] The Civil Protection Code: what changes http://www.protezionecivile.gov.it/servizio-nazionale/storia/il-codice-di-protezione-civile-cosa-cambia

management of emergencies and their overcoming. It also aims to guarantee linear, effective and timely operations.

The new elements introduced by the Code are:

1. Forecasting and prevention. As far as forecasting is concerned, the Code provides for innovations relating to the study including dynamic studies of possible risk scenarios. Forecasting activities are preparatory to the activities of the alert system and civil protection planning. With regard to prevention activities, the evolution of the subject over time is taken into account, making it clear that the field of prevention is structural and non-structural, even in an integrated manner. Non-structural prevention is composed by many activities such as alerting and dissemination of civil protection knowledge on risk scenarios and rules of conduct and civil protection planning. Structural prevention is reintroduced as "structural civil protection prevention", to underline the existence of specific civil protection issues when it comes about structural prevention. The Civil Protection Department is integrated in the working tables where the lines of structural prevention are defined. The structural interventions of risk mitigation in an emergency context are also regulated. Finally, the need for integrated structural and non-structural prevention actions is specified.
2. Management of national emergencies. Before the Code, national intervention including the activation of extraordinary instruments was subject to the declaration of a state of emergency. The preventive activation was decided by an autonomous evaluation of the competent Bodies. The state of mobilization, introduced by Legislative Decree no. 1 of January 2, 2018, overcomes this limit and allows the territorial system to mobilize its resources and request the contribution of national resources, even before the declaration of the state of emergency. If the event turns into a disaster, the emergency machine is set in motion. Otherwise, a unilateral act by the Head of Department can define the costs incurred by those who have taken preventive action.
3. Duration of the state of emergency. The Code redefines the duration of the state of emergency of national importance, bringing it to a maximum of 12 months, extendable for a further 12 months.
4. Civil protection planning. The Code reaffirms the key role of planning and aims to overcome a compiling concept of the Plan in favor of an evolved vision aimed at making this tool fully operational.
5. Civil protection risks. The Code sets out the types of risk that civil protection is concerned with: seismic, volcanic, tsunami, hydraulic, hydrogeological, adverse weather phenomena, water shortages, forest fires. It also specifies the risks on which the National Service may be called upon to cooperate: chemical, nuclear, radiological, technological, industrial, transport, environmental, sanitary, uncontrolled return of satellites and space debris.
6. Scientific community. The Code clarifies the criteria of operation in the Civil Protection System, which only accepts those products considered mature according to the rules of the scientific world. The scientific community participates in the National Service through integrated activities and through preparatory experimental activities.
7. Competence Centres. The Code codifies the function of the Competence Centres, whose specificity is to produce products that can be used in the field of civil protection. Now, the Competence Centres become instruments of the entire System.
8. Participation of citizens in civil protection activities. The Code introduces the principle of citizen participation aimed at increasing awareness of risks and the growth of community resilience. This participation can take place in various areas, from vocational training, to civil protection planning and through participation in voluntary sector.

3.6 Standard Operation Procedures for data transmission in case of Declaration of the State of Emergency

In the following paragraphs is described the Standard Operation Procedure for data transmission in case of Declaration of the State of Emergency.[15]

When a big disaster happens and there is evidence from the media and the local authorities to think that the specific case have a big extension and/or intensity, and/or exceeds the coping capacity of local administration (in monetary value, materials, personnel and capacities needed) than the Head of the Region sends as soon as possible a letter to the Presidency of the Council of Ministers, specifically to the Head of National Department of Civil Protection (Figure 14). The letter is a Preliminary Request to Declare the State of Emergency and it specifies the kind of disaster happened, the territory affected and when the event occurred.

After that the Head of Civil Protection in the Region sends a letter in which requests from the Provinces and Municipalities interested by the event to integrate the Preliminary Request with analytical data with regard to the different activities to be taken to cope with the event and to quantify the financial resources necessary for this purpose, of course, according to estimates currently available.

Should be announced to the population with a specific press release how to submit the reports to the municipalities for the restoration of the private housing assets, and for the recognition of the damages suffered by economic and productive off-farm activities.

With respect to the damage to agriculture in terms of facilities and in terms of crops the reports should be submitted to the decentralized structures of the Service of Agriculture, Forestry and Fisheries.

Moreover, the survey must be carried out for the damage suffered by the municipal and province public assets. The recognition activity is carried out by the competent administrations on each asset, on the basis of the procedures related to their own organizational structure (for further detail about this procedure refer to Appendix 2).

To be underlined that in this first moment are not necessary technical expertise or other additional documentation. The Region has the task of collecting information from municipalities. The purpose is to have a first indicative survey of the damage to be sent to the National Civil Protection in the shortest time possible.
To facilitate and homogenize the collection of this information two summarizing tabs were prepared. The fields of the first tab sent to municipalities for the preliminary summary of the overall damage includes:

- the total monetary value in Euro of each municipality regarding the damages of private subjects; and
- the total monetary value in Euro of each municipality regarding the damages suffered by economic and productive activities.

The second tab is about the expenses incurred or estimated to mitigate or eliminate risk situations, to ensure the necessary assistance and recovery of affected populations and implement all the necessary activities for the safeguarding of the areas involved.

[15] The SOP described is based on the Declarations of the State of Emergency in case of severe weather in Marche Region.

The second tab is divided into two parts. The first part concerning the economic quantification of damage by reporting the overall amount for each type of intervention:

- Assistance to the population;
- Use of civil protection voluntary, including meals;
- Freight of resources, dewatering pumps, pressure washers, earth moving, etc. Used to clean the public areas and public sewers, as well as to restore the usability of private property;
- Waste disposal;

and the overall amount for the reconnaissance of the estimated needs for the restoration of public property:

- Interventions for the arrangement of waterways;
- Works to put in security road networks and infrastructure;
- Interventions to restore public buildings or intended for public use;
- Other (provide details).

The second part contains specific descriptive information on the damage:

- to watercourses (Type of watercourse, Denomination, Location, Description of damage);
- to municipal and vicinal roads and other public infrastructure (Road denomination, Location, Description of damage);
- to public buildings or intended for public use (Road denomination, Location, Description of damage).

The Region than collects the information from the Provinces and Municipalities and transmits it to the Head of National Civil Protection and to the Presidency of the Council of Ministers.

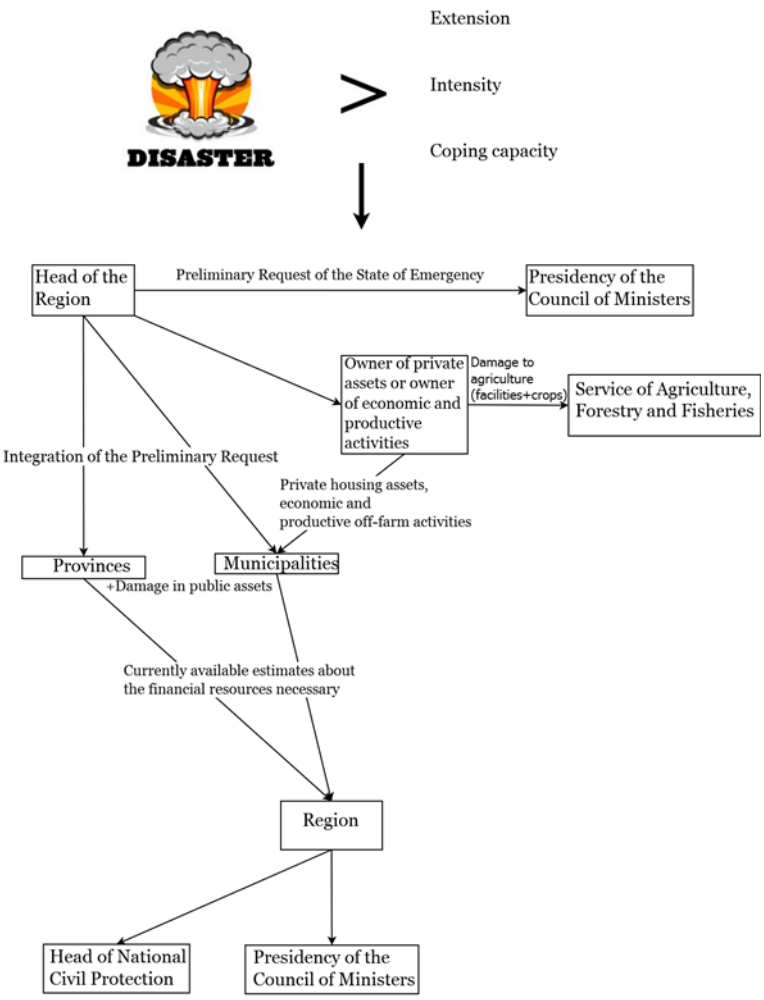


Figure 14. Request of the State of Emergency.

With resolution of the Council of Ministers (Figure 15) is declared the State of Emergency and after that an ordinance is made.[16] Before the Law decree no. 59/2012 the ordinance, according to art 5, par. 3 of law 225/1992 (which established the "National Service of Civil Protection"), were issued by the President of the Council of Ministers (OPCM). At present the Law decree no. 59/2012 provides that the Head of Civil Protection Department has the task of issuing, along with regions involved, ordinances (OCDPC – Ordinance of the Head of the Department of Civil protection) for carrying out interventions during a state of emergency, and dealing with its fulfilment.[17] The ordinance is published in the Official Gazette of the Italian Republic.

With the OCDPC or OPCM are regulated the first urgent interventions of civil protection (top priority works) and also the recognition of needs with regard to public and private property and to the economic and productive activities.

[16] In the declaration of the State of Emergency is indicated also the public administration responsible in ordinary times that takes care of the remaining activities to overcome definitively the criticalities caused by the emergencies.

[17] Legal measures of National Civil Protection
http://www.protezionecivile.gov.it/jcms/en/provvedimenti.wp?request_locale=en

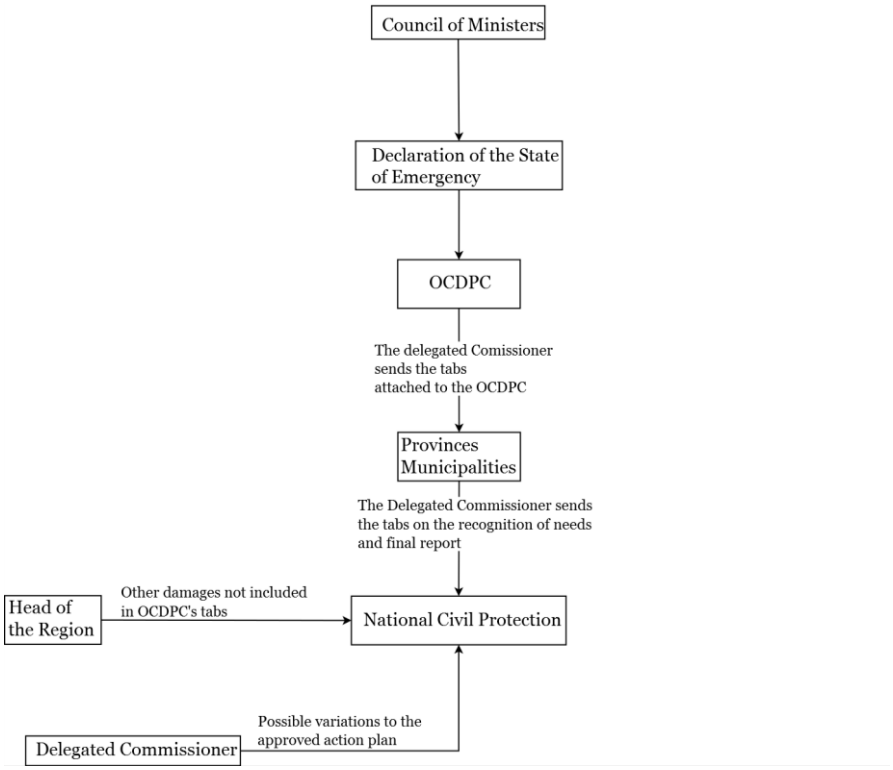


Figure 15. Declaration of the State of Emergency and Needs Recognition.

3.7 Ordinance of the Head of the Department of Civil protection – OCDPC[18]

The OPCM and OCDPC for the first urgent civil protection interventions after an exceptional event generally contain some articles among which the first is the appointment of the delegated commissioner and the preparation of the intervention plan. Other articles that are found in almost all the ordinances considered for this study are:

- contributions autonomous accommodation;
- financial coverage;
- damage recognition;
- any exceptions to current legislation.

For the specific case of the extraordinary events of May 2014 the OCDPC[19] at the begging briefly describes what kind of event occurred, where occurred and when. The ordinance have 11 Articles and have also a technical attachment that represents the procedural reference. The articles of the ordinance are listed below:

1. Appointment of Commissioner and the work program;
2. Contributions autonomous accommodation;
3. Financial coverage;
4. Exceptions;

[18] The ordinances are emitted by the Head of Civil Protection Department, if it is not written differently in the declaration of the state of emergency by the Council of Ministers. The acts of the ordinances are in each case followed by the Head of the Department. Before the ordinances were emitted by the President of the Council of Ministers or by a Minister delegated by him. To emit it is necessary to know the Regions affected http://www.protezionecivile.gov.it/jcms/it/view_prov.wp?contentId=LEG34388

[19] OCDPC example for the events of 2-4 May 2014 in Marche Region, Italy.

5. Subject responsible for the needs recognition;
6. Public property;
7. Private assets;
8. Economic and productive activities;
9. Procedures for the recognition of needs and final report;
10. Report of the Delegated Commissioner;
11. Suspension of mortgages;[20]

The technical attachment to the OCDPC represents the procedure for the recognition of the needs for the restoration of public and private facilities and infrastructures damaged, as well as the damage to economic and productive activities, to cultural heritage, and the building stock in order to overcome the emergency as a result of extreme events occurred during a specific interval of time and in a specific territory.
The aim of the document is to facilitate the control activities, the homogenization and representation of data and information relating to public and private assets, as well as of economic and productive activities, in compliance with the time defined in the Ordinance.

The technical attachment to the OCDPC is composed by:

1. Recognition of the needs for intervention on public property;
2. Recognition of the needs for intervention on private assets;
3. Recognition of the need for economic and productive activities;
4. Final Report;
5. The tabs (see Table 10, Table 11 and Table 12).

In the first three columns of the tables Table 10, Table 11 and Table 12 are reported all the fields cointained in the tabs attached to the OCDPC (default fields) and in the last column are some examples from the tables filled with data for the event of 2-4 May in Marche Region, Italy (specific case examples).[21]

[20] http://www.protezionecivile.gov.it/jcms/it/view_prov.wp?contentId=LEG47263
[21] The tecnical attachments for the activity of need recognition of the OCDPCs are the same for any type of emergency see http://www.protezionecivile.gov.it/jcms/it/allegati_tecnici.wp

Table 10. Table/Tab A attached to the OCDPC and examples in the last column.

Table A - Recognition of the needs for intervention on public property	General information of the building	Region	Marche
		Event	Severe weather
		Date of event	May 2014
		Municipality	Senigallia
		Province	Ancona
		Address	Road or i.e. indication of the stream
		Use	Stream, bridge, road, pool, sports facility, equipment, warehouses - communal dressing rooms, dog pound, organizations' headquarters, electrical installations of low and medium voltage
	Project	Reporting agent	Municipality
		Implementing body	Municipality
		Intervention title	Top priority works for the restoration of the discharge in the sea of the stream damaged, stream cleaning, maintenance of roads, structural bridge rehabilitation, arrangement of landslide movement, restore capabilities i.e. sports arena, purchase equipment to be used for the roads and environment, restore of previous functionality of damaged assets
		Project status	1- Rough Estimate 2 - Feasibility Study 3 - Preliminary Project 4 - Final Project 5 - Executive Project
	Financing	Estimated cost	Amount (€)
		Co-financing share (€)	Amount (€)
		Funds (€)	Amount (€)
	Insurance	Not refundable by insurance	True/False
		Refundable by insurance for Euro	-amount - amount in course of quantification
		Insurance award payments in the last 5 years	Total payments made (€)

Table 11. Table/Tab B attached to the OCDPC and examples in the last column.

Table B - Recognition of the needs for intervention on private assets	General information of the building	Region	Marche
		Event	Severe weather
		Date of event	May 2014
		Building in the Municipality of	Senigallia
		Province	Ancona
		Address of building	Road/Square
		The building is	1 - Property 2 - co-owned 3 - leased 4 - other personal right of enjoyment 5 - common condominium part
		Use	1 - Main house 2 - inhabited for other reasons 3 - leased 4 - not used as a residence and not leased
	Current status of the building	Status	1 - Destroyed 2 - Declared unusable 3 - Damaged 4 - Damaged and restored partially 5 - Damaged and totally restored
		Evacuated	Yes/No
		Structural type	1 - Reinforced Concrete 2 - brickwork 3 - Other
		Surface (m^2)	
	Restoration	Total cost of restoration (€)	
	Insurance	Not refundable by insurance	True/False
		Refundable by insurance for Euro	-amount - amount in course of quantification
		Insurance award payments in the last 5 years	Total payments made (€)
		Notes	I.e. Insurance data not quantified

Table 12.Table/Tab C attached to the OCDPC and examples in the last column.

Table C - Recognition of the need for economic and productive activities	General information of productive and economic activities	Region	Marche
		Event	Severe weather
		Date of event	May 2014
		Sede dell'attività ubicata nel Comune	Senigallia
		Province	Ancona
		Address of the venue of activity	Road/Square
		The venue is	1 - company's property 2 - leased 3 - used for other reasons 4 - common condominium part
	Current status of the business location	Status	1 - Destroyed 2 - Declared unusable 3 - Damaged 4 - Damaged and restored partially 5 - Damaged and totally restored
		Evacuated (YES/NO)	
		Structural type	1 - Reinforced Concrete 2 - Brickwork 3 - Other
		Surface (m^2)	
	Restoration	Total cost for structural/functional restoration (€)	
		Needs to restore machinery/equipment (€)	
		Needs to purchase damaged goods (€)	
		Total cost of the damage (€)	
	Insurance	Not refundable by insurance	True/False
		Refundable by insurance for Euro	-amount - amount in course of quantification
		Insurance award payments in the last 5 years	Total payments made (€)
		Notes	I.e. Insurance data not quantified

The Delegated Commissioner sends the tabs attached to the OCDPC to the Provinces and Municipalities and when they send them back filled, and in any case not later than 90 days from the publication of OCDPC on GURI, the Commissioner sends the tabs on the recognition of needs and the final report to the National Civil Protection.
If there are other damages during the event (damages not already included on the OCDPC's tabs) than the Head of the Region affected by disaster event sends a new request to the National Civil Protection. As an example, after the event of 2-4 May 2014 in Marche Region, there was numerous reports about chattels and means of transport damaged, so the Head of the Region Marche the 18th of October 2014 (more than 5 months after the event) made a new request to the National Civil Protection in order to refund this damages. So it was requested to insert this kind of damages in a new ordinance of the civil protection.
If in the process of implementation of the action plan (after various month after the event) the Delegated Commissioner finds that there are variations, than he send a new request to National Civil Protection by detailing all the variations.

Starting from the 23d March 2016 there are some changes in the tabs for the Preliminary Request of the state of emergency and of those for the reporting of the damages, criticalities and needs in case of severe weather. The new tabs for the Preliminary Request have more detail regarding the top priority works for the first emergency phase (the interventions in public property are separate in work performed or underway and work to be performed). There is more detail also on the interventions about the reduction of residual risk and are included also the ordinances of the mayor for evacuation. The new tabs are reported in the tables of Appendix 3 while in Appendix 4 are described the bureaucratic procedures for the case study of May 2014 in Marche Region, Italy.

3.8 Damage estimation[22]

The information about the damage to public property should be filled in the forms by the competent administrations on the single assets (municipal technicians quantify the costs while the mayor certifies the expenditure), for the damage to the private property should be filled by the owners of the properties affected, while for the damage to economic and productive activities should be filled by the owner of the economic/productive activities affected (see Figure 16). For private and economic and productive activities the forms are filled as autocertifications and eventually can be followed by an expertise after and if funds are allocated for this damages.

After the approval of the funds for the private assets and economic and productive activities should be done an asseverate examination by a professional in order to prove that what was declared is true or false.[23]

[22] Thanks to Cesarina Santinelli, former accountant at the Department for Integrated Security Policies and Civil Protection, Marche Region, contact: cesarina.santinelli@regione.marche.it
[23] OCDPC n. 179.

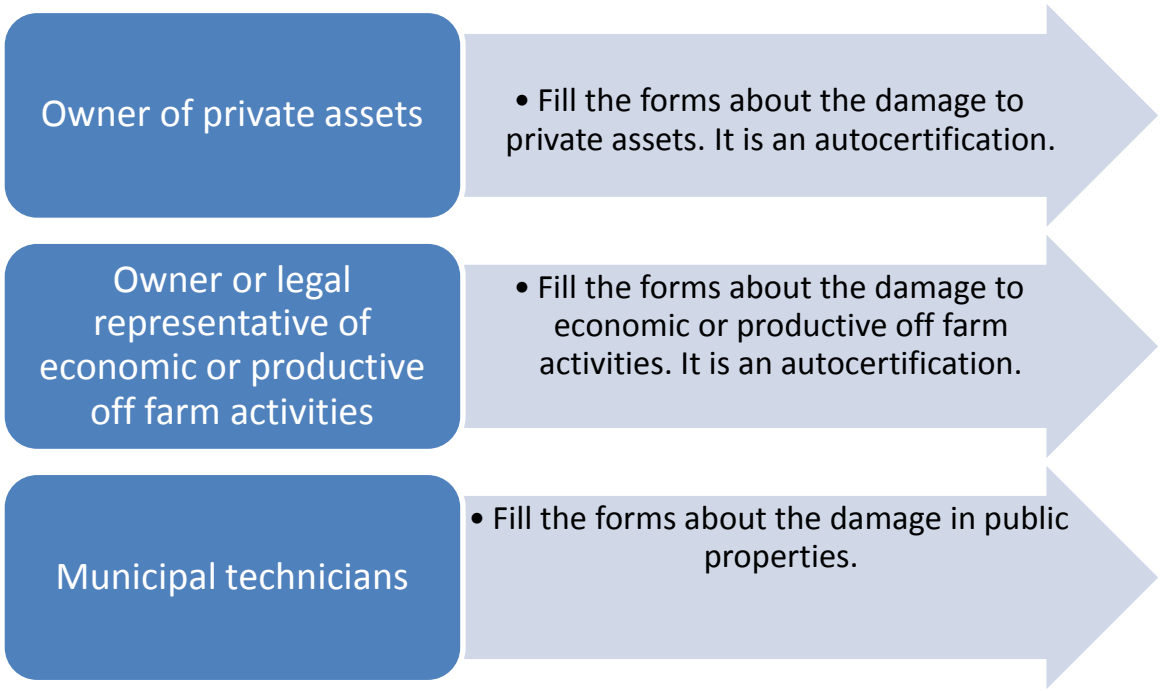


Figure 16. Responsible persons for the forms of needs assessment/recognition

The Appendix 2, Appendix 5 and Appendix 6 report other details on how to fill the tabs attached to OCDPC.

3.9 State of Natural Calamity

The State of National Emergency and the State of Natural Calamity are two different and non-equivalent instruments. The definitions are different even though they are often used, both by the media and by representatives of local institutions, as equivalent or substantially similar.

The State of Emergency concerns the Civil Protection while the State of Natural Calamity is an instrument connected exclusively to the agricultural sector. In fact, his reconnaissance is done through a decree of the Minister of Agricultural, Food and Forestry Policies.

So, the State of National Emergency and the State of Natural Calamity are two different instruments with no dependence between them, it can exist a state of Natural Calamity without a State of National Emergency when there is damage in the agricultural sector only.

The European Commission considers earthquakes, avalanches, landslides and floods, whirlwinds, hurricanes, volcanic eruptions and forest fires of natural origin as natural calamities. There is no damage threshold for an event to be considered a natural calamity except that more activities/organizations/companies must have suffered damage.

Furthermore, the European Commission also takes into consideration the adverse weather conditions that can be assimilated to a natural disaster that are defined as: "adverse weather conditions such as frost, storms and hail, ice, heavy or persistent rain or severe drought, which destroy more than 30% of the annual average production of a farmer calculated on the basis of the previous three-year period or its average three-year production calculated over the previous five years, excluding the year with the lowest production and the one with the highest production ". Other adverse weather conditions can also be considered: adverse weather conditions that are not included in the previous ones (European Union Guidelines for State aid in the agricultural and forestry sectors and in rural areas 2014 to 2020 (2014/C 204/01)., 2014) (Commission Regulation (EU) No 702/2014 of 25 June 2014, 2014).

In Italy the definitions of the single events that cause damage can be found in the Annual Agricultural Insurance Plan, approved every year for the following year by the Ministry of Agricultural, Food and Forestry Policies (see GURI).

3.10 Standard procedures for data transmission in case of declaration of the State of Natural Calamity

When natural events cause damages to farm activities the procedure for data transmission is the one described in Figure 17.

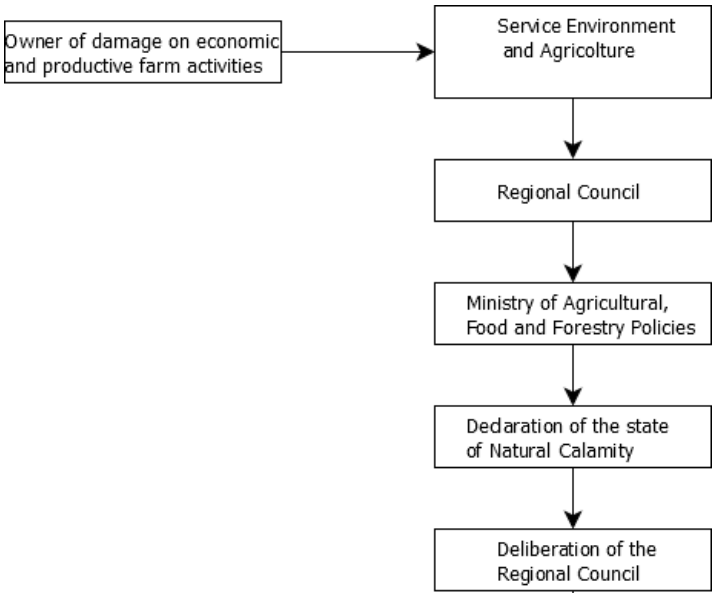


Figure 17. SOP for data transmission in case of declaration of Natural Calamity.[24]

The owners of damages on economic and productive farm activities should report the damage to the regional offices of the Service of Environment and Agriculture, decentralized one in each Province. This service is a technical body of the Regional Council. The Regional Council within 60 days since the end of the event that caused the damages decide to send a request to the Ministry of Agricultural, Food and Forestry Policies in order to recognize the event as extraordinary and that caused damages. In the request sent to the Ministry there is also an estimation of the economic damage classified for each damage category and for each Province (each Province listed the Municipalities affected). The damages are classified in four categories:

- agricultural productions;
- business structures;
- installations and stocks of agricultural enterprises;
- infrastructure related to agricultural activity.

As for the agricultural productions there are state insurance so the reimbursement for this category is practically inactive. Only for the case of the floods of 2-4 May 2014 in Marche Region, there was a Decree Law (51/2015 of 28/9/2015) which specify that also the agricultural production should be

[24] The diagram and the description was made by taken as reference the following documents: Deliberation of the Regional Council of 28/9/2015 nr. 795, of 27/6/2011 nr. 918, of 22/12/2014 nr. 1426, of 19/4/2011 nr. 554 kindly provided by Gianni Fermanelli, responsible of the procedures.

reimbursed because some owners of the damage could not find a reinsurance company that makes the insurance for high risk flood prone areas or they found but the prices were not acceptable.

The Ministry of Agricultural, Food and Forestry Policies decides if the request can be accepted or not. If the request is accepted than with a Ministerial Decree is proclaimed the Declaration of the State of Natural Calamity. This Ministerial Decree is published on GURI and within 45 days from the publication on GURI of the State of Natural Calamity the requests of compensation should be presented to the competent Regional authorities.

With a following Decree the Ministry decides which will be the share of the National Solidarity Fund for the Region. There are some criteria requested to access the National Solidarity Fund (under comma 3, article 5, of legislative decree 102/04) (Legislative Decree of 29 March 2004, n. 102 , "Financial measures in support of agricultural enterprises, under Article 1, paragraph 2, letter i) of the Law 7 March 2003, n. 38", 2004):

- can benefit the agricultural enterprises as in art. 2135 of the Civil Code, including agricultural cooperatives carrying on the agricultural production activities, registered in the Companies Register;
- and that as a result of the recognized calamitous event, have suffered a greater damage than 30% of gross marketable production.[25]

After the Declaration the Regional Council makes a Deliberation in which establishes:

- the deadline to submit applications;
- procedures, criteria, and methods for the submission of applications and the provision of the contributions;
- the priorities of reimbursement in case of lack of funds and in function of what assigned by the state.[26]

The aids for the restoration of business structures, installations and stocks must not exceed 80% of the actual damage amount, so any other public aid paid for the same purposes and the related insurance compensation must be taken into account.

The Regional Council Resolution also contains one or more of the attachments described below:

- Attachment “A”:
    1. Delimitation of the areas (as described in the Regional Resolution) for which the compensatory measures can be applied;
    2. Subjects admitted to financing (eg. agricultural enterprises, agricultural cooperatives registered in the business register, with damages greater than 30% of gross marketable production);
    3. Types of interventions admitted to financing (eg restoration of buildings and other rural artefacts, greenhouses and areas for processing and selling products etc.)

[25] The Gross Marketable Production has been established, based on the productive sorting of the year, adding up for each crop the product of the surface invested with the average annual quantities, produced at the unit surface, in the previous three years for the average selling price obtained in each year. Alternatively can be used the average data of the five-year period, with exclusion of the year with the lowest production and the year with the highest production. The calculation must be made at the level of individual companies.
[26] Sometimes the priority of funds allocation is given in a following act.

4. Interventions and damages not allowed to contribution (interventions that have benefited from public aid or insurance, damage to crops, damage of less than 30% etc.);
5. How to submit applications;
6. Examination of the applications (within 90 days of the deadline for submitting applications, prepare the list of admissible applications);[27]
7. Presentation and content of restoration projects for business structures, installations and stocks;
8. Examination of projects to restore business structures, payment of contributions and controls;

- Attachment "B"- Application for admission to contributions:
    1. The application is made in the form of a substitutive declarations of the deed of notoriety;
    2. The application is completed by the company owner or his legal representative;
    3. The application shall include among others:
        - Identification of the damaged business structure (parcel, cadastral sheet, address), with the description of the damages suffered, the type of restoration intervention, the presumed cost based on an estimative metric calculation and the indication of any urgent interventions performed;
        - Declaration of entitlement to assets;
        - Declaration that the agricultural enterprise that benefits from the contributions, single or associated, has the requisites foreseen by article 2135 of the civil code, that is registered before the occurrence of the events at the Chamber of Commerce (CCIAA) to the register of companies; who is in possession of a company file pursuant to DPR 503/99 and Legislative Decree 99/2004; that the damaged structures fall within the areas delimited with DGR and therefore are included in the declaration made by decree of the Minister of Agricultural, Food and Forestry Policies, which suffered damage of not less than 30% of gross marketable production;
        - Declaration attesting the causal link between the damage suffered and the exceptional weather event;
        - Declaration attesting that the restoration intervention does not use other public benefits of community, state, regional and local origin, or insurance forms.
- Attachment "C":
    1. Parameters for determining the financial amount of the operating loan pursuant to art. 5 paragraph 3, letter b) of Legislative Decree 102/2004.

In Table 13 are reported the fields of the application that can be useful for data record in FloodCat.

[27] Anyone who is unsatisfied can send a request within 15 days from the publication in the Official Bulletin of the Marche Region - BURM. There will be a sample check of the received declarations (substitutive declarations of the deed of notoriety).

Table 13. Fields of the request of compensation for agricultural economic activities vs FloodCat categories.

Fields of the request of compensation	Fields of the tab damage of FloodCat
Address of entreprise	Damage localization
Declaration of damages higher than 30 %	Damage class (medium-high)
Damage descritpion	Summary of Damage, Other description of Damage, Damage Description
Each request	Damage category (Agriculture and Livestock)
Where present the field: crop or livestock, type	Damage subcategory
Total	Economic value

In the scheme of submitted applications is not required, the numerical value of the sub category of damage, eg. in ha or kg of production, useful instead for inclusion in FloodCat.

In Appendix 7 is reported the bureaucratic procedure for the State of Calamity of May 2014 in Marche Region.

3.11 Funds for Natural Calamities

The reference regulations regarding natural calamities at national and European level are the following:

- The legislative decree 29 March 2004, n. 102, "Financial interventions in support of agricultural enterprises, pursuant to article 1, paragraph 2, letter i) of the law of 7 March 2003, n. 38 " (Fondo Di Solidarietà Nazionale (FSN), 2004);
- Legislative Decree No. 82/2008 of April 18, 2008 (amendment and integration of Legislative Decree 102/2014);
- Regulation (EU) n. 702/2014;
- Ministerial Decree 15757 (application of Legislative Decree 102/2004 pursuant to EU Regulation 702/2014);
- Regulation (EC) n. 2012/2002 establishing the European Solidarity Fund.

The legislative decree 29 March 2004, n. 102, in the text amended by legislative decree n.82/08, provides the activation of the National Solidarity Fund (FSN) in agriculture in case of natural calamities and adverse weather conditions similar to them.

The National Solidarity Fund (FSN) aims to promote prevention interventions mainly to deal with damage to agricultural and livestock production, agricultural business facilities and agricultural infrastructure, in areas hit by natural calamities or exceptional events, within the limits of available resources of the Fund itself. The FSN envisages the following types of intervention:

- measures aimed at encouraging the stipulation of insurance contracts against the damage of production and structures;
- compensatory interventions, exclusively in the case of damage to productions and structures not included in the annual agricultural insurance plan, aimed at the economic and productive recovery of agricultural enterprises that have suffered damage;
- restoration interventions of infrastructures connected to agricultural activity, including irrigation and reclamation, compatibly with the primary needs of agricultural enterprises.

Those who suffered damage of not less than 20 percent of gross marketable production, if they are located in disadvantaged areas and 30 percent of gross marketable production if located in other areas, can benefit from the interventions to favor the recovery of productive activity.

In order to favor the economic and productive recovery of agricultural enterprises, the following aid can be granted, in single or combined form, at the choice of the regions, taking into account the needs and effectiveness of the intervention, as well as the financial resources available:

- capital grants up to 80 per cent of the ascertained damage based on the ordinary gross marketable production of the previous three-year period;
- five-year amortization loans;
- extension of agricultural credit operations;
- social security benefits.

In the event of damage caused to business structures and stocks, capital grants of up to 100 percent of actual costs may be granted as compensation.

Capital grants are disbursed on the basis of assigned resources, up to a maximum of 80% of actual costs (this for non-insurable assets such as structures, focus on prevention).

Contributions in favor of the entitled parties will be liquidated by the director of the P.F. Public emergency works and prevention of seismic risk, in two solutions: at progress equal to 50% of the amount and at balance.

The aid scheme must be activated within three years of the occurrence of adverse climatic events that can be assimilated to a natural disaster. In accordance with the provisions of Reg. (EC) 1857/2006, aid must be paid within 4 years of the occurrence of the expense or loss.

The checks will be carried out at the beginning and at the end of the works, at a minimum of 10% of the projects admitted to funding for each verification phase.

As an example, here is reported, for the event of 2-4 May 2014, the total estimate of the damages, made on 30/06/2014, which was of 28.649.000 Euro, only for agriculture (agricultural productions, business structures and infrastructure).

Damages to production and facilities eligible for subsidized insurance are excluded from the aforementioned benefits.

Measures aimed at restoring the infrastructures connected to agricultural activity, including irrigation and reclamation, can also be adopted, with the expense of the total load of the National Solidarity Fund.

A non-interest bearing current account called «National Solidarity Fund» in the name of the Ministry of Agricultural and Forestry Policies is opened at the Central Treasury (Fondo Di Solidarietà Nazionale (FSN), 2004).

Aid intended to compensate for damage caused by adverse climatic events that can be assimilated to natural disasters is reduced by 50%, except when they are granted to beneficiaries who have taken out an insurance policy to cover at least 50% of their average annual production or income derived from production and the statistically more frequent climate risks in the Member State or region concerned for which insurance coverage is provided.

The aid and any other payments received as compensation for losses, including those received under other national or Union measures or by virtue of insurance policies relating to indemnified damages, are limited to 80% of the eligible costs. The aid intensity can be increased to 90% in areas subject to natural constraints (Commission Regulation (EU) No 702/2014 of 25 June 2014, 2014).

Contributions are granted for the subscription of insurance policies in favor of small and medium enterprises. The maximum aid intensity on policies is limited to 65% of the cost of the insurance premium for insurance contracts that provide for compensation if the damage exceeds 30% of production. For example, if the insurance policy costs 20 euros / year / hectare per production cycle then the maximum aid would be 65% x 20 euros. The insurance only compensates for the cost necessary to remedy the losses and does not imply any obligations regarding the type and quantity of future agricultural production (Decreto Ministeriale 15757, 2015).

A European Union Solidarity Fund is established which aims to enable the Community to deal with emergency situations quickly, effectively and flexibly. As soon as possible, and in any case not later than ten weeks from the date on which the first damage due to the catastrophe occurred, the State may submit to the Commission a request for intervention by the Fund providing all the information available (Regolamento (CE) N. 2012/2002 del Consiglio, 2002).

4 Emergency data in Italy

To ensure the monitoring of public finance flows, the law n. 225/1992 in article 5 paragraph 5bis establishes that the delegated commissioners holders of special accounting must prepare the report of all the incomes and all the expenses that regard the interventions for which they have been delegated, on the basis of the approved accounting scheme with ministerial decree of 27 March 2009. The report must be produced within 40 days of the annual closing of each financial year or, in the event that the state of emergency closes before, within 40 days from the end of the management or appointment of the Delegated Commissioner. The reports must be available on the website of the Civil Protection Department.[28]

The states of emergency related to various types of risk declared before the Law n. 100/2012 (which "limited" the duration of the state of emergency) were declared and extended by Decree of the President of the Council of Ministers and the Commissioner was delegate of the Government and not of the Head of the Civil Protection Department. Some states of emergency are still open (update of 19 May 2019) and the funds are not managed by the Civil Protection Department.

In order to make statistics on the fund of the emergencies were considered the bad weather events of after 2011, which for the FloodCat purposes were considered as first priority events. For this events the state of emergency were emitted with a subsequent ordinance. There are five ordinances emitted for the above described events:

- Event of March 2015 – Ordinance 264/2015;
- Event of May 2014 – Ordinance 179/2014;
- Events of 10-13, 25-27 November and 2 December 2013 – Ordinance 141/2014;
- Events of 2013-2014-2015 – Private Ordinance 378/2016;
- Event of 10-13 November 2012 – Law 228/2012 art.1, comma 548 and DPCM 23/03/2013;

From the above listed the event of 10-13 November 2012 cannot be used for the statistics as there was not an OCDPC but a DPCM emitted and they do not have the same structure and fields required so cannot be comparable between them. While the ordinance 378/2016 is emitted for three event and only for the data on private buildings and goods and will be used to compare with the data of table B of the ordinances 264/2015, 179/2014 and 141/2014 to see how differ the data between the two need recognitions.

This statistics were made because the statistics that will follow in the other chapters consider only the data contained on FloodCat. As FloodCat was designed following the Flood Directive requirements and the correlated database schemas and also have some default categories and subcategories, some of the expenses occurred during an emergency are not considered in it eg. for example most of the data contained in the Action Plan (eg. volunteers meal, waste disposal, machine rental etc. in the very first emergency phase). The data of the Action Plan are also here used for statistics because usually are totally funded by the state, while Ordinance usually are not.

This paragraph is to remind briefly how the data collection in case of emergency of type C is made. There are two data collections: the action plan and the tabs attached to the ordinance. The action plan is composed by the following listed tabs:

- Tab A1: Relief interventions and assistance to the population;
- Tab A2: Contributions for autonomous accommodation (CAS);

[28] States of emergency reporting http://www.protezionecivile.gov.it/amministrazione-trasparente/interventi-straordinari-emergenza/rendicontazione-degli-stati-di-emergenza. Page last update 6/09/2018.

- Tab A3 Urgent measures, implemented or to be implemented, aimed at restoring the functionality of essential public services as well as avoiding situations of danger or damage to persons or property;
- Other (example “Equipment restoration of the Regional Functional Centre and securing the regional hydrographic network” and/or “Material restoration of the Regional Emergency Response Centre”)

The tabs attached to the ordinance are:

- Recognition of the needs for intervention on public property;
- Recognition of the needs for intervention on private assets;
- Recognition of the need for economic and productive activities.

In Figure 18 are shown the total economic loss of the tab A1 and the economic loss of each component of the tab A1 for 3 events: May 2014, March 2015 and November-December 2013. From the 6 components of tab A1 the voices “Assistance to the population”, “Provisional measures of accommodation of evacuated population” and “Employment of volunteering” seemed that did not have a high economic impact. The components with the highest economic impact are “Facility rental”, “Waste disposal” and “Other” not specified expenses. The event with the highest economic loss regarding tab A1 is the event of May 2014 due mainly to the components “Waste disposal” and “Facility rental” with 45% and 36% of total tab A1 ($5.4*10^6$). Following is the event of November-December 2013 with a very close amount of nearly $5.2*10^6$ due mainly to “Facility rental”, “Other” and ““Waste disposal” with 50%, 29% and 16% respectively. The event of March 2015 recorded for tab A1 nearly half of the sum of the two previous mentioned events caused mainly by “Other” and “Facility rental” with 57% and 42% respectively.

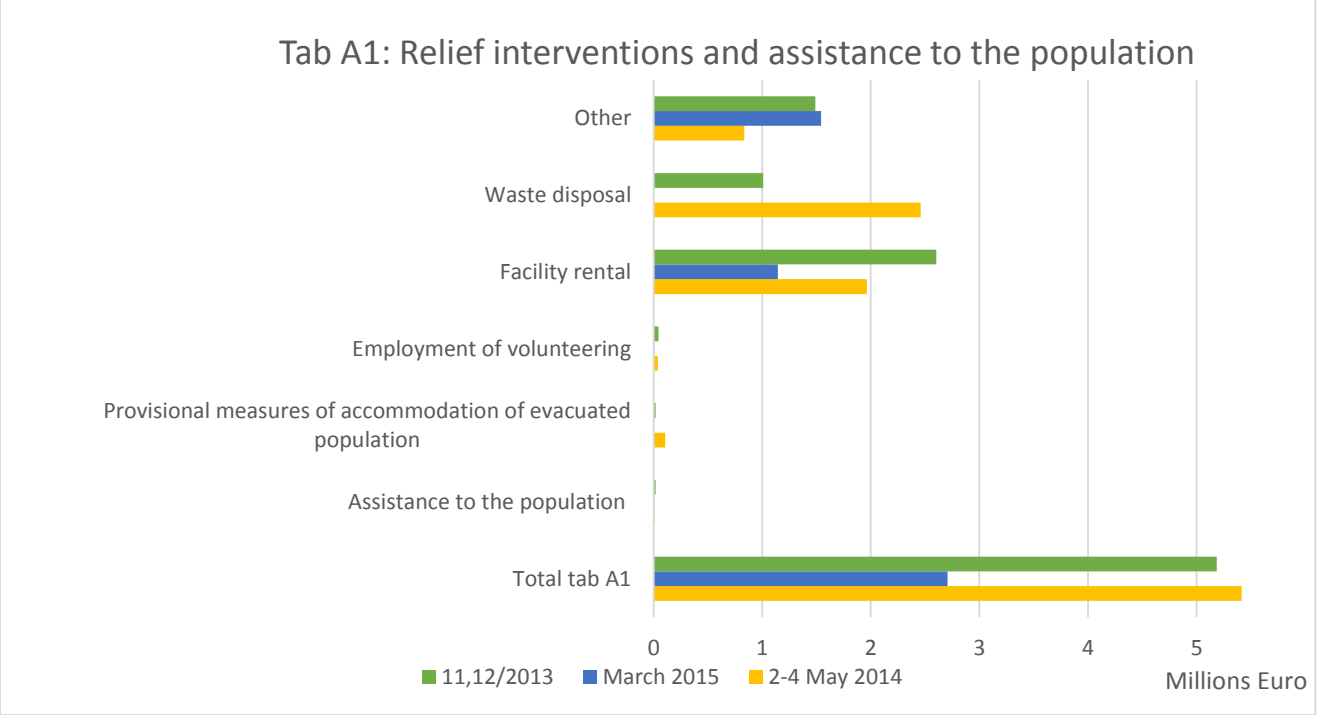


Figure 18. Tab A1: Relief interventions and assistance to the population for three events.

Figure 19 shows tab A2 “Contributions autonomous accommodation” of the intervention plan for the 3 events: May 2014, March 2015 and November-December 2013. It is shown the number of people evacuated, how many of them were disable and the total cost for their accommodation. The events of March 2015 and November-December 2013 shows insignificant values compared with the event of May 2014 in which nearly 3000 people were evacuated from their habitations, of which 40 disabled, and a total amount of nearly 2.5 million Euro for the accommodation in other buildings.

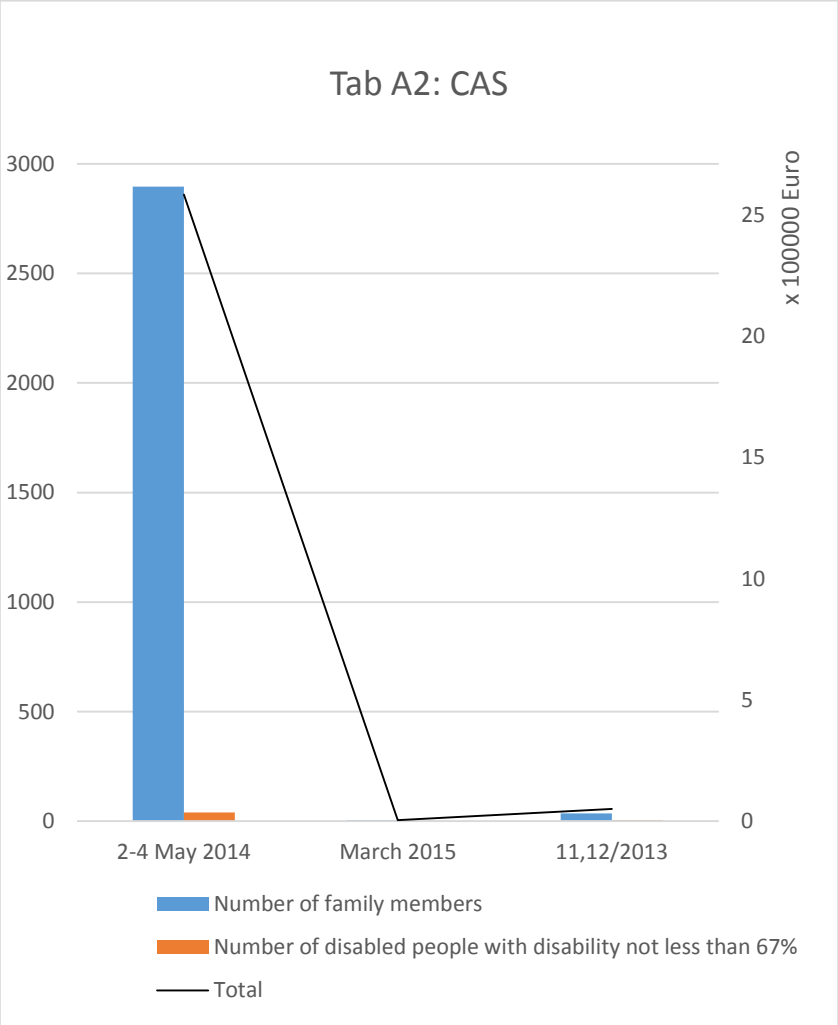


Figure 19. Tab A2: Contributions autonomous accommodation.

While considering the entire action plan for the three events (Figure 20), it is clear that the tab that mostly affects the total amount is tab A3 for the events of March 2015 and November-December 2013, while the event of May 2014 had higher expenses for tab A1. The event of November-December 2013 recorded the highest amount for the action plan with more than 21 million Euros, following with a similar amount is the event of March 2015 with nearly 18 million and the last the event of May 2014 with nearly 10.5 million Euro. For the events of May 2014 and November-December 2013 were recorded some additional expenses, here exposed as “Other” which

“Equipment restoration of the Regional Functional Centre and securing the regional hydrographic network” and “Material restoration of the Regional Emergency Response Centre”.

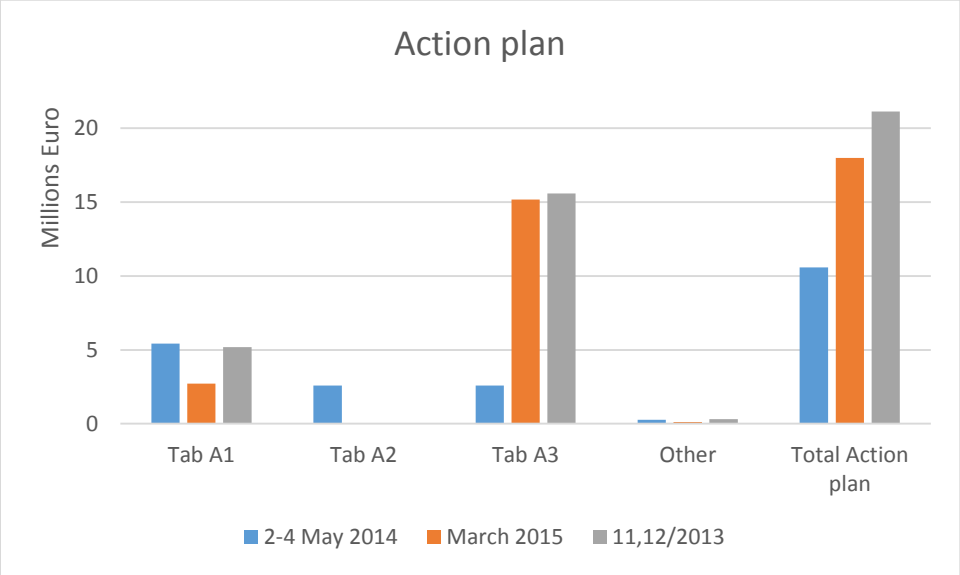


Figure 20. Action plan.

Now let’s analyse the expenses of the tabs attached to the ordinance for the three events. It is obvious from Figure 21 that the tab that mostly influenced the total expense of the ordinance is Tab A of public property. The value Total Ordinance is given by the sum of tab A, B and C, while Ordinance Private have only the values of damages on private property, similar to Tab B but made with more accuracy and more controls about the self-declared values of the damages. It is interesting that the values of the Ordinance Private represent nearly 30 % of the value of Tab B for the three events.

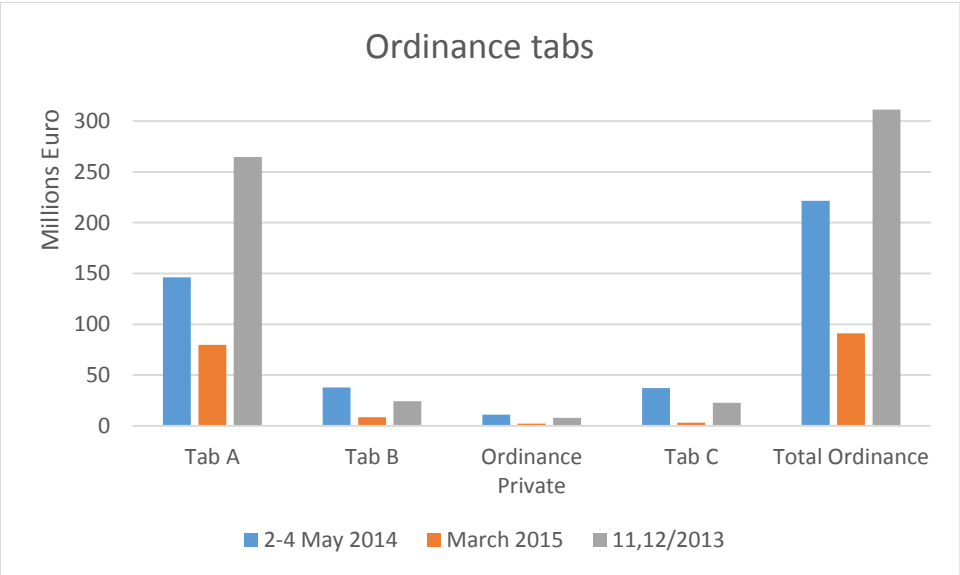
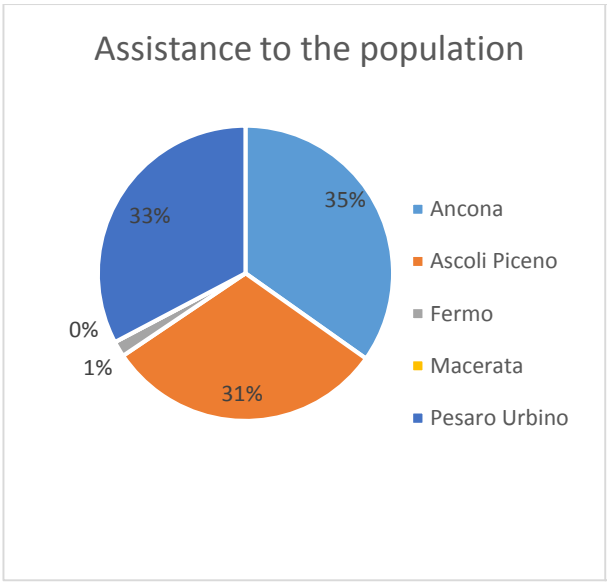


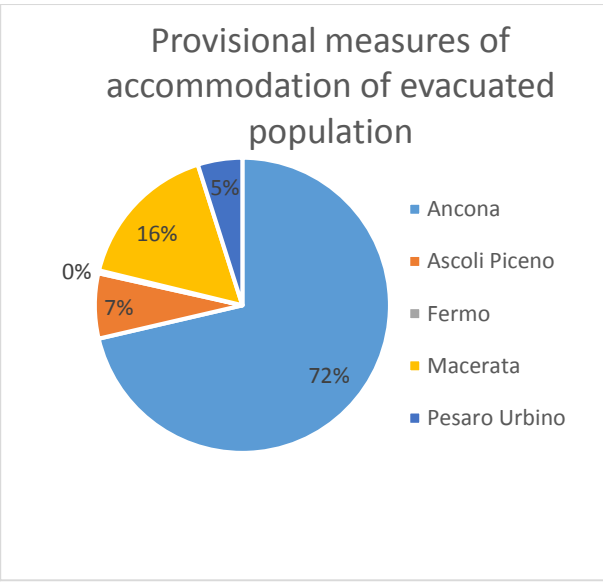
Figure 21. Ordinance tabs for each event and private ordinance.

For the three events the state financed resources are nearly the same as the total amount of the Action Plan.

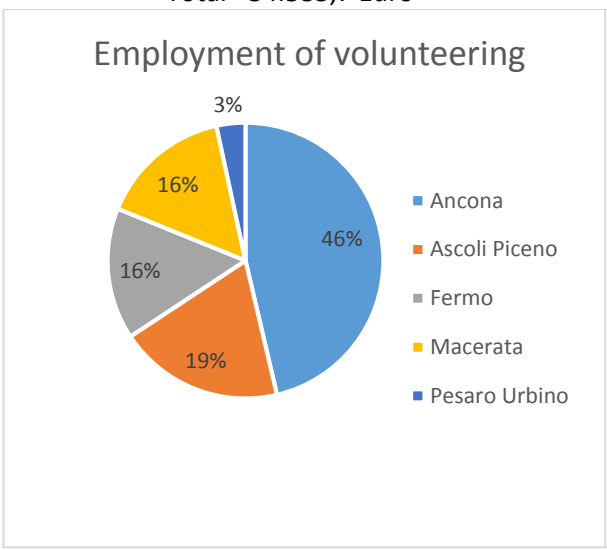
Figure 22 shows the fields of Tab A1 of the Action Plan, “Relief interventions and assistance to the population”, for each province. Is reported the total of the three events: May 204, March 2015 and November-December 2013. To be noted that the event of March 2015 do not have the field “Waste disposal” on the Action Plan. The field “Assistance to the population” is the most evenly distributed with the provinces of Ancona, Ascoli Piceno and Pesaro Urbino with nearly 30 % of total, while Macerata and Fermo did not recorded high damages in this field. In nearly all the fields of tab A1 (except the field “Other”), the province of Ancona is the most damaged with the highest economic loss recorded.



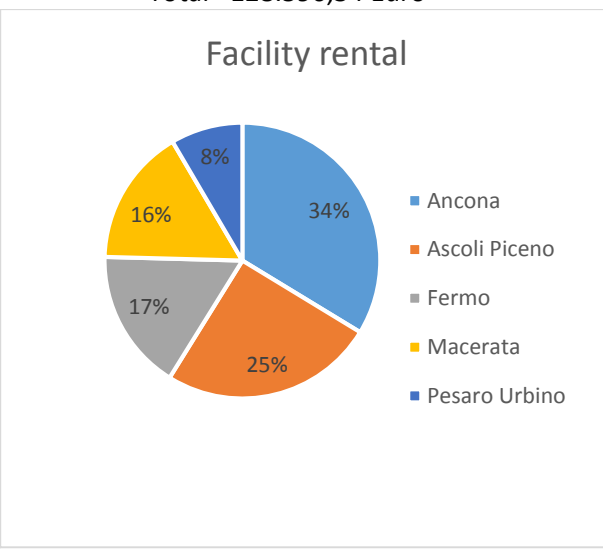
Total= 34.383,7 Euro



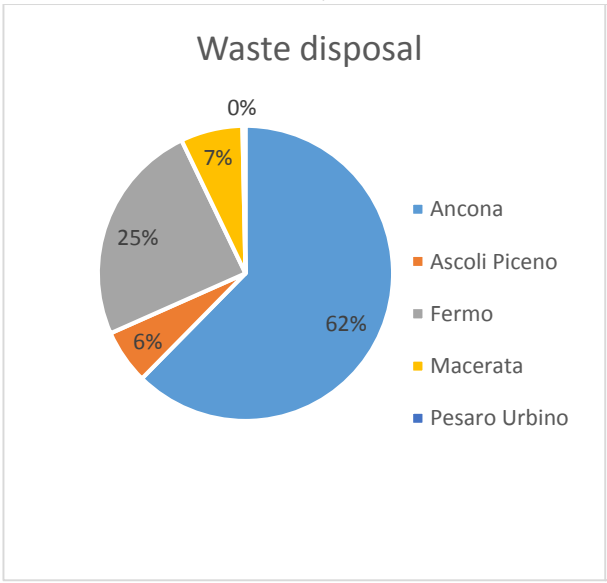
Total= 128.596,34 Euro



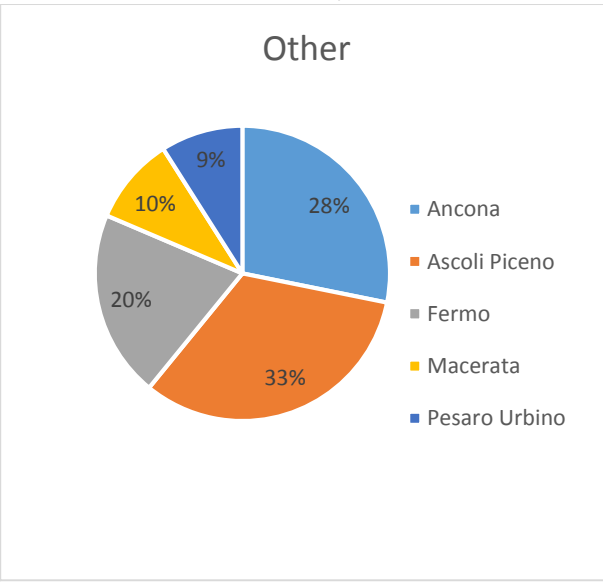
Total= 93.289,38 Euro



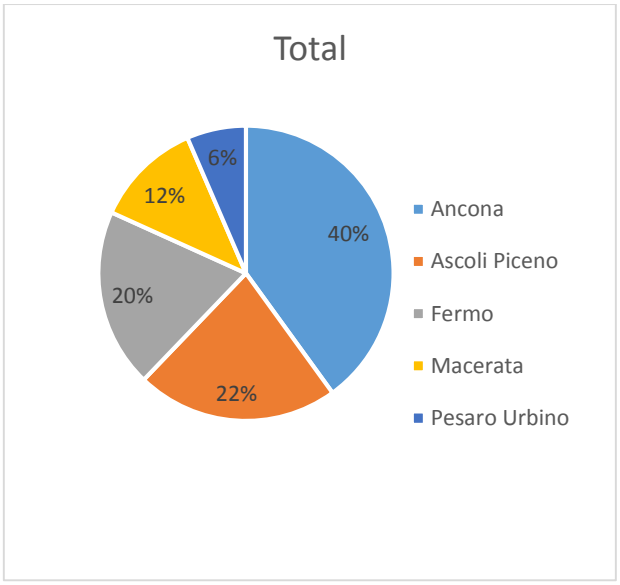
Total= 5.715.999,54 Euro



Total= 3.468.383,26 Euro



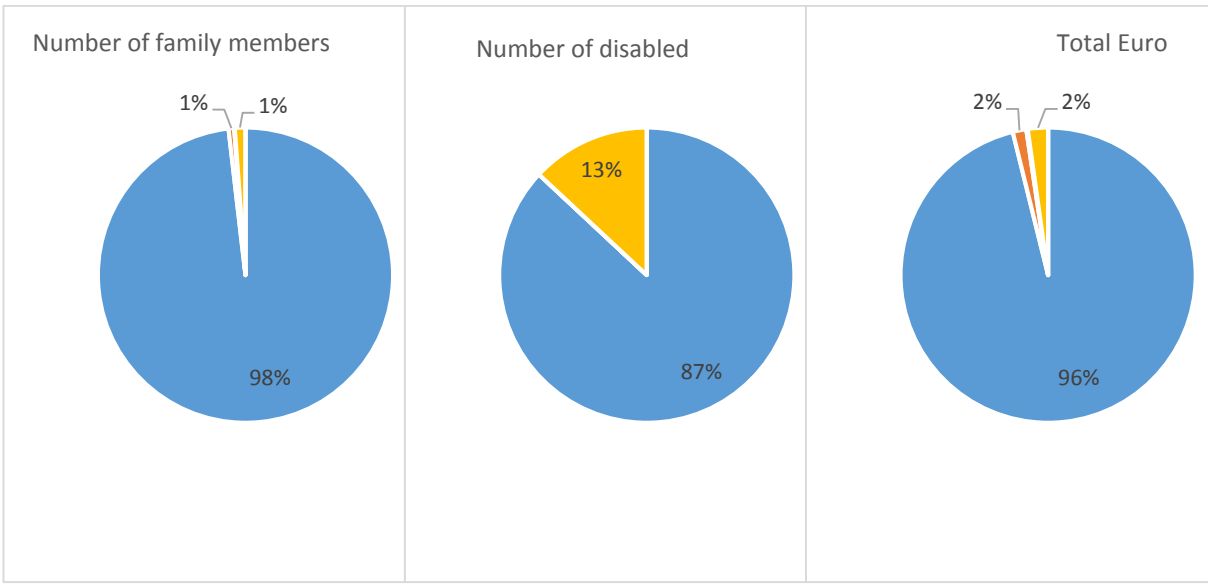
Total= 3.868.238,31 Euro



Total= 13.308.890,53 Euro

Figure 22. Tab A1 of Action Plan for the three events.

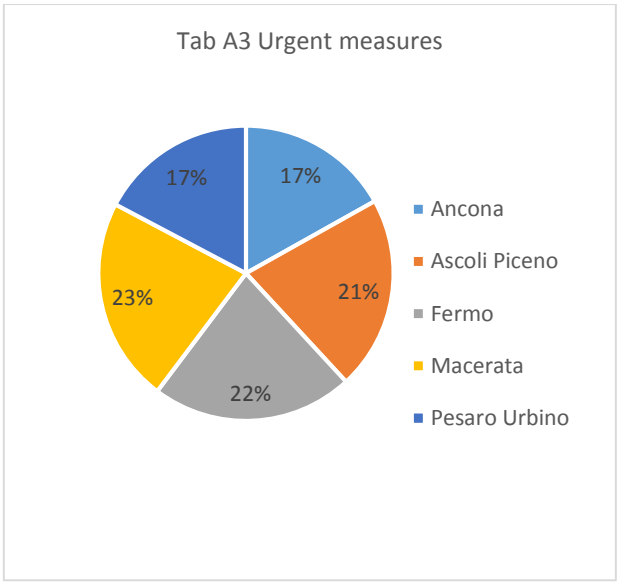
Figure 23 shows "Tab A2: Contributions autonomous accommodation". Again the province of Ancona is the most affected with nearly all of the total records.



Total= 2.937 Total=46 Total= 1.775.560 Euro

Figure 23. Tab A2: Contributions autonomous accommodation.

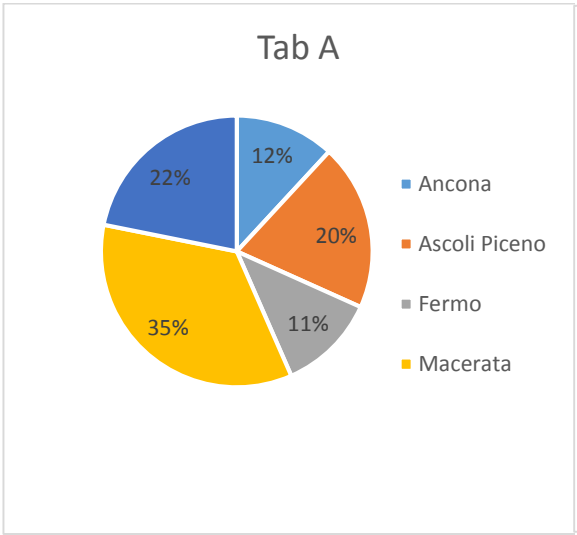
Figure 24 shows "Tab A3: Urgent measures, implemented or to be implemented, aimed at restoring the functionality of essential public services as well as avoiding situations of danger or damage to persons or property". The damages during the three events are quite evenly distributed and in decreasing order are 23% Macerata, 22% Fermo, 21% Ascoli Piceno, and 17% Ancona and Pesaro Urbino.



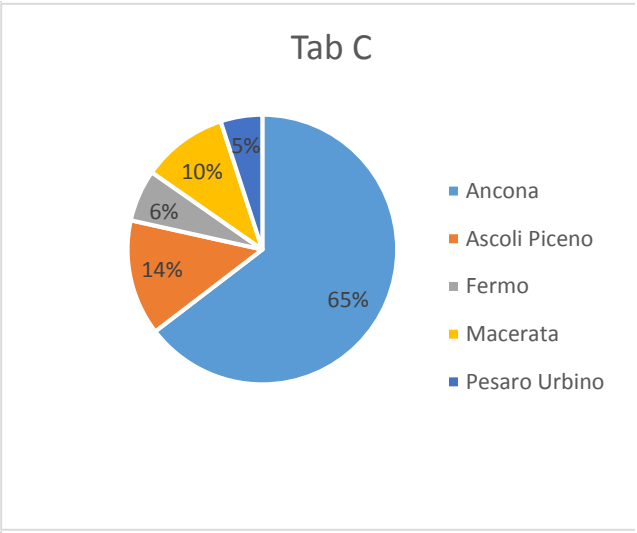
Total= 31.693.998,34 Euro

Figure 24. Tab A3: Urgent measures.

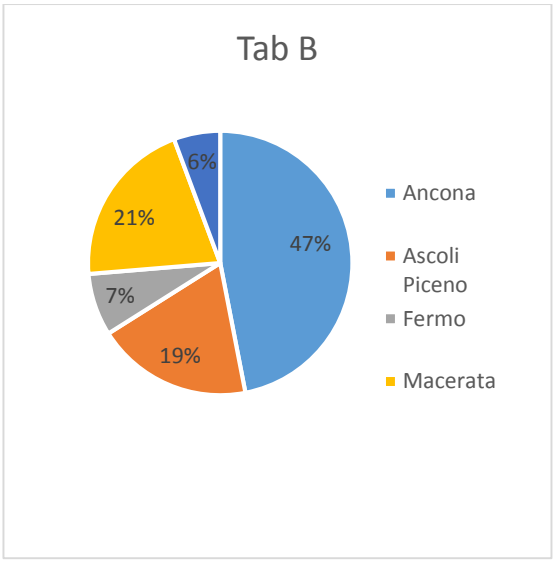
Figure 25 shows the three tabs of the ordinances, for the three events considered. It is shown also the Private Ordinance that have the damages of private property. The most damaged province regarding the public property (Tab A) for the three events is Macerata while for the damages in economic and productive activities (Tab C) the most damaged province is Ancona with 65%. While Tab B and the Private ordinance have both the damage on private property for the three events they differ because the Private Ordinance is more accurate and have more controls on the data. The Private Ordinance is only 30% of the value of Tab B so in the first needs recognition of the three events, there was an overestimation of 70%. The distribution between the provinces do not differ much.



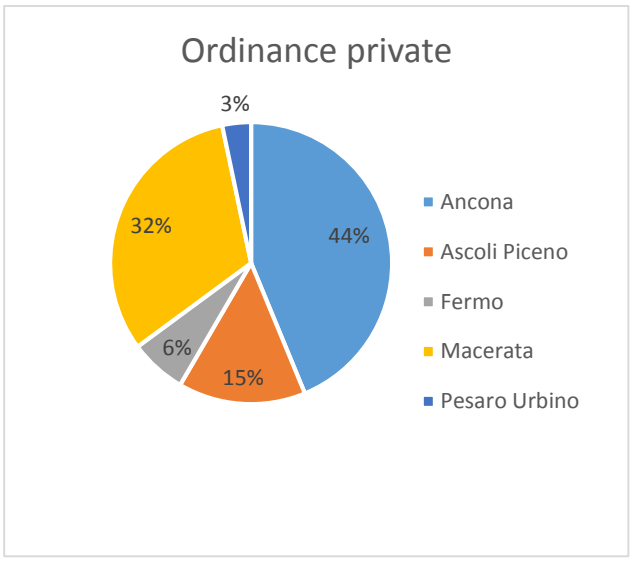
Total= 490.607.507,69 Euro



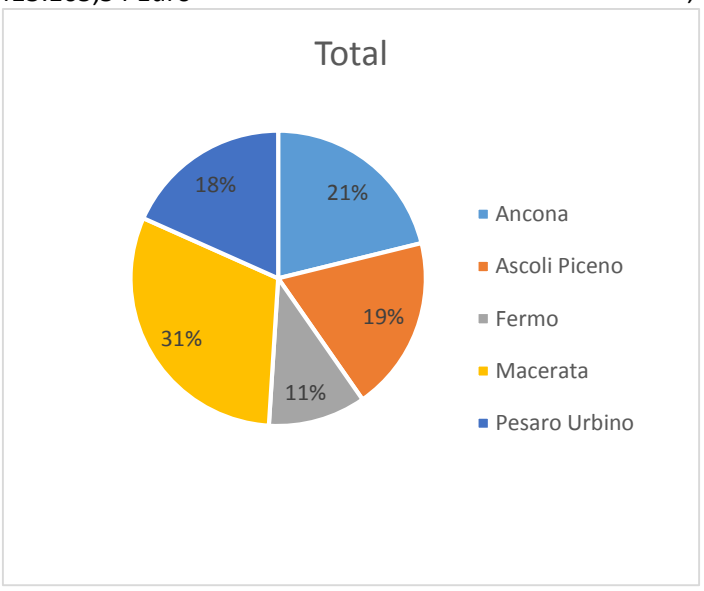
Total= 63.062.606,21 Euro



Total= 70.413.165,54 Euro



Total= 21.277.140,193 Euro



Total= 624.083.279,44 Euro

Figure 25. Ordinances.

5 Integrating emergency data in FloodCat

This chapter describes the FloodCat system as a flood database applied to Region Marche.

5.1 Marche Region

The Marche is an Italian region with ordinary statute of central Italy of about 1.5 million inhabitants, with Ancona as its capital, facing east on the Adriatic Sea. The Umbrian-Marche Apennines mark the border with Tuscany and Umbria to the west; to the north the region borders with Emilia-Romagna and the Republic of San Marino, to the south with Abruzzo and Lazio.

The Marches are part of the Adriatic-Ionian Euroregion, whose forum (Ionian Adriatic Initiative) is located in the capital of Ancona.

The lowlands, not detectable in percentage, are limited to a narrow coastal strip and to the part of the valleys closest to the mouth of the rivers. The Marche region is therefore entirely hilly and mountainous. In particular, the Marche is one of the most hilly regions of Italy: the hills comprise 69% of the territory (6,462.90 km²) and as many as 82% of the municipalities are located in the hills.

Marche region have 5 provinces: Ancona, Ascoli Piceno, Fermo, Macerata, Pesaro e Urbino and 228 municipalities (Marche, 2019).

5.2 Data source and database consistency in Marche Region

Loss data requested by FloodCat are collected by different offices in relation of the affected sector. The main data sources are: the flood event reports (regional civil protection) (Event Reports), the georeferred flooded areas (basin or district authority), the damage data collected following the civil protection ordinances in case of national emergency declaration, data collected by the regional agriculture service following the state of natural calamity. These last two sources provide statistics regarding the economic cost of damages as the estimate allows to have access to public national funds. This information is relevant for FloodCat as disaster databases usually lack on economic loss data.

For Marche Region, more than ten ordinances were adopted in case of severe weather, starting from 2002. The ordinances were inserted on FloodCat together with the Event Reports relating to the same event as they provide complementary data. Moreover more than 30 Report of minor Events were inserted and the delimited flooded area of the event of May 2014 from the Basin Authority (AdB). For each event metadata information was stored as required in the INSPIRE Directive.

In Table 14 are represented for each extraordinary event happened in Marche Region and for which there were available data if there is an Event Report and eventually a Declaration of the state of Emergency.

With the law decree n. 59 of 15 May 2012, the Head of the Civil Protection Department issues the ordinances (OCDPC), but previously the same ordinances were issued by the President of the Council of Ministers (OPCM).

Table 14. Data source in Marche Region.

Nr.	Year	Extraordinary event	Event report	OCDPC/OPCM/ Declaration of the state of Emergency Documents/Links
1.	2002	8/2002		Ordinance N. 3276/2001 E 3311/2003 Protocol 0354032 of 19/05/2015
2.	2005	6-10/10/2005	+	
3.		25-27/11/2005	+	
4.		11-12/12/2005	+	
5.	2006	3-4/01/2006	+	
6.		18/04/2006	+	
7.		16/9/2006	+	OPCM n. 3548/06 (modified by article 4, comma 1, OPCM n 3564/07 and the DCD n 4/06 and DCD n 4/07) and O.P.C.M. n. 3721/08 http://www.normativaitaliana.it/nazionale/OPCM%2025-10-2006%20n.3548.asp
8.		26/9/2006	+	OPCM n. 3548/06 (modified by article 4, comma 1, OPCM n 3564/07 and the DCD n 4/06 and DCD n 4/07) and O.P.C.M. n. 3721/08 http://www.normativaitaliana.it/nazionale/OPCM%2025-10-2006%20n.3548.asp
9.	2007	6-7/10/2007	+	OPCM n. 3689 of 2 July 2008 http://www.gazzettaufficiale.it/eli/id/2008/07/10/08A04921/sg;jsessionid=MHtlLBiT4+xpHJQezqjcxA__.ntc-as2-guri2a
10.	2008	5-7/3/2008	+	
11.		21-22/7/2008	+	
12.		14-15/11/2008	+	OPCM n. 3734 of 16 January 2009 http://www.protezionecivile.gov.it/jcms/it/view_prov.wp?contentId=LEG21823
13.		11-12/12/2008	+	OPCM n. 3734 of 16 January 2009 http://www.protezionecivile.gov.it/jcms/it/view_prov.wp?contentId=LEG21823
14.	2009	21-22/4/2009	+	
15.		27/5/2009 31/5/- 2/6/2009	+	
16.	2010	12/2009-3/2010	+	
17.		5-9/1/2010	+	
18.		9-10/3/2010	+	
19.		15/5/2010	+	
20.		28-29/9/2010	+	
21.		28/11-3/12/2010	+	
22.		13–19/12/2010	+	
23.	2011	1-3/3/2011	+	DPCM of 23 March 2013 http://www.regioni.it/download/news/290664/ OCDPC n. 7 of 10 June 2012 http://www.protezionecivile.gov.it/jcms/it/view_prov.wp?facetNode_1=f4_4_5&prevPage=provvedimenti&catcode=f4_4_5&contentId=LEG33454 Protocol note 0101248 of 18/02/2013
24.	2012	1-13/2/2012	+	DPCM of 23 March 2013 http://www.regioni.it/download/news/290664/
25.		10-13 November 2012	+	Law 228/2012 art.1, comma 548 and DPCM 23/03/2013 2/CDM12 of 26/11/2013 Letter 0791847 of 03/12/2013
26.		11/2012		Hard copies in Marche's Civil Protection November 2012 (storm surges)

27.	2012-2013	Autumn-Winter 2012-2013	+	
28.	2013	March 2013		OCDPC n. 85 of 29 May 2013 http://www.protezionecivile.gov.it/jcms/it/view_prov.wp?contentId=LEG39573
29.		10-13/11/2013	+	OCDPC n. 141 of 22 January 2014 http://www.protezionecivile.gov.it/jcms/it/view_prov.wp?contentId=LEG43787 Protocol 0345325 of 16/05/2014
30.		25-27/11/2013 e 2/12/2013	+	OCDPC n. 141 of 22 January 2014 http://www.protezionecivile.gov.it/jcms/it/view_prov.wp?contentId=LEG43787 Protocol 0345325 of 16/05/2014
31.	2014	2-4/5/2014	+	OCDPC 179/2014 Protocol 0746343 of 18/10/2014
32.		26-31/7/2014	+	Protocol 595555 of 25/08/2014
33.	2015	4-9/2/2015	+	
34.		25-26/2/2015	+	
35.		4-6/3/2015	+	OCDPC n. 264 of 3 July 2015 http://www.protezionecivile.gov.it/jcms/it/view_prov.wp?contentId=LEG53127 Protocol 0707412 of 08/10/2015
36.	2016	23/3/2016	+	Protocol 0251623 of 19/04/2016 + data integration 0405978 of 17/06/2016

In addition to the events listed in the table there is also the Private Ordinance 378/2016 which refer to three years, 2013-2014-2015.

For the purposes of FloodCat platform the Event report of Marche Region may contain the information listed below:

- Event name;
- source of flooding;
- event category;
- start date;
- time frame;
- unit of management;
- Other relevant information about the event;
- Phenomenon name;
- Description of the phenomenon;
- Characteristic of flooding;
- Mechanism of flooding;
- Name of damage,
- Summary of the damage;
- Other damage description;
- Date of the damage;
- Damage class;
- Mechanism of flooding;
- Damage category (not always clear);

- Damage subcategory (not always clear);
- Damage description;
- Numeric value of the damage;

The Economic value of the damage cannot be found in the event report and there is small distinction between the damage caused by floods and landslides.

The shape files form the Basin Authority are helpful for the delimitation of the areas of the tab Phenomenon of FloodCat.

The Ordinances have data on the economic value of damages and the numeric value of them. Also from the Ordinances can be classified the damages into FloodCat categories and subcategories although there is no similar categorization between them because in order to understand the appropriate category and subcategory of FloodCat, it is necessary to deduct it from the field description of the Ordinances. The Ordinances are very important for FloodCat data feed because can be used for the tab Damage which from the Event Report is difficult to feed and there is data lack.

Other data can be found in the following documents:

- Hydraulic unit - report of hydraulic and emergency services, data on the event classification and assessment of the damage;
- Reports or inspections following storm surges, data on marine floods of coastal areas;
- Applications for admission to contributions from the National Solidarity Fund, following a declaration of natural calamity, data on the damage in agricultural economic and productive activities.

Further detailed data, depending on the damage sub-category, can also be found at Municipalities, Provinces, ANAS, ENEL distribution and production, Marche Reclamation Consortium, Integrated water service operators, Highways for Italy, Aerdorica, MiBACT Marche, Trenitalia, Marche Reunited Hospitals.

Till 07/10/2018 (date in which the data feeding for this PhD ended) the database FloodCat contained the data as shown in the tables Table 15, Table 16, Table 17, Table 18. For Marche Region there is a total of 148 events, 466 phenomenon, 1513 damages and 3679 damage records. 90% of the damage were inserted during this PhD and following a specific procedure (explained in the following paragraphs) adapted for FloodCat and Marche Region territory.

Table 15. Number of Event tabs for Marche Region.

UoM	Tronto	Regional	Conca-Marecchia
with FloodCat methodology	12	38	8
From AVI catalogue	16	60	14
Total	28	98	22

Table 16. Number of Phenomenon tabs for Marche Region.

UoM	Tronto	Regional	Conca-Marecchia
with FloodCat methodology	22	337	17
From AVI catalogue	16	60	14
Total	38	397	31

Table 17. Number of Damage tabs for Marche Region.

UoM	Tronto	Regional	Conca-Marecchia
with FloodCat methodology	84	1044	30
From AVI catalogue	94	249	12
Total	178	1293	42

Table 18. Number of Damage records for Marche Region.

UoM	Tronto	Regional	Conca-Marecchia
with FloodCat methodology	298	2968	58
From AVI catalogue	94	249	12
Total	392	3217	70

5.3 FloodCat vs. OCDPC

In order to insert the information contained in the tabs attached to the OCDPC in the new web platform for floods, FloodCat, as there is a huge amount of data and cannot be inserted manually, it was necessary to study which of the fields contained in OCDPC's tabs can be merged/is comparable with the categories and subcategories of FloodCat. To do this was taken as a case study the case of the extraordinary event of 2-4 May 2014 in Marche Region, Italy because have many information. The results are represented in Table 19 and

Table 20. Except for the category “Agriculture, zootechny, fisheries, mines”, which data are managed by another institution (see paragraph 0), all other FloodCat categories can be filled by the tabs of the Ordinances and tab A1 of Action Plan as described in the above mentioned tables. This makes this sources of information very valuable for FloodCat and an effort to make this sources more FloodCat “friendly”, by slightly adding or changing the fields that they contain, must be done in order to make the data filling of FloodCat automatic, not manually.

To be noted that matches were not found for all the subcategories of FloodCat but this probably may also vary from a flood to another, eg. there may be some floods which floods an area with industries containing contaminants released in the environment and more subcategories of the category environment could be represented in FloodCat.

To be mentioned that the tables Table 19 and

Table 20 were discussed and distributed to ISPRA and the Italian National Department of Civil Protection and helped shaping the new classification in categories and subcategories as released with the most recent ISPRA notes of May 2018 (Notes on FloodCat, 2018).

Table 19. Fields OCDPC (Tab A) vs. FloodCat.

Fields OCDPC	Categories/Subcategories of FloodCat
Public property (tab A)	
Riverside stretch consolidation; Waterways; Stream; Stream (restoration of bank defences, embankment restoration); Surface water network - state ditches; Public water course; River	1-Environment/Impacts on the hydromorphological characteristics of the water body (bank collapses/incisions/erosions/depositions/meander cuts/avulsion phenomena) OR 2- Hydraulic works/Longitudinal defence works (embankments, bank walls, brushes)
Works in the riverbed	Environment/Removal of debris carried by flood (from riverbeds, beaches, flooded areas ...)
Bridles; crossbars; thresholds	Hydraulic works/Transversal defence works (thresholds, bridles, crossbars)
Country roads	Communication and transport infrastructures/Country/private roads
SR	Communication and transport infrastructures/Regional roads
SP	Communication and transport infrastructures/Provincial roads
SS	Communication and transport infrastructures/State roads
Road; Road conditions	Communication and transport infrastructures/Municipality roads
Bridges; Municipal bridge	Communication and transport infrastructures/Bridges, viaducts, crossings
Sports facility; Football field; Rugby field; Palasport; Athletic track; Tennis facilities; Pool; Municipal sports field; Gym; Municipal gym; Sports field	Economic activities in the tourist-recreational sector/Economic activities in the sports sector (sports centres/facilities, gyms, stadiums...)
Public park	Cultural heritage, Landscape/Landscape heritage, parks and nature reserves
Public gardens	Facilities/Services of public interest/ Other Facilities/Services of public interest - urban green areas
Purchase of vehicles and equipment	NO
Warehouses - municipal changing rooms; Locker room; Kennel; Location of Associations; The casacce public building; Storage area	Facilities/Services of public interest/ Facilities/Services for public administration - other offices/public services
Low and medium voltage electrical systems; Electrical installations; Public lighting; Public lighting network; Electric cabins; Distribution plants	Technological and service infrastructures/Network support systems (power plants, electrical substations, photovoltaic systems)
Electric energy; Electricity distribution	Technological and service infrastructures/Electric power distribution lines
Rest home and protected municipal residence; Retirement	Facilities/Services of public interest/Health facilities/services - nursing homes, shelters for the elderly, the disabled, etc.

home	
Server/UPS damage etc.	Technological and service infrastructures/Technological and service infrastructures
Parking area	Communication and transport infrastructures/Service areas, parking lots
Public buildings	Facilities/Services of public interest /Facilities/Services for public administration - other offices/public services
Historical archive	Cultural heritage, landscape/Historic and architectural sites/assets
Cemetery; Municipal Cemetery; Civic cemetery	Facilities/Services of public interest/Cemetery
Schools; Nurseries; Institute; High school; Elementary School; Nursery school; School gym; School buildings; Secondary school; School plexus; Asylum	Facilities/Services of public interest/Facilities/Services for education-Kindergartens/Schools/Universities
Municipal Theatre; Municipal convention centre; Youth centre; Social service centre	Economic activities in the tourist-recreational sector/Economic activities in the cultural/recreational sector (Cinema, theatres, exhibitions, congresses ...)
Museums	Cultural heritage, landscape/Museums
Sewers; Sewerage network; Sewer pipeline	Technological and service infrastructures/Sewer systems
Expansion cases	Hydraulic works/Expansion cases/Lamination tanks
Aqueduct; Water supply pipelines; Water conduct; Surface water network	Technological and service infrastructures/Aqueducts
Municipal Office; Town Hall; City Hall	Facilities/Services of public interest/ Facilities/Services for public administration (locations/activities of municipalities, province, region, prefecture)
Pipeline; Natural gas distribution network	Technological and service infrastructures/Pipelines
Imhoff tank; Purification plant	Technological and service infrastructures/Depurator
Church; Convent	Cultural heritage, landscape/Buildings/Places of worship
Civic Tower; palace Urbani; palace Maria Princess; Ruspantino building	Cultural heritage, landscape/Historical and Architectural Heritage

Table 20. Fields OCDPC (Tab B, C) and Action Plan Tab A1 vs. FloodCat.

Fields OCDPC	Categories/Subcategories of FloodCat
Private housing (tab B)	
Main house; inhabited on another leased basis; common part of the condominium	Private buildings and goods/Public/private buildings for residential purposes (residential, eg, residential areas, condominiums, single-family houses, social housing, garages, basements)
Not used as a dwelling and not leased	Private buildings and goods/Private buildings for non-residential use (not residential, eg offices, shops, warehouses)
Vehicles	Private buildings and goods/Private means of transport
Domestic appliances	Private buildings and goods/Goods contained in private buildings
Economic and productive activities (tab C)	
All (use of "Total Damage Cost" for economic value field of damage tab)	Economic activities in the commerce, industry, crafts and construction sectors/Economic activities sector industry
Action plan, tab A1 - aid interventions and assistance to the population	
Provisional measures for settlement of the evacuated population	Evacuated***

Damage on vehicles are not a homogeneous data and not always present in the need recognitions because the DPCN does not consider vehicles as a damaged refundable asset because they are insurable by insurance companies. In FloodCat a field has been introduced for them only in the last version of May 2018 on our suggestion. The reimbursement does not take place with the detail of the appliances, but in a lump sum way for a flooded compartment. In the flooded compartment everything is inserted, even the furniture. [29]

To be noted that the tab B of the needs recognition contains only the information on the building if evacuated or not, not the number of evacuated.

With regard to the damage on economic and productive activities in the tabs attached to OCDPC there is no field that describes the type of activity in order to associate to them the "equivalent/proper" Category/Subcategory of FloodCat, while in the forms that each representative of economic and productive activities fills, there is a field with the description of the type of activity. After all the forms have been collected (some of the forms can be found in the Region and all of them can be found in Municipalities) all the data fills the default tabs of OCDPC, in this way some data contained in the forms are not inserted. This data can be found in the Municipalities but it would be a long work to search and insert each of them one by one as the data are many.

[29] Source National Civil Protection Department. We thank the compensation official Emilio De Francesco.

5.4 FloodCat vs. Natural Calamity

In Table 21 are reported the fields of the request of compensation for agricultural economic activities that can be useful for data record in FloodCat.

Table 21. Fields of the request of compensation for agricultural economic activities vs. FloodCat categories.

Fields of the request of compensation	Fields of the tab damage of FloodCat
Address of entreprise	Damage localization
Declaration of damages higher than 30 %	Damage class (medium-high)
Damage descritpion	Summary of Damage, Other description of Damage, Damage Description
Each request	Damage category (Agriculture and Livestock)
Where present the field: crop or livestock, type	Damage subcategory
Total	Economic value

In the scheme of submitted applications is not required, the numerical value of the sub category of damage, eg. in ha or kg of production, useful instead for inclusion in FloodCat.

In Appendix 7 is reported the bureaucratic procedure for the State of Calamity of May 2014 in Marche Region.

5.5 FC methodology applied to Marche Region

In May 2018 the Italian Department of Civil Protection and the Higher Institute for Environmental Protection and Research (ISPRA) produced a document (Notes on FloodCat, 2018) that explain the legal framework in which FloodCat was created and the structure of the database. In this document all the fields of the database are explained, is reported if they are mandatory or not and which should be unique for each tab. However the document, event that detailed in the explanation of the fields contained in FloodCat, leaves the operator that fills the database, a wide range of freedom on how to do the data record. Each Italian Region or Autonomous Province can adapt their own way of filling, by following a few general rules reported in the 2018's document.

For Marche Region a methodology was defined in order to make a homogeneous data record and to adapt historical data already collected to FloodCat requested database fields. It consists on correlating the meteorological event with the Unit of Management and the flood phenomena to the basin or sub-basin, the damage to municipality. The data were recorded taking into account three elevation bands: mountainous, hilly and coastal in order to analyse the different flood mechanisms depending on territory's altitude.

The event tab was made using the Event Reports and is connected to one UoM, one origin and a defined temporal interval. Each phenomena tab is connected to a basin (except those of province) and to an altimetric band, while the damage tab is one for each municipality and is mainly filled with data from Civil Protection Ordinances. The data population was manually made as it was difficult to find similarities between the fields of FloodCat's tabs and the available data, previously collected. It was also difficult to find the exact damage geo-localization.

Following is described in detail the methodology used to fill FloodCat for Marche Region.

TAB EVENT

The name of the Event have been composed using the Report Event date and the Ordinance issued if present. So a general event name would be “DV_Regione Marche: Evento del gg_mm_aaaa_OCDPC nnn/aaaa” for example “DV_Regione Marche: Evento del 2-4 maggio 2014_OCDP 179/2014”. DV stands for “to validate” because all the data inserted have been validated by an operator in Civil Protection. After the validation “DV” is deleted from the event name. Each event is connected to a UoM and if there is an event (as considered in the Event Reports, mainly as meteorological events) that affects 3 UoM than in FloodCat should be recorded as three events. Also if there is an event (as considered in the Event Reports) that causes floods of different sources than in FloodCat should be recorded as separate events for each flood source (eg. fluvial, storm surge etc.). When the flood source is not very clear and cannot be determinate clearly or there are some minor floods of different source, than the Source recorded should be the one predominant for the event (as considered in ER). Usually for the Marche Region they are all of fluvial origin, unless there are storm surges or floods due to insufficient artificial drainage systems in case of localized events. The return time should be recorded if known as the maximum identified over the entire area (for classes, as indicated by ISPRA - DPC).

TAB PHENOMENON

The name of the tab Phenomenon is of two types in function of the declaring subject in the tabs of OCDPC (Municipality or Province):

- Municipalities - “Overflowing, flooding and landslides in the basin of NAME: ELEVATION BAND municipalities” for example “Overflowing, flooding and landslides in the basin of Tronto river: hilly municipalities”;
- Provinces - “Overflowing, flooding and landslides in the territory of the province NAME” for example “Overflowing, flooding and landslides in the territory of the province of Ancona”

This type of nomenclature has been chosen for the phenomena since the data collected as a result of the ordinance include both overflowing and flooding. Furthermore, in the Marche it is common to have many disruptions/landslides in the territory due to the geological/lithological characteristics of the area. As it is difficult to separate the damages it was decided to merge these characteristics in the phenomena, except in known cases. In the future it might be useful to include this detail in the forms, in order to facilitate the insertion of the data in FloodCat.

We have chosen to identify the phenomenon on a river basin scale. The basin was then divided into mountain, hilly and coastal municipalities to be able to detail the characteristics of the flood in a more realistic manner (coastal or mountain basins could have very different characteristics and mechanisms).

A subdivision by Province was chosen, as well as by Municipality, since in the case of damage to public property, of competence/property of the provincial administration the municipality where the damage occurred has not always been specified, in addition there is damage to provincial public property that extend to more than one municipality such as the provincial roads or embankments/sides.

In the Appendixes are reported the Unit of Management as in the Flood Directive for the territory of Marche Region (Appendix 8), the subdivision of the territory of the Marche Region into regional, interregional and national basins according to the Basin Authority (Appendix 9) and the division of municipalities in mountainous, hilly and coastal (Appendix 10).

The Characteristics of flooding for each tab phenomenon should be the predominant for each tab (eg. Flash flood etc.). For the mechanism of flooding it is possible multiple choice if known. In the tab

Phenomenon can be inserted shapefiles for the flood area geolocation, otherwise when no shape file is available than should be the centre of gravity of the portion of territory or approximate polygon. To be noted that the reference system of the shape file should be WGS84 EPSG 4326.

TAB DAMAGE

The name of the tab Damage is of two types in function of the declaring subject in the tabs of OCDPC (Municipality or Province):

- Damages in the municipality of NAME – eg. Damage in the municipality of Senigallia;
- Damages in the territory of the province of NAME (this in case in which there were no indications concerning the Municipality or inter-municipality damage were reported in the OCDPC tabs - Damages in the territory of the province of Ancona.

The mechanism of flooding should be the predominant for each tab (eg. "Overcoming of natural containment capacity"). The geolocation of damage if not know exactly should be the municipality centre of gravity or location if available. To be noted that the reference system of the shape file should be WGS84 EPSG 4326.

Critical facts: using this type of approximate location, we could have damages outside the flooded area, also given that some damages could be associated with other types of instability (eg in the road system, many of the damages are due to landslides). Furthermore, if the localization is approximate, if two basins fall into a municipality, we will have an inaccurate information and the damage could be associated with the wrong basin.

All the data recorded in FloodCat for Marche Region with this methodology have been checked and validated with the Regional Civil Protection.

5.6 Da.Ma – Documentary platform for Bad Weather Damages

Da.Ma is a documentary platform for Bad Weather Damages in Marche Region. It includes a Web Application and a database for distributed data digitization and document production/processing as in OCDPC n. 264 of 3/7/2015. The Demo version was developed in 2015 for bad weather/flood events. Da.Ma assures a proper management of the entire life cycle of documents from production to storage. It can produce automatically report data for drafting liquidation decrees and controls. Da.Ma allows single sign-on of the local institutions.

Actually Da.Ma's Demo is offline. The access is reserved through user and password and the functions of the user can be different:

- User Admin – can create and activate events/phases;
- User from Civil Protection Service – management of procedures;
- User local institutions (eg. provinces, municipalities) – data entry and document production.

The user Admin creates one or more events and makes them active to be chosen, the user local institution select one event and one phase (for example the phase of "Preliminary survey") and insert damage data within their territory of competence. The data recorded permits to produce documents which should be signed electronically with Raffaello Card. After the local institutions record the data Da.Ma send an e-mail of notification to the system admin and to the civil protection operators. Figure 26 shows the first step to access Da.Ma.

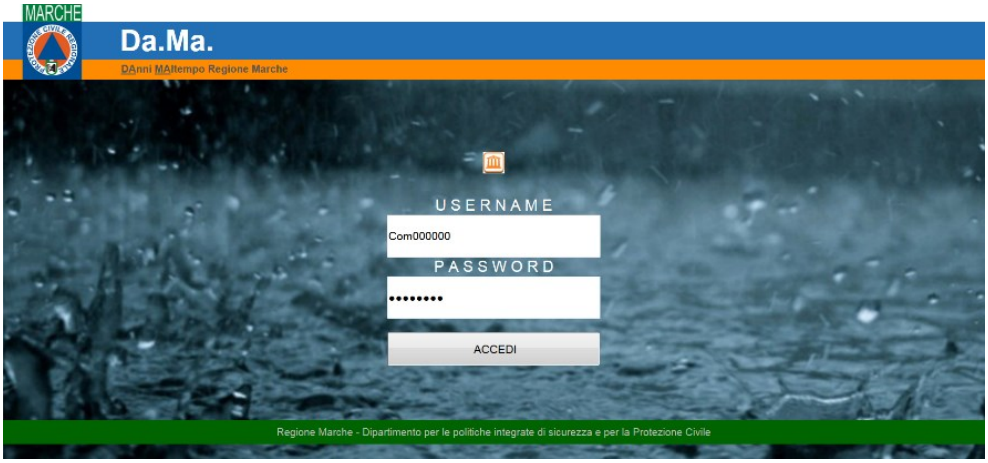


Figure 26. System access.

It is important to note that Da.Ma can be applied to different operative phases which can be activated gradually. Are developed time control mechanisms and high level of user/system interaction. Reporting and data analysis can be produced and integrated with liquidation and control administrative activities.

The system was developed to facilitate the execution of procedures originating from ordinances and provisions on urgent interventions for bad weather emergencies. Have been carried out and validated functional tests on software components but "Massive" tests with real users and "distribution" have not been carried out.

5.7 Optimization of Da.Ma for FloodCat purposes

During the period of work in the Regional Civil Protection Centre of Marche Region have been carried out also the activity of optimization of the database Da.Ma for automatic data transfer in FloodCat. The work have been done alongside the creators of Da.Ma which explained the structure and functions. After a detailed comprehension of Da.Ma Demo database have been identified the fields to add in order to make the data transfer in FloodCat automatic.

For the Tab A (regarding public property damages) of the OCDPC contained in Da.Ma have been suggested to add two drop down menu after the field of damage description. The first drop down menu should contain all the Categories of FloodCat except “Agriculture, zootechny, fisheries, mines”, “Economic activities trade sector, industry, crafts, building”, “Private buildings and goods” and “Population/human health”. After choosing the Category a second drop down menu should contain all the FloodCat subcategories of the chosen Category (

Appendix 11). Also should be added a third drop down menu in which to choose the basin that caused the damages.

For the Tab B (regarding private property damages) of the OCDPC contained in Da.Ma have been suggested to add two drop down menu. The first should contain all the subcategories of the category “Private buildings and goods” (as obviously the corresponding category for tab B of OCDPC is this one). The second drop down menu would enable to choose the basin that caused the damages.

For the Tab C (regarding economic and productive activities) of the OCDPC contained in Da.Ma have been suggested to add three drop down menu. The first should contain the categories “Economic activities trade sector, industry, crafts, building” and “Private buildings and goods”. The second drop down menu should contain all the subcategories of the category “Economic activities trade sector, industry, crafts, building” if this category is chosen or only the subcategory “Private buildings for non-living use (non-residential, eg. offices, shops, warehouses) if the category “Private buildings and goods” is chosen. The third drop down menu would enable to choose the basin that caused the damages.

Regarding the A1 and A2 of the Action Plan, the fields “Total number of evacuated for each municipality throughout the emergency period” and “Total economic value for the evacuated throughout the emergency period” can be matched in FloodCat with the Category “Population/human health”, subcategory “Evacuated”, the fields “Numeric value” and “Economic value” respectively.

In Da.Ma should appear automatically for each municipality, to which altimetric band they belong as in Appendix 10. Would also be useful to insert in Da.Ma the geolocation of the damage. In the tabs of synthesis should be inserted also a column that shows the numerical value of the damage eg. Number of houses and should be used the unit of measurement present in FloodCat for each subcategory of damage. Add eventually a metadata reference.

5.8 Database of agriculture service

In Marche Region exists the SIAR portal that stands for “Regional Agriculture Information System” (Sistema Informativo Agricoltura Regionale). The SIAR is a portal created to support the back office activities of regional officials and the front office activities of the Agricultural Assistance Centres (CAA) inherent to the interventions promoted, through the publication of tenders, by the Agriculture service of the Marche Region. It is the system that allows the electronic submission of applications for subsidies and contributions in the agricultural sector in response to the active tenders, published by the Marche Region and by the other public institutions of the territory. It also offers the possibility for registered companies to carry out the following online practices:

- Presentation of the Notification of Biological Activity and Annual Production Plans;
- Application for Agricultural Fuel Assignment (UMA);
- Application for enrolment in the Agri-turistic Operators Register (EROA).

The system also allows the regional administration to manage and update an exhaustive database of all technical and administrative information of the agricultural sector concerning companies and their activities. Access to the reserved area is allowed only to registered users.
The portal SIAR is also used by the Agri-food Policy Service to direct requests for aid from agricultural companies damaged by adverse weather events that can be assimilated to natural disasters or natural disasters (Figure 27).

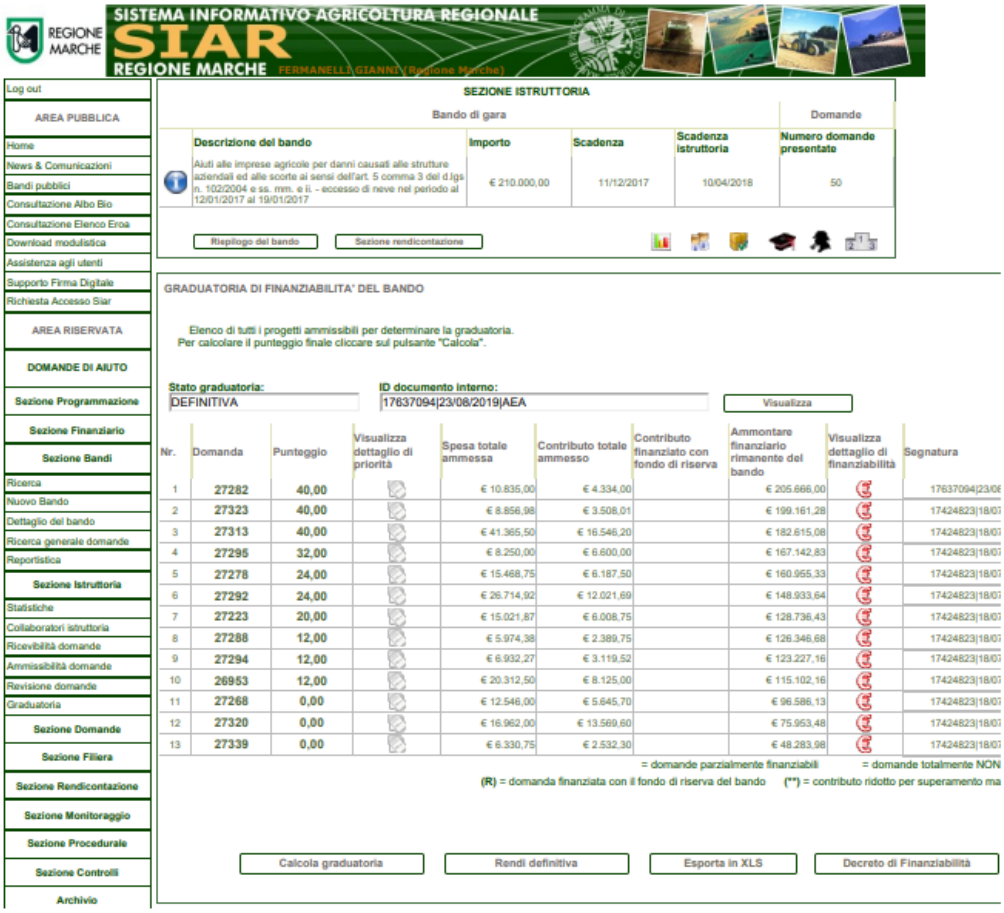


Figure 27. Screenshot of SIAR for the 2017 snow event.

As the SIAR system is not open access than the fields of the database are not known and a comparison with FloodCat fields cannot be made in order to make data transfer automatic.

5.9 OCDPC's tabs optimized for FloodCat purposes

The optimization of OCDPC's tabs for FloodCat purposes is very similar to Da.Ma optimization because Da.Ma itself was constructed following the OCDPC n. 264 of 3/7/2015. Following are described the suggestions:

- Tab A (public property damages) – add two columns after the field of damage description. The first should show all the Categories of FloodCat except "Agriculture, zootechny, fisheries, mines", "Economic activities trade sector, industry, crafts, building", "Private buildings and goods" and "Population/human health". The second added column should show the FloodCat subcategory of the chosen Category (

- Appendix 11). A third column should be added in which to choose the basin that caused the damages;
- Tab B (private property damages) – add two columns. The first should show all the subcategories of the category “Private buildings and goods”. In the second column should be written the basin that caused the damages;
- Tab C (economic and productive activities) – add three columns. In the first should be written the category between the two “Economic activities trade sector, industry, crafts, building” and “Private buildings and goods”. In the second should be specified the subcategory of the category “Economic activities trade sector, industry, crafts, building” if this category is chosen or only the subcategory “Private buildings for non-living use (non-residential, eg. offices, shops, warehouses) if the category “Private buildings and goods” is chosen. The third column would enable to choose the basin that caused the damages.

Regarding the A1 and A2 of the Action Plan, the fields “Total number of evacuated for each municipality throughout the emergency period” and “Total economic value for the evacuated throughout the emergency period” can be matched in FloodCat with the Category “Population/human health”, subcategory “Evacuated”, the fields “Numeric value” and “Economic value” respectively.

5.10 Metadata

Since the data comes from multiple regional services, it is essential to trace the source of the data. It is also a requirement of the INSPIRE directive. For the data entered in FloodCat for the Marche Region, excel cards have been prepared with predefined fields on the information sources used for each event. Below are the fields of the template tab (Table 22) and a tab filled with an explanatory event (Figure 28). The template tab can be repeated for each event/s for as many source of data are available.

Table 22. Template metadata used in Marche Region.

Name of the event/s in FloodCat	Data
Type of data	
Source of data	
Contact person/service	
Data collection date	

Nome evento	DV_Regione Marche_Evento del 2-4 maggio 2014_OCDPC 179/2014+378/2016_Fiume Conca-Marecchia
	DV_Regione Marche_Evento del 2-4 maggio 2014_OCDPC 179/2014+378/2016
	DV_Regione Marche_Evento del 2-4 maggio 2014_OCDPC 179/2014+378/2016_Tronto
Tipologia del dato	Danni a livello comunale e provinciale
Fonte del dato	Ordinanza del Capo Dipartimento della Protezione Civile 179/2014:
	schede A,B,C relative alla ricognizione dei fabbisogni prot. n. 0746343 del 18/10/2014.
	Evacuati: piano degli interventi: scheda A1 - Decreto del Commissario Delegato Maltempo maggio 2014 n.2/CDM14 del 08/09/2014; Scheda A2 Contributi per l'autonoma sistemazione.www.norme.marche.it.
Referente	Servizio Protezione Civile - servizio.protezionecivile@regione.marche.it . PEC: regione.marche.protciv@emarche.it
azione documentazione	settembre-ottobre 2014
Tipologia del dato	Descrizione dell'evento; caratteristiche e meccanismo della piena
Fonte del dato	Rapporto di evento 2-4 maggio 2014. http://www.regione.marche.it/Regione-Utile/Protezione-Civile
Referente	Servizio Protezione Civile, Centro Funzionale Regionale - e-mail: spc.centrofunzionale@regione.marche.it . PEC: regione.marche.protciv@emarche.it
Data documentazione	08/07/2014
Tipologia del dato	Perimetrazione area inondabile; caratteristiche e meccanismo della piena
Fonte del dato	Sintesi Preliminare sull'evento del 3 Maggio 2014 - ID: 7376332 del 20/06/2014 (Autorità di Bacino regionale)
	Dato vettoriale. Formato shape file. Nome: Allagamenti_03_05_2014_region.shp . Datum EPSG: 3004 - Perimetrazione effettuata mediante mappe Copernicus EMSR083 e sopralluoghi post evento
Referente	Servizio Tutela, Gestione e Assetto del Territorio - P.F. Difesa del suolo e della costa. e-mail: funzione.difesasuolo@regione.marche.it PEC: regione.marche.difesasuolo@emarche.it
Data documentazione	20/06/2014
Tipologia del dato	caratteristiche e meccanismo della piena
Fonte del dato	Relazione - report fotografico e allegati relativi all'evento alluvionale che ha colpito il bacino idrografico del fiume Misa 2-4 maggio 2014
	Prot.79884 del 06/06/2014
Referente	Settore VII Tutela e Valorizzazione dell'Ambiente; Provincia di Ancona. (Nel 2017 funzioni trasferite al Servizio Tutela, Gestione e Assetto del Territorio: P.F. Tutela del territorio della Regione Marche. e-mail: servizio.territorio@regione.marche.it PEC: regione.marche.servizioterritorio@emarche.it)
Data documentazione	06/06/2014

Figure 28. Metadata example.

In previous versions FloodCat did not have any field in which could be recorded the source of data. After our suggestion have been added in the tabs Event and Phenomenon the part "Reference" where can be kept track for different types of sources many fields as links, pdf files etc. (as in detail described in ISPRA 2018's Notes (Notes on FloodCat, 2018))

5.11 Implementation of FloodCat in Marche Region

During the PhD have been designed and written the first and only User Manual for FloodCat which can be found and downloaded on http://www.mydewetra.org/wiki/images/f/f4/FloodCat_manuale.pdf .

Here are listed some of the difficulties occurred during the implementation of the Flood Directive and FloodCat in Marche Region:

- Identifying the sources of data in Marche Region;
- Retrieval of historical data owned by different public services;
- Difficulty in connecting different regional services. Shared procedures should be defined and should be identified contact persons for each service;
- The database was continuously updating in the conceptual and informatics format and there were many versions with which to work with and analyse the data. It was not a finished and stable database with which to work;
- Many changes was made to the database thank to the suggestions made during the PhD that helped shaping and improving the database conceptually and in the informatics interface;
- The data population was manually made as it was difficult to find similarities between the fields of FloodCat's tabs and the available data, previously collected;
- It was difficult to find the exact damage geo-localization;
- It was difficult at the begging to understand what to consider an event (eg. the meteorological event as in the event report and other options);
- There were many cases where a municipality falls in more than one basin territory, it was difficult to choose the UoM to whom the damages belong to;

- In previous versions FloodCat did not have any field in which could be recorded the source of data. After our suggestion have been added in the tabs Event and Phenomenon the part "Reference" where can be kept track for different types of sources many fields as links, pdf files etc.;
- The Plan for the hydrogeological structure (PAI) of Marche Region (low and high probability) is displayed incorrectly. The only correct one is the medium probability one;
- Shape files in the phenomenon tab were difficult to upload, the system did not allow it;
- Data entry from multiple users: it should be possible to differentiate data entry from different users. For example some officials/services should be able to modify only the phenomena but not the event or modify/insert only the damages. Some users should able to modify only a specific category of damage (eg. the category "Agriculture, zootechny, fisheries, mines" must be the only category that can be changed by the agriculture service). A trace will remain of the user who entered the data and for each modification/update during the time;
- The numerical value needed in damage tab is difficult to establish for example in the case of streams, banks and the roads are never specified the length in m or km;

Suggestions/improvements and things to keep in mind for the implementation of the Flood Directive and FloodCat in Marche Region:

- The Economic value of the damage cannot be found in the event report;
- There is small distinction between the damage caused by floods and landslides;
- The shape files form the Basin Authority are helpful for the delimitation of the areas of the tab Phenomenon of FloodCat;
- The Ordinances have data on the economic value of damages and the numeric value of them;
- From the Ordinances can be classified the damages into FloodCat categories and subcategories although there is no similar categorization between them;
- We propose to define a referent for each Service or establish a regional work group to develop internal procedures for updating the database and officially request credentials to access the platform;
- Have been inserted new subcategories (eg. Private buildings and goods/Private means of transport, Private buildings and goods/Goods contained in private buildings, Agriculture, zootechny, fisheries, mines/Greenhouses and Tree nursery etc.)
- Have been improved the categories denomination;
- All the data recorded in FloodCat for Marche Region with this methodology have been checked and validated with the Regional Civil Protection;
- In the scheme of the request of compensation for agricultural economic activities is not required, the numerical value of the sub category of damage, eg. in ha or kg of production, useful instead for inclusion in FloodCat;
- Da.Ma represents an excellent tool to have a homogenous automatic flow of the data of damages to FloodCat;
- With regard to the damage on economic and productive activities in the tabs attached to OCDPC there is no field that describes the type of activity in order to associate to them the "equivalent/proper" Category/Subcategory of FloodCat;
- The tabs of the Ordinances and the tab A1 of Action Plan are very valuable for FloodCat data feed;
- Include in the tabs of OCDPC a column that shows the cause of the damage eg. Choosing between flood, landslide or rain;
- By using an approximate location for the damage tab, we could have damages outside the flooded area;

- Currently in the Marche Region there is a lack of economic data following localized events. For new events it will be necessary to evaluate how to collect or obtain minor event data;
- With regard to the data on economic damage in agricultural economic and productive activities, it is suggested to consider the census for admission to contributions following the Declaration of the State of Calamity. It must be kept in mind however that these data provide a significant underestimation of the damage since not all the activities have access to the contributions (eg. they are not registered in the list of companies, they are not insured etc.);
- Add rivers to the default FloodCat layers in order to make a better geolocation of damages;
- It is advisable to add secondary basins in the catchment layer. It can help locate the reported damage along the minor hydrographic network;
- By our suggestion the UoM have been listed in alphabetic order;
- The perimeter of the flooded areas will be for the events of the past always approximated. No one in the Region had the task of precisely delimiting it. The former Basin Authority has provided for some events the shape files used to update the PAI. The flooded area also depends on the scale for which it is bounded and on the base cartography used, the reference system and the datum converter. It is suggested to indicate a minimum scale;
- At our suggestion a search tool has been added in the phenomena tab in the below frame, as was done for the search in damage tab;
- At our suggestion was inserted the field “Surface Water body” to the tab Phenomenon to make more easy eventually statistics and to make it more friendly with the Water Framework Directive 2000/60/CE;
- FloodCat’s previous versions did not allow to change the damage subcategory after the first recording, it was changed after our suggestion;
- The icons for geolocation in the damage tab should have an information appearing when the mouse is on them, because are not very clear (eg. The polygon icon have multiple functions);
- The system, upon our suggestion no longer requires to select the flood mechanism each time the damage tab is changed;
- When exporting the damage card, it would be very useful to have two columns with latitude and longitude coordinates, so that you can quickly load it on a GIS as a delimited text layer. There are currently txt files with coordinates in a zip format. It is not clear how to use them;
- It is recommended to clear all fields after saving a damage category and sub-category. Currently they remain in memory when a new category is inserted. It can be a source of error;
- Given that for each damage it is possible to insert more sub-categories, it would be useful to be able to localize with a point or polygon also the sub-categories, in the case in which the overall damage refers to the municipal level (eg there may be more schools / universities damaged in a common or more than one municipal road). This is useful to not create more damage tabs for each geolocalized subcategory;
- Damages must be listed in a more appropriate manner (eg alphabetical order). Currently when a damage is modified and saved it appears at the top of the ranking. In this way it is difficult to find a damage in the case in which various damages have been inserted per municipality;
- Currently, statistical analysis tools are missing. We propose some basic ones, at least to be used for the analysis of the data inserted inside UoM, even if a comparison will be difficult given the heterogeneity in the definition of the event (eg. Region Emilia Romagna has inserted as an event what the Marche has considered a damage card (they have transferred the data automatically from their pre-existing database);
- The accumulated damage class should be shown for each basin;
- Insertion of different drop down menus in the OCDPC’s tabs containing description, this would help making more standard fields than just a subject dependant description;

- In the OCDPC tabs there are no fields attributable to the event origin, characteristics and mechanisms. The latter were derived from the Event Reports or reports prepared by the former Basin Authorities or former provincial civil engineering;
- Evacuated: in the OCDPC tab B for private property it is required to specify whether the building has been evacuated but not to indicate the number of people evacuated. For the inclusion in FloodCat it would be useful to add this information. The number of evacuees is indicated in the A1 tab of Action Plan. It would be useful to combine this information in a single form;
- Proposal to assign the damage class: breakdown by ranges of monetary value or better by type of indicator as done in the case of Sweden. eg if there are deaths, it is classified as a high class of damage, if hospitals are damaged, high damage class etc. to be able to make a sum for each area/basin and find the ASPFR;
- Make Da.Ma data able to fill FloodCat fields;
- Insert in the OCDPC tabs for Marche Region the cause of damage so if it is landslide should not be entered in FloodCat;
- Different methodologies to insert data between Regions makes difficult to make statistics and compare them in terms of number of events, phenomenon and damages;
- During the exportation of the records from FloodCat into excel files downloaded for statistics, all the AVI events of Marche Region lack on the field “Date” in the damage records. Probably the transfer from the AVI catalogue to FloodCat have not been done properly because the event tabs had the information about the field “Date”. The “Date” have been entered manually in order to make statistics, taken from the Event records;
- The informatics problems occurred during the testing period were quite time consuming, it take time till those are fixed;
- There were many problems with the geolocation, many times the system do not save the location as a simple municipality barycentre or as a shape file, many precise geolocations inserted following the addresses declared during the need recognition, were not saved by the system;
- Using a proxy geolocation like the municipality barycentre can appear in the maps that the damages are outside the flooded areas. Also this may occur because not all the damages derived from floods but also can occur from landslides or rain directly;
- FloodCat platform do not have direct analysis tools for the recorded data. In order to analyse the data have to be downloaded in excel files. It would be good to add some simple analysis tool in FloodCat;
- Was suggested to add the unit of measurement for each subcategory in the numeric value. This is important because FloodCat did not have any unit of measurement and could make the data on numeric value totally not usable for the future as they could be with high probability very heterogeneous between different regions in Italy and also between different recording authorities. For example the roads, the unit of measure should be metres or kilometres, for agriculture hectares etc. After our suggestion all FloodCat subcategories was completed by ISPRA and DPC with a unit of measurement. This is very important also in the case where the economic loss estimation is made by using quantitative indicators (which are those of the field numeric value of FloodCat) and that first should be used in the same unit of measurement and converted if needed;

To be underlined that the user permission given for this PhD was special and unique (other users are mainly authorities) because served to improve the part of conceptualising the databases (categories and fields) and the informatics part. The user manual was written as part of the PhD and the final notes on FloodCat structure was written taking into account the suggestions made during the PhD. It was a continuously changing not definitive database till the end of data record for Marche Region which made the use more difficult and was shaped by the big contribution of this PhD.

Many meeting with different authorities at Marche Region and with competent authorities from other Regions was carried out during the PhD in order to improve and consolidate FloodCat as a database and also to find the referents from each authority that should deal with FloodCat purposes. This administrative steps of finding the referents from each competent authority have been slow and some are still under assignment. So for FloodCat implementation were and are still ongoing the assignment of the different responsibilities and was necessary to create a new structure of collaboration and new agreements and Standard Operation Procedures (SOP) between the different authorities inside and outside the Region itself as the basins may fall under two regions for example. It is also necessary to find out how to make the validation process as in FloodCat the event may have different status ex. Validated or Not Validated and to find which authorities should have this responsibility.

From the meetings and the documents shared between the authorities emerged the following:

- usually in the regional offices converge all the reports of damage and requests for restoration. In many cases, a clear and unambiguous distinction between processes of various kinds is not clearly and unambiguously possible: flooding, rainfall effects, slopes, etc. The selection of only flood events would be very laborious and very subjective and would also cause a lack of perception, by those examining the cadastre, of the real effects, also in economic terms, of the events. Eliminating the processes/damages related to the slopes would entail a strong point of separation between the real and overall economic demands (which also take into account the slopes and the hybrid ones) and those on FloodCat;
- probably the European guidelines in which the FloodCat catalogue is based were created for the North-European countries where the "alluvial event" (intended as an episode of prolonged and/or intense rainfall) substantially coincides with the "flood" (understood as floods caused by the flooding of watercourses). In Italian national reality, in fact, very often fluvial and slope processes interact and fade also into phenomena related to the rains that cause huge damages;
- it was proposed to transfer the results of the various regional databases to the FloodCat, requesting the Civil Protection Department to integrate the application with items such as "Slope processes"; "Other processes" etc.. This would cause a lower selection burden (however subjective and questionable) on the part of the regions and a greater adherence to the realities of the general framework. Then who elaborating the archive and report to the EU could exclude or filter some records if needed;
- FloodCat system have limitations on the type of shape files uploaded and this is limiting because shape files may come from different sources, in some cases INSPIRE compliant and also easily uploaded in GIS systems, but FloodCat do not allow the upload. It is suggested to be possible to add all shape files INSPIRE compliant and GIS system compliant and to automatically convert the georeferenced system to the default one;
- it is not clear which damages to record on FloodCat and who should record what;
- some damages are geolocated (ex. those of municipalities) and some are not (those of provinces);
- in some Regions there are substantially no direct information about the damages, and the relative amounts, relating to works outside the regional jurisdiction (ANAS, railways, highways, oil/gas pipelines, power lines, various infrastructures) so there would be a damage underestimation;
- it is necessary to define if the reported damages or those actually financed are inserted;
- Ignoring the data relating to cases that are not strictly regional, alters the real general picture. Acquiring them, on the other hand, involves the creation of procedures (now absent in some Regions) and a non-trivial work of georeferencing and organization;

- Following a flood event, a very significant fraction of the amounts related to damage/restoration is related to municipal or provincial roads. In some (few) cases the damages are clearly classifiable in relation to alluvial dynamics (included in FloodCat) or landslide (to exclude or not from FloodCat?). The mass of the processes triggered by the precipitations that involve the viability represent a kind of incertae sedis between the processes due to the direct action of the waters and those of the slope (runoff, exhaustion, siphoning, differential failure, erosion);
- from regional databases it is basically impossible to separate the information relating to the monetary amount of damages compared to those of the restorations. In the face of an amount indicated, in particular, it is not normally known whether this amount refers to: 1) a pure restoration of the damage (in this case it would be similar to the flood damage "damage" field), 2) an intervention intended to improve the situation, 3) both points 1 and 2. In principle is possible to report the amounts as proposed by our competent offices;
- is it conceivable to agree that more damage below a certain threshold is combined and geo-referenced on the centre of the municipality or on a locality;
- it is not clear the use of the fields related to "return times" and "frequency" if they refer to rainfall or flow;
- some think that the event tab should also have an approximately georeferenced polygon;
- problems connected with "validation". Many regions do not have an internal path for formal data validation, which comes from various internal sources and, in part, also external ones. Furthermore, references to the origin of the data could not be entered on the FloodCat in previous versions. Was proposed 1) the addition of one or more fields that may indicate the origin of the data (Metadata already comprehended in the last FloodCat version); 2) that each region prepare a metadata document (a kind of quality document) with details: the origin of the data; the methods of collection; their degree of reliability and other useful elements for full understanding and full "weighing" of the data (already done for Marche Region);
- it is necessary to adopt procedures of data collection after an event in order to make the data recording in FloodCat automatic (already done for Marche Region);
- propose a minimum standard for all Regions.

The comments emerged from the meetings and the shared documents during the PhD duration are mainly in line with what suggested during this PhD in order to improve and optimize FloodCat.

In the date of 05/12/2017 was signed the protocol number 0007832/2017 "Agreement for the coordination of the feed activities of the FloodCat platform (Flood Catalogue) for the construction of the national catalogue of flood events". The protocol has validity till 22 December 2021, in which ends the second management cycle required by the Floods Directive.

The agreement have been signed between the District Basin Authority of Po river, the Regions Emilia-Romagna, Liguria, Lombardia, Piemonte, Toscana, Veneto, Marche, the Autonomous Region of Valle D'Aosta, the Autonomous Province of Trento and the Department of Civil Protection in order to achieve a close coordination in the implementation of the activities connected with FloodCat. The agreement defined the activities of the various signatories in order to effectively coordinate the implementation of FloodCat.

It not known if other Regions have signed other similar agreements because the document were not shared.

From the testing period we can also say that the FloodCat platform ensures a high level of disaggregation for the elements recorded and for their geographical location and this allows:

- to relate the records with a high number of indicators for Target A,B,C,D of Sendai Framework;
- to export the dataset according to different output data models : FD reporting schema, JRC-DLD Guidance minimum requirements;
- to be used for different purposes (civil protection activities, recovery, reporting for European and International regulations, risk model validation).

To be mentioned that there is an agreement between the Italian Civil Protection Department (DPC) and JRC that envisages the possibility for Union Civil Protection Mechanism (UCPM) participating countries to obtain the technological transfer of the FloodCat platform and in line with the agreement FloodCat was implemented in Greece. FloodCat demonstrated to be a flexible tools that can be adapted in different institutional context and targeted to National needs and again the high level of data disaggregation facilitates the use of DLD for multiple-purposes (from Global policies to National needs).

6 Statistical analysis of FloodCat records

For the below statistics are used all the events of the three Units of Management of Marche Region[30,31]:

- UoM ITR111 - Marche Regional Basin Authority;
- UoM ITI01319 - Marecchia Conca Interregional Basin Authority;
- UoM ITI028 - Tronto Interregional Basin Authority;

Although there is another UoM in Marche Region, the UoM ITN010 – Tevere National Basin Authority, it comprehend a really small territory of the Region (just the municipalities of Castelsantangelo sul Nera, Monte Cavallo, Serravalle di Chienti, Ussita and Visso) and during the data feed of FloodCat, except data from AVI catalogue, were not registered any event for this UoM. To mention that the damages recorded during the PHD represent 90% of all damage records for Marche Region. The events recorded for the UoM ITN010 have not been included in the statistics because with high probability are events of other Regions territory and are only records of AVI catalogue for which the affected territory not always is clear.

Regarding the data of the interregional UoM, in some cases it is not clear about the data coming from the AVI Catalogue if the damage records fall within the administrative boundaries of Marche region. The selection of these events is difficult because during the transfer of data from AVI to FloodCat for the part of the location there is a very general descriptive field that does not allow to distinguish which region they belong to. To keep in mind that over the years there have been many administrative changes for which some municipalities have moved from one region to another. In any case, the data of the AVI Catalogue for the interregional UoM are relatively few compared to the total data.

The data comprehend the data recorded for Marche Region till 7 October 2018 when the excel extract from FloodCat have been done.

6.1 Damage records

Each damage tab in FloodCat can have different damage records, each damage record is composed by one category, and one subcategory selected, a numeric value field and an economic value field.

Figure 29 shows the number of damage records for each year in Marche Region, comprehending data from AVI catalogue also. It have been chosen to show the number of damage records because the number of events, phenomenon and damage tabs depends on the methodology used and the methodology used during the PhD is different from the one used for AVI catalogue data. With FloodCat data have been possible to construct a 54 years temporal trend. Data from 2002 till 2018 have been recorded during this PhD with the methodology explained in paragraph 5.5. As is shown in Figure 29 there is an increasing trend on the number of damage records. The year with the highest number of damage records is 2013 (1.017 damage records) followed by the year 2011 (686 damage records) and 2014 (642 damage records). As can be seen the years from 2011 till 2016 have the highest damage records representing 83% of all damage records. The uprising trend of the last years may be due to a higher data availability and also because the floods may have affected higher number of municipalities or a higher number of sectors (Categories/Subcategories). Another cause can be the uprising number of exposed elements and a higher variability of the exposed elements in the hazard vulnerable areas. The years before 2002 have in total 355 damage records and are all

[30] Flood Directive in Marche Region http://www.regione.marche.it/Regione-Utile/Paesaggio-Territorio-Urbanistica-Genio-Civile/Direttiva-alluvioni#Finalit%C3%A0

[31] Law n. 221/2015 modifications http://www.appenninosettentrionale.it/itc/?page_id=579

from the AVI catalogue. The most affected years in terms of number of damage records for the AVI catalogue are 1976 and 992 with 70 and 52 damage records respectively.

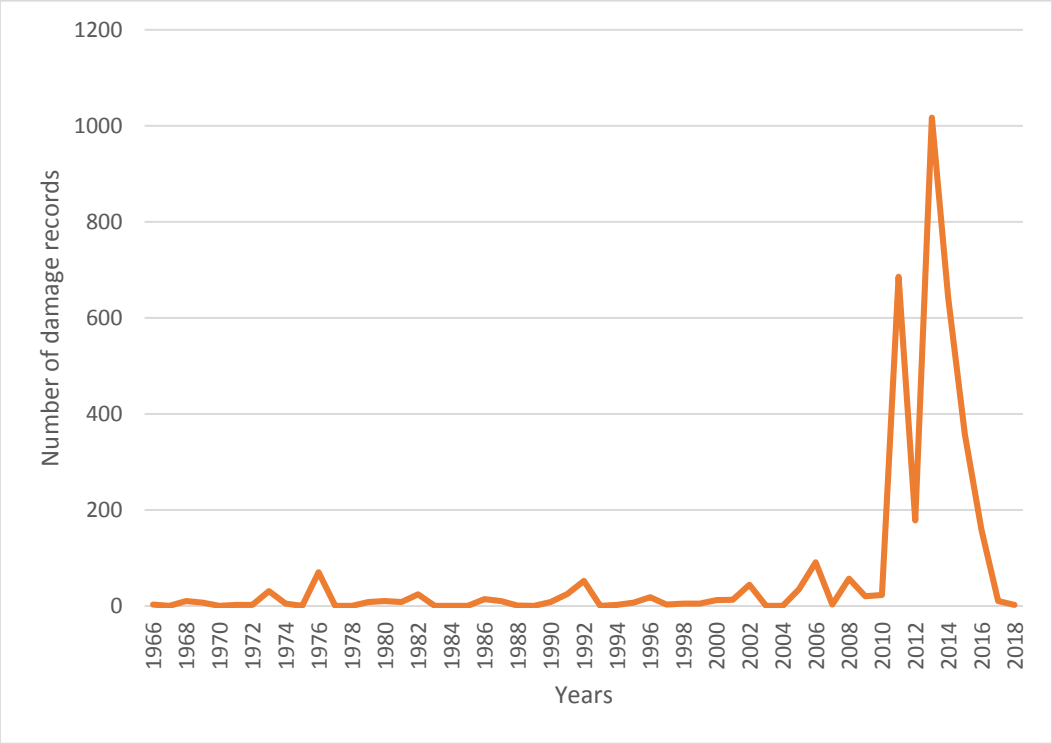


Figure 29. Number of damage records in FloodCat for Marche Region for each year (1966-2018).

Figure 30 shows the monthly trend of the number of damage records present in FloodCat for the temporal interval from 1966 to 2018. In decreasing order the months with the highest damage records are March (1.214 damage records), December (846 damage records) and May (522 damage records). This three months recorded 70% of the total damage records.

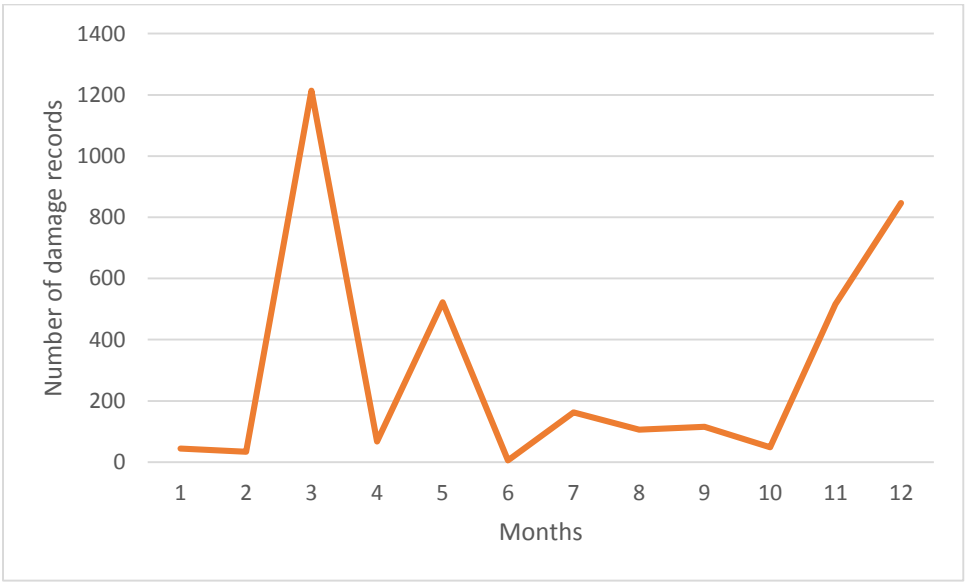


Figure 30. Number of damage records in FloodCat for Marche Region for each month (years 1966-2018).

While analysing the seasonal trend of the damage records (Figure 31) the season with the highest records is spring with nearly 50% of all records.

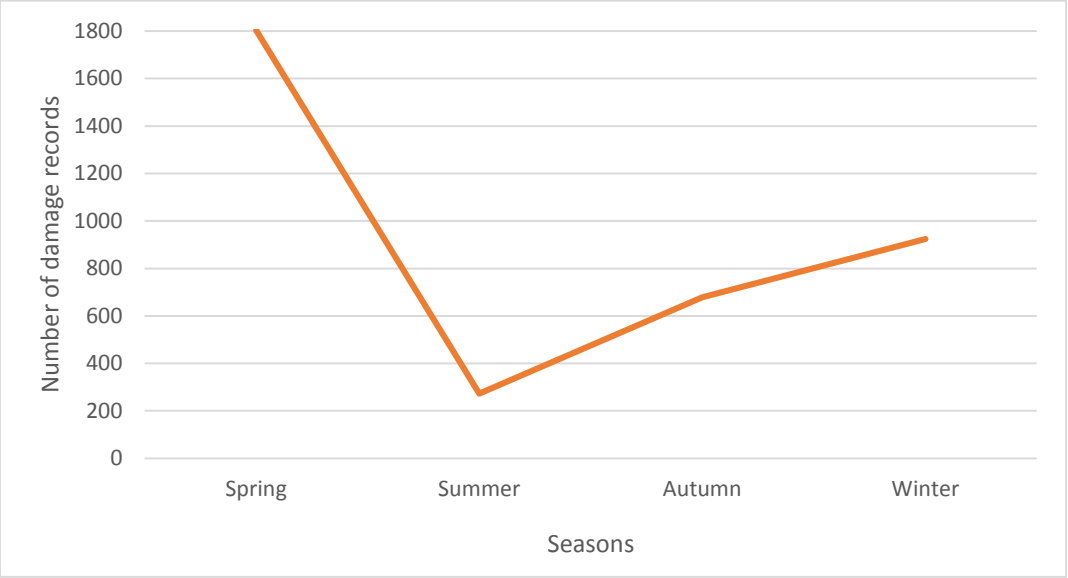


Figure 31. Number of damage records in FloodCat for Marche Region for each season (years 1966-2018).

When the categories are related with the number of damage records than it is clear that the one that have more records is “Communication and transport infrastructure” with 1.246 records followed by “Public interest structures/services” with 747 records (Figure 32). This two categories represent more than 50% of the total damage records with a category selected (there are some records without a selected category).

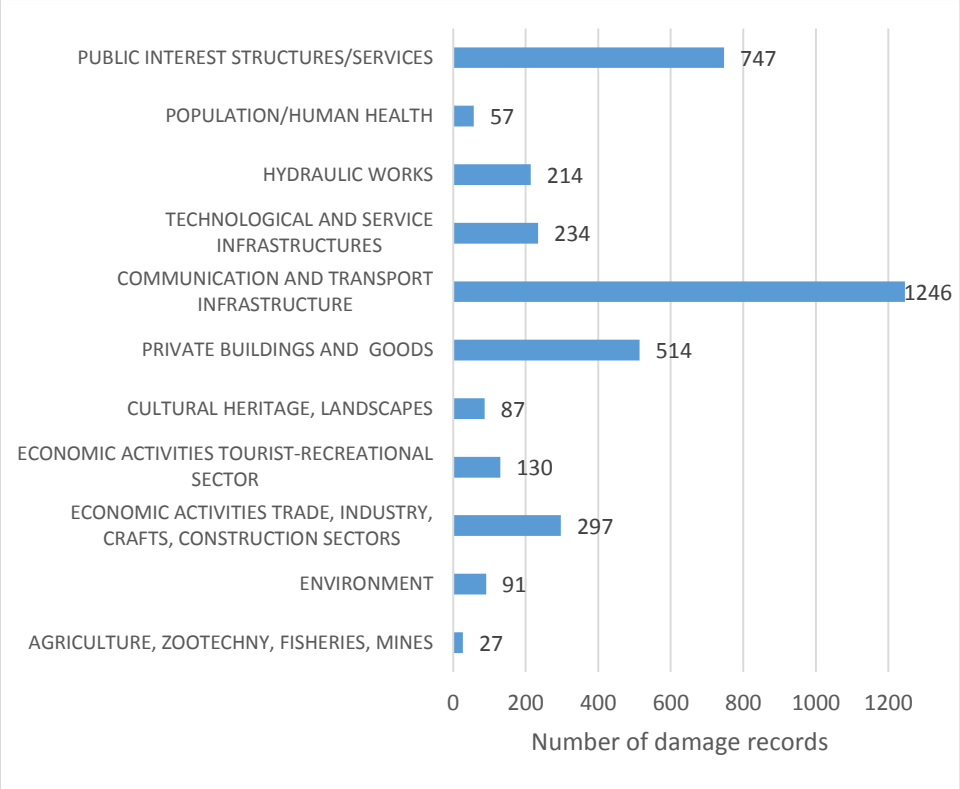
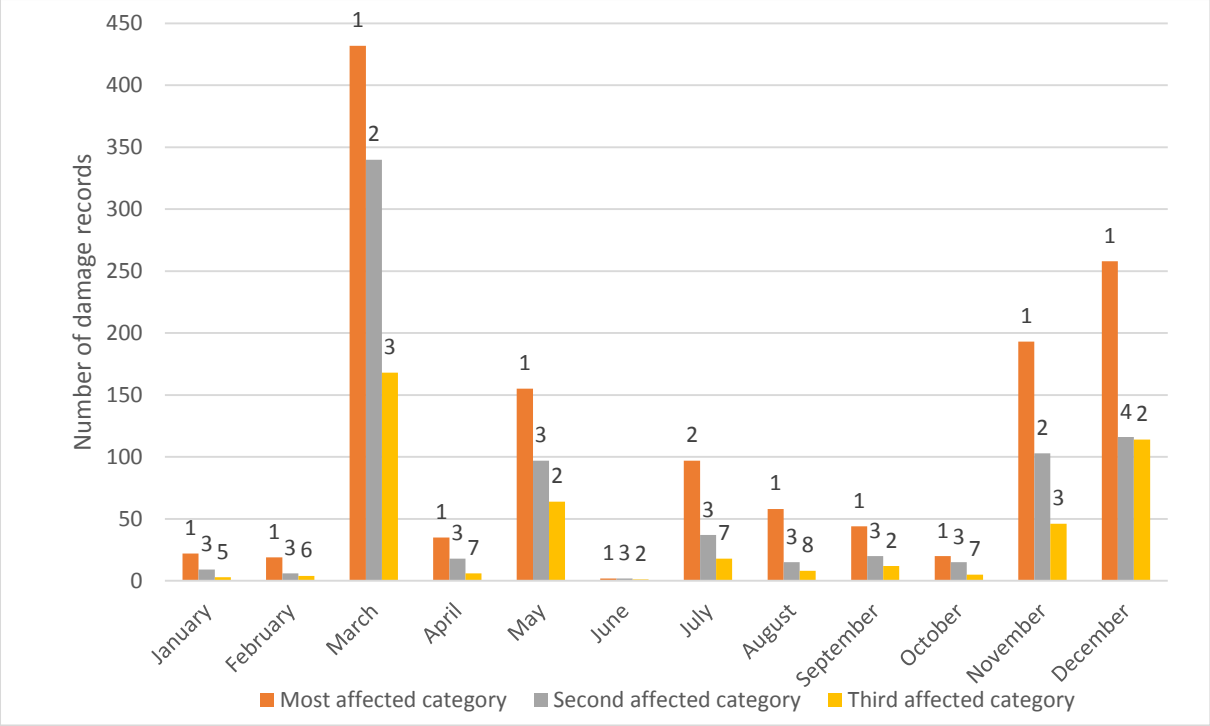


Figure 32. Number of damage records in FloodCat for Marche Region for each Category (years 1966-2018).

In order to see if the affected categories change through the months was made the chart of Figure 33. This chart shows the number of damage records for the first, second and third most affected category for each month for the temporal period 1966-2018. The number over the bars show the category represented. Except for July, the most affected category is “Communication and transport infrastructure”. Except for March, November and December, the second affected category for all the remaining months is “Private buildings and goods”. The third affected category for each month present a higher variability as shown in Figure 33.



COMMUNICATION AND TRANSPORT INFRASTRUCTURE	PUBLIC INTEREST STRUCTURES/SERVICES	PRIVATE BUILDINGS AND GOODS	TECHNOLOGICAL AND SERVICE INFRASTRUCTURES	ECONOMIC ACTIVITIES TOURIST-RECREATIONAL SECTOR	AGRICULTURE, ZOOTECHNY, FISHERIES, MINES	ECONOMIC ACTIVITIES TRADE, INDUSTRY, CRAFTS, CONSTRUCTION SECTORS	CULTURAL HERITAGE, LANDSCAPES
1	2	3	4	5	6	7	8

Figure 33. Number of damage records in FloodCat for Marche Region for each month for the three most affected categories (years 1966-2018).

6.2 Economic loss

From a total of 3.679 damage records only 82% (3.016 damage records) have recorded the economic value of the damage. This is a very good result because usually the disaster databases lack from data on direct economic loss. The highest number of damage records (DR) is recorded for those DR that have an economic loss comprehended in the interval 100.001-500.000 Euro while the highest economic loss is recorded for those DR that have an economic loss comprehended in the interval 1.500.001-5.000.000 Euro (Figure 34). The total economic loss recorded in FloodCat is nearly one billion Euro (10^9Euro). Only the years between 2002 and 2017 recorded economic loss, specifically 8 years with an average of 120*10^6 Euro of economic loss for affected year. The records from AVI catalogue do not have the economic loss value.

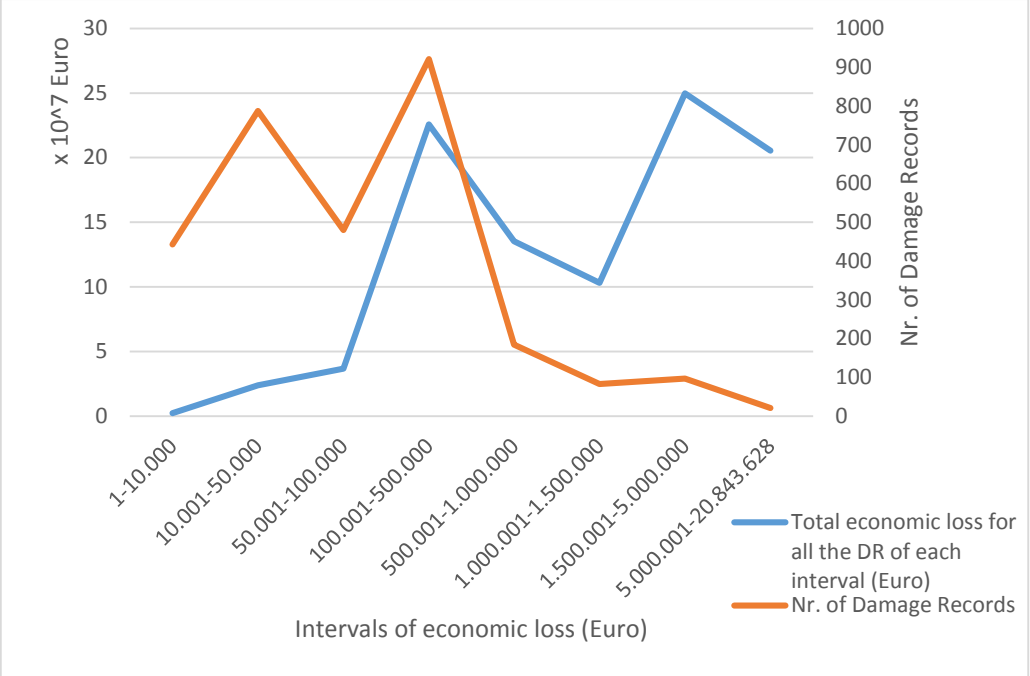


Figure 34. Total economic loss for all the DR of each interval (Euro) and number of Damage Records in FloodCat for Marche Region for each interval of economic loss (Euro) (years 1966-2018).

Figure 35 shows the economic loss in Euro recorded in FloodCat for Marche Region for each of the years with economic data. The year with the highest economic loss is 2011 followed by 2013 and 2014 representing 35%, 30% and 22% of total recorded economic losses of FloodCat. The economic loss of 2011 represents 8,4 ‰ (thousand percent) of Marche Region's PIL for the year 2011, while for 2013 and 2014 represents 7,5 ‰ and 5,3 ‰ of the respective PIL for the year.

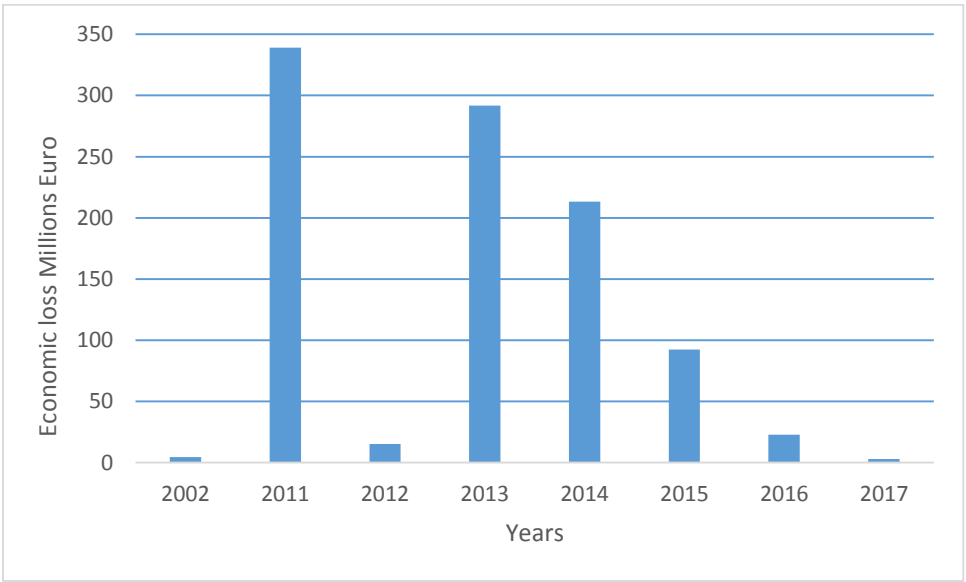


Figure 35. Economic loss (Euro) in FloodCat for Marche Region for each year (years 2002-2017).

As per capita GDP expresses the level of wealth per inhabitant produced by a territory in a given period by dividing the Economic loss of a specific year with its GDP per capita would be possible to

know how many inhabitants' wealth had been lost during the disaster (Figure 36). More than 13.000 inhabitants' wealth have been lost during 2011, more than 11.600 in 2013 and more than 8.200 in 2014.

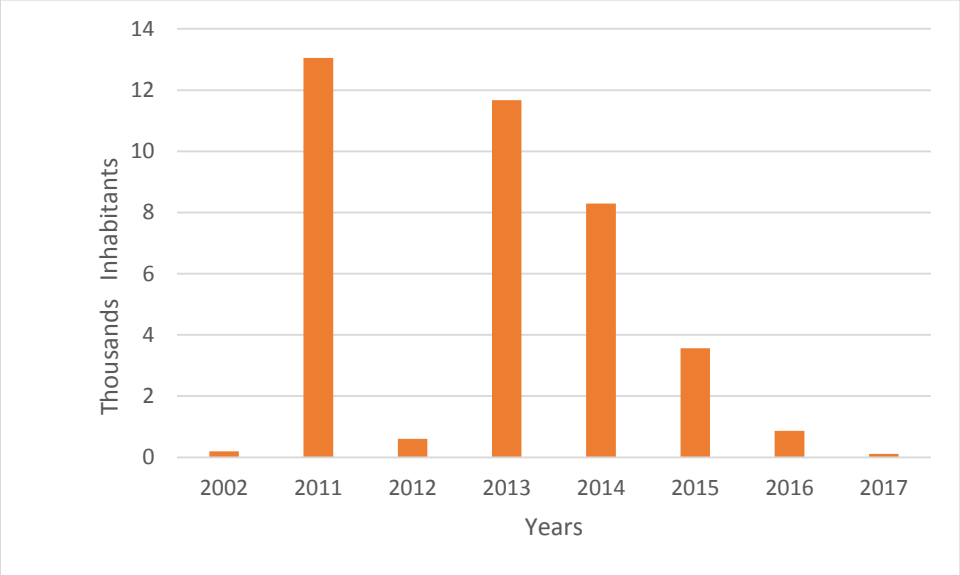


Figure 36. Economic loss YEAR/GDP per capita of Marche Region for YEAR for the years 2002-2017.

When considering the economic loss for each month (Figure 37) the most affected are March with 46% of total economic loss and May with 20% of total economic loss. The most affected season is Spring with 66% of total economic loss (Figure 38).

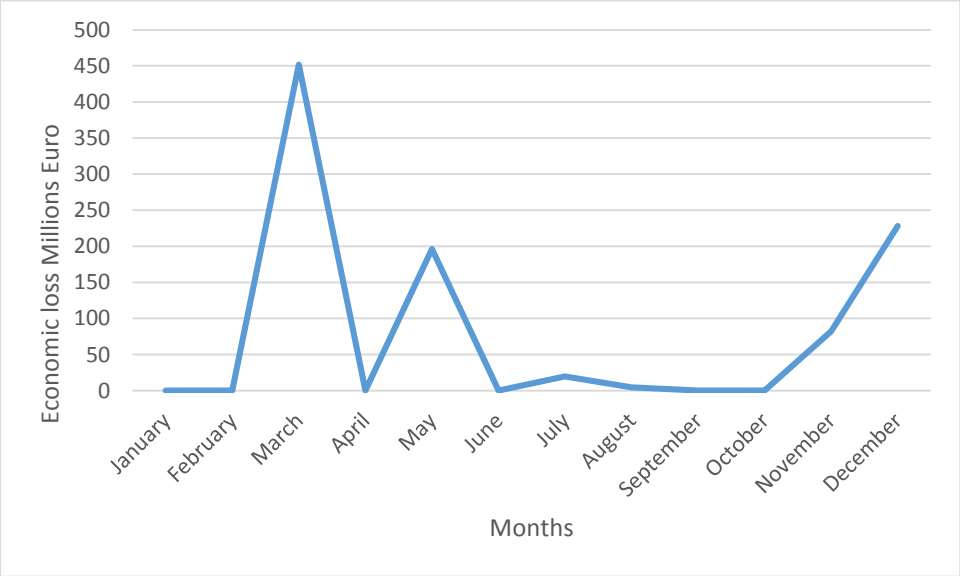


Figure 37. Economic loss in Euro for each month (years 2002-2017).

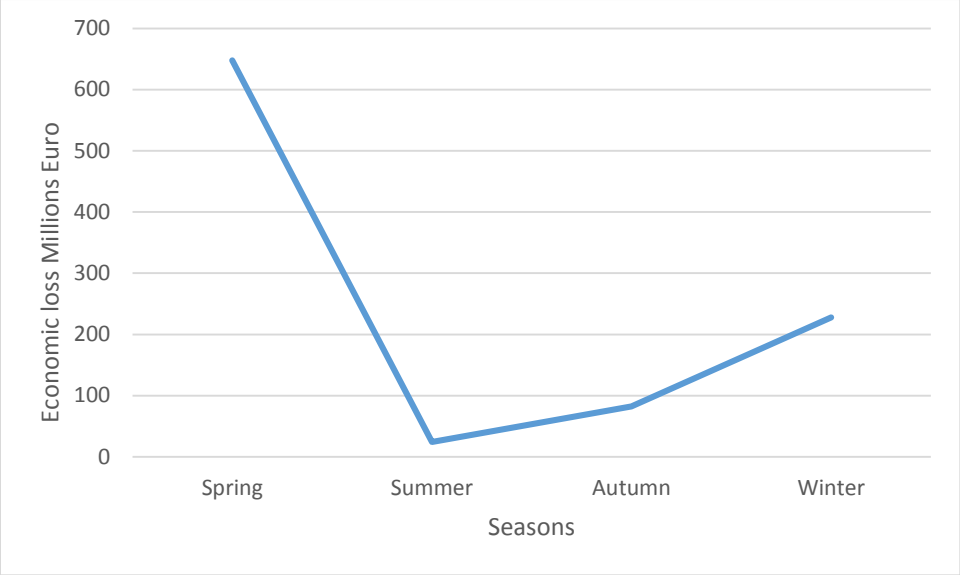


Figure 38. Economic loss in Euro for each season (years 2002-2017).

In terms of economic loss the most affected category is “Communication and transport infrastructure” with 43% of total economic loss (Figure 39). The second most affected category is “Public interest structures/services” followed by “Private buildings and goods” and “Economic activities trade, industry, crafts, construction sectors”.

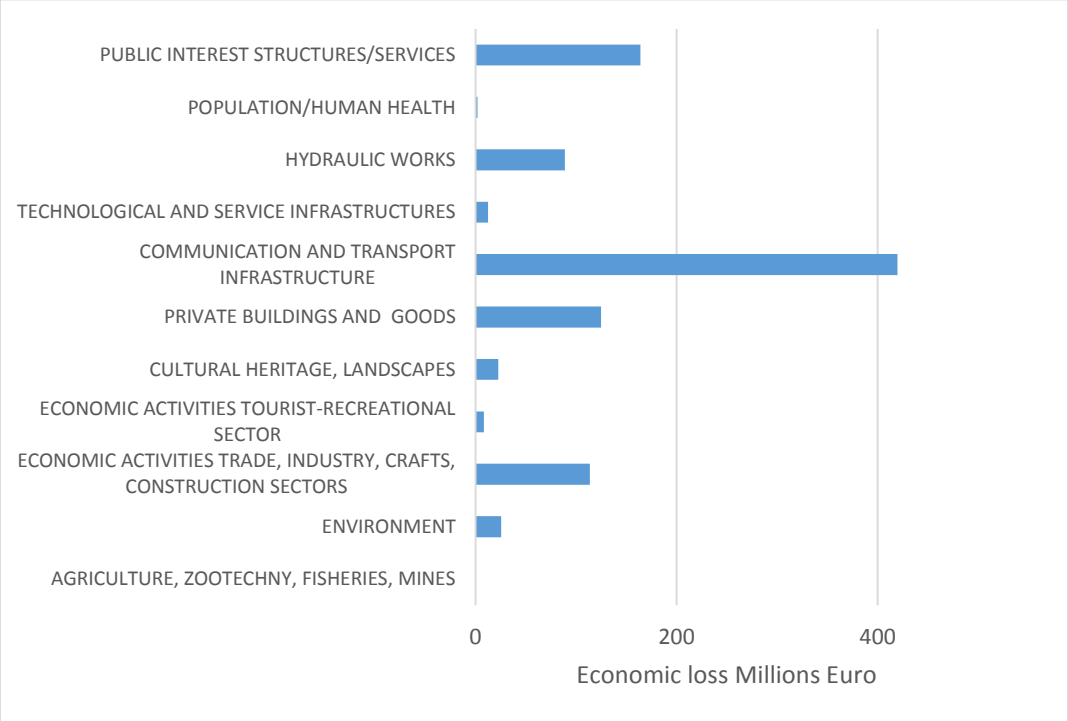


Figure 39. Economic loss in Euro for each FloodCat category (years 2002-2017).

7 Case study

Was selected as a case study the event of 2-4 May 2014. The reasons for choosing this event are that it was Declared the State of Emergency and many data were available starting from a detailed Event Report of the Civil Protection Service, Functional Regional Centre; the Intervention Plan; Ordinance of the Head of Department of Civil Protection 179/2014; Ordinance for private damages 378/2016; Damages on means of transport and movable property: protocol number 0746391 and the Perimeter of flooded area by the Regional Basin Authority.

Following is summarized the disaster event based on the description of the Event Report (Event Report of 2-4 May 2014, 2014).

The rainfall of May 2 was preceded by a very rainy period which determined the saturation of the soil and consequently reduced the infiltration capacity of the water in the ground.

This event was marked by particularly intense rainfall that affected the hilly-coastal portion of the region the day of May 2 and intensified starting from the early hours of Saturday May 3, 2014. Figure 40 shows the daily cumulative recorded on the days of 2, 3 and 4 May 2014.

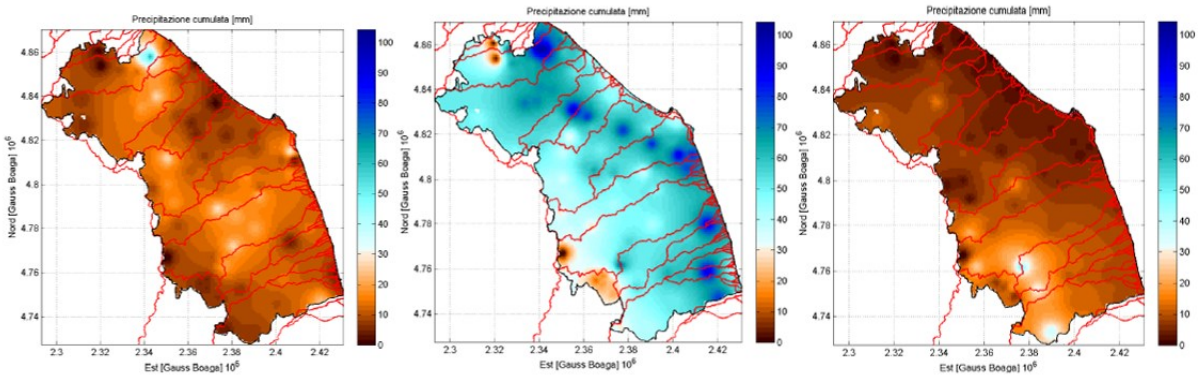


Figure 40. Map of daily cumulative precipitation (mm) on the entire regional territory of 02/05/2014, 03/05/2014 and 04/05/2014, obtained by interpolating the data of the rain gauges in remote measurement of the MIR network.

The intense precipitation initially occurred on the Foglia river basin and then on the rest of the region, particularly on the basins of Misa, Cesano, Esino and Musone, have caused flooding and widespread landslides throughout the region.

The greatest effects were recorded in the Misa basin, affected in the early hours of Saturday 3 May by heavy precipitations and durability comparable to the run-off time of basin, which put the entire river network in crisis causing floods in various points.

Following the flood, the Misa embankments were surmounted at numerous points, with consequent erosion and breakthrough. Figure 41 is a photo of Senigallia – area Via Capanna after the event.

Figure 41. Senigallia - area Via Capanna.

Historically the Misa basin has been affected by different flooding events (26/11/1940, 12/09/1955, 19/08/1976). Despite the flow, estimated equal to 540m^3s^{-1} was higher than in November 1940, the flooding in the town of Senigallia did not reach the magnitude of the previous event, thanks to the over-elevation of the containment walls in the city as well as the lamination action exerted by the overflow of the secondary grid and the breaking of the embankment in the locality Bettolelle.

The precipitation of 3 May have also determined the triggering of numerous and widespread landslides, mainly along the roads, with consequent inconvenience to traffic, but also in the vicinity of houses and population centres. The phenomena occurred also and mostly in the days following the event. I fenomeni più ricorrenti sono stati crolli, colate di fango e colate di detriti. The most recurrent phenomena were collapses, mudslides and debris flows. The landslides in particular affected the entire hilly and coastal belt of the region, while there were fewer effects on the high-hill and mountain areas.

Table 23 reports the physical characteristics and the actually observed effects on the territory for the event 2 to 4 May.

Table 23. Physical characteristics and the actually observed effects on the territory for the event 2 to 4 May.

	2 May	3 May
Meteorological	Precipitations of particular intensity that have affected the coastal hilly portion of the region on the day of May 2 and have intensified starting from the early hours of Saturday 3 May 2014.	The most critical interval was between 00:00 am and 6:00 am on May 3, 2014 with an areal average estimated on the region of about 25mm in 6 hours. The most intense downpours occurred in the coastal hilly portion, with peaks on the 6 hours of 65,6mm recorded at the station of Montecchio (PU), 56,6mm at S. Lorenzo in Campo (PU), 60,4mm at Barbara (AN), 58,6 mm at Jesi (AN), 56,8mm at Rostighello (AN). In the early hours of the day of May 3, rainfall initially affected the valley area of the Musone basin, moving quickly over the basin of Triponzio, a tributary of Esino, and then on the Misa, Cesano, Arzilla and Foglia basins. In the 00-06 interval of 03/05 in the Misa basin there was an average contribution of meteoric influx per single cumulative of 1563,2 [litri/(s km2).
Hydro-geological		Following the previously described precipitations, particularly critical for the coastal medium-small basins, significant flooding occurred on the hydrographic network of the central-northern portions and in particular of the river Misa. The event had an impulsive and rapid progression. At the Bettolelle hydrometric station an overall rise of about 4.5m was achieved in 5 hours. In particular, over a period of two and a half hours, there was an increase in the hydraulic tension of about three meters from 5 to 7.30 am on 3 May. Precipitations have also led to a sudden rise in hydrometric levels in secondary basins (Triponzio and Fiumicello, a tributary on the right of the Musone river). On the Triponzio torrent there has been an increase in the hydrometric level of about six meters in less than six hours. The rapid response of the basins was determined by the heavy rainfall, the pre-existing saturation conditions of the soils that favoured run-off, and by the predominantly impermeable soils (mainly clay) that characterize these basins. The phenomena of flood, even if with different effects, have affected most of the basins of the region. Overlap of the banks of Misa in numerous points, resulting in erosion and breakthrough. Damage to infrastructure and agricultural activities. Trigger of numerous and widespread landslides.
Damages		3 deaths in Senigallia, evacuated, damages in private and public assets, damages in agricultural and non-agricultural economic activities

7.1 Statistical analysis with Action plan data

The statistics below are made taking into account the data of the 2CDM14[32], the Action Plan.

The action plan of the event of May 2014 in Marche Region have 5 tabs as below explained:

1. A1 – Relief interventions and assistance to the population;
2. A2 – Contributions for autonomous accommodation;
3. A3 – Urgent measures, implemented or to be implemented, aimed at restoring the functionality of essential public services as well as avoiding situations of danger or damage to persons or property;
4. A4 – Equipment restoration of the Regional Functional Centre and securing the regional hydrographic network;
5. A5 - Material restoration of the Regional Emergency Response Centre.

[32] Decree of the Deputy Commissioner of Bad Weather May 2014, n. 2/CDM14 of 08/09/2014. Subject: Alluvial events in May 2014. OCDPC n. 179 of 10 July 2014, art.1, subsection 4. Plan of interventions and procedures concerning the methods of liquidation and control of the interventions.

The economic damage detailed in the action plan is usually totally financed by the State.

In Figure 42 the different categories of Tab A1 of the action plan are shown. The economic damages of the category “Assistance to the population” are totally due to the province of Ancona while in the category “Provisional measures of accommodation of evacuated population” the 82% to the province of Ancona and 18% to the province of Macerata. The employment of volunteers in Marche Region was higher in the Province of Ancona with 74% of economic resources required compared to the total of this category. The Province of Ancona spent more than the other provinces also with regard to facility rental (59%), waste disposal (82%) and other unspecified expenses (50%). Considering the total economic damage of the A1 tab, the province with the largest allocation of funds is Ancona with 69% followed by Fermo with 12%, Macerata 9%, Ascoli Piceno 6% and Pesaro Urbino with 4%. Considering the total damage for each category of the A1 tab it is clear that the one with the greatest economic damage is the disposal of waste with about 2,5 million Euro spent representing 46% of the whole A1 tab while the facility rental is in second position with 36%.

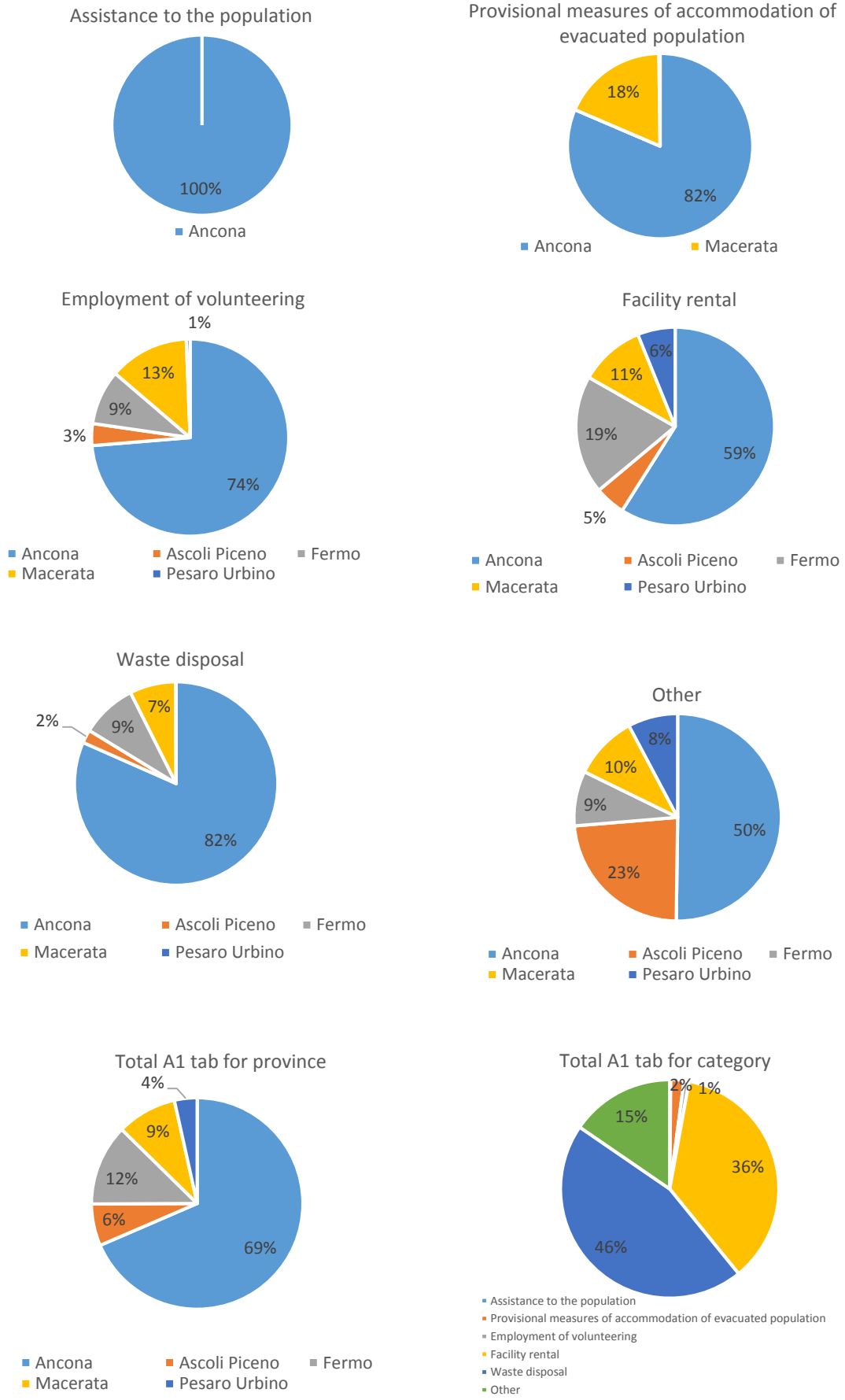


Figure 42. Tab A1 – Relief interventions and assistance to the population.

A2 tab, “Contributions for autonomous accommodation”, has a total of about 1,7 million Euro of damages, of which 99% are due to the municipality of Senigallia to settle the evacuated population from the date of the evacuation order until 10 July 2014, without taking into account the extension of the state of emergency. Also the number of evacuees in the municipality of Senigallia represents 99% of the total with 2.861 evacuated.

A3 tab “Urgent measures, implemented or to be implemented, aimed at restoring the functionality of essential public services as well as avoiding situations of danger or damage to persons or property” as shown in Figure 43 is almost evenly divided among the 5 provinces, with 28% Ancona, 20% Macerata, 19% Fermo, 17% Ascoli Piceno and 16 Pesaro Urbino.

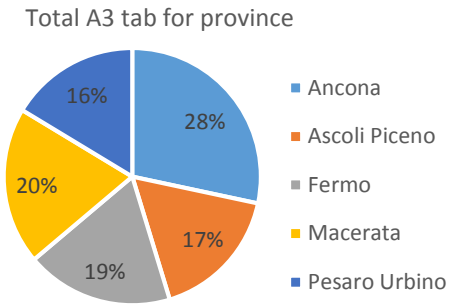


Figure 43. Total cost of A3 tab for each province, Tot=2.589.755 Euro.

Figure 44 shows how each tab affects the total of the intervention plan. In decreasing order the tab A1 has the highest demand of financial resources with 54% followed by A3 with 26%, A2 with 17% and A4 with 3%.

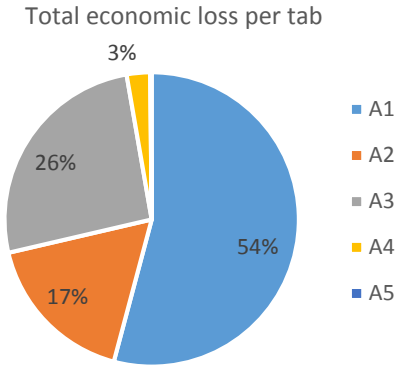


Figure 44. Total economic damage per tab of the action plan, Tot=10 million Euro.

There is only a small overlay of the action plan data with the FloodCat data regarding the evacuees which are considered in both with the difference that the action plan consider only the immediately evacuated persons.

7.2 Statistical analysis with FloodCat data

The flood data of Marche Region have been recorded following the FloodCat database requirements and a methodology which classify the damages in catchment and altimetric bands. Figure 45 shows the number and percentage of damaged municipalities for each altimetric band considering all the

Unit of Management (UoM)[33] of Marche Region. The most affected altimetric band of the event is the hilly one with nearly 50% of the total affected municipalities. This is probably due to landslide data often included in flood data, is difficult to split each contribute.

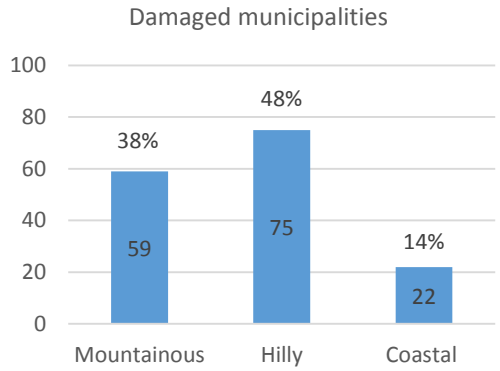


Figure 45. Number of damaged municipalities classified in three altimetric bands: mountainous, hilly and coastal for all the event.

As shown in Figure 46 the economic loss recorded in FloodCat is higher in coastal municipalities with nearly 45% of the total, followed by the hilly municipalities with 36,2% and the mountainous with the remaining 19%. The total economic loss reaches almost 186 million Euro[34].

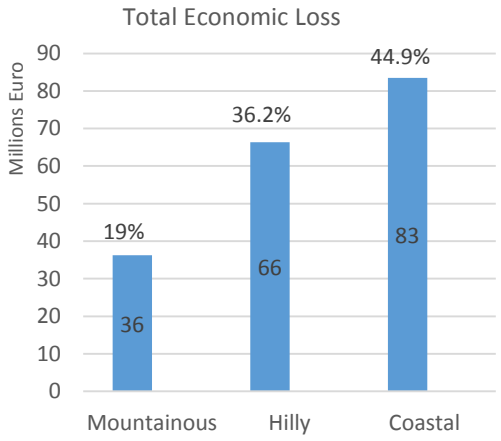


Figure 46. Total economic loss/altimetric band.

When considering the economic loss caused by each category of FloodCat (Figure 47) the highest economic loss is due to the category “Communication and transport infrastructures” with 35,62% followed by “Private buildings and goods” with 33,04%. This two categories represent alone nearly 70% of the total economic loss recorded on FloodCat for this event. The other categories in decreasing order of economic loss are “Environment” 8,89%, “Economic activities trade, industry, crafts and building sectors” 8,33%, “Public interest structures/services” 6%, “Hydraulic works” 4,4%, “Economic activities tourist-recreational sector” 1,37% and the categories “Population/human

[33] Unit of Management – UoM, Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks , https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32007L0060&from=EN

[34] The damages recorded for the provinces is not taken into account.

health", "Technological and service infrastructures" e "Cultural and landscape heritage" with less than 1% each.

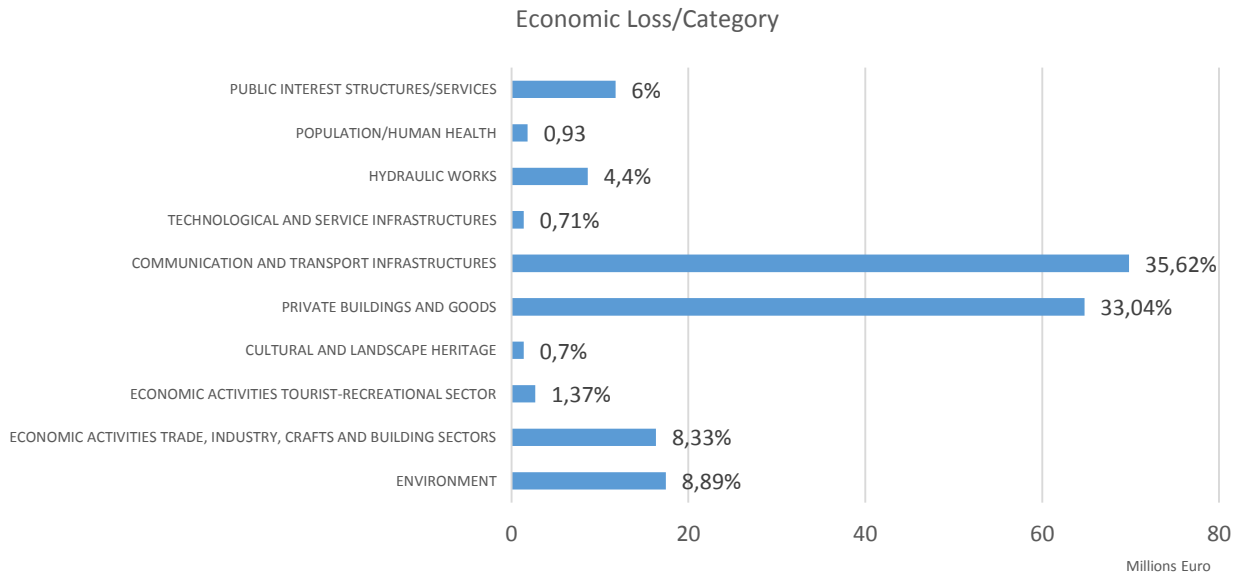


Figure 47. Economic loss for each category. Total nearly 186 million Euro.[35]

The high amount of loss in the category "Communication and transport infrastructure" is due for more than half (55%) to the Municipal roads followed by Provincial roads (40%), Bridges/Viaducts/Crossings (4%) e Other/Not specified (1,1 %) (Figure 48). The other subcategories have a total influence of less than 1% both. The road damages, provincial and municipality ones, is probably due to the landslides which are often mixed with flood data when collected and recorded.

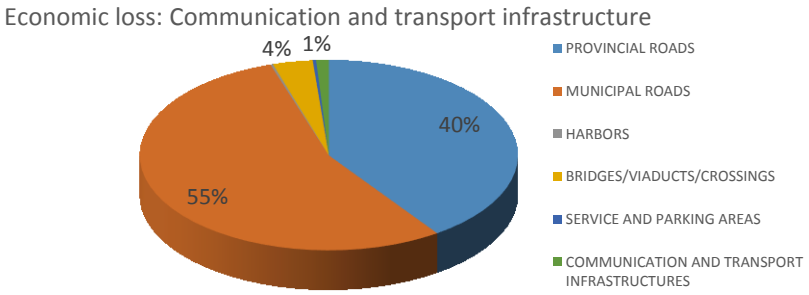


Figure 48. Economic loss of the category "Communication and transport infrastructure". Total amount nearly 70 million Euro.

The second category with the highest economic loss is "Private buildings and goods" with 33,04% that in Figure 49 is shown with the respective subcategories. The highest economic loss of this category is caused by "Economic activities trade sector"[36] and "Goods contained in private buildings" which both represent 64% of all the category loss. The subcategories "Private means of transport" and "Public/private buildings for residential use" affect 20% and 16% respectively while

[35] Since the category "Agriculture, zootechnics, fishing, mines" do not have any record, it was not represented in the graphics.

[36] On this subcategory, in previous version of FloodCat were registered the damages from the tab C of the ordinance 179/2014. Before the May 2018 edits this subcategory was "Commercial activities (offices/shops/shopping centres/artisan workshops)". This subcategory now is part of the category "Economic activities trade, industry, crafts and building sectors".

subcategories “Private buildings for non-residential use” and “Goods contained in private areas” hadn’t registered damages.

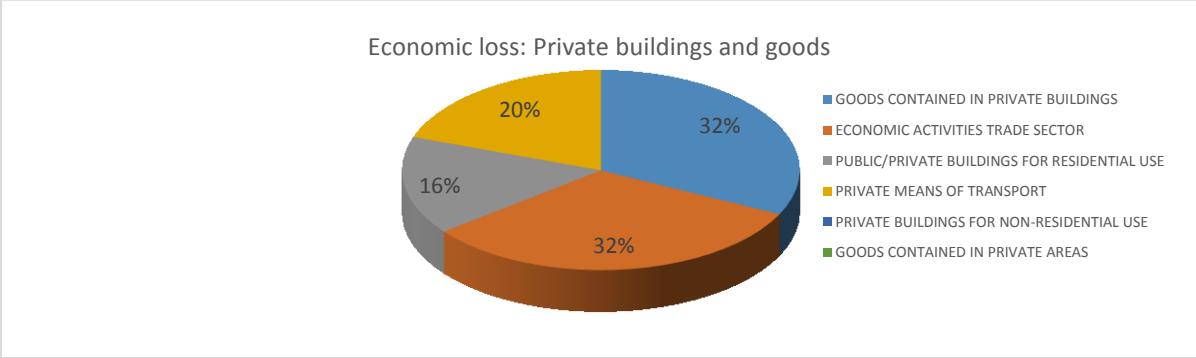


Figure 49. Economic loss of the category “Private buildings and goods”. Total amount nearly 65 million Euro.

In order to identify if the damaged category vary in function of the altimetric band the histogram of Figure 47 have been made separated for each altimetric band as in the Figure 50, Figure 51 and Figure 52. It is clear that the most affected categories vary in function of the altimetric band. In the mountainous municipalities the categories with the highest economic loss are, in decreasing order, "Communication and transport infrastructures" (70% of total economic loss of mountainous municipalities), “Public interest structures/services” (13% of total economic loss of mountainous municipalities) and "Economic activities trade, industry, crafts and building sectors" (5% of total economic loss of mountainous municipalities).

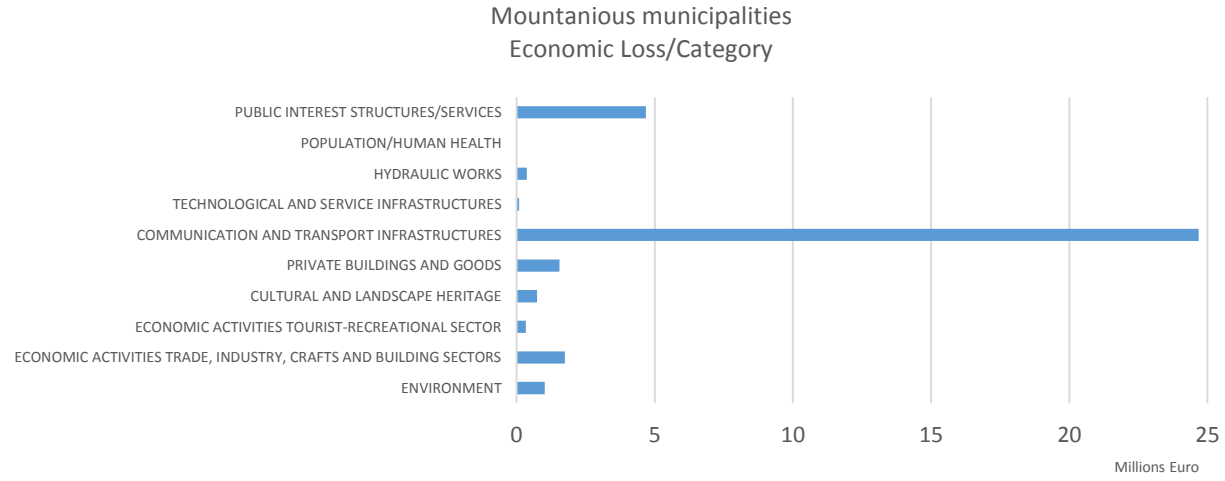


Figure 50. Economic loss for each category, mountainous municipalities.

In the hilly municipalities the categories with the highest economic loss are, in decreasing order, "Communication and transport infrastructures" (40,1% of total economic loss of hilly municipalities), “Environment” (19,7% of total economic loss of hilly municipalities) and "Economic activities trade, industry, crafts and building sectors" (19,4% of total economic loss of hilly municipalities). Compared to the mountainous municipalities, the economic loss of the hilly ones are more evenly distributed.

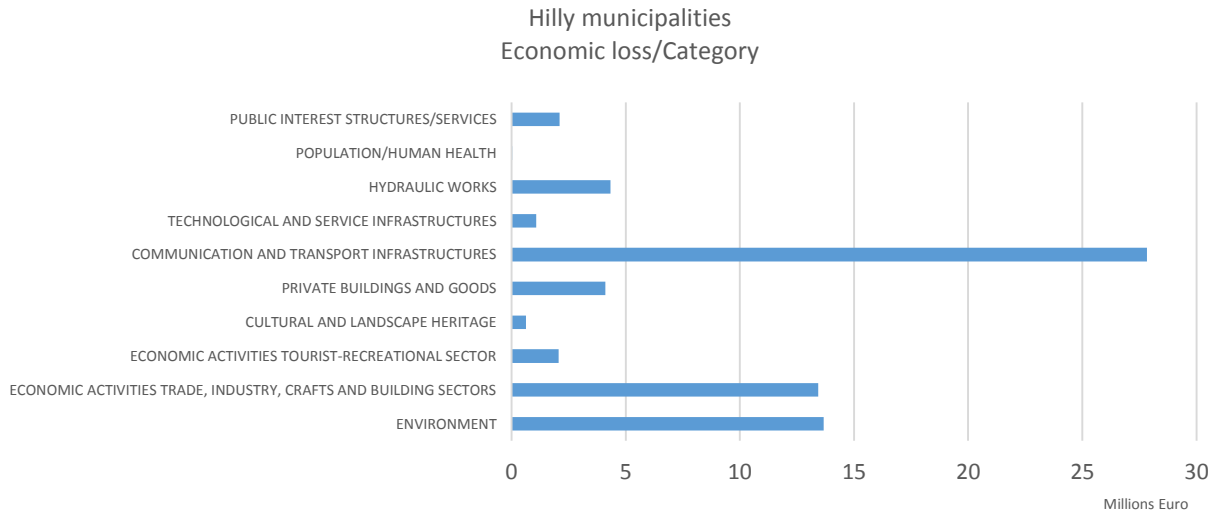


Figure 51. Economic loss for each category, hilly municipalities.

In the coastal municipalities the categories with the highest economic loss are, in decreasing order, "Private buildings and goods" (47% of total economic loss of coastal municipalities), "Economic activities trade, industry, crafts and building sectors" (27% of total economic loss of coastal municipalities) and "Communication and transport infrastructures" (12% of total economic loss of coastal municipalities).

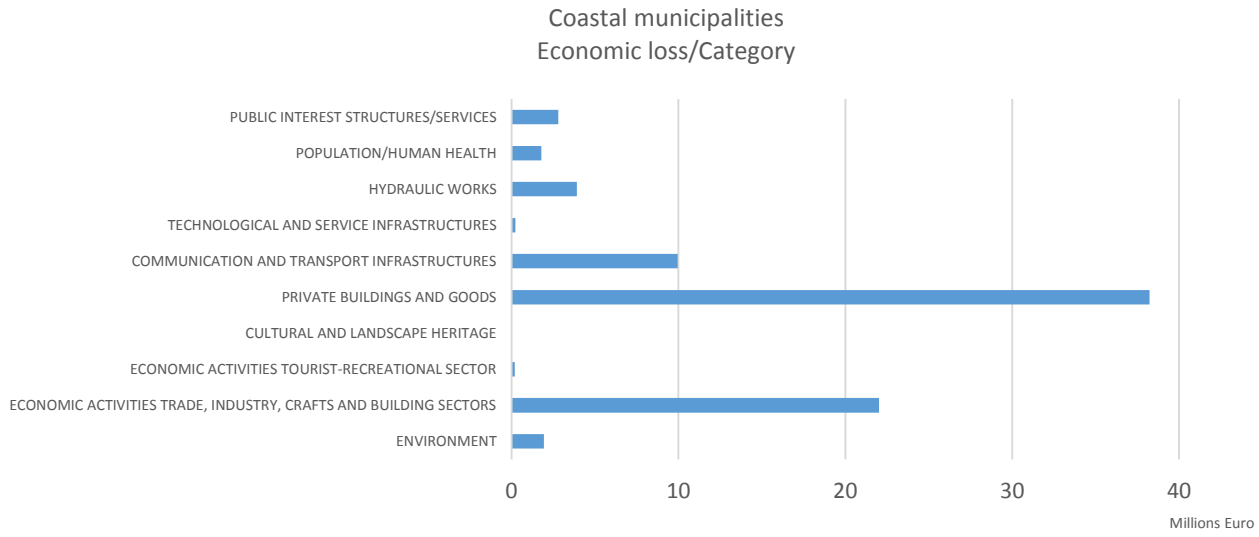


Figure 52. Economic loss for each category, coastal municipalities.

Compared to the mountainous and hilly municipalities, the economic loss of the coastal ones are higher in the category "Private buildings and goods" composed as in Figure 53. 50% of the total amount is due to “Goods contained in private buildings” of which 99% only caused in the municipality of Senigallia (coastal), the most damaged by the event.

The high amount of economic loss in the category "Private buildings and goods" can be explained by the population and building data. The coastal municipalities although represent only 10,2 % of the surface of the entire Region Marche, they have nearly 40% of the houses occupied by residents and

nearly 40 % of the resident population at the 2011 Census of the entire Region Marche. The density of population inhabitants/km2 of the entire region is 163,95 p/km2 while for the coastal municipalities is 613,99 p/km2, nearly 375 % higher than the density of the entire region.[37]

The high loss in this category of the coastal municipalities can also be explained by the low slope of their territory that collects the precipitations of the basins and the proximity to the mouth of the river.

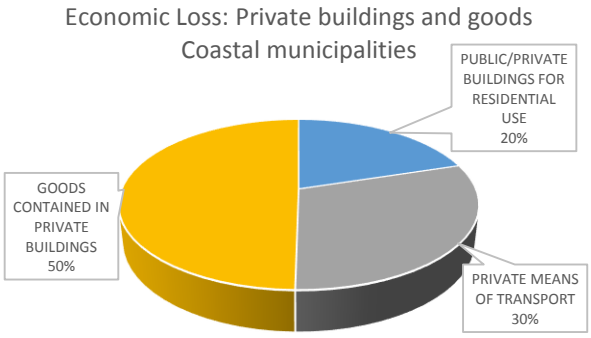


Figure 53. Economic Loss: Private buildings and goods. Total nearly 38 million Euro.

Figure 54 shows the economic loss and numeric values of different categories and sub-categories. This have been chosen between the others because have recorded quantitative values among economic loss. The numeric value represent the units of the represented Category/Subcategory. The category "Economic activities trade, industry, crafts and building sectors" has recorded the highest economic loss between those represented in the figure. The total units damaged were 567, which could be shops, industries, craft shops etc. The average economic loss for each unit is more than 65 thousand Euros. The most affected municipality for this category is Senigallia with 338 (60% of total in terms of units) units damaged and an economic loss of more than 20 million Euro (56% of total in terms of monetary value). Comparing the units damaged for the represented categories/subcategories in decreasing order the three most affected are "Damages to population-evacuated" with 2.879 people evacuated and an economic loss of more than 1,8 million Euro, "Private means of transport" with 2.661 units and more than 12,5 million Euro and "Public/private buildings for residential use" with 1.177 units and more than 10 million Euro of economic loss. Although the average economic loss for unit is in inverted order as listed above, with ≈630, ≈4.780 and ≈8.770 Euro.

[37] Elaboration of data from the National Institute of Statistics https://www.istat.it/. Was used 2011 Census data because was the latest Census data available before 2014, year of the event.

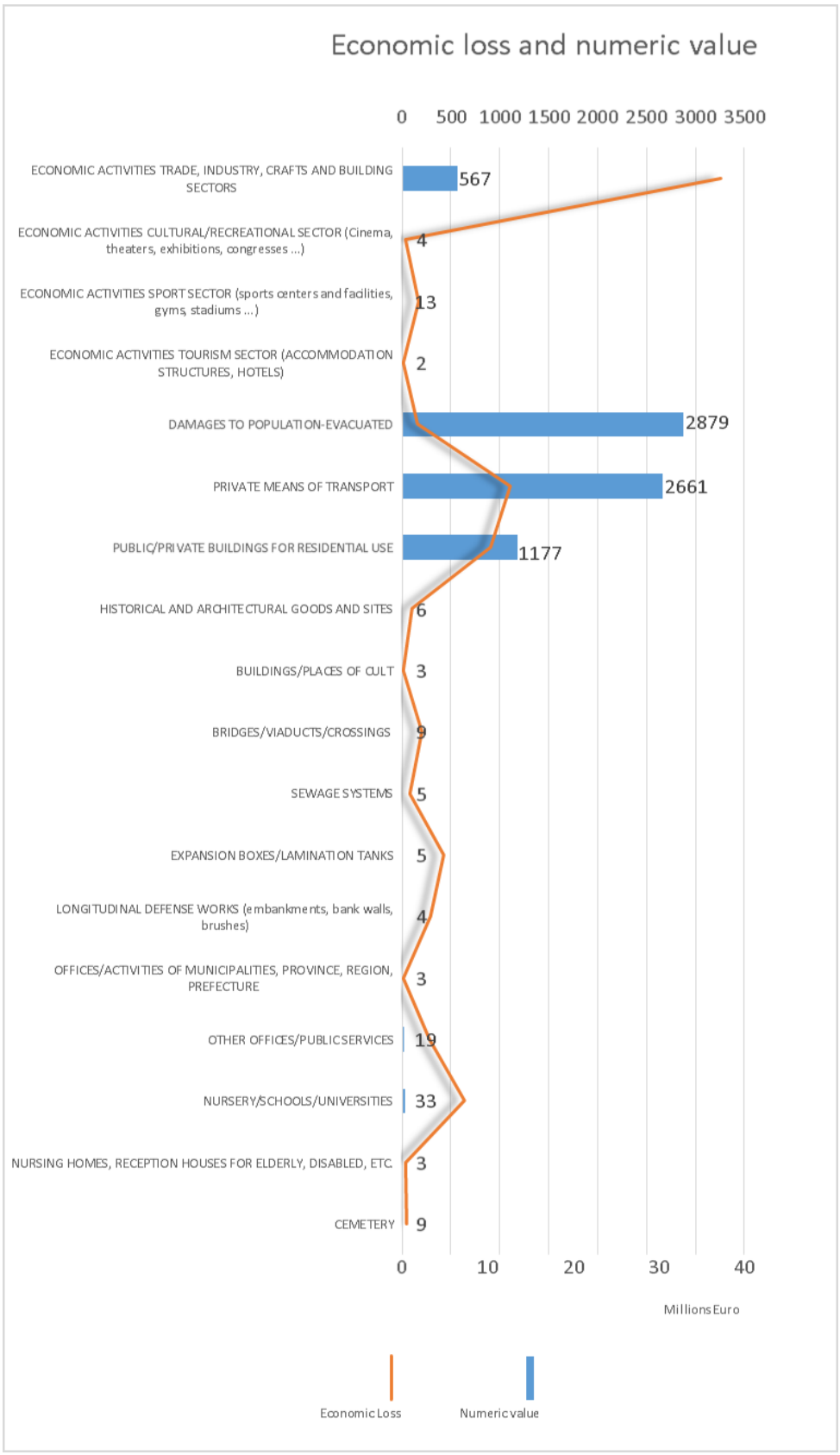


Figure 54. Economic loss and numeric value of selected categories/sub-categories.[38]

[38] The units are not referred to the same unit of measurement ex. Evacuated report the number of persons while the Private means of transport reports the number of vehicles.

7.3 Spatial analysis/distribution

Figure 55 shows the position of Marche Region in Italy and a zoomed layer with the borders of Marche Region to which are overlaid the UoM's Conca-Marecchia, Regionale Marche, Tronto e Tevere. The UoM of Tevere have just a small portion in Marche Region in the municipalities of Castelsantangelo sul nera, Monte Cavallo, Serravalle di Chienti, Ussita and Visso. For the event of May 2014 there were no damages recorded in the Tevere UoM. The figure have underneath the Digital Elevation Model-DEM in order to show the morphology of the territory which have three main altimetric bands: mountainous, hilly and coastal. Figure 56 shows the position on the map of the municipalities mentioned in the text below.

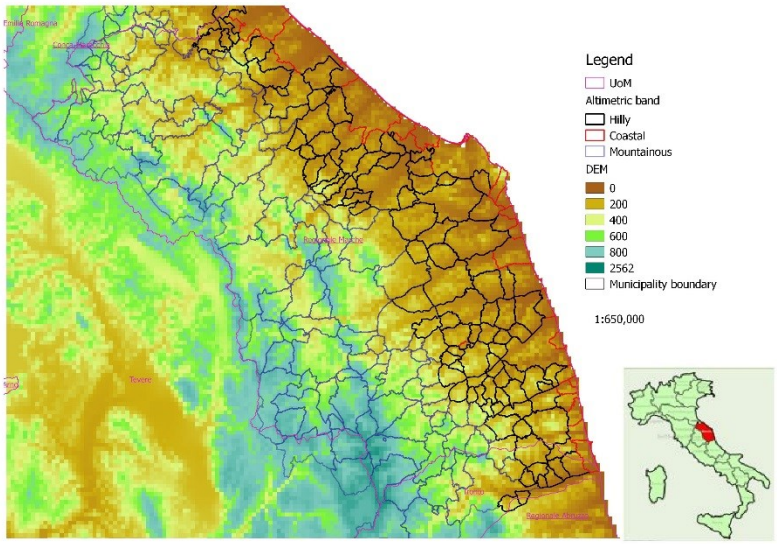


Figure 55. UoM and altimetric bands for Marche Region.

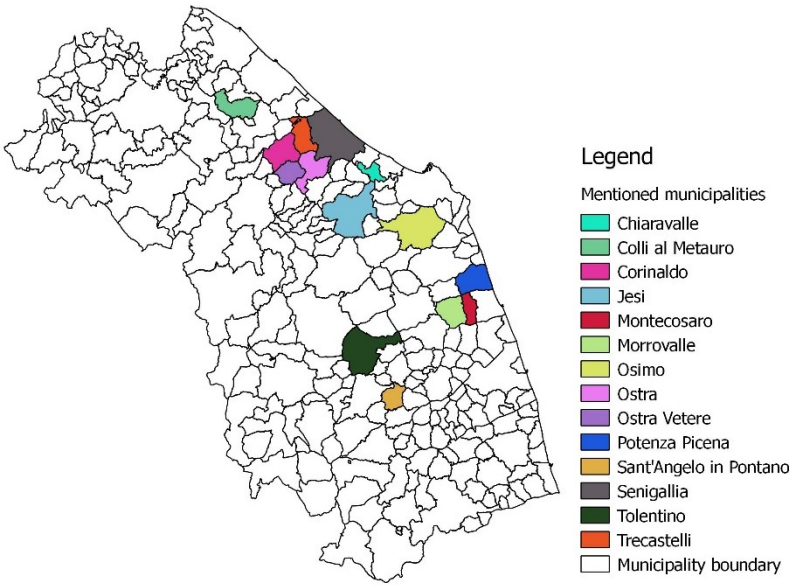


Figure 56. Mentioned municipalities.

As shown in Figure 57 the municipality with the highest economic loss is Senigallia with more than 70 million Euro of damages which is nearly 40% of the total economic loss of all municipalities. As

term of comparison is reported the total income of the municipality of Senigallia (the most affected and with the greatest economic damage) of the year 2014: 90.826.737 € (with 1993,08 € per capita).[39] Following there is Ostra and Morrovalle with nearly 11 million Euro each (6%). There are 33 municipalities with more than 1 million Euro of damages (14,4% of total municipalities). The total affected municipalities which registered economic loss are 146 that represent 63,8 % of total municipalities of Marche Region.

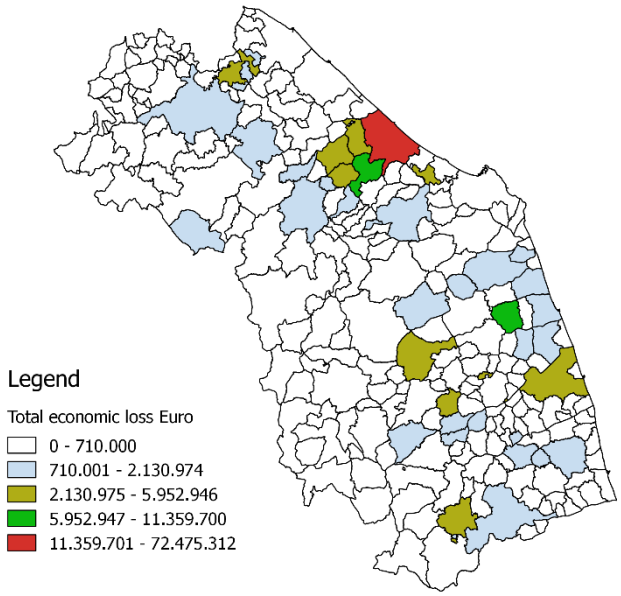


Figure 57. Total economic loss for each municipality.

The municipality of Senigallia alone have 996 buildings for residential use damaged (represent 5,3 % of the houses occupied by residents as by Census 2011), which is 85% of all buildings damaged during the event and 74% of all economic loss caused by buildings for residential use (Figure 58). Following, in decreasing order or the municipalities with more than 10 buildings for residential use damaged, there are Ostra (39), Osimo (21), Tolentino and Trecastelli (20), Chiaravalle (13) and Jesi (11) (Figure 58). Only 49 municipalities have suffered damage in buildings for residential use, which represents 21,4 % of total municipalities of Marche Region.

[39] Open bilanci http://storico.openbilanci.it

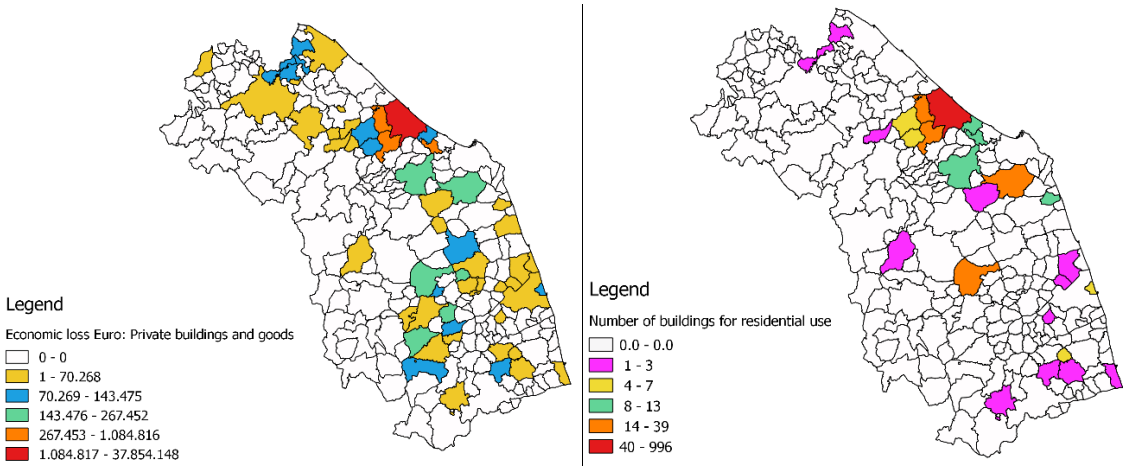


Figure 58. Economic loss due to "Private buildings and goods" and Number of buildings for residential use.

During the event of May 2014 2.661 means of transport were damaged of which 2.344 only in the municipality of Senigallia with nearly 11,5 million Euro of damages. Following, in decreasing order there are the municipalities with more than 10 means of transport damaged, there are Ostra (114), Trecastelli (69), Chiaravalle (64), Osimo (20) and Jesi (12) (Figure 59). Only 15 municipalities have suffered damage in means of transport, which represents 6,5% of total municipalities of Marche Region.

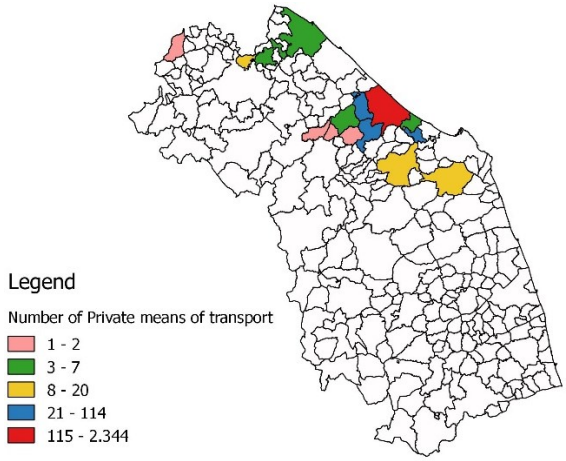


Figure 59. Number of Private means of transport.

338 economic activities from trade, industry, crafts, and building sectors were damaged in Senigallia representing 60% of all activities, while in terms of economic loss of this activities are 56% of total. Following, in decreasing order of the municipalities with more than 10 activities damaged, there are Ostra (67), Osimo (30), Ostra Vetere (21), Jesi (15), Sant'Angelo in Pontano (13), Trecastelli (12), Corinaldo (11) (Figure 60). Only 38 municipalities have suffered damage in economic activities from trade, industry, crafts, building sectors, which represents 16,6% of total municipalities of Marche Region.

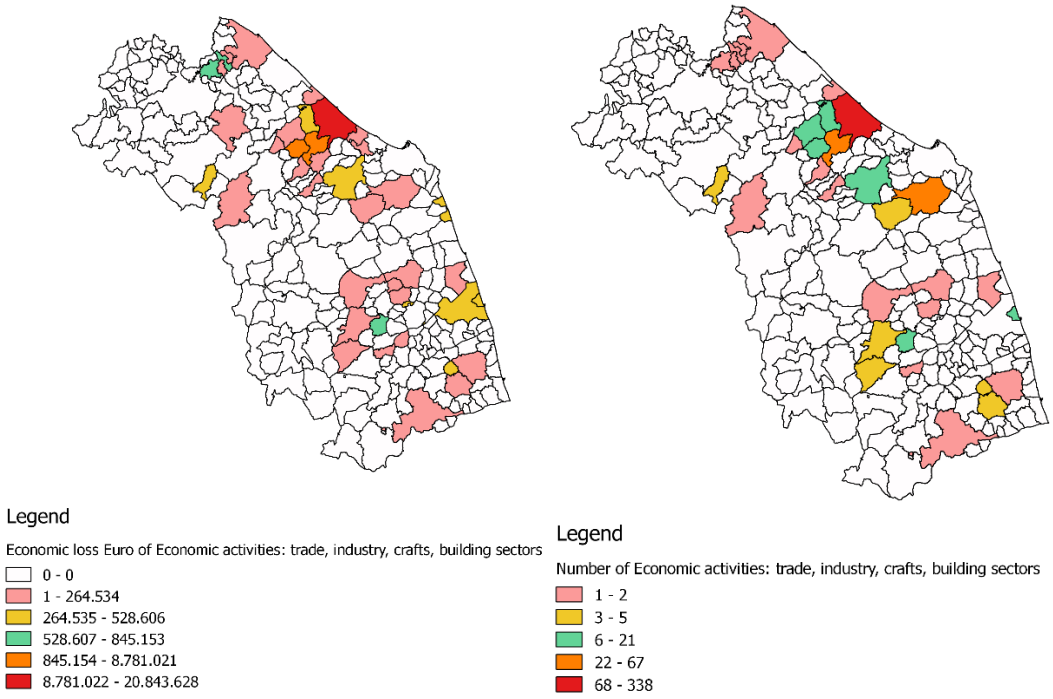


Figure 60. Economic loss and number of Economic activities: trade, industry, crafts, building sectors.

Figure 61 shows the economic loss and number of evacuated. In Senigallia were evacuated 2.861 people causing more than 1,7 million Euro of economic loss (the economic reimbursement is given for accommodation issues as by national regulations), without taking into account the extension of the state of emergency. In the following six municipalities there were people evacuated: Senigallia, Potenza Picena (7), Montecosaro (6), Tolentino (5), Colli al Metauro and Ostra. In the last two municipalities there were evacuated only in the first emergency phase and there are no data on the number of the evacuated.

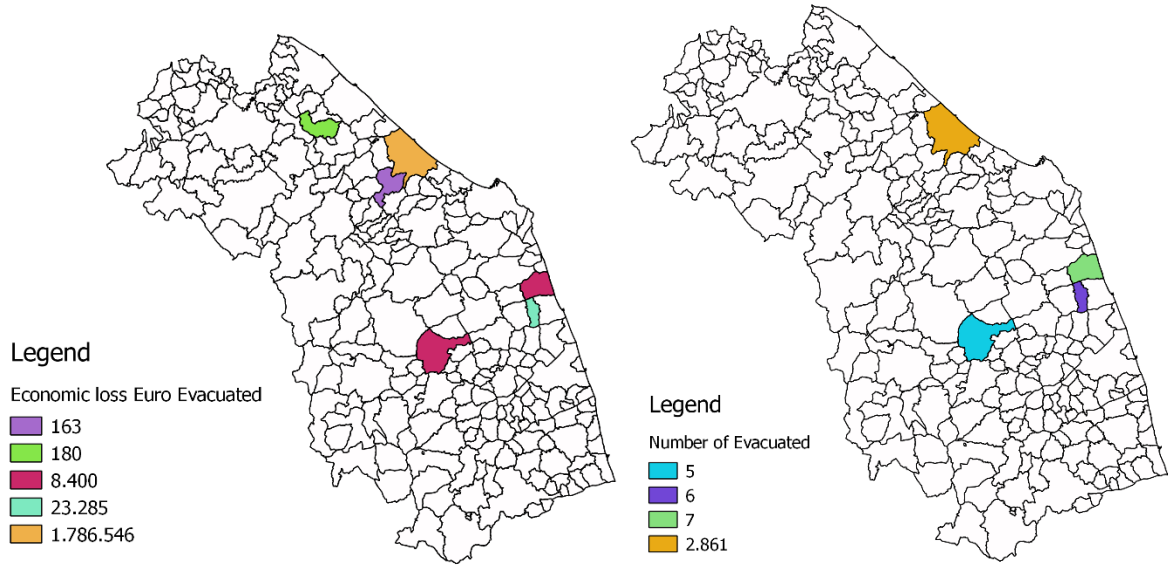


Figure 61. Economic loss and number of evacuated.

Following (

Table 24) is reported a summary table of the analysis carried out via FloodCat. Are indicated with Cat those that are categories and with Sub those that are subcategories. In FloodCat are not recorded data for the category “Agriculture, zootechnics, fishing, mines” because these data were not available.

The category “Environment” have a total economic loss of nearly 16,6 million Euro and 10,5% of the municipalities of Marche Region recorded damages in this category. The most affected municipalities in terms of economic loss are Morrovalle (≈10,5 million Euro), Montelabbate (≈1,7 million Euro) and Senigallia (≈1,1 million Euro).

The category “Economic activities trade, industry, crafts and building sectors” have 567 units damaged, which could be shops, industries, craft shops etc. The average economic loss for each unit is more than 65 thousand Euro. The most affected municipality for this category is Senigallia with 338 units (60% of category total in terms of units) damaged and an economic loss of more than 20 million Euro (56% of category total in terms of monetary value). Following, in decreasing order of the municipalities with more than 10 activities damaged, there are Ostra (67), Osimo (30), Ostra Vetere (21), Jesi (15), Sant'Angelo in Pontano (13), Trecastelli (12) and Corinaldo (11). Only 38 municipalities have suffered damage in economic activities from trade, industry, crafts and building sectors, which represent 16,6% of total municipalities of Marche Region.

The category “Economic activities tourist-recreational sector” have a total economic loss of nearly 2,6 million Euro and 9,6% of the municipalities of Marche Region recorded damages in this category. The most affected municipalities in terms of economic loss are Chiaravalle (≈0,92 million Euro), Castelbellino (≈0,25 million Euro) and Loreto (≈0,24 million Euro).

The category “Cultural and landscape heritage” have a total economic loss of nearly 1,4 million Euro and just a few municipalities recorded damages in this category. The most affected municipalities in terms of economic loss are Monte San Martino (≈0,6 million Euro), Morrovalle (≈0,4 million Euro) and Corridonia (≈0,18 million Euro).

The category “Private buildings and goods” have a total economic loss of nearly 44 million Euro and 23,1% municipalities of Marche Region recorded damages in this category. The most affected municipalities in terms of economic loss are Senigallia (≈37,8 million Euro), Ostra (≈1,1 million Euro) and Chiaravalle (≈0,9 million Euro).

The category “Communication and transport infrastructures” have a total economic loss of nearly 62,5 million Euro and 50,2% municipalities of Marche Region recorded damages in this category (highest number of affected municipalities comparing to other categories). The most affected municipalities in terms of economic loss are Senigallia (≈8,1 million Euro), Sant'Angelo In Pontano (≈4,5 million Euro) and Corinaldo (≈3,5 million Euro).

The category “Technological and service infrastructures” have a total economic loss of nearly 1,4 million Euro and 18,3% municipalities of Marche Region recorded damages in this category. The most affected municipalities in terms of economic loss are Ostra Vetere (0,5 million Euro), Senigallia (≈0,2 million Euro) and Castelleone di Suasa (≈0,2 million Euro).

The category “Hydraulic works” have a total economic loss of nearly 8,6 million Euro and 7,4% municipalities of Marche Region recorded damages in this category. The most affected municipalities in terms of economic loss are Fermo (≈3,5 million Euro), Sant'Elpidio a Mare (≈1,9 million Euro) and Ortezzano (≈1,4 million Euro).

The category “Population/human health” have a total economic loss of nearly 1,8 million Euro and just a few municipalities recorded damages in this category. The most affected municipalities in terms of economic loss are Senigallia (≈1,8 million Euro), Montecosaro (≈23,3 thousand Euro) and Potenza Picena (≈8,4 thousand Euro). 2.882 people were affected during this event of which 3 were deaths and the rest evacuated.

The category “Public interest structures/services” have a total economic loss of nearly 9,6 million Euro and 18,8% municipalities of Marche Region recorded damages in this category. The most affected municipalities in terms of economic loss are Senigallia (≈2,5 million Euro), Vallefoglia (≈0,8 million Euro) and San Lorenzo In Campo (≈0,8 million Euro).

The subcategories with the highest number of units damaged, in decreasing order, are “Damages to population-evacuated” with 2.879 people evacuated and an economic loss of more than 1.8 million Euro, “Private means of transport” with 2.661 units and more than 12,5 million Euro and “Public/private buildings for residential use” with 1.177 units and more than 10 million Euro of economic loss. Although the average economic loss for unit is in inverted order as here listed with ≈630, ≈4.780 and ≈8.770 Euro.

In Senigallia were evacuated 2.861 people causing more than 1,7 million Euro of economic loss, without taking into account the extension of the state of emergency. In this six municipalities there were people evacuated: Senigallia, Potenza Picena (7), Montecosaro (6), Tolentino (5), Colli al Metauro and Ostra. In the last two municipalities there were evacuated only in the first emergency phase and there are no data on the number of the evacuated.

During the event of May 2014 2.661 means of transport were damaged of which 2.344 only in the municipality of Senigallia with nearly 11,5 million Euro of damages. Following, in decreasing order or the municipalities with more than 10 means of transport damaged, there are Ostra (114), Trecastelli (69), Chiaravalle (64), Osimo (20) and Jesi (12). Only 15 municipalities have suffered damage in means of transport, which represents 6,5% of total municipalities of Marche Region.

The municipality of Senigallia alone have 996 buildings for residential use damaged, which is 85% of all buildings damaged during the event and 74% of all economic loss caused by buildings for residential use (Figure 30). Following, in decreasing order or the municipalities with more than 10 buildings for residential use damaged, there are Ostra (39), Osimo (21), Tolentino and Trecastelli (20), Chiaravalle (13) and Jesi (11). Only 49 municipalities have suffered damage in buildings for residential use, which represents 21,4 % of total municipalities of Marche Region.

There are 106 mountainous municipalities in Marche Region 50% of which suffered damages during the event of May 2014 and a total economic loss of nearly 34,3 million Euro. The most affected municipalities are Sant'Angelo In Pontano (≈6 million Euro), Tolentino (≈2,7 million Euro) and Roccafluvione (≈2,5 million Euro).

There are 100 hilly municipalities in Marche Region 76% of which suffered damages with a total economic loss of nearly 70,2 million Euro. The most affected municipalities are Ostra (≈11,4 million Euro), Morrovalle (≈11,3 million Euro) and Corinaldo (≈3,9 million Euro).

The coastal municipalities although in smaller number respect the hilly and the mountainous ones (only 23 coastal municipalities) recorded a higher economic loss. The total economic loss of the coastal municipalities was more than 80 million Euro and 74% were affected from the event. The most affected municipalities are Senigallia (≈72,4 million Euro), Fermo (≈4,2 million Euro) and Potenza Picena (≈1,2 million Euro).

The municipality with the highest economic loss is Senigallia with more than 70 million Euro of damages which is nearly 40% of the total economic loss of all municipalities. As term of comparison is reported the total income of the municipality of Senigallia (the most affected and with the greatest economic damage) of the year 2014: 90.826.737 € (with 1993,08 € per capita). The losses caused by the May 2014 event had an economic loss of more than 75% of the total income of Senigallia in the year 2014. Following there is Ostra and Morrovalle with nearly 11 million Euro each (6%). There are 33 municipalities with more than 1 million Euro of damages (14,4% of total municipalities). The total affected municipalities which registered economic loss are 146 that represent 63,8 % of total municipalities of Marche Region.

Table 24. Statistic summary of the event.[40]

Event of 2-4 May 2014					
	Numeric value	Economic losses (Euro)	Affected municipalities (%)	Most affected municipalities (in terms of economic loss, Euro)	Most affected municipalities (in terms of units)
(Cat) Environment	-	≈16,6 million	10,5	Morrovalle (≈10,5 million), Montelabbate (≈1,7 million), Senigallia (≈1,1 million)	-
(Cat) Economic activities trade, industry, crafts and building sectors	567	≈37,2 million	16,6	Senigallia (≈20,8 million), Ostra (≈8,8 million) Ostra Vetere (≈1,5 million)	Senigallia (338 units), Ostra (67 units), Osimo (30 units)
(Cat) Economic activities tourist-recreational sector	-	≈2,6 million	9,6	Chiaravalle (≈0,92 million), Castelbellino (≈0,25 million), Loreto (≈0,24 million)	-
(Cat) Cultural and landscape heritage	-	≈1,4 million	3	Monte San Martino (≈0,6 million), Morrovalle (≈0,4 million), Corridonia (≈0,18 million)	-
(Cat) Private buildings and goods	-	≈43,9 million[41]	23,1	Senigallia (≈37,8 million), Ostra (≈1,1 million), Chiaravalle (≈0,9 million)	-
(Cat) Communication and transport infrastructures	-	≈62,5 million	50,2	Senigallia (≈8,1 million), Sant'Angelo In Pontano (≈4,5 million), Corinaldo (≈3,5 million)	-
(Cat) Technological and service infrastructures	-	≈1,4 million	18,3	Ostra Vetere (0,5 million), Senigallia (≈0,2 million), Castelleone di Suasa (≈0,2 million)	-
(Cat) Hydraulic works	-	≈8,6 million	7,4	Fermo (≈3,5 million), Sant'Elpidio a Mare (≈1,9 million), Ortezzano (≈1,4 million)	-
(Cat) Population/human health	2.882[42]	≈1,8 million	2,6	Senigallia (≈1,8 million), Montecosaro (≈23,3 thousand), Potenza Picena (≈8,4 thousand)	-
(Cat) Public interest structures/services	-	≈9,6 million	18,8	Senigallia (≈2,5 million), Vallefoglia (≈0,8 million), San Lorenzo In Campo (≈0,8 million)	-
(Sub) Damages to population-evacuated	2.879	≈1,8 million	2,6	Senigallia (≈1,8 million), Montecosaro (≈23,3 thousand), Potenza Picena (≈8,4 thousand)	Senigallia (2.861 evac.), Potenza Picena (7 evac.), Montecosaro (6 evac.)
(Sub) Private means of transport	2.661	≈12,7 million	6,5	Senigallia (≈11,5 million), Ostra (≈0,4 million), Chiaravalle (≈0,3 million)	Senigallia (2.344 units), Ostra (114 units), Trecastelli (69 units)
(Sub) Public/private buildings for residential use	1.177	≈10,3 million	21,4	Senigallia (≈7,6 million), Sant'Angelo In Pontano (≈0,3 million), Sarnano (≈0,2 million)	Senigallia (996 units), Ostra (39 units), Osimo (21 units)
Mountainous municipalities	106	≈34,3 million	50	Sant'Angelo In Pontano (≈6 million), Tolentino (≈2,7 million), Roccafluvione (≈2,5 million)	-
Hilly municipalities	100	≈70,2 million	76	Ostra (≈11,4 million), Morrovalle (≈11,3 million), Corinaldo (≈3,9 million)	-

[40] The table does not include the data of the provinces.

[41] The value reported is with the new classifications of May 2018 where the subcategory “Economic activities trade sector” is not included in the category “Private buildings and goods”.

[42] Of which 3 dead.

Coastal municipalities	23	≈ 81,1 million	74	Senigallia (≈72,4 million), Fermo (≈4,2 million), Potenza Picena (≈1,2 million)	-
All categories	-	≈185,6 million	63,8	Senigallia (≈70 million), Ostra (≈11 million), Morrovalle (≈11 million)	-

8 Integrating FloodCat with international frameworks

Disaster risk is increasing. Many can be the causes as the land use change, increased exposure in hazard prone areas, climate change, higher amount of data available through the years etc..

Many international organizations (UN Office for Disaster Risk Reduction – UNDRR, former UNISDR, Joint Research Centre, Sigma Reinsurance) have underlined the importance of gathering and recording disaster loss data. The disaster loss data can be very useful because as essential evidence for sound policy-making and evaluating progress in reducing disaster risks (De Groeve, Poljansek, Ehrlich, & Chorbane, Current status and Best Practices for Disaster Loss Data recording in EU Member States, 2014). With increased understanding of the disaster trends and their impacts, better prevention, mitigation and preparedness measures can be planned to reduce the impact of disasters on the communities.

Specifically for the Flood hazard, across the bibliography are identified different issues that make difficult the implementation of the Flood Directive, among them there is the general lack of data when quantifying the flood consequences because it is required a considerable amount of information both in time and space.

Disaster databases usually lack on economic loss data. To overcome this through the years have been developed several methods for the assessment of economic losses as the Damage And Loss Assessment methodology (The International Bank for Reconstruction and Development/The World Bank, 2010), the OECD Framework For Accounting National Risk Management Expenditures And Losses of Disasters (2014), the IRDR Guidelines on Measuring Losses from Disasters (2015).

Sendai Framework is nowadays the most important agreement in the field of DRR. Also the 17 October 2019, experts from 31 of the Union Civil Protection Mechanism (UPCM) participating countries met with their National Sendai Framework counterparts in Brussel. During this meeting emerged that European countries have moved a step closer to aligning their civil protection agendas with the implementation of the global plan to reduce disaster losses, the Sendai Framework for Disaster Risk Reduction.

The Sendai Framework recommended that the necessary indicators to measure its progress should be developed through an intergovernmental process by establishment of an Open-ended Intergovernmental Expert Working Group (OEIWG) on indicators and terminology relating to DRR. The work of this group took place in conjunction with the work of the Inter agency and Expert Group on Sustainable Development Goal Indicators (IAEG-SDGs).

Comprising experts nominated by Member States and relevant stakeholders, OEIWG developed the terminology relating to DRR and a set of 38 indicators of progress for the seven global targets. The final outcome was produced in December 2017 “Technical Guidance for Monitoring and Reporting on Progress in Achieving the Global Targets of the Sendai Framework for Disaster Risk Reduction” by UNDRR (Technical Guidance for Monitoring and Reporting on Progress in Achieving the Global Targets of the Sendai Framework for Disaster Risk Reduction, 2017).

As disaster databases usually lack on economic loss data and also because small events with no state of emergency declared have damages but the need recognition and consequently the economic loss damage have not been reported we will focus on Target C “Reduce direct disaster economic loss in relation to global gross domestic product (GDP) by 2030”. To give an idea of the magnitude of the potentially missing costs, more than 118,000 records (from 274,973 records in total, used for GAR 2013, 43 %) were found in the dataset with qualitative but not quantitative indicators (Global Assessment Report on Disaster Risk Reduction 2013, 2013). The OIEWG’s report contains a chapter

with all the indications on target C "Technical Note on Data and Methodology to Estimate Direct Economic Loss to Measure the Achievement of Target C of the Sendai Framework for Disaster Risk Reduction". This chapter outlines the data, indicators and methodologies required for the estimation of direct economic costs attributed to disasters. The economic model built for the Sendai Framework to assess direct economic losses caused by disasters is under development. It started from concepts and methods of more detailed and refined models such as the United Nations Economic Commission for Latin America and the Caribbean (ECLAC) methodology, but was simplified to respond to the challenge of evaluating hundreds or thousands of events around the globe that did not have a proper economic assessment of economic damage in the field and improved with the development of the technical guidance notes for targets and indicators. Also to be mentioned that following large-scale disasters in order to assess economic loss are used methodologies such as PDNA (Post Disaster Damage and Needs Assessment) and DALA (Damage, Loss and Need Assessment) derived from the above-mentioned ECLAC methodology. So for this study the referring methodology will be based mainly on OIEWG's methodology for Sendai target C. This methodology have been used in the Global Assessment Report on disaster Risk Reduction 2019 (Global Assessment Report on Disaster Risk Reduction (GAR), 2019) and the new online Sendai Framework Monitoring system that is a state-of-the-art system built to support all the new indicators, extended hazards types and metadata mechanisms that were recommended by OEIWG and adopted by the United Nations General Assembly.[43]

8.1 OIEWG's methodology for Sendai Target C

The "Technical Note on Data and Methodology to Estimate Direct Economic Loss to Measure the Achievement of Target C of the Sendai Framework for Disaster Risk Reduction" outlines the data, indicators and methodologies required for the estimation of direct economic costs attributed to disasters. The indications and formulas contained in the above mentioned notes are based on:

- a simplified and adapted version of the UN Economic Commission for Latin America and the Caribbean methodology for disaster assessment (UN-ECLAC, 2014) (Handbook for Disaster Assessment, 2014) (for built environment based on the concept of replacement values, or rehabilitation or reconstruction costs), Indicators C-3, C-4 and C-5;
- a methodology to assess economic losses of the agricultural sector that has been developed by the Food and Agriculture Organization of the United Nations (FAO) (based on the concept of lost production), Indicator C-2.

Following there is a brief summary of Target C technical note. For further detail please refer to the "Technical Guidance for Monitoring and Reporting on Progress in Achieving the Global Targets of the Sendai Framework for Disaster Risk Reduction" by UNDRR (Technical Guidance for Monitoring and Reporting on Progress in Achieving the Global Targets of the Sendai Framework for Disaster Risk Reduction, 2017).

Table 25 lists the indicators recommended by the OIEWG for the measurement of global Target C of the Sendai Framework. It also synthetize the formulas with which the indicators can be calculated.

[43] Sendai Framework Monitoring database can be accessed at https://sendaimonitor.unisdr.org.

Table 25. Indicators, formulas and comments for SFDRR Target C.

No.	Indicator	Associated formulas/Comments
C-1	Direct economic loss attributed to disasters in relation to global gross domestic product. (compound indicator) C1=(C2+C3+C4+C5+C6)/GDP	
C-2	Direct agricultural loss attributed to disasters (Agriculture is understood to include the crops, livestock, fisheries, apiculture, aquaculture and forest sectors as well as associated facilities and infrastructure.) C2=C-2C (Direct crop loss)+C-2L (Direct livestock loss)+C-2FO (Direct forestry loss)+C-2A (Direct aquaculture loss)+C-2FI (Direct fisheries loss)	C-2C (Direct crop loss)=Loss in annual crop stocks + Loss in perennial crop stocks + Annual crop production loss + Perennial crop production loss + Crop assets loss (complete and partial)
		C-2L (Direct livestock loss)=Loss in livestock stocks + Livestock production loss + Livestock asset replacement and/or repair costs (complete and partial)
		C-2FO (Direct forestry loss)=Loss in forestry stocks + Forestry production loss + Forestry asset loss (complete and partial)
		C-2A (Direct aquaculture loss)=Loss in aquaculture stocks + Aquaculture production loss + Aquaculture asset loss (complete and partial)
		C-2FI (Direct fisheries loss)=Loss in fisheries stocks+ Fisheries production loss + Fisheries asset loss (complete and partial)
C-3	Direct economic loss to all other damaged or destroyed productive assets attributed to disasters.	Method 1 – If no differentiation between damaged and destroyed is made in the data collection: C3=C3a(number of productive assets of each type, either damaged OR destroyed)*average asset size*construction cost per square meter*equipment ratio*infrastructure ratio*affected ratio
		Method 2 – Damaged and Destroyed Assets Separate Reporting: C3=[C3b(number of productive assets damaged of each type)*average asset size*construction cost per square meter*equipment ratio*infrastructure ratio*damage ratio] + [C3c(number of productive assets destroyed of each type)*average asset size*construction cost per square meter*equipment ratio*infrastructure ratio]
C-4	Direct economic loss in the housing sector attributed to disasters. C4=C4a (economic value of loss in houses damaged by disaster)+C4b (economic value of loss in houses destroyed by disaster)	C4a(economic value of loss in houses damaged by disaster)= number houses damaged*average size*construction cost per square meter*equipment ratio*infrastructure ratio*damage ratio
		C4b(economic value of loss in houses destroyed by disaster)= number houses destroyed*average size*construction cost per square meter*equipment ratio*infrastructure ratio
C-5	Direct economic loss resulting from damaged or destroyed critical infrastructure attributed to disasters. (it is almost impossible to provide guidance for all types of infrastructure) C5=C5(buildings)+C5(linear)+C5(other)	Critical Infrastructures that consists of buildings (for example Health and Education facilities) Method 1 – Data not disaggregated (no distinction of Damaged/Destroyed) C5(buildings)=number of affected facilities*average size of the facilities*construction cost per Unit*equipment ratio*infrastructure ratio*affected ratio
		Critical Infrastructures that consists of buildings (for example Health and Education facilities) Method 2 – Data disaggregated in Damaged and Destroyed C5a(buildings)=number of damaged facilities*average size of the facilities*construction cost per Unit* infrastructure ratio*affected ratio C5b(buildings)=number of destroyed facilities*average size of the facilities*construction cost per Unit* infrastructure ratio
		Critical Infrastructures that consists of linear elements (for example roads)

		Method 1 – Data no disaggregated (no distinction of Damaged/Destroyed) C5(linear)=length of affected elements*rehabilitation cost per Unit length
		Critical Infrastructures that consists of linear elements (for example roads) Method 2 – Data disaggregated in Damaged and Destroyed C5a(linear)(economic loss from damaged infrastructure)=length of damaged elements*rehabilitation cost per Unit length C5b(linear)(economic loss from destroyed infrastructure)=length of damaged elements*reconstruction cost per Unit length
C-6	Direct economic loss to cultural heritage damaged or destroyed attributed to disasters.	• The value of cultural heritage assets cannot be assessed in simple economic terms, and even less in terms of Direct Economic Loss; • Most losses associated with cultural heritage are intangible losses, i.e. associated with the historical and/or artistic value of cultural heritage assets. Also, a good part of economic losses associated with cultural assets are indirect losses, mainly connected to future income losses associated to tourism, culture, and recreation; • Costs to be evaluated by experts and on a per case basis because of great variation in the value of cultural heritage assets.

8.2 Target C adapted to Marche Region

Given the very significant differences among data collection processes around the world, the OIEWG Report and discussions gave countries freedom to choose between the methodology proposed by the secretariat or a selected nationally defined methodology by which direct economic loss attributed to disasters is determined. In all cases and independently of the selected economic assessment methodology, the secretariat strongly suggests, as best practice, that all of the physical damage indicators are collected and kept by countries as these are important information assets, to feed Risk Assessments, to help understanding disaster risk, and to provide transparency as means of verification of the indicators. They can also play an important role in Quality Control of the data.

In such a context this paragraph will try to adapt direct economic loss estimation formulas to the Italian case and more specifically to Marche Region territory.

As shown in Table 25 the indicator C6 is very difficult to estimate because the cultural heritage have a great variation in the asset value and have to be evaluated by experts and on a per case basis. Also most losses associated with cultural heritage are intangible losses, i.e. associated with the historical and/or artistic value of cultural heritage assets and a good part of economic losses associated with cultural assets are indirect losses, mainly connected to future income losses associated to tourism, culture, and recreation. As a result cannot be proposed a formula or the calculation of the direct economic loss of the cultural heritage in Marche Region. Also as the indicator C1 is a compound indicator it would not be possible to calculate neither.

In FloodCat for Marche Region there is only one damage record of the category “Agriculture, zootechny, fisheries, mines” that have recorded the numeric value of the damage and also is not clear which unit of measurement is referred to. For this reasons the indicator C2 of SFDRR that relates to agriculture loss is not worth to calculate.

A problem that still remains in FloodCat is that the unit of measurements for each subcategory are still not specified in the database and for the purposes of damage estimation the quantitative

indicators are very important and the basis for all the estimations formulas. For this reason will not be performed calculations on the indicator C3. We will focus on the indicator C4 and C5 because although in FloodCat the unit of measurements continue not to be clear in the database, when recording data during the PhD the recording of the numeric value followed the same logic of what the OIEWG's methodology consider quantitative indicators. Will be considered the houses, the educational facilities and the health facilities. The educational and health facilities have a much higher variance than houses in size and therefore in economic value. The value of the square meter was valuated with the same criteria as for the housing sector, and it also didn't consider equipment and other costs associated to disaster recovery and reconstruction.

To be mentioned that FloodCat do not allow to consider if an asset is damaged or destroyed although it contains a field on the class of damage which was requested by the DPC and ISPRA not to fill. The calculations will be made taking into consideration that the assets were damaged and destroyed in order not to overestimate the economic loss by considering the assets all destroyed or underestimate by considering the assets all damaged. Assuming 20% of the assets reported to be affected are considered destroyed and the rest (80%) suffered damage. If an average damage ratio of 25% is used, then the overall affected ratio would be the composite of 100% damage for 20% of assets plus 25% damage to 80% of industries, giving an overall average affected ratio of 40%. For the formulas will be used the same unit price in constant monetary units for all the moments in order to observe only affected surface trend.

According to the law of 18 April 1962, n. 167 "Provisions to promote the acquisition of areas for economic and popular building" Article 1 the municipalities with a population of more than 50,000 inhabitants or provincial capitals are required to form a plan of the areas to be used for the construction of economic or popular housing (PEEP), as well as complementary urban and social works and services, including public green areas (LEGGE 18 aprile 1962, n. 167 "Disposizioni per favorire l'acquisizione di aree ... per l'edilizia economica e popolare", n.d.). In some PEEP found on the web was found out that a surface of 21 m^2 was dedicated for each inhabitant (if we consider a house in which live at least two people than it should be at least 42 m^2 (Piano per l'edilizia economica e popolare (P.E.E.P.) - Apl 4 Petralacroce (Forte Altavilla)) and that the construction surface should not be bigger than 96 m^2 (Comune di Treviso). This is in line with the methodology proposed by OIEWG that suggest a 45 square meter house.

The final simplified formulas used for the next paragraph are:

Economic value of loss in houses damaged and destroyed (C4) =
NDDH*36*(GDPpc2011*0.0118+304.74)

Where:

- NDDH = Number of damage and destroyed houses;
- 36 = (45 m^2 *40%) + (40 % * 45 m^2)
    - 45 m^2 is the construction surface, as by the methodology proposed by OIEWG, concept of a "Social Interest Housing solution" used in many types of risk assessments;
    - average affected ratio of 40%;
    - 18 = 45 m^2 * 40 % (where 45m^2 is considered as the surface of a social interest housing solution and 40% that consider the value of the equipment and the value of the urban infrastructure associated to loss of houses which should account to water, sewage, roads, green areas, electrical and communications infrastructure that usually results damaged in disasters);

- (GDPpc2011 * 0.0118 + 304.74) = 1 m^2 of basic construction, formula provided by Compass International, the GDPpc is the GDP of Marche Region (not of Italy) for the year 2011 as the year with the highest economic damage.

Economic value of loss in Education facilities (C5 buildings EF) =
NAF*60*(GDPpc2011*0.0118+304.74)

Where:

- NAF = number of affected facilities;
- 60 = (75 m^2 *40%) + (40 % * 75 m^2)
  - 75 m^2 average size of the facilities. Construction area for small schools was estimated as a facility of two classrooms of 6x5 meters (60 sqM2) plus a common area of 15 sqM2, for a total of 75 m^2, UN-ECLAC DaLA Methodology;
  - average affected ratio of 40%;
  - 30 = 75 m^2 * 40 % (40% that consider the value of the equipment and the value of the urban infrastructure associated to loss of the facility which should account to water, sewage, roads, green areas, electrical and communications infrastructure that usually results damaged in disasters);
- (GDPpc2011 * 0.0118 + 304.74) = 1 m^2 of basic construction, formula provided by Compass International, the GDPpc is the GDP of Marche Region (not of Italy) for the year 2011 as the year with the highest economic damage.

Economic value of loss in Health facilities (C5 buildings H) = NAF*38,4*(GDPpc2011*0.0118+304.74)

Where:

- NAF = number of affected facilities;
- 38,4 = (48 m^2 *40%) + (40 % * 48 m^2)
  - 48 m^2 average size of the facilities. Health facilities were characterized as a waiting room of 3x4 Mts. (12 m^2), a consulting room of 3x4 M an operating/first aid section of 5x4 Mts. (20 m^2), with a medicine depot and maintenance area of 4 m^2, for a total of 48 m^2, UN-ECLAC DaLA Methodology;
  - average affected ratio of 40%;
  - 30 = 48 m^2 * 40 % (40% that consider the value of the equipment and the value of the urban infrastructure associated to loss of the facility which should account to water, sewage, roads, green areas, electrical and communications infrastructure that usually results damaged in disasters);
- (GDPpc2011 * 0.0118 + 304.74) = 1 m^2 of basic construction, formula provided by Compass International, the GDPpc is the GDP of Marche Region (not of Italy) for the year 2011 as the year with the highest economic damage;

8.3 Target C applied to data of Marche Region

The formulas of the previous paragraph have been applied to the data of FloodCat for Marche Region. Was selected only the data with quantitative indicators and an economic value recorded for the private housing sector, the educational facilities and health facilities. This because the aim is to see how much this formulas are close the real economic loss recorded in order to see if the formulas can be useful in the future to estimate the economic damage in the above mentioned categories in cases when the declaration of the state of emergency is not made and so there is no need recognition and data on damages. This will help calibrating the damage formulas with real data recorded.

For the private housing sector, in FloodCat was selected the data of the category "Private buildings and goods", subcategory "Private/Public buildings for residential use". This subcategory name was changed in 2018 by adding "public" but were recorded data only on private buildings as was named in previous FloodCat versions. There is a total of 128 records that contains a quantitative value and an economic value for this subcategory. The formulas will apply to this selection comparing calculated and real data. Figure 62 shows the results. All the data except one are comprehended in a small interval of economic loss. The highest value is due to a damage record with 885 damaged building. In this isolated case the estimated value and the real recorded one differ most than all other records: 19.479.443 Euro the estimated loss (3 times higher) and 6.472.801 Euro the recorded loss. There is a big overestimation of the damage in this case.

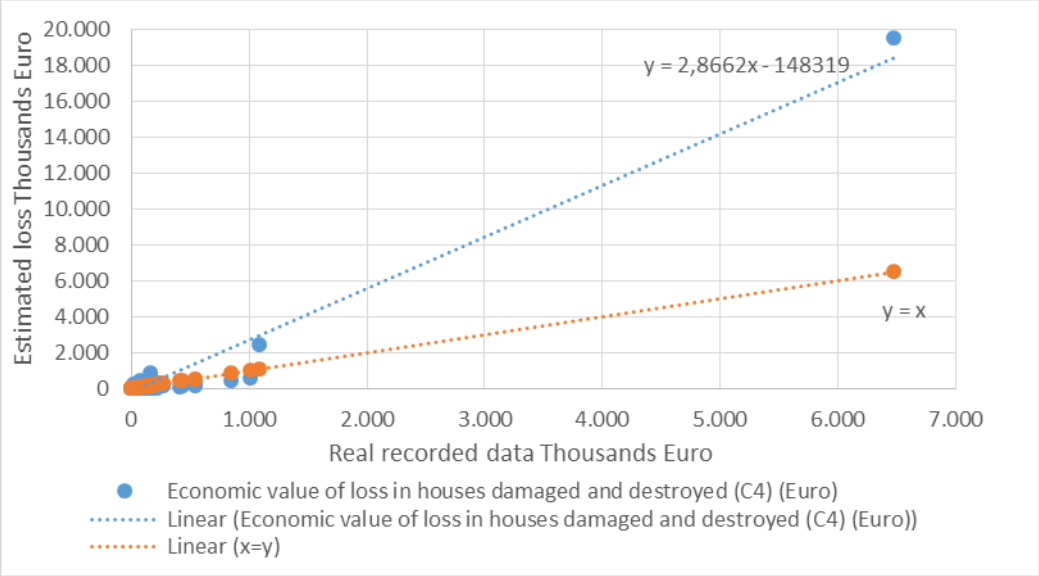


Figure 62. Real data vs. estimated data. Housing sector.

When excluding this damage record from the analysis than we would have the result in Figure 63 where the recorded value and the estimated one match better and the tendency line visually seems like coincident with an equation Y=0.9901X+12.544, which is a great result with a coefficient before X of nearly 1. As a conclusion it would be appropriate to say that the proposed formulas in the previous paragraph for the housing sector can be a solution in the cases where there is not a need recognition for the damaged housing sector because it is a small event and this are not recorded or because it is a bigger event but the data on housing are not collected because it is not foreseen a reimbursement by the State (In Italy usually the houses are not reimbursed because they should be insured and the insurance companies deal with this damages). In the future it would be appropriate to test again this formula for the damage records with high quantitative values of houses.

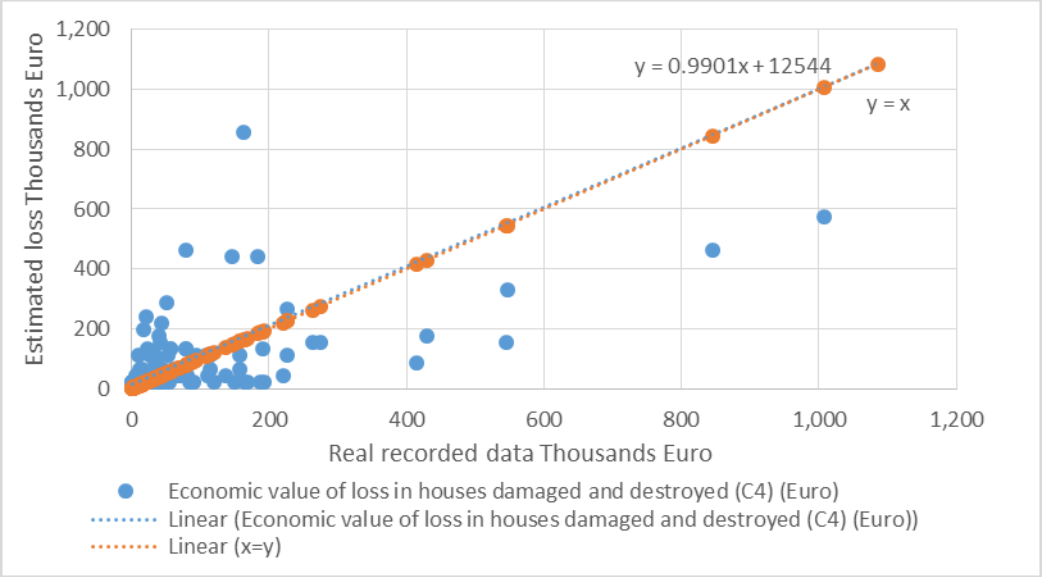


Figure 63. Real data vs. estimated data excluding highest damage record. Housing sector.

For the educational facilities, in FloodCat was selected the data of the category "Public interest structures/services", subcategory "Structures/Services for education Kindergarten/Schools/Universities". There is a total of 48 records that contains a quantitative value and an economic value for this subcategory. The formulas will apply to this selection comparing calculated and real data. Figure 64 shows the results. The results shows that the formula can underestimate the damages and should be made greater effort to better align real data with estimated data for the educational facilities.

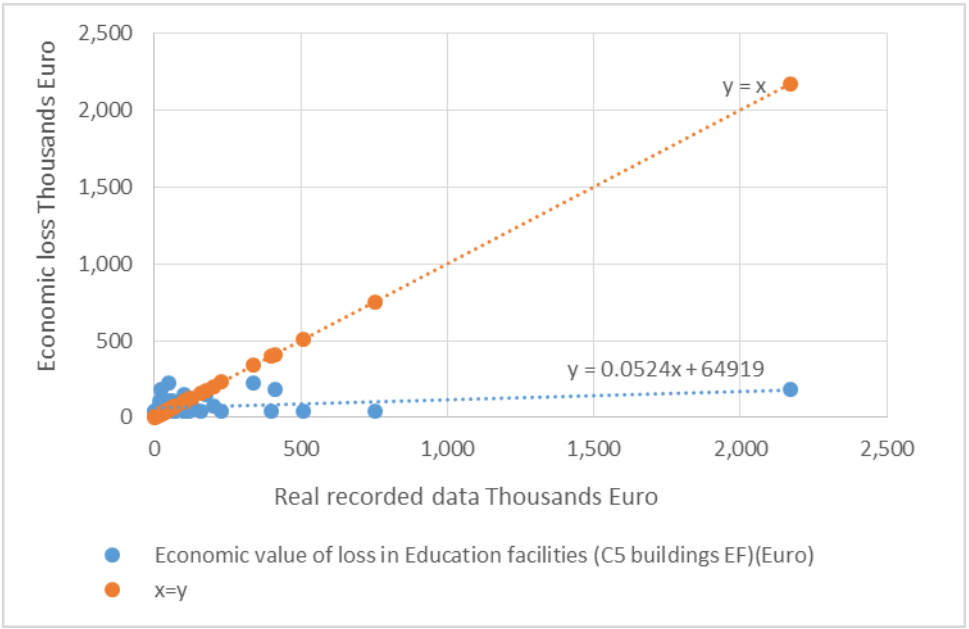


Figure 64. Real data vs. estimated data. Educational facilities.

For the health facilities, in FloodCat was selected the data of the category "Public interest structures/services", subcategories "Structures/Services for sanitary assistance – Hospitals" and "Structures/Services for health – Nursing homes, shelters for the elderly, the disabled, etc.". There is a total of 10 records that contains a quantitative value and an economic value for this subcategories.

The formulas will apply to this selection comparing calculated and real data. Figure 65 shows the results. As in all ten damage records was recorded only one facility than the estimated value is always one and there is no variety. For this reason the formula for health facilities have to be used in a larger dataset to understand if it can be a good formula to estimate damage or not. Anyway for the data shown in Figure 65 except for two damage records, the other 8 damage record shows that the formula underestimate the damage.

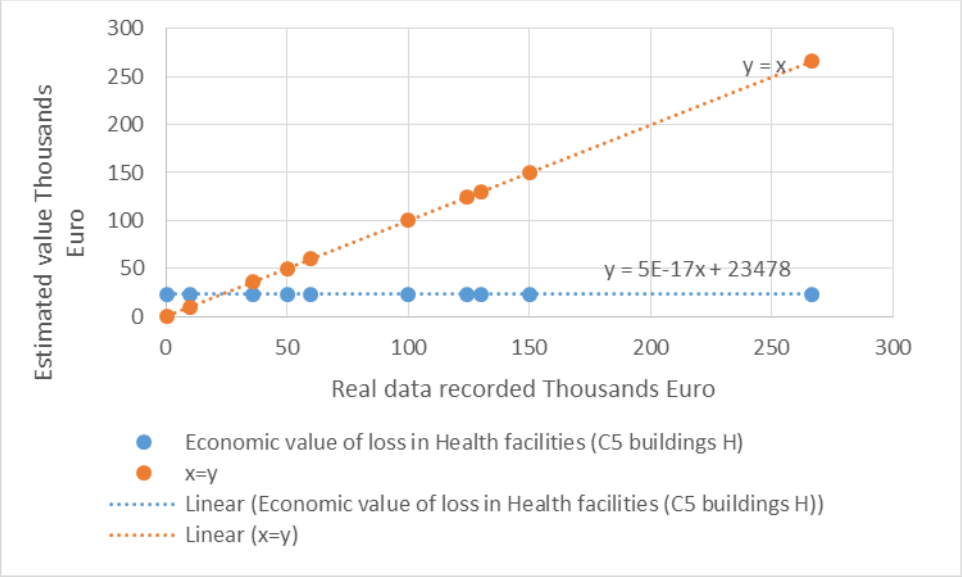


Figure 65. Real data vs. estimated data. Health facilities.

9 Overall conclusions and discussion

At global level exist different databases that record disasters: hazard specific, multi-hazard, focused on natural disasters, focused on technological disasters or both type of disasters. Some databases have some threshold criteria for entries as EM-DAT while others like DesInventar do not have a threshold value for entries. The databases have different structures and different fields for the record, there is a lot of heterogeneity in different aspects. The geographical level of data collection and recording also is different, there are also databases at country level, regional level etc.. Here it is reported a table (Table 26) that compares and shows the main characteristics of the above mentioned databases.

Table 26. Main database characteristics.

Database name	EM-DAT	NatCatSERVICE	SHELDUS	CDD	DesInventar Sendai	Global Active Archive of Large Flood Events	Catalogue AVI	FloodCat
Owner	CRED	Munich RE	Arizona State University	Public Safety Canada	UNDRR	University of Colorado	CNR	DPC
Website	https://www.emdat.be/	https://natcatservice.munichre.com/	https://cemhs.asu.edu/sheldus	https://www.publicsafety.gc.ca	www.desinventar.net/migrate_Sendai.html	http://floodobservatory.colorado.edu	http://avi.gndci.cnr.it/	http://www.mydewetra.org/
Hazard	Multi-hazard	Multi-hazard	Multi-hazard	Multi-hazard	Multi-hazard	Floods	Floods & Landslides	Floods
Geographical coverage	Global	Global	US	events that have directly affected Canadians	Global	Global	Italy	Italy
Number of entries till 2018	more than 22000	more than 18,169	898194	more than 1000	Depends on the country	4711 (period 1985-2018)	(period 1030-2001) more than 25.000 records	not quantified, comprehend AVI records
Source of data	UN agencies, non-governmental organisations, insurance companies, research institutes and press agencies	Munich RE branch offices; Insurance Associations; Insurance press; Scientific sources; Weather services; Governmental and non-governmental organisations	National Climatic Data Centre's monthly Storm Data publications, NGDC's Tsunami Event Database, USGS (earthquakes)	Federal institutions, provincial/territorial governments, non-governmental organizations and media sources	Government agencies, NGOs, and research institutes, newspapers	News, governmental, instrumental, and remote sensing sources	journals/newspapers, expert interviews, books, published and unpublished technical and scientific reports	Regional authorities
Loss indicators related to	Event Location Population Economy	Event Location Population Economy Housing Infrastructure	Event Location Population Economy	Event Location Population Economy	Event Location Population Economy Housing Infrastructure	Event Location Population Economy	Event Location Population Economy Housing Infrastructure	Event Location Population Economy Housing Infrastructure

In the common goal of reducing the risk of forthcoming disasters, legislation, initiatives, documents and frameworks at national, European and international level have been produced during the last decades to find common targets and set milestones for the coming horizon. An effort was made to compare FloodCat with the above mentioned initiatives which are relevant for this doctoral study. This comprehend the European Union Flood Directive, the Joint Research Centre's guidances on disaster losses, the Sendai Framework for Disaster Risk Reduction 2015-2030, the Sustainable Development Goals, AVI catalogue and the INSPIRE Directive.

The data of the proposed database of JRC's "Guidance for recording and sharing disaster damage and loss data" contained in the table Event are very similar to those contained in the tabs Event and Phenomenon of FloodCat while the data contained in the tables Assets and Damage are hardly comparable with the tab Damage of FloodCat as they are conceptualized very differently. The Damage tab of FloodCat can be seen as an intersection/combination of the tables Assets (and associated tables) and Damages (and associated tables) of JRC's proposal. Because of the different conceptualization behind (data on the assets pre-event of JRC and only post damage data of FloodCat) and because of the many associated tables, their relative connection and fields not explained in detail as in FloodCat the comparison is just an effort to match heterogeneous methodologies. FloodCat comprehend the proposed fields of the Event part of the proposed JRC's database by 74%.

All the Sendai indicators of the Global Targets A, B, C and D can be measured or in a few cases roughly measured using FloodCat. The Global Targets E, F and G cannot be compared with FloodCat as they deal with number of nations, international cooperation and early warning.

Regarding the Sustainable Development Goals, SDG2-SDG10, SDG12, SDG14-SDG17 have no similarities in FloodCat. Only the SDG1, SDG11 and SDG13 have few indicators that match with FloodCat. Some SDG are repeated in different targets (1.5, 11.5, 13.1 and 1.5, 11.5) and the only two matches in FloodCat are the field numeric value for the whole category Population/Human Health and the filed economic value for whole categories. Certainly better data to match the SDG indicators can be found not in FloodCat but in the National Statistical Institute – INSTAT, in the Ministries and World Bank data.

About AVI and FloodCat we can say that the two databases are very similar if we focus only on the fields contained in both databases without taking into consideration the structure of the databases. Although FloodCat have some fields that cannot be found on AVI for the flood part. Considering all the fields of FloodCat they match with the fields of AVI by nearly 70%.

The Flood Directive is compliant with the INSPIRE Directive because comprehend the contents of the NZ and other Inspire themes. Consequently FloodCat, as designed under the Flood Directive guidance and schemas, is compliant with the INSPIRE Directive.

In order to describe the whole emergency cycle in a holistic way were described in the thesis the alerting procedures that precede emergencies. Were made clear the differences between the terms bulletin, warning and alert.

As part of the emergency cycle, the State of National Emergency and the State of Natural Calamity were investigated and were in detail described the legal framework and the Standard Operation Procedures. Were identified as very useful source of data for FloodCat purposes, the OCDPCs in case of State of National Emergency and the request of compensation for agricultural economic activities in case of State of Natural Calamity.

Statistics have been produced with the data of the bad weather events emergencies of after 2011, which for the FloodCat purposes were considered as first priority events. When considering the entire action plan data the tab that mostly affects the total amount is tab A3 “Urgent measures, implemented or to be implemented, aimed at restoring the functionality of essential public services as well as avoiding situations of danger or damage to persons or property”. When considering the data of the OCDPCs the most damaged province regarding the public property (Tab A) is Macerata while for the damages in economic and productive activities (Tab C) the most damaged province is Ancona with 65%. While Tab B and the Private ordinance have both the damage on private property they differ because the Private Ordinance is more accurate and have more controls on the data. The Private Ordinance is only 30% of the value of Tab B so in the first needs recognition of the three events, there was an overestimation of 70%. The distribution between the provinces do not differ much.

Loss data requested by FloodCat are collected by different offices in relation of the affected sector. The main data sources are: the flood event reports (regional civil protection) (Event Reports), the georeferred flooded areas (basin or district authority), the damage data collected following the civil protection ordinances in case of national emergency declaration, data collected by the regional agriculture service following the state of natural calamity. These last two sources provide statistics regarding the economic cost of damages as the estimate allows to have access to public national funds. This information is relevant for FloodCat as disaster databases usually lack on economic loss data.

For Marche Region, more than ten ordinances were adopted in case of severe weather, starting from 2002. The ordinances were inserted on FloodCat together with the Event Reports relating to the same event as they provide complementary data. Moreover more than 30 Report of minor Events were inserted and the delimited flooded area of the event of May 2014 from the Basin Authority (AdB). For each event metadata information was stored as required in the INSPIRE Directive.

The Economic value of the damage cannot be found in the event report and there is small distinction between the damage caused by floods and landslides. The shape files form the Basin Authority are helpful for the delimitation of the areas of the tab Phenomenon of FloodCat. The Ordinances have data on the economic value of damages and the numeric value of them. Also from the Ordinances can be classified the damages into FloodCat categories and subcategories although there is no similar categorization between them because in order to understand the appropriate category and subcategory of FloodCat, it is necessary to deduct it from the field description of the Ordinances. The Ordinances are very important for FloodCat data feed because can be used for the tab Damage which from the Event Report is difficult to feed and there is data lack.

From 12 October 1900 till 07/10/2018 (date in which the data feeding for this PhD ended) the database FloodCat contained a total of 148 events, 466 phenomenon, 1513 damages and 3679 damage records. 90% of the damage were inserted during this PhD and following a specific procedure (explained in the following paragraphs) adapted for FloodCat and Marche Region territory.

In order to insert the information contained in the tabs attached to the OCDPC in the new web platform for floods, FloodCat, as there is a huge amount of data and cannot be inserted manually, it was necessary to study which of the fields contained in OCDPC’s tabs can be merged/is comparable with the categories and subcategories of FloodCat. Except for the category “Agriculture, zootechny, fisheries, mines”, which data are managed by another institution (see paragraph 0), all other FloodCat categories can be filled by the tabs of the Ordinances and tab A1 of Action Plan. This makes this sources of information very valuable for FloodCat and an effort to make this sources more

FloodCat “friendly”, by slightly adding or changing the fields that they contain, must be done in order to make the data filling of FloodCat automatic, not manually. The results of the comparison were discussed and distributed to ISPRA and the Italian National Department of Civil Protection and helped shaping the new classification in categories and subcategories as released with the most recent ISPRA notes of May 2018 (Notes on FloodCat, 2018).

Damage on vehicles are not a homogeneous data and not always present in the need recognitions because the DPCN does not consider vehicles as a damaged refundable asset because they are insurable by insurance companies. In FloodCat a field has been introduced for them only in the last version of May 2018 on our suggestion because in the private Ordinance there were data on damaged vehicles. The reimbursement does not take place with the detail of the appliances, but in a lump sum way for a flooded compartment. In the flooded compartment everything is inserted, even the furniture while in FloodCat the damage to private goods is a subcategory apart.

To be noted that the tab B of the needs recognition contains only the information on the building if evacuated or not, not the number of evacuated so the tab A1 of Action Plan should be referred to for evacuees.

With regard to the damage on economic and productive activities in the tabs attached to OCDPC there is no field that describes the type of activity in order to associate to them the “equivalent/proper” Category/Subcategory of FloodCat, while in the forms that each representative of economic and productive activities fills, there is a field with the description of the type of activity. After all the forms have been collected (some of the forms can be found in the Region and all of them can be found in Municipalities) all the data fills the default tabs of OCDPC, in this way some data contained in the forms are not inserted. This data can be found in the Municipalities but it would be a long work to search and insert each of them one by one as the data are many.

Another effort was made to compare the fields of the request of compensation for agricultural economic activities with FloodCat. To be noted that in the scheme of submitted applications is not required, the numerical value of the sub category of damage, eg. in ha or kg of production, useful instead for inclusion in FloodCat.

Considering the sources of data, their content, the specific Marche region territory, and also taking into account FloodCat requirements a methodology have been design for the purpose of FloodCat filling. The methodology was defined in order to make a homogeneous data record and to adapt historical data already collected to FloodCat requested database fields. It consists on correlating the meteorological event with the Unit of Management and the flood phenomena to the basin or sub-basin, the damage to municipality. The data were recorded taking into account three elevation bands: mountainous, hilly and coastal in order to analyse the different flood mechanisms depending on territory’s altitude.

The event tab was made using the Event Reports and is connected to one UoM, one origin and a defined temporal interval. Each phenomena tab is connected to a basin (except those of province) and to an altimetric band, while the damage tab is one for each municipality and is mainly filled with data from Civil Protection Ordinances. The data population was manually made as it was difficult to find similarities between the fields of FloodCat’s tabs and the available data, previously collected. It was also difficult to find the exact damage geo-localization.

Da.Ma is a documentary platform for Bad Weather Damages in Marche Region. It includes a Web Application and a database for distributed data digitization and document production/processing as in OCDPC n. 264 of 3/7/2015. Actually Da.Ma’s Demo is offline. The access is reserved through user

and password and the functions are different depending on the user. Tests with real users and "distribution" have not been carried out.

Have been carried out the activity of optimization of the database Da.Ma for automatic data transfer in FloodCat. After a detailed comprehension of Da.Ma Demo database have been identified the fields to add in order to make the data transfer in FloodCat automatic and the fields that already match.

In Marche Region exists the SIAR portal that stands for “Regional Agriculture Information System” (Sistema Informativo Agricoltura Regionale). The portal SIAR is also used by the Agri-food Policy Service to direct requests for aid from agricultural companies damaged by adverse weather events that can be assimilated to natural disasters or natural disasters. As the SIAR system is not open access than the fields of the database are not known and a comparison with FloodCat fields cannot be made in order to make data transfer automatic.

The optimization of OCDPC’s tabs for FloodCat purposes is very similar to Da.Ma optimization because Da.Ma itself was constructed following the OCDPC n. 264 of 3/7/2015.

Since the data comes from multiple regional services, it is essential to trace the source of the data. It is also a requirement of the INSPIRE directive. For the data entered in FloodCat for the Marche Region, excel cards have been prepared with predefined fields on the information sources used for each event. In previous versions FloodCat did not have any field in which could be recorded the source of data. After our suggestion have been added in the tabs Event and Phenomenon the part “Reference” where can be kept track for different types of sources many fields as links, pdf files etc. (as in detail described in ISPRA 2018’s Notes (Notes on FloodCat, 2018))

Many difficulties occurred during the implementation of the Flood Directive and FloodCat in Marche Region. The PhD helped with suggestions in improving the FloodCat platform.

To be underlined that the user permission given for this PhD was special and unique (other users are mainly authorities) because served to improve the part of conceptualising the databases (categories and fields) and the informatics part. The user manual was written as part of the PhD and the final notes on FloodCat structure was written taking into account the suggestions made during the PhD. It was a continuously changing not definitive database till the end of data record for Marche Region which made the use more difficult and was shaped by the big contribution of this PhD.

Many meeting with different authorities at Marche Region and with competent authorities from other Regions was carried out during the PhD in order to improve and consolidate FloodCat as a database and also to find the referents from each authority that should deal with FloodCat purposes. The comments emerged from the meetings and the shared documents during the PhD duration are mainly in line with what suggested during this PhD in order to improve and optimize FloodCat.

From the testing period we can also say that the FloodCat platform ensures an high level of disaggregation for the elements recorded and for their geographical location and this allows:

- to relate the records with a high number of indicators for Target A,B,C,D of Sendai Framework;
- to export the dataset according to different output data models : FD reporting schema, JRC-DLD Guidance minimum requirements;
- to be used for different purposes (flexible database) (civil protection activities, recovery, reporting for European and International regulations, risk model validation).

To be mentioned that there is an agreement between the Italian Civil Protection Department (DPC) and JRC that envisages the possibility for Union Civil Protection Mechanism (UCPM) participating countries to obtain the technological transfer of the FloodCat platform and in line with the agreement FloodCat was implemented in Greece. FloodCat demonstrated to be a flexible tools that can be adapted in different institutional context and targeted to National needs and again the high level of data disaggregation facilitates the use of DLD for multiple-purposes (from Global policies to National needs).

In FloodCat for Marche Region there is a total of 148 Events recorded and 3.679 damage records. The database for Marche Region contains data comprehended in the temporal interval from 1966 to 2018, 53 years (

Table 27). The data before 2002 are those of the AVI catalogue adapted to FloodCat. There is an average of nearly 70 damage records for each year with the maximum records in 2013. In total were recorded 3 deaths that occurred in the municipality of Senigallia during the event of May 2014. The highest number of evacuated was also in Senigallia during the event of May 2014 with 2.861 evacuated. 1.476 houses were damaged or destroyed in total. In 2013 was recorded the highest number of commercial and industrial economic activities damage or destroyed and the highest number of public buildings damaged or destroyed. The total economic loss recorded is nearly 1 billion Euro of which more than 40% are caused by the category “Communication and transport infrastructure”.

Table 27. Summary statistics.

FloodCat events Marche Region (year range 1966-2018)					
	TOTAL	**Average for Year**	**Maximum for Year**	**Average for Damage Record**	**Maximum for Damage Record**
Damage Records	3.679	69,4	1.017 (2013)	-	-
Mortality	3 (Senigallia municipality 2014)	-	3	-	3
Evacuated	3.063	58	2.879 (2014)	-	2.861 (Senigallia municipality 2014)
Houses affected (Civil buildings)	1.476	27,8	1.177 (2014)	0,4	885
Public buildings	335	6,3	154 (2013)	-	100 (2006)
Commercial and industrial economic activities	518	9,8	270 (2013)	-	67 (2014 municipality of Ostra)
Economic Losses* (Euro)	982.271.938	18.533.433	339.113.248 (2011)	266.994	20.843.628 (2014 municipality of Senigallia)

Was selected as a case study the event of 2-4 May 2014. The reasons for choosing this event are that it was Declared the State of Emergency and many data were available starting from a detailed Event Report of the Civil Protection Service, Functional Regional Centre; the Intervention Plan; Ordinance of the Head of Department of Civil Protection 179/2014; Ordinance for private damages 378/2016; Damages on means of transport and movable property: protocol number 0746391 and the Perimeter of flooded area by the Regional Basin Authority.

During the event of 2-4 May 2014 occurred in Marche Region, Italy, the most affected altimetric band of the event is the hilly one with nearly 50% of the total affected municipalities. This is probably due to landslide data often included in flood data. The economic loss recorded in FloodCat is higher in coastal municipalities with nearly 45% of the total, followed by the hilly municipalities with 36,2% and the mountainous with the remaining 19%. The total economic loss reaches almost 186 million Euro.

The highest economic loss is due to the category “Communication and transport infrastructures” with 35,62% followed by “Private buildings and goods” with 33,04%. This two categories represent alone nearly 70% of the total economic loss recorded on FloodCat for this event. The high amount of loss in the category “Communication and transport infrastructure” is due for more than half (55%) to the Municipal roads and Provincial roads (40%). The road damages, are probably due to the landslides which are often mixed with flood data when collected and recorded. The highest economic loss of the category “Private buildings and goods” is caused by “Economic activities trade sector”[44] and “Goods contained in private buildings” which both represent 64% of all the category loss. The subcategories “Private means of transport” and “Public/private buildings for residential use” affect 20% and 16% respectively while subcategories “Private buildings for non-residential use” and “Goods contained in private areas” hadn’t registered damages. 50,2% municipalities of Marche Region recorded damages in the category “Communication and transport infrastructures” (highest number of affected municipalities comparing to other categories) while the category “Private buildings and goods” affected 23,1% municipalities.

The most affected categories vary in function of the altimetric band. Compared to the mountainous and hilly municipalities where the category "Communication and transport infrastructures" dominates, the economic loss of the coastal municipalities are higher in the category "Private buildings and goods" composed 50% of the total amount by “Goods contained in private buildings” of which 99% only caused in the municipality of Senigallia, the most damaged by the event.

The high amount of economic loss in the category "Private buildings and goods" can be explained by the population and building data. The coastal municipalities although represent only 10,2 % of the surface of the entire Region Marche, they have nearly 40% of the houses occupied by residents and nearly 40 % of the resident population at the 2011 Census of the entire Region Marche. The density of population inhabitants/km2 of the entire region is 163,95 p/km2 while for the coastal municipalities is 613,99 p/km2, nearly 375 % higher than the density of the entire region.

The high loss in this category of the coastal municipalities can also be explained by the low slope of their territory that collects the precipitations of the basins and the proximity to the mouth of the river.

The category “Population/human health” have a total economic loss of nearly 1,8 million Euro and just a few municipalities recorded damages in this category. The most affected municipalities in terms of economic loss are Senigallia (≈1,8 million Euro), Montecosaro (≈23,3 thousand Euro) and Potenza Picena (≈8,4 thousand Euro). 2.882 people were affected during this event of which 3 were deaths and the rest evacuated.

The subcategories with the highest number of units damaged, in decreasing order, are “Damages to population-evacuated” with 2.879 people evacuated and an economic loss of more than 1.8 million Euro, “Private means of transport” with 2.661 units and more than 12,5 million Euro and “Public/private buildings for residential use” with 1.177 units and more than 10 million Euro of economic loss. Although the average economic loss for unit is in inverted order as here listed with ≈630, ≈4.780 and ≈8.770 Euro.

The municipality with the highest economic loss is Senigallia with more than 70 million Euro of damages which is nearly 40% of the total economic loss of all municipalities. As term of comparison

[44] On this subcategory, in previous version of FloodCat were registered the damages from the tab C of the ordinance 179/2014. Before the May 2018 edits this subcategory was “Commercial activities (offices/shops/shopping centres/artisan workshops)”. This subcategory now is part of the category “Economic activities trade, industry, crafts and building sectors”.

is reported the total income of the municipality of Senigallia (the most affected and with the greatest economic damage) of the year 2014: 90.826.737 € (with 1993,08 € per capita). The losses caused by the May 2014 event had an economic loss of more than 75% of the total income of Senigallia in the year 2014. Following there is Ostra and Morrovalle with nearly 11 million Euro each (6%). There are 33 municipalities with more than 1 million Euro of damages (14,4% of total municipalities). The total affected municipalities which registered economic loss are 146 that represent 63,8 % of total municipalities of Marche Region.

In order to integrate FloodCat with international frameworks it was tried to adapt direct economic loss estimation formulas, based on the OIEWG Report proposed methodology, to the FloodCat data for Marche Region. Was selected only the data with quantitative indicators and an economic value recorded for the private housing sector, the educational facilities and health facilities.

The formula for the housing sector can be a solution in the cases where there is not a need recognition for the damaged housing sector because it is a small event and this are not recorded or because it is a bigger event but the data on housing are not collected because it is not foreseen a reimbursement by the State (In Italy usually the houses are not reimbursed because they should be insured and the insurance companies deal with this damages). In the future it would be appropriate to test again this formula for the damage records with high quantitative values of houses.

For the educational facilities the results shows that the formula can underestimate the damages and should be made greater effort to better align real data with estimated data.

For the health facilities there are not enough records to properly test the formula. For this reason the formula for health facilities have to be used in a larger dataset to understand if it can be a good formula to estimate damage or not.

More studies should be made in the future to calibrate the damage formulas with real data recorded for a wider number of sectors.

Flood damage assessment is still an area, which does not attract as much attention as other hydrological topics. This study is a contribution in this field. The results of the thesis are important for flood risk management and event documentation in Italy and Europe. This is a very application oriented study and FloodCat is ready to be applied in practice.

11 Appendixes

11.1 Appendix 1

11.1.1 World Conferences on Disaster Risk Reduction (WCDRR)

The United Nations to date have organized three World Conferences on Disaster Risk Reduction (WCDRR) that focus on disaster and climate risk management in the context of sustainable development. The three World Conferences have been hosted by Japan: in Yokohama in 1994, in Kobe in 2005 and in Sendai in 2015. Requested by the UN General Assembly, the United Nations Office for Disaster Risk Reduction (UNISDR) served as the coordinating body for the Second and Third UN World Conference on Disaster Reduction in 2005 and 2015.[45]

The Third UN World conference adopted the Sendai Framework for Disaster Risk Reduction 2015-2030. Previous conference outcomes include the Hyogo Framework for Action 2005 - 2015: Building the Resilience of Nations and Communities to Disasters in 2005 and the Yokohama Strategy and Plan of Action for a Safer World in 1994.

11.1.2 First World Conference on Natural Disaster Reduction in Yokohama, 1994

The First World Conference on Natural Disasters Reduction in Yokohama, Japan from 23 to 27 May 1994, adopted the Yokohama Strategy and Plan of Action for a Safer World: Guidelines for Natural Disaster Prevention, Preparedness. It was the main outcome of the mid-term review of the International Decade of Natural Disaster Reduction (IDNDR) and established 10 principles for its strategy, a plan of action and a follow-up. Furthermore, it provides guidelines for natural disaster prevention, preparedness and mitigation.
The Yokohama Strategy and Plan of Action for a Safer World responded to the request of the General Assembly to:

1. Review the accomplishments of the Decade at national, regional and international levels;
2. Chart a programme of action for the future;
3. Exchange information on the implementation of Decade programmes and policies;
4. Increase awareness of the importance of disaster reduction policies;

The ten principles of the Yokohama Strategy for a Safer World:

1. Risk assessment is a required step for the adoption of adequate and successful disaster reduction policies and measures.
2. Disaster prevention and preparedness are of primary importance in reducing the need for disaster relief.
3. Disaster prevention and preparedness should be considered integral aspects of development policy and planning at national, regional, bilateral, multilateral and international levels.
4. The development and strengthening of capacities to prevent, reduce and mitigate disasters is a top priority area to be addressed during the Decade so as to provide a strong basis for follow-up activities to the Decade.
5. Early warnings of impending disasters and their effective dissemination using telecommunications, including broadcast services, are key factors to successful disaster prevention and preparedness.

[45] www.unisdr.org/

6. Preventive measures are most effective when they involve participation at all levels, from the local community through the national government to the regional and international level.
7. Vulnerability can be reduced by the application of proper design and patterns of development focused on target groups, by appropriate education and training of the whole community.
8. The international community accepts the need to share the necessary technology to prevent, reduce and mitigate disaster; this should be made freely available and in a timely manner as an integral part of technical cooperation.
9. Environmental protection as a component of sustainable development consistent with poverty alleviation is imperative in the prevention and mitigation of natural disasters.
10. Each country bears the primary responsibility for protecting its people, infrastructure, and other national assets from the impact of natural disasters. The international community should demonstrate strong political determination required to mobilize adequate and make efficient use of existing resources, including financial, scientific and technological means, in the field of natural disaster reduction, bearing in mind the needs of the developing countries, particularly the least developed countries.[46]

11.1.3 Second World Conference on Disaster Reduction in Kobe, 2005

The Second World Conference on Disaster Reduction conference was held in Kobe, Hyogo Prefecture, Japan from 18 to 22 January 2005. The Conference took place immediately after the commemoration of the tenth anniversary of the Great Hanshin-Awaji Earthquake which struck Kobe and its neighbouring area in the early hours on 17 January 1995, killing more than 6,400 people and injuring about 40,000. Also the conference came in less than a month after the 2004 Indian Ocean tsunami (26 December 2004) and had a high attendance with 4,000 participants from around the world in the opening day. The event had the attention of international media.[47]

The Conference took stock of progress in disaster risk reduction accomplished since the Yokohama Conference of 1994 and to make plans for the next ten years. The following four documents are the main outcome of the Second WCDRR. They represent a strong commitment of the international community to address disaster reduction and to engage in a determined, results-oriented plan of action for the next decade.

1. Review of the Yokohama Strategy and Plan of Action for a Safer World;
2. Hyogo Declaration;
3. Hyogo Framework of Action 2005-2015: Building the Resilience of Nations and Communities to Disasters;
4. Common Statement of the Special Session on the Indian Ocean Disaster: risk reduction for a safer future.[48]

[46] Yokohama Strategy and Plan of Action for a Safer World, Guidelines for Natural Disaster Prevention, Preparedness and Mitigation, http://www.ifrc.org/Docs/idrl/I248EN.pdf

[47] http://www.iisd.ca/vol26/enb2604e.html

[48] http://www.unisdr.org/2005/wcdr/wcdr-index.htm

The Conference launched in 19th January the International Early Warning Programme (IEWP)[49] that had bring together United Nations organizations including the World Meteorological Organization (WMO), the United Nations Educational, Scientific and Cultural Organization (UNESCO), the World Food Programme (WFP), and the United Nations Environment Programme (UNEP), the International Strategy for Disaster Reduction (ISDR) and the ISDR Platform for the Promotion of Early Warning, together with the German Disaster Reduction Committee and other organizations.[50]

The Conference objectives were the following:

- To conclude and report on the review of the Yokohama Strategy and its Plan of Action, with a view to updating the guiding framework on disaster reduction for the twenty-first century;
- To identify specific activities aimed at ensuring the implementation of relevant provisions of the Johannesburg Plan of Implementation of the World Summit on Sustainable Development on vulnerability, risk assessment and disaster management;
- To share best practices and lessons learned to further disaster reduction within the context of attaining sustainable development, and to identify gaps and challenges;
- To increase awareness of the importance of disaster reduction policies, thereby facilitating and promoting the implementation of those policies;
- To increase the reliability and availability of appropriate disaster-related information to the public and disaster management agencies in all regions, as set out in relevant provisions of the Johannesburg Plan of Implementation.[51]

The goal of the World Conference was to find ways to reduce the toll of disasters through preparation, and ultimately to reduce human casualties. Due to the proximity to the devastating Indian Ocean tsunami, developing a global tsunami warning system was high on the agenda. Other topics included:

- pledges to reduce disaster damage
- healthcare after disaster
- early warning systems
- safe building standards
- agree upon cost-effective preventative countermeasures
- a global database on relief and reconstruction and a centre on water hazards

The Pacific Rim Tsunami Warning system is an example of a cost-effective warning system; its yearly operating cost is approximately US$4 million. The yearly operating cost of a hypothetical global warning system is estimated at US$30 million. This cost, compared to the international aid donations

[49] Effective early warning systems have been widely recognized as worthwhile and necessary investments. Such systems, coupled with humanitarian aid and better preparedness, have greatly cut the number of people dying from famine, saving 2 million lives over the last 20 years.
In 2004, millions of people in the Americas and Asia were evacuated when tropical storms struck, undoubtedly saving thousands of lives. Experts agree that the lack of comparable early-warning system in the Indian Ocean was a factor in the huge loss of life there from the 26 December 2004 tsunami.
One third of more than 1 hundred million people whom the World Food Programme assists are those affected by natural hazards.

[50] http://www.un.org/press/en/2005/iha998.doc.htm

[51] https://www.unisdr.org/2005/wcdr/preparatory-process/1st-announc/First-Announcement-WCDR-eng.pdf World Conference on Disaster Reduction - First Announcement;

of nearly US$8 billion for the 2004 Indian Ocean earthquake and tsunami, clearly demonstrates the cost effectiveness of such a system.[20]

There is a strong international commitment towards establishing adequate early warning systems (in line with the Pacific Tsunami Warning System already operating since 1965) in all regions of the world.[52]

Hyogo Framework for Action

The Hyogo Framework for Action (2005–2015): Building the Resilience of Nations and Communities to Disasters was one of the outcomes of the 2005 conference. The Hyogo Framework (HFA) was the first plan to explain, describe and detail the work required from all different sectors and actors to reduce disaster losses. It was developed and agreed on with the many partners needed to reduce disaster risk - governments, international agencies, disaster experts and many others - bringing them into a common system of coordination.

The expected outcome of the HFA is the substantial reduction of disaster losses, in lives and in the social, economic and environmental assets of communities and countries. To attain this expected outcome, the Conference resolves to adopt the following strategic goals:

1. The more effective integration of disaster risk considerations into sustainable development policies, planning and programming at all levels, with a special emphasis on disaster prevention, mitigation, preparedness and vulnerability reduction;
2. The development and strengthening of institutions, mechanisms and capacities at all levels, in particular at the community level, that can systematically contribute to building resilience[53] to hazards;
3. The systematic incorporation of risk reduction approaches into the design and implementation of emergency preparedness, response and recovery programmes in the reconstruction of affected communities.

Drawing on the conclusions of the review of the Yokohama Strategy, and on the basis of deliberations at the World Conference on Disaster Reduction and especially the agreed expected outcome and strategic goals, the Conference has adopted the following five priorities for action:

1. Ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation.
2. Identify, assess and monitor disaster risks and enhance early warning.
3. Use knowledge, innovation and education to build a culture of safety and resilience at all levels.
4. Reduce the underlying risk factors.
5. Strengthen disaster preparedness for effective response at all levels.[54]

Figure 66 reports a summary of the HFA.

[52] http://www.preventionweb.net/files/13072_185825e1.pdf

[53] Resilience: "The capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure This is determined by the degree to which the social system is capable of organising itself to increase this capacity for learning from past disasters for better future protection and to improve risk reduction measures." UN/ISDR. Geneva 2004.

[54] http://www.unisdr.org/files/1037_hyogoframeworkforactionenglish.pdf Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters

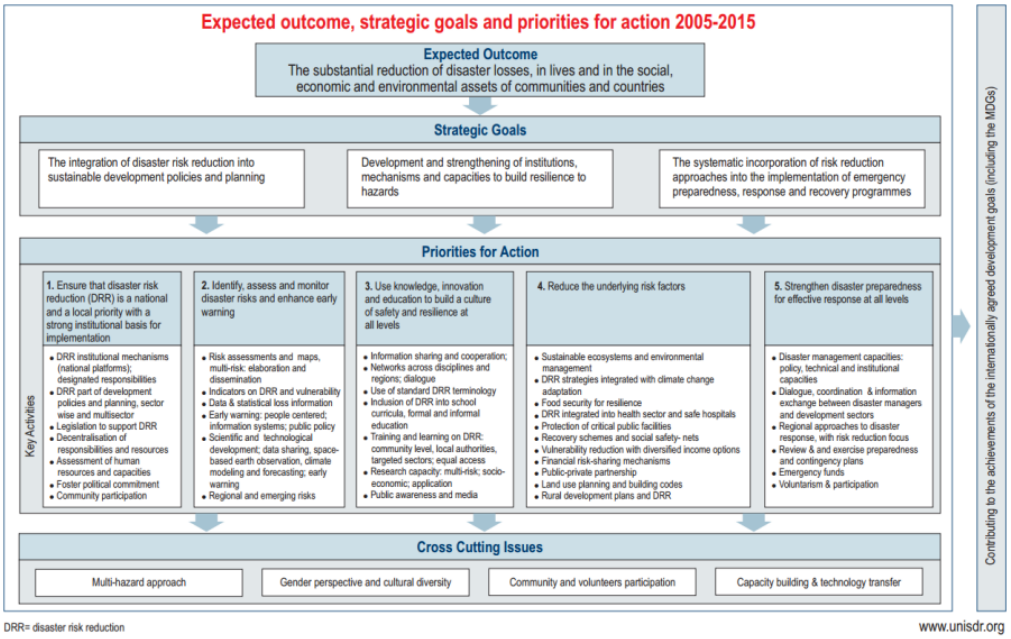


Figure 66. Summary of the HFA.[55]

11.2 Appendix 2

Box 1 Recognition of the needs for intervention on public property

The recognition activity is carried out by the competent administrations on each asset, on the basis of the procedures related to their own organizational structure.

The quantification of the damage and of restoration measures, in the absence of suitable reference design documents, can take place on the basis of quantitative estimation of the surfaces/volumes concerned, even on a percentage basis compared to the entire property/object.

In any case should be used as an economic reference the current regional price list in force and, where necessary, other official reference price lists.

At the end of the individual evaluations the competent Administrations, should complete for each intervention the attached form A (technical economic analytical) in which should be given the possible impact of insurance coverage and the possible co-financing resource that can be allocated to the individual intervention.

In the tab in addition to the indication of the Public Subject requesting the intervention, should be proposed the eventual Actuator Subject of the contract.

In identifying the intervention, in addition to the place names is asked to indicate if significant, also the usage of the good (i.e. the use to which the damaged public structure is used, e.g. military barracks, schools, healthcare etc.). Must be indicated, the description of the damage and the characteristics of the planned works (e.g. reconstruction, service work, etc.) should also be assessed purpose of the intended intervention (e.g. risk reduction, restoration of normal socio - economic activities, etc.).

Finally should be indicated the project status of the intervention.

The card should be signed by the competent Administration of the good and subject to approval of the Delegated Commissioner.

[55] http://www.unisdr.org/files/8720_summaryHFP20052015.pdf

11.3 Appendix 3

Table 28. Tab A after 23d March 2016.

APPLICANT ENTITY		
DENOMINATION		
PROVINCE OF		
A	Organization and execution of rescue and assistance service to the affected population implemented in the immediately after the event (Art. 5 paragraph 2 letter a) L. 225/92 and following changes and/or additions)	
DESCRIPTION		AMOUNT (€)
A1	Accommodation for evacuees/assistance to the population	
A2	Purchase of basic necessities (Fuel, means for first operations, food, volunteer expenses etc.)	
A3	Provision of services (first lodging, vacuum truck, removing mud, rubble and waste, rentals etc.).	
TOTAL €		
A4	ORDINANCES OF THE MAYOR FOR EVACUATION	
n.	of	
n.	of	

Table 29. Tab B after 23d March 2016.

B	Restoration of public services functions and of strategic infrastructure networks (Art. 5 paragraph 2 letter b) Law 225/92 and following changes and/or additions- including the actions carried out in the first emergency phase (works, services and supplies of "top priority" works) - **WORK PERFORMED OR UNDERWAY**		
LOCATION	DESCRIPTION	PERFORMED AMOUNT (€)	UNDERWAY AMOUNT (€)
TOTAL €			

Table 30. Tab C after 23d March 2016.

C	Implementation of measures, also structural ones, to reduce the residual risk closely linked to the event, aiming primarily the protection of public and private safety (art. 5, paragraph 2, letter c) L. 225/92 and following changes and/or additions) WORK TO BE PERFORMED	
LOCATION	DESCRIPTION	AMOUNT (€)
TOTAL €		

Table 31. Tab D after 23d March 2016.

D	Recognition of the need for the restoration of facilities and infrastructure, public and private, damaged, as well as the damage to economic and productive activities, to cultural heritage and the built heritage (Art. 5 paragraph 2 letter d) Law 225/92 and following changes and/or additions)	
LOCATION	DESCRIPTION	AMOUNT (€)

TOTAL €		

11.4 Appendix 4

This paragraph reports a case of study of all different operations made at institutional level in order to handle the situation created by the severe weather of 2-4 May 2014 in Marche Region, Italy. **Error! Reference source not found.** reports the detailed schedules for the bureaucratic procedures and reference regulations. This is a typical example on how is the Standard Operation Procedure for data transmission in case of type C emergency.

Between 2 and 4 May 2014, the Marche Region has been affected by exceptional weather events that caused extensive damage and highlighted numerous critical issues in the hydrographic network of the region.

With note prot. 0312681 of 05/05/2014 the President of the Region asked the Cabinet to the Prime Minister the declaration of the state of emergency for the exceptional weather events 2-4 May 2014.

The Council of Ministers, in its meeting of 30.06.2014, declared the state of emergency, for a maximum period of 180 days from the date of adoption of the above order, as a result of the events in the Marche region in the days 2 to 4 May 2014. This provision assigns to the Marche Region, for the implementation of the interventions, the sum of € 10,000,000.00 from the Fund[56] for National Emergencies.

With the presidential Decree No. 101 / PRES of 09.05.2014, have been adopted the organizational arrangements and planned certain exceptions to the regional regulations.

In implementation of the above mentioned, the Head of the Department of Civil Protection of the Presidency of the Council of Ministers adopted the Ordinance no. 179 of 10.07.2014 concerning "First urgent intervention of civil protection as a result of exceptional weather conditions that occurred in the days 2 to 4 May 2014, in the territory of the Marche Region" with which, among other things, appointed as Commissioner Delegated the Director of the Department for integrated policies for security and civil protection of the Marche Region.

By Decree No. 1/CDM14 of 09/05/2014 the delegate Commissioner identified the subjects in charge of carrying out activities to cope the states of emergency under review.

With note n. 68769 of 26.8.2014 was announced the opening of the appropriate special accounting foreseen by OCDPC, n. 5847 headed to "DIR.P.C.MARCHE C.D.O.179".

By Decree of the delegated Commissioner n. 2/CDM14 of 08.09.2014 was approved the intervention plan and the procedures concerning the modalities for liquidation and controls, referring to various types of intervention, as indicated clearly in Annex B) of the same decree and identified the officials responsible for the implementation of the plan as responsible of the related proceedings.

[56] Article 5, paragraph 5 of Law 24.02.1992, n. 225.

At the end of 2015 ended the state of emergency and the acts were passed to a regional service as described below.

Under current legislation, at least ten days before the state of emergency expires, the Head of the Civil Protection Department shall issue, in consultation with the Ministry of Economy and Finance, a special order to encourage and regulate the taking over of the competent public administration in the ordinary way to coordinate their activities, subsequent to the event, which may be necessary after the expiry of the term of the state of emergency. With that order can be identified within the public administration competent to coordinate interventions, the person to whom is headed the special account opened specifically for the emergency in question, for the continuation of the operational management of the same, during a fixed period for the completion of the operations covered by the ordinances adopted pursuant to paragraphs 2 and 4-ter.

Near the deadline of the state of emergency , since all the proceedings have not been finalized yet, the Delegated Commissioner forwarded to the Department of Civil Protection of the Presidency of the Council of Ministers the agreement necessary for the adoption of the Ordinance of taking over in the ordinary management of activities by Marche Region, comprehending the name of the subject that usually has jurisdiction for the conclusion of the initiatives launched in the following of OCDPC n. 179 of July 10, 2014.

With OCDPC n. 271 of 27 July 2015, concerning the "Takeover of the Marche Region in the initiatives aimed at overcoming the critical situation created as a result of exceptional weather conditions that occurred in the days 2 to 4 May 2014, in the territory of the Region itself", the functions of the delegated Commissioner are were transferred to the Director of PF Infrastructure, transport and energy.

With decree n. 309/ITE of 28.09.2015 the Head of Infrastructure, Transport and Energy Services indicated the subjects appointed to perform the functions for the conclusion of the procedures relating to the ordinance of the Head of Department of Civil Protection of the Presidency of the Council of Ministers n. 271 of 27 July 2015.

Table 32. Schedules for the bureaucratic procedures of severe weather 2-4 May 2014 in Marche Region.

Description	Date
When the event occurred	2-4 May 2014
The Head of the Region sent the note n. 0312681 to the Head of National Civil Protection as a Preliminary Request to Declare the State of Emergency	5 May 2014
The Head of Region's Civil Protection sent a letter to municipalities, provinces and prefectures (for information) to transmit the tabs of damage in order to integrate the Preliminary Request	5 May 2014
to the Head of DPCN-Letter about the preliminary report of the event	10 May
The Head of the Region sent to the Head of DPCN a note with the copy of the Preliminary Report of the Event and with the tabs that summarize the value of the damage encountered. Is reconfirmed the Request of the State of Emergency.	20 May
Resolution of the Council of Ministers, Declaration of the State of Emergency, valid for 180 days, over the territory of Marche Region, caused by the events of 2-4 May 2014	30 June 2014
Nota della Regione Marche---non trovata	7 July 2014
Agreement of Marche Region	10 July 2014
OCDPC 179 - Ordinanza del Capo Dipartimento della Protezione Civile	10 July 2014

Between others in article 1: Appointment of Commissioner and the work program - the Director of the department for integrated security policies and Civil Protection of Marche Region is appointed as Delegated Commissioner [57]	
The Delegated Commissioner sends to the Extraordinary Commissioners of the Provinces and to the Mayors of the affected Municipalities, and for information to the prefectures, Regional Directorate of Fire Service and Public Assistance and Regional Command of State Forestry Corps, a communication that provided guidance for implementing what established in OCDPC 179[58]	17 July 2014
1/CDM14 First organizational arrangements	04/09/2014
2CDM14 Intervention plan and the procedures concerning the modalities for liquidation and controls[59]	8 Settembre 2014
The Director of the department for integrated security policies and Civil Protection as Delegated Commissioner sends to the Head of National Civil Protection (Presidency of the Council of Ministers) the tabs for the recognition of needs, within 90 days from OCDPC	18 October 2014
The Head of Marche Region sends to the Head of National Civil Protection (Presidency of the Council of Ministers) the damages not included on OCDPC (chattels and means of transport)	18 October 2014
3/CDM14 Liquidation of actions of rescue and assistance to the population for a total of € 4,958,888.28 charged to the Special Account n. 5847.[60]	1st December 2014
4/CDM14 Equipment restoration of the Regional Functional Centre compromised by the exceptional weather conditions that occurred from 2 to 04/05/2014. Network M.I.R. Expertise approval No. 4/14 € 50,000.00 VAT incl. to rely on the Special Account 5847	15/12/2014
5/CDM14 Restoring equipment to manage mobile secretary. Amount based auction € 3,500.00 charged to the Special Account n. 5847. CIG Z63123F558	17/12/2014
6/CDM14 Restoring delivery pipes, motor pumps bottom filters. Amount based auction € 10,000.00 paid by the Special Account No. 5847. CIG ZC4123F409	17/12/2014
1/CDM14 Liquidation of actions of rescue and assistance to the population for a total of € 216,983.88 paid by the Special Account No. 5847.	14/01/2015
2/CDM14 Admission to financing and expenditure commitment in favor of local authorities for € 2,462,476.89 to € and liquidation for 2,297,431.99.	29/01/2015
3/CDM14 Agreement with CIMA Foundation to carry out the activities planned by article 1 letter c.3. e) of O.C.D.P.C. n.179/2014 - Amount € 207,400.00 including VAT charged on the Special Account 5847.	11/02/2015
4/CDM14 Restoring facilities for the management of mobile secretary - Outcome and new placement. Amount based auction € 3,500.00 paid by the Special Account. 5847 IGC Z63123F558	24/02/2015
5/CDM14 Restoring delivery pipes, motor pumps bottom filters. Final award. CIG ZC4123F409	04/03/2015
6/CDM14 Liquidation of actions of rescue and assistance to the population for a total of € 387,395.00 paid by the Special Account No. 5847.	11/03/2015
7/CDM14 Restoring facilities for the management of mobile secretary - definitive and effective Award. CIG Z63123F558	24/03/2015
8/CDM14 Restoring delivery pipes, motor pumps bottom filters. ZC4123F409 - liquidation € 11,881.74 paid by the Special Account No. 5847	14/04/2015
9/CDM14 Restoring facilities for the management of mobile secretary - CIG Z63123F558 - liquidation € 4,252.68 charged to the Special Account n. 5847	14/04/2015
10/CDM14 Agreement with CIMA Foundation to carry out the activities planned by article 1 letter c.3. e) of O.C.D.P.C. n.179/2014 - Liquidation amount € 20,740.00 including VAT charged Special Account 5847-1 ° delivery. CIG 6187628029	20/04/2015

[57] http://www.protezionecivile.gov.it/resources/cms/documents/OCDPC_179__10luglio2014.pdf
[58] http://www.meteomarche.it/bo/allegati/files/MaltempoMAggio2014/cd/ComunicazioneCDMM2014.pdf
[59] http://www.meteomarche.it/bo/allegati/files/MaltempoMaggio2014/cd/DecretoCDM2_2014.pdf
[60] http://www.meteomarche.it/bo/allegati/files/MaltempoMaggio2014/cd/DecretoCDM3_2014.pdf

From Delegated Commissioner To Head of Department of Civil Protection (Presidency of the Council of Ministers)	30 June 2015

* CDM14 Delegated Commissioner May 2014

For the events from 2-5 May 2014 in Marche Region, the Delegated Commissioner made 16 decrees.[61]

[61] http://www.norme.marche.it Select Decreti, Struttura *Commissario Delegato Maltempo Maggio 2014 for all the Decrees of Delegated Commissioner. Subsequent decrees related to May 2014 can be found under Servizio Infrastrutture Trasporti Energia entering the keyword May 2014, or flooding events in May 2014 - OCDPC n. 179 of July 10, 2014.

11.5 Appendix 5[62]

Box 2. Recognition of the needs for intervention on private property

The recognition activity is carried out by the competent municipality administrations, on the basis of the procedures related to their own organizational structure.

For the purposes of assessing the amount needed for the restoration work on private buildings, municipalities emit appropriate public notice, to which can respond the concerned property owners.

In the case of rented property or detained for other reasons, in the first instance can also be accepted the reporting issued by the holder or beneficiary.

In case of apartment buildings all individual notifications, together with that relating to eventual common parts, are collected by the Administrator of condominium and sent by him to the municipality in a single file, accompanied by a summary of the number of properties held as a principal residence, and the amount needed for the restore operation, including that relating to the interventions on the structural elements and common parts of the building.

The reporting is produced by using tab B that must be given to the municipality in the manner prescribed in the public notice.

In the reporting in addition to the general information of the declarant and the property identification data, should be included:

-the current situation of the property and if the same results to be evacuated because of the event;

-a brief description of the property in the context of the building where it is located;

-a description of the claimed damage;

- a rough estimate of the amount needed for the structural and functional repair of the property divided on operations on the structures, installations, finishes and window frames, with the exception of movable property and appliances.

In the first instance, the quantification of the damage and of remedial measures may take place through a self-certification that provides a brief assessment of necessary needs (eg. through invoices and cost estimates, market research, etc.), however, to be confirmed later in case of a positive outcome of the investigation to access any contribution, with a sworn appraisal, showing the fortuity connection between the damage found and the event to an amount no greater than the estimated summary, prepared by an experienced professional in the field , registered in their professional register. For the estimate should be used as an economic reference the current regional price list in force and, where necessary, other official reference price lists.

In the form should also be indicated the absence or existence of a dedicated reimbursement determined by related insurance coverage, and any indications of the premiums paid in the last five-year period. It must also be specified if the eventual refund has already been quantified by the insurance company.

It must also be stated that the units of properties damaged comply with the provisions planned by development legislation, spatial planning and construction sector, therefore, have not been implemented not in conformity or in the absence of authorizations or concessions provided by law and shall be declared the fortuity connection with the event in question.

In this perspective is the responsibility of the municipality office to check the claims during the reporting and quantification of the damage.

Ultimately should be taken note that the report is produced exclusively for the purposes of recognition of the need for the restoration of the private building heritage and does not constitute automatic recognition of any contributions paid by the public finances for the restoration of damages.

[62] Ocdpc 179

11.6 Appendix 6

Box 3. Ricognizione del fabbisogno per le attività economiche e produttive.

The recognition activity is carried out by the municipal administrations concerned, based on the procedures related to their organizational structure. The municipal administrations issue a specific public notice, to which the owners of the economic/productive activities concerned may respond.

The report is produced using form C of «Recognition of the needs for economic and productive activities» which must be delivered to the municipality according to the methods established in the Public Notice.

In the report, in addition to the personal details of the declarant and the data of the economic/productive activity, the following must be indicated:

-the current situation of the building where the activity takes place and if it has been evacuated due to the event;

-a brief description of the building inserted in the context of the building in which it is located;

-a description of the damages;

-a summary assessment of the needs necessary for the structural and functional restoration of the building subdivided by interventions on the structures, systems, finishes and windows;

-a summary assessment of the needs necessary for the restoration of machinery and equipment;

-a summary assessment of the purchase price of stocks of raw materials, semi-finished and finished products, damaged or destroyed due to exceptional events that can no longer be used.

In the first instance, the quantification of the damage and of the restoration interventions can take place through a summary assessment of the necessary needs (eg through invoices and cost estimates, market surveys, etc.), to be confirmed in any case later, in the case of positive outcome of the preliminary investigation to access any contribution, with a sworn expert report showing the causal link between the ascertained damage and the event for an amount not exceeding that summarily estimated, drawn up by a professional expert in the field , registered in the relevant professional register.

The form must also indicate the absence or existence of a specific reimbursement certificate determined by relative insurance coverage, with the possible indication of the premiums paid in the last five years. It must also be specified whether the possible repayment has already been quantified by the insurance company.

It must also be declared that the damaged building units comply with the provisions of the urban planning, sectorial and building planning regulations.

11.7 Appendix 7

In Table 33 is described the bureaucratic procedure for the State of Calamity of May 2014 in Marche Region.

Table 33. Bureaucratic procedure for the State of Calamity of May 2014 in Marche Region.

Description	Data
La Giunta Regionale, con DGR n. 787 rettificata con DGR 911 del 28 Luglio 2014, ha proposto ai sensi e per gli effetti del D.Lgs. 102/04, al Ministero delle Politiche Agricole Alimentari e Forestali il riconoscimento di evento atmosferico a carattere eccezionale, per le piogge alluvionali dei giorni 2 e 3 Maggio 2014, in considerazione dei danni arrecati sul territorio regionale alle produzioni agricole (comma 2, art. 5 del d.lgs 102/2004), alle strutture aziendali, agli impianti e alle scorte delle imprese agricole (comma 3, art. 5 del d.lgs 102/2004), e alle infrastrutture connesse all'attività agricola (comma 6, art. 5 del d.lgs 102/2004). Stima totale dei danni: 28.649.000 Euro.	30/6/2014
Con DM n. 9379 è stata riconosciuta la possibilità di attivare gli aiuti previsti dai commi 3 e 6, art 5 del d.lgs 102/2004.	9/9/2014
D.G.R. n. 1045 del 21 settembre 2014	21/9/2014
D.G.R. n. 1093 stabilisce le modalità e le procedure per la concessione dei contributi previsti dal d.lgs 102/2004.	29/09/2014
D.G.R. 1185 Integrazioni alla DGR 1093 del 29/09/2014, Criteri di priorità per il finanziamento delle domande in funzione dell'ammontare totale del fabbisogno di spesa e del finanziamento assegnato dallo Stato.	27/10/2014
D.G.R. 1186 Rettifica della DGR n. 787 del 30/6/2014	27/10/2014
Con il D.M. del 28/11/2014 – Modifica del decreto (n. 9379) 09 settembre 2014 è stato incluso il Comune di Pergola tra quelli danneggiati dall'eccezionalità dell'evento atmosferico piogge alluvionali dei giorni 2 e 3 Maggio 2014.	28/11/2014
D.G.R. 1426 con oggetto: D.M. del 28/11/2014 – Modifica del decreto (n. 9379) 09 settembre 2014 relativo alla dichiarazione dell'esistenza del carattere di eccezionalità degli eventi calamitosi (piogge alluvionali dei giorni 2 e 3 Maggio 2014) verificatesi nella Regione Marche – Modalità e procedure per la concessione di contributi ai sensi dell'art. 5 del d.lgs. 102/2004.	22/12/2014
La domanda per l'erogazione degli aiuti di cui all'articolo 5, comma 6, del d.lgs n. 102/2004 deve essere presentata entro il termine perentorio del 24 Gennaio 2015. (Ai sensi del comma 5, at. 5, del d.lgs 102/2004 "Le domande di intervento debbono essere presentate alle autorità regionali competenti entro il termine perentorio di 45 giorni dalla data di pubblicazione del decreto di declaratoria nella GURI e di individuazione delle zone interessate, di cui all'articolo 6, comma 2".	24/01/2015
Successivamente all'entrata in vigore del DL 51/2015, convertito con modifiche dalla legge 2 Luglio 2015, n. 91, il Ministro delle Politiche Agricole Alimentari e Forestali, con decreto 3797 2015, prot. N. 18037, pubblicato sulla Gazzetta Ufficiale della Repubblica Italiana n. 2215 del 16 settembre 2015, ha accolto la proposta della GR anche per la parte riguardante l'attivazione degli aiuti di cui all'art. 5 commi 2 del d.lgs 102/2004. Decreto Ministeriale di declaratoria, prot. N. 18037, con il quale è stata riconosciuta la possibilità di accesso alle misure di aiuto previste dal comma 2, art.5 del d.lgs 102/2004 ss. Mm. E ii. Per le imprese agricole danneggiate dalle piogge alluvionali dei giorni 2 e 3 Maggio 2014.*	03/09/2015
Delibera della Giunta Regionale: stabilisce il termine ultimo per la presentazione delle domande e stabilisce le procedure, i criteri, e le modalità per la presentazione delle richieste di aiuto e per l'erogazione dei contributi di cui al punto precedente come definite negli allegati A, B, C che fanno parte di questa delibera. D.L. 51/2015 convertito con legge n. 91/2015 – D.M. n. 18037 del 03 settembre 2015, evento atmosferico eccezionale, piogge alluvionali dei giorni 2 e 3 Maggio 2014, verificatosi nel territorio della provincia di Ancona – Modalità e procedure per la concessione di contributi ai sensi dell'art. 5, comm2, del d.lgs. 102/2004.	28/09/2015

Ai sensi del comma 5, art. 5, del d.lgs 102/2004 “Le domande di intervento debbono essere presentate alle autorità regionali competenti entro il termine perentorio di 45 giorni dalla data di pubblicazione del decreto di declaratoria nella Gazzetta ufficiale della RI e di individuazione delle zone interessate, di cui all’articolo 6, comma 2. Tale termine coincide con il giorno 31 Ottobre 2015.	31/10/2015

11.8 Appendix 8

Table 34. Unit of Management as in the Flood Directive for the territory of Marche Region.

COD	**UoM**
ITI01319	Conca-Marecchia
ITR111 (parte)	Regionale Marche (parte) Litorale tra Gabicce e Pesaro, Fiume Foglia, Rio Genica, Torrente Arzilla, Fiume Metauro, Litorale tra Metauro e Cesano, Fiume Cesano, Litorale tra Cesano e Misa, Fiume Misa, Litorale tra Misa e Fosso Rubiano, Fosso Rubiano, Fiume Esino, Litorale tra Esino e Musone, Fiume Musone, Rio Fiumarella o Bellaluce, Fiume Potenza, Fosso Pilocco, Torrente Asola, Fiume Chienti, Litorale tra Chienti e Tenna, Fiume Tenna, Fosso Valloscura-Rio, Petronilla, Fiume Ete Vivo, Fosso Fel Molinello-Fosso di S. Biagio, Fiume Aso, Rio Canale, Torrente Menocchia, Torrente S. Egidio, Fiume Tesino, Torrente Albula.
ITI028	Tronto
ITN010	Tevere

11.9 Appendix 9

Figure 67. Regional, Interregional and National Basins.[63]

11.10 Appendix 10

1-Municipalities classification *(coastal, hilly or mountainous)*.

The municipalities are classified in three categories as by the characteristics of the territory of Marche Region and in order to keep a main characteristic in three macro areas of the basins.

[63] Website of Basin Authority of Marche Region http://www.autoritabacino.marche.it/bacini.asp

Tabella 1. Classificazione comuni (costieri, collinari o montani).[64]

Mountainous municipality[65]	Hilly municipalities	Coastal municipalities[66]
Acqualagna	Acquaviva Picena	San Benedetto del Tronto
Acquasanta Terme	Agugliano	Grottammare
Amandola	Appignano	Cupra Marittima
Apecchio	Barbara	Massignano
Apiro	Belmonte Piceno	Campofilone
Appignano Del Tronto	Belvedere Ostrense	Pedaso
Arcevia	Camerano	Altidona
Arquata Del Tronto	Camerata Picena	Fermo
Ascoli Piceno	Carassai	Porto San Giorgio
Auditore	Cartoceto	Porto Sant'Elpidio
Belforte All'Isauro	Castel di Lama	Civitanova Marche
Belforte Del Chienti	Castelbellino	Potenza Picena
Bolognola	Castelfidardo	Porto Recanati
Borgo Pace	Castelleone di Suasa	Numana
Cagli	Castelplanio	Sirolo
Caldarola	Castorano	Ancona
Camerino	Chiaravalle	Falconara Marittima
Camporotondo Di Fiastrone	Colli al Metauro	Montemarciano
Cantiano	Colli del Tronto	Senigallia
Carpegna	Corinaldo	Mondolfo
Castelraimondo	Corridonia	Fano
Castelsantangelo Sul Nera	Cossignano	Pesaro
Castignano	Falerone	Gabicce Mare
Cerreto D'Esi	Filottrano	
Cessapalombo	Folignano	
Cingoli	Francavilla d'Ete	
Colmurano	Gradara	
Comunanza	Grottazzolina	
Cupramontana	Jesi	
Esanatoglia	Lapedona	
Fabriano	Loreto	
Fermignano	Macerata	

[64]Aggiornamento Comuni Regione Marche - anno 2017 - shape file fornito da REGIONE MARCHE - Servizio Tutela, Gestione e Assetto del Territorio P.F. Urbanistica, paesaggio ed informazioni territoriali

[65]Sistema Informativo della Montagna – SIM, Ministero delle Politiche Agricole Alimentari e Forestali , Corpo Forestale dello Stato, Comuni montani e parzialmente montani classificati ai sensi della Legge 991/1952. Secondo questa legge sono considerati territori montani i Comuni censuari situati per almeno l'80 per cento della loro superficie al di sopra di 600 metri di altitudine sul livello del mare e quelli nei quali il dislivello tra la quota altimetrica inferiore e la superiore del territorio comunale non è minore di 600 metri, sempre che il reddito imponibile medio per ettaro, censito, risultante dalla somma del reddito dominicale e del reddito agrario, determinati a norma del regio decreto-legge 4 aprile 1939, n. 589, convertito nella legge 29 giugno 1939, n. 976 (4), maggiorati del coefficiente 12 ai sensi del decreto legislativo 12 maggio 1947, n. 356 (5), non superi le lire 2400. http://www.simontagna.it/portalesim/comunimontani.html

[66] https://it.wikipedia.org

Fiastra	Magliano di Tenna	
Fiuminata	Maiolati Spontini	
Force	Maltignano	
Fossombrone	Massa Fermana	
Fratte Rosa	Mogliano	
Frontino	Mombaroccio	
Frontone	Monsampietro Morico	
Gagliole	Monsampolo del Tronto	
Genga	Monsano	
Gualdo	Montalto delle Marche	
Isola Del Piano	Montappone	
Loro Piceno	Monte Giberto	
Lunano	Monte Porzio	
Macerata Feltria	Monte Rinaldo	
Matelica	Monte Roberto	
Mercatello Sul Metauro	Monte San Giusto	
Mercatino Conca	Monte San Pietrangeli	
Mergo	Monte San Vito	
Mondavio	Monte Urano	
Monte Cavallo	Monte Vidon Combatte	
Monte Cerignone	Monte Vidon Corrado	
Monte San Martino	Montecarotto	
Montecalvo In Foglia	Montecassiano	
Montecopiolo	Montecicardo	
Montedinove	Montecosaro	
Montefalcone Appennino	Montefano	
Montefelcino	Montefiore dell'Aso	
Montefortino	Montegiorgio	
Montegallo	Montegranaro	
Monte Grimano Terme	Montelabbate	
Montelparo	Monteleone di Fermo	
Montemonaco	Montelupone	
Muccia	Monteprandone	
Palmiano	Monterubbiano	
Peglio	Montottone	
Penna San Giovanni	Moresco	
Pergola	Morro d'Alba	
Petriano	Morrovalle	
Piandimeleto	Offagna	
Pietrarubbia	Offida	
Pieve Torina	Ortezzano	
Piobbico	Osimo	
Pioraco	Ostra	
Poggio San Vicino	Ostra Vetere	

Ripe San Ginesio	Petriolo	
Roccafluvione	Petritoli	
Rosora	Poggio San Marcello	
Rotella	Pollenza	
San Ginesio	Polverigi	
San Lorenzo In Campo	Ponzano di Fermo	
San Severino Marche	Rapagnano	
Santa Vittoria In Matenano	Recanati	
Sant'Angelo In Pontano	Ripatransone	
Sant'Angelo In Vado	San Costanzo	
Sant'Ippolito	San Marcello	
Sarnano	San Paolo di Jesi	
Sassocorvaro	Santa Maria Nuova	
Sassofeltrio	Sant'Elpidio a Mare	
Sassoferrato	Serra De' Conti	
Sefro	Servigliano	
Serra San Quirico	Spinetoli	
Serra Sant'Abbondio	Tavullia	
Serrapetrona	Terre Roveresche	
Serravalle Di Chienti	Torre San Patrizio	
Smerillo	Trecastelli	
Staffolo	Urbisaglia	
Tavoleto	Valfornace	
Tolentino	Vallefoglia	
Treia		
Urbania		
Urbino		
Ussita		
Venarotta		
Visso		

11.11 Appendix 11

Categories and subcategories of FloodCat as by 2018's ISPRA notes (Notes on FloodCat, 2018).

CATEGORIA	DB CAT	SOTTOCATEGORIA	DB SOTTOCAT	Codice EU
AGRICOLTURA, ZOOTECNIA, PESCA, MINIERE	21	AREE A SEMINATIVO	2101	B43
AGRICOLTURA, ZOOTECNIA, PESCA, MINIERE	21	VIGNETI, FRUTTETI, OLIVETI, ETC	2102	B43
AGRICOLTURA, ZOOTECNIA, PESCA, MINIERE	21	RISAIE	2103	B43
AGRICOLTURA, ZOOTECNIA, PESCA, MINIERE	21	COLTURE ARBOREE (PIOPPETI, SALICETI, ETC)	2104	B43
AGRICOLTURA, ZOOTECNIA, PESCA, MINIERE	21	SERRE	2105	B43
AGRICOLTURA, ZOOTECNIA, PESCA, MINIERE	21	AREE BOSCATE/PRATI/PASCOLI	2106	B43
AGRICOLTURA, ZOOTECNIA, PESCA, MINIERE	21	IMPIANTI ZOOTECNICI/ALLEVAMENTO BESTIAME	2107	B43
AGRICOLTURA, ZOOTECNIA, PESCA, MINIERE	21	CAVE E MINIERE	2108	B43
AGRICOLTURA, ZOOTECNIA, PESCA, MINIERE	21	PESCA	2109	B43
AGRICOLTURA, ZOOTECNIA, PESCA, MINIERE	21	ATTIVITÀ AGRICOLE	2110	B43
AMBIENTE	20	CONTAMINAZIONE/INQUINAMENTO DI CORPI IDRICI	2001	B21
AMBIENTE	20	IMPATTI SULLE CARATTERISTICHE IDROMORFOLOGICHE DEL CORPO IDRICO (CROLLI DI SPONDA/INCISIONI/EROSIONI/DEPOSIZIONI/TAGLI DI MEANDRO/FENOMENI DI AVULSIONE)	2002	B21
AMBIENTE	20	CONTAMINAZIONE/INQUINAMENTO - AREE DESIGNATE PER L'ESTRAZIONE DI ACQUA PER USO POTABILE	2003	B22
AMBIENTE	20	CONTAMINAZIONE/INQUINAMENTO - CORPI IDRICI INTESI A SCOPO RICREATIVO COMPRESE LE ACQUE DI BALNEAZIONE	2004	B22

CATEGORIA	DB CAT	SOTTOCATEGORIA	DB SOTTOCAT	Codice EU
AMBIENTE	20	CONTAMINAZIONE/INQUINAMENTO - AREE PROTETTE RETE NATURA 2000 (DIR. HABITAT, UCCELLI)	2005	B22
AMBIENTE	20	CONTAMINAZIONE/INQUINAMENTO PER PRESENZA DI IMPIANTI IPPC E SEVESO	2006	B23
AMBIENTE	20	CONTAMINAZIONE/INQUINAMENTO PER PRESENZA DI IMPIANTI SEVESO	2007	B23
AMBIENTE	20	CONTAMINAZIONE/INQUINAMENTO PER PRESENZA DI IMPIANTI IPPC	2008	B23
AMBIENTE	20	CONTAMINAZIONE/INQUINAMENTO PER PRESENZA DI FONTI PUNTUALI O DIFFUSE DI INQUINAMENTO	2009	B23
AMBIENTE	20	CONTAMINAZIONE/INQUINAMENTO PER PRESENZA DI AREE SENSIBILI AI NUTRIENTI COMPRESE LE ZONE VULNERABILI A NORMA DELLE DIRETTIVE NITRATI E REFLUI	2010	B23
AMBIENTE	20	CONTAMINAZIONE/INQUINAMENTO PER PRESENZA DI DISCARICHE	2011	B23
AMBIENTE	20	CONTAMINAZIONE/INQUINAMENTO PER PRESENZA DI INCENERITORI	2012	B23
AMBIENTE	20	ALTRI IMPATTI SUL SUOLO, SULLA BIODIVERSITÀ, LA FLORA E LA FAUNA	2013	B24
AMBIENTE	20	RIMOZIONE DETRITI TRASPORTATI DA ALLUVIONE (da alvei, spiagge, aree inondate...)	2014	B44
ATTIVITÀ ECONOMICHE SETTORE COMMERCIO, INDUSTRIA, ARTIGIANATO, EDILIZIA	22	ATTIVITÀ ECONOMICHE SETTORE COMMERCIO	2201	B44
ATTIVITÀ ECONOMICHE SETTORE COMMERCIO, INDUSTRIA, ARTIGIANATO, EDILIZIA	22	ATTIVITÀ ECONOMICHE SETTORE INDUSTRIA	2202	B44

CATEGORIA	DB CAT	SOTTOCATEGORIA	DB SOTTOCAT	Codice EU
ATTIVITÀ ECONOMICHE SETTORE COMMERCIO, INDUSTRIA, ARTIGIANATO, EDILIZIA	22	ATTIVITÀ ECONOMICHE SETTORE ARTIGIANATO	2203	B44
ATTIVITÀ ECONOMICHE SETTORE COMMERCIO, INDUSTRIA, ARTIGIANATO, EDILIZIA	22	ATTIVITÀ ECONOMICHE SETTORE EDILIZIA (cantieri)	2204	B44
ATTIVITÀ ECONOMICHE SETTORE TURISTICO-RICREATIVE	23	ATTIVITÀ ECONOMICHE SETTORE TURISMO (STRUTTURE RICETTIVE, ALBERGHI)	2301	B44
ATTIVITÀ ECONOMICHE SETTORE TURISTICO-RICREATIVE	23	ATTIVITÀ ECONOMICHE SETTORE TURISMO - CAMPEGGI	2302	B44
ATTIVITÀ ECONOMICHE SETTORE TURISTICO-RICREATIVE	23	ATTIVITÀ ECONOMICHE SETTORE TURISMO - STABILIMENTI BALNEARI	2303	B44
ATTIVITÀ ECONOMICHE SETTORE TURISTICO-RICREATIVE	23	ATTIVITÀ ECONOMICHE SETTORE CULTURALE/RICREATIVO (Cinema, teatri, esposizioni, congressi..)	2304	B44
ATTIVITÀ ECONOMICHE SETTORE TURISTICO-RICREATIVE	23	ATTIVITÀ ECONOMICHE SETTORE SPORTIVO (Centri/impianti sportivi, palestre, stadi...)	2305	B44
BENI CULTURALI, PAESAGGISTICI	24	SITI/BENI ARCHEOLOGICI	2401	B31
BENI CULTURALI, PAESAGGISTICI	24	SITI/BENI STORICI E ARCHITETTONICI	2402	B31
BENI CULTURALI, PAESAGGISTICI	24	EDIFICI/LUOGHI DI CULTO	2403	B31
BENI CULTURALI, PAESAGGISTICI	24	BIBLIOTECHE	2404	B31
BENI CULTURALI, PAESAGGISTICI	24	MUSEI	2405	B31
BENI CULTURALI, PAESAGGISTICI	24	MONUMENTI	2406	B31
BENI CULTURALI, PAESAGGISTICI	24	OPERE D'ARTE	2407	B31
BENI CULTURALI, PAESAGGISTICI	24	BENI PAESAGGISTICI, PARCHI E RISERVE NATURALI	2408	B32

CATEGORIA	DB CAT	SOTTOCATEGORIA	DB SOTTOCAT	Codice EU
BENI CULTURALI, PAESAGGISTICI	24	ALTRI IMPATTI SUL PATRIMONIO CULTURALE E PAESAGGISTICO	2409	B33
EDIFICI E BENI PRIVATI	25	EDIFICI PUBBLICI/PRIVATI A USO ABITATIVO (residenziale, ad es., centri abitati, condomini, case monofamiliari, edilizia popolare, garage, scantinati)	2501	B41
EDIFICI E BENI PRIVATI	25	EDIFICI PRIVATI A USO NON ABITATIVO (non residenziale, ad es., uffici, negozi, magazzini)	2502	B41
EDIFICI E BENI PRIVATI	25	MEZZI DI TRASPORTO PRIVATI	2503	B41
EDIFICI E BENI PRIVATI	25	BENI CONTENUTI IN EDIFICI PRIVATI	2504	B41
EDIFICI E BENI PRIVATI	25	BENI CONTENUTI IN AREE PRIVATE	2505	B41
INFRASTRUTTURE DI COMUNICAZIONE E TRASPORTO	26	**INFRASTRUTTURE DI COMUNICAZIONE E TRASPORTO**	**2601**	**B42**
INFRASTRUTTURE DI COMUNICAZIONE E TRASPORTO	26	INFRASTRUTTURE DI COMUNICAZIONE E TRASPORTO-STRADE PROVINCIALI	2602	B42
INFRASTRUTTURE DI COMUNICAZIONE E TRASPORTO	26	INFRASTRUTTURE DI COMUNICAZIONE E TRASPORTO-STRADE REGIONALI	2603	B42
INFRASTRUTTURE DI COMUNICAZIONE E TRASPORTO	26	INFRASTRUTTURE DI COMUNICAZIONE E TRASPORTO-STRADE STATALI	2604	B42
INFRASTRUTTURE DI COMUNICAZIONE E TRASPORTO	26	INFRASTRUTTURE DI COMUNICAZIONE E TRASPORTO-FERROVIE/METROPOLITANE	2605	B42
INFRASTRUTTURE DI COMUNICAZIONE E TRASPORTO	26	INFRASTRUTTURE DI COMUNICAZIONE E TRASPORTO-STRADE COMUNALI	2606	B42
INFRASTRUTTURE DI COMUNICAZIONE E TRASPORTO	26	INFRASTRUTTURE DI COMUNICAZIONE E TRASPORTO-STRADE PRIVATE/INTERPODERALI	2607	B42
INFRASTRUTTURE DI COMUNICAZIONE E TRASPORTO	26	INFRASTRUTTURE DI COMUNICAZIONE E TRASPORTO-PONTI, VIADOTTI, ATTRAVERSAMENTI	2608	B42

CATEGORIA	DB CAT	SOTTOCATEGORIA	DB SOTTOCAT	Codice EU
INFRASTRUTTURE DI COMUNICAZIONE E TRASPORTO	26	INFRASTRUTTURE DI COMUNICAZIONE E TRASPORTO-AEROPORTI	2609	B42
INFRASTRUTTURE DI COMUNICAZIONE E TRASPORTO	26	INFRASTRUTTURE DI COMUNICAZIONE E TRASPORTO-AUTOSTRADE/SUPERSTRADE	2610	B42
INFRASTRUTTURE DI COMUNICAZIONE E TRASPORTO	26	INFRASTRUTTURE DI COMUNICAZIONE E TRASPORTO-PORTI	2611	B42
INFRASTRUTTURE DI COMUNICAZIONE E TRASPORTO	26	INFRASTRUTTURE DI COMUNICAZIONE E TRASPORTO-ELIPORTI	2612	B42
INFRASTRUTTURE DI COMUNICAZIONE E TRASPORTO	26	INFRASTRUTTURE DI COMUNICAZIONE E TRASPORTO-TRASPORTI A FUNE	2613	B42
INFRASTRUTTURE DI COMUNICAZIONE E TRASPORTO	26	INFRASTRUTTURE DI COMUNICAZIONE E TRASPORTO-VIE D'ACQUA INTERNE (ES. NAVIGLI)	2614	B42
INFRASTRUTTURE DI COMUNICAZIONE E TRASPORTO	26	INFRASTRUTTURE DI COMUNICAZIONE E TRASPORTO-STAZIONI FERROVIARIE/METROPOLITANE	2615	B42
INFRASTRUTTURE DI COMUNICAZIONE E TRASPORTO	26	INFRASTRUTTURE DI COMUNICAZIONE E TRASPORTO-SOTTOPASSI	2616	B42
INFRASTRUTTURE DI COMUNICAZIONE E TRASPORTO	26	INFRASTRUTTURE DI COMUNICAZIONE E TRASPORTO-AREE DI SERVIZIO, PARCHEGGI	2617	B42
INFRASTRUTTURE TECNOLOGICHE E DI SERVIZIO	27	**INFRASTRUTTURE TECNOLOGICHE E DI SERVIZIO**	**2701**	**B42**
INFRASTRUTTURE TECNOLOGICHE E DI SERVIZIO	27	INFRASTRUTTURE TECNOLOGICHE E DI SERVIZIO-RADIO/TELEVISIONE	2702	B42
INFRASTRUTTURE TECNOLOGICHE E DI SERVIZIO	27	INFRASTRUTTURE TECNOLOGICHE E DI SERVIZIO-LINEE TELEFONICHE FISSE E MOBILI	2703	B42
INFRASTRUTTURE TECNOLOGICHE E DI SERVIZIO	27	INFRASTRUTTURE TECNOLOGICHE E DI SERVIZIO-GASDOTTI	2704	B42

CATEGORIA	DB CAT	SOTTOCATEGORIA	DB SOTTOCAT	Codice EU
INFRASTRUTTURE TECNOLOGICHE E DI SERVIZIO	27	INFRASTRUTTURE TECNOLOGICHE E DI SERVIZIO-CONDOTTE FORZATE	2705	B42
INFRASTRUTTURE TECNOLOGICHE E DI SERVIZIO	27	INFRASTRUTTURE TECNOLOGICHE E DI SERVIZIO-OLEODOTTI	2706	B42
INFRASTRUTTURE TECNOLOGICHE E DI SERVIZIO	27	INFRASTRUTTURE TECNOLOGICHE E DI SERVIZIO-LINEE DI DISTRIBUZIONE ENERGIA ELETTRICA	2707	B42
INFRASTRUTTURE TECNOLOGICHE E DI SERVIZIO	27	INFRASTRUTTURE TECNOLOGICHE E DI SERVIZIO-IMPIANTI A SUPPORTO DELLE RETI (CENTRALI, CABINE ELETTRICHE, IMPIANTI FOTOVOLTAICI)	2708	B42
INFRASTRUTTURE TECNOLOGICHE E DI SERVIZIO	27	INFRASTRUTTURE TECNOLOGICHE E DI SERVIZIO-ACQUEDOTTI	2709	B42
INFRASTRUTTURE TECNOLOGICHE E DI SERVIZIO	27	INFRASTRUTTURE TECNOLOGICHE E DI SERVIZIO-SISTEMI FOGNARI	2710	B42
INFRASTRUTTURE TECNOLOGICHE E DI SERVIZIO	27	INFRASTRUTTURE TECNOLOGICHE E DI SERVIZIO-DEPURATORI	2711	B42
INFRASTRUTTURE TECNOLOGICHE E DI SERVIZIO	27	INFRASTRUTTURE TECNOLOGICHE E DI SERVIZIO-DISCARICHE	2712	B42
INFRASTRUTTURE TECNOLOGICHE E DI SERVIZIO	27	INFRASTRUTTURE TECNOLOGICHE E DI SERVIZIO-INCENERITORI	2713	B42
INFRASTRUTTURE TECNOLOGICHE E DI SERVIZIO	27	INFRASTRUTTURE TECNOLOGICHE E DI SERVIZIO-PUNTI DI PRELIEVO DI ACQUA POTABILE (POZZI, SORGENTI)	2714	B42
OPERE IDRAULICHE	28	**OPERE IDRAULICHE-OPERE DI SBARRAMENTO (dighe, traverse)**	**2801**	**B45**
OPERE IDRAULICHE	28	**OPERE IDRAULICHE-OPERE DI DIFESA LONGITUDINALI (argini, muri di sponda, pennelli)**	**2802**	**B45**
OPERE IDRAULICHE	28	**OPERE IDRAULICHE-OPERE DI DIFESA TRASVERSALI (soglie, briglie, traverse)**	**2803**	**B45**
OPERE IDRAULICHE	28	**OPERE IDRAULICHE-CANALIZZAZIONI (comprese le tombinature)**	**2804**	**B45**
OPERE IDRAULICHE	28	**OPERE IDRAULICHE-SCOLMATORI/SCARICATORI/SFIORATORI**	**2805**	**B45**

CATEGORIA	DB CAT	SOTTOCATEGORIA	DB SOTTOCAT	Codice EU
OPERE IDRAULICHE	28	OPERE IDRAULICHE-CASSE DI ESPANSIONE/VASCHE DI LAMINAZIONE	2806	B45
OPERE IDRAULICHE	28	OPERE IDRAULICHE-OPERE DI BONIFICA	2807	B45
OPERE IDRAULICHE	28	OPERE IDRAULICHE-IDROVORE	2808	B45
OPERE IDRAULICHE	28	OPERE IDRAULICHE-CHIAVICHE	2809	B45
OPERE IDRAULICHE	28	OPERE IDRAULICHE-OPERE DI DIFESA COSTIERA (AD ES., PENNELLI, BARRIERE)	2810	B45
OPERE IDRAULICHE	28	ALTRE OPERE IDRAULICHE	2811	B45
POPOLAZIONE/SALUTE UMANA	29	DANNI ALLA SALUTE UMANA-DA INQUINAMENTO O CONTAMINAZIONE	2901	B11
POPOLAZIONE/SALUTE UMANA	29	DANNI ALLA SALUTE UMANA-INTERRUZIONE SERVIZI (fornitura/trattamento acqua, comunicazione, trasporto, energia, gas...)	2902	B11
POPOLAZIONE/SALUTE UMANA	29	DANNI ALLA POPOLAZIONE-MORTI	2903	B11
POPOLAZIONE/SALUTE UMANA	29	DANNI ALLA POPOLAZIONE-FERITI	2904	B11
POPOLAZIONE/SALUTE UMANA	29	DANNI ALLA POPOLAZIONE-DISPERSI	2905	B11
POPOLAZIONE/SALUTE UMANA	29	DANNI ALLA POPOLAZIONE-EVACUATI	2906	B11
POPOLAZIONE/SALUTE UMANA	29	DANNI ALLA POPOLAZIONE-ISOLATI	2907	B11
POPOLAZIONE/SALUTE UMANA	29	ALTRI IMPATTI SULLA SALUTE UMANA/POPOLAZIONE	2908	B13
STRUTTURE/SERVIZI DI PUBBLICO INTERESSE	30	STRUTTURE/SERVIZI PER AMMISTRAZIONE PUBBLICA (SEDI/ATTIVITÀ DI COMUNI, PROVINCIA, REGIONE, PREFETTURA)	3001	B12
STRUTTURE/SERVIZI DI PUBBLICO INTERESSE	30	STRUTTURE/SERVIZI PER AMMISTRAZIONE PUBBLICA-ALTRI UFFICI/SERVIZI PUBBLICI	3002	B12

CATEGORIA	DB CAT	SOTTOCATEGORIA	DB SOTTOCAT	Codice EU
STRUTTURE/SERVIZI DI PUBBLICO INTERESSE	30	STRUTTURE/SERVIZI PER ASSISTENZA SANITARIA-OSPEDALI	3003	B12
STRUTTURE/SERVIZI DI PUBBLICO INTERESSE	30	STRUTTURE/SERVIZI PER LA SALUTE-CASE DI CURA, CASE DI ACCOGLIENZA PER ANZIANI, DIVERSAMENTE ABILI, ECC.	3004	B12
STRUTTURE/SERVIZI DI PUBBLICO INTERESSE	30	STRUTTURE/SERVIZI PER ISTRUZIONE-ASILI/SCUOLE/UNIVERSITÀ	3005	B12
STRUTTURE/SERVIZI DI PUBBLICO INTERESSE	30	STRUTTURE/SERVIZI PER LA SICUREZZA-CASERME VVF	3006	B12
STRUTTURE/SERVIZI DI PUBBLICO INTERESSE	30	STRUTTURE/SERVIZI PER LA SICUREZZA-CASERME VARIE (CC-PS-EI)	3007	B12
STRUTTURE/SERVIZI DI PUBBLICO INTERESSE	30	STRUTTURE/SERVIZI PER LA SICUREZZA-PENITENZIARI, CARCERI	3008	B12
STRUTTURE/SERVIZI DI PUBBLICO INTERESSE	30	ALTRE STRUTTURE/SERVIZI DI PUBBLICO INTERESSE - CIMITERI	3009	B12
STRUTTURE/SERVIZI DI PUBBLICO INTERESSE	30	ALTRE STRUTTURE/SERVIZI DI PUBBLICO INTERESSE - AREE VERDI URBANE	3010	B12

11.12 Terminology/Glossary

Table 35. Acronyms.

UNISDR	United Nations Office for Disaster Risk Reduction
WCDRR	World Conferences on Disaster Risk Reduction
IDNDR	International Decade of Natural Disaster Reduction
HFA	Hyogo Framework for Action
ISPRA	Higher Institute for Environmental Protection and Research
DPCN	Italian National Department of Civil Protection
ER	Event Report
PAI	The Plan for the Hydrogeological Structure (Piano per l'assetto idrogeologico)
FD	Flood Directive
ASPFR	Areas of Significant Potential Flood Risk (FD)
SF	Sendai Framework
SFDRR	Sendai Framework for Disaster Risk Reduction
Da.Ma	Is a documentary platform for Bad Weather Damages. Demo version. Da.Ma stands for Danni Maltempo.

Table 36. Glossary.

United Nation's General Assembly	The General Assembly, comprised of all 193 Members of the United Nations, provides a unique forum for multilateral discussion of the full spectrum of international issues covered by the Charter. The General Assembly (GA) is the main deliberative, policymaking and representative organ of the UN.[67]
Direct economic loss	The monetary value of total or partial destruction of physical assets existing in the affected area. Direct economic loss is nearly equivalent to physical damage. Direct economic losses usually happen during the event or within the first few hours after the event and are often assessed soon after the event to estimate recovery cost and claim insurance payments. These are tangible and relatively easy to measure.
Replacement cost	The cost of replacing damaged assets with materials of like kind and quality. This includes both private and public assets. Replacement is not necessarily an exact duplicate of the subject but serves the same purpose or function as the original (please note this does not consider building back better).
The Global Platform for Disaster Risk Reduction	The Global Platform for Disaster Risk Reduction is a biennial forum for information exchange, discussion of latest developments, knowledge and partnership-building across sectors, with the goal of improving implementation of disaster risk reduction through better communication and coordination amongst stakeholders. Its core function is to enable governments, NGOs, scientists, practitioners, and UN organizations to share experience and formulate strategic guidance for the implementation of global disaster risk reduction agreements: the 2005 Hyogo Framework for Action and its post-2015 successor the Sendai Framework.
Open-ended intergovernmental expert working group – OIEWG	The open-ended intergovernmental expert working group – OIEWG, comprised of experts nominated by States, and supported by the United Nations Office for Disaster Risk Reduction (UNDRR), with involvement of relevant stakeholders, for the development of a set of possible indicators and terminology to measure global progress in the implementation of Sendai Framework in coherence with the

[67] http://www.un.org/en/ga/

	work of the inter-agency and expert group on sustainable development indicators (Resolution adopted by the General Assembly on 2 February 2017, 2017).

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