LODE PROJECT

Conceptualization and development of the data model (Collect, store and manage damage data for the Agriculture Sector and integration with other relevant societal sectors)

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Conceptualization and development of the data model

Collect, store and manage damage data for the Agriculture Sector and integration with other relevant societal sectors

1. INTRODUCTION

Deliverable 3.1 main objective is to illustrate a pathway to the development of relational databases as part of the information system for collecting and managing post-disaster data. It is providing the methodological approach that has been discussed and shared between the consortium and the developers of the Politecnico di Milano so as to make sure on the one hand that the most important aspects of the damage and the damaged assets are included for future analysis and on the other to ease the software development part and to standardize it as much as possible. In fact, from previous experiences carried out in the Idea project and in the Service run for the Catalunya Civil Protection, it became clear that a compromise needs to be achieved between the "logic" and elegance of the data model and the feasibility and the possibility to implement the data model in real terms, practically as originally intended.

The second and third chapter illustrate the main methodological choices that have been taken and the consequent data model in a rather abstract way. The logic abstraction permits actually the standardization that is necessary for implementation whilst preserving the possibility to embed the richness of features and characteristics of both damaged assets and types of damage and losses.

The fourth chapter makes explicit how this logic permits the replicability of the system in other sectors besides the one that has been used as pilot, agriculture. The fifth chapter illustrates some of the integrations that still are needed to be able to attach the system under development to the Risk Data Hub. The sixth and the seventh chapter describe ongoing developments, including the current drafting version of the interface for the agricultural sector and the logic schematic representation of the data model that lays behind the interface. In the annex the guidelines developed for the partners to help standardize the process and the representation of the data model for the different sectors is provided.

1.1. MAIN OBJECTIVES FOR THE DEVELOPMENT OF THE IT SYSTEM and inputs for the definition of a standardized data model to be applied to different sectors

LODE project aims at improving the collection, storage and organization of post-disaster damage and loss data to support a variety of applications and its concrete goal is to develop a damage and loss data information system for DRR and CCA to enhance our understanding of disaster impacts to multiple societal sectors at relevant spatial and temporal scales.

This report focuses on the first activities and studies carried out to fulfil the LODE practical aim considering that currently most of the damage collection processes are carried out manually filling paper-forms or traditional file-based schemes (Fig. 1). The collection of the data through an ICT (Information and Communications Technology) application user-interface would allow to insert the data directly into a relational database reducing the time of the operations which are generally carried out filling first the forms manually and then inserting the data into the archive. Even if countries have procedures to collect data, rarely they use ICT tools and/or have databases to store and manage post- event damage data. For example, in Italy the Civil Protection carries out surveys after natural disasters with volunteer and experts' teams that fulfill prefigured paper formats on site which data are manually digitalized at the end of every day spent on field. Another example is the CARM (Murcia Regional Government) Cultural Heritage Unit collects data regarding estimation of damage (such as for the Lorca earthquake 2011) in a paper based form consequently analysis and interrogation of data becomes costly in terms of time and needed resources. Administrative procedures, long and dense bureaucracy and continuous changes in mandates and ordinances and fragmentation and non-clear responsibilities of whom should collect and maintain the data are reasons for the complications encountered in the adoption of advanced and more efficient tools.

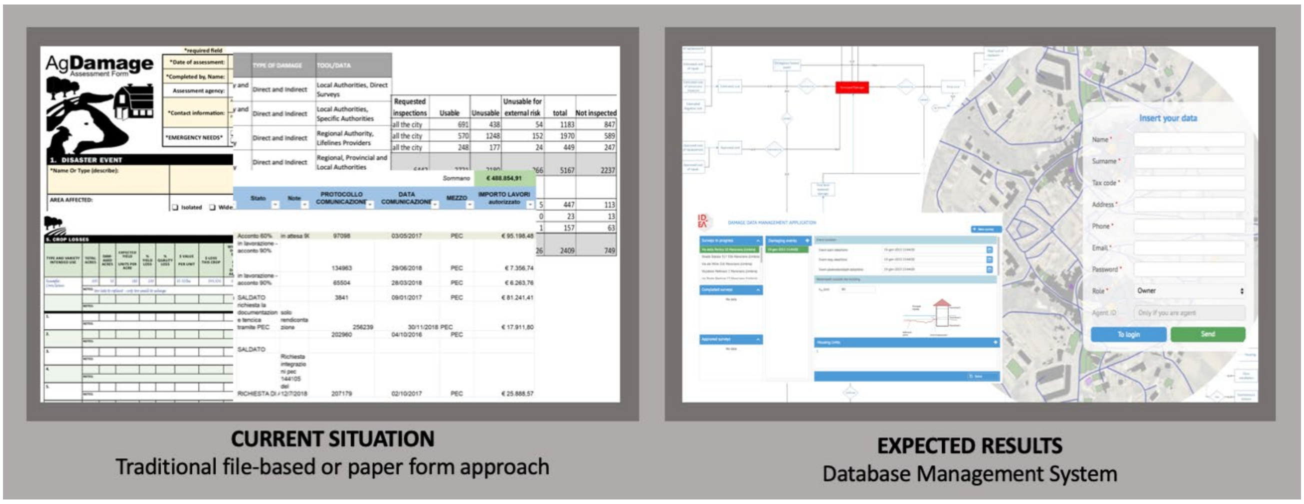

Figure 1. representation of current situation and expected results

It is fundamental to highlight that the LODE project gets shaped on prior experience gained through the development of a former project funded by DG ECHO: IDEA (http://www.ideaproject.polimi.it) – Improving Damage analysis to Enhance cost benefit Analysis, therefore activities and studies have been carried out with a more results-oriented approach. According to IDEA data is a resource to be managed, accessed and analyzed by a multitude of stakeholders (Deliverable E1: Technical report on post-disaster damage meta-data) for different purposes: reporting for compensation, allow aggregation at higher levels, cost benefit analyses, forensic investigation, improved inputs for risk modelling, production of a complete event damage report. The project focused on some main objectives: collaborative development and active participation in the development of a system to collect and store damage and loss data, and minimize unnecessary work, particularly with regard to the creation of wasteful documentation. In particular, during IDEA researcher and stakeholders together addressed several issues related to damage and loss data such as the importance to develop a process of continuous data collection and management across the entire time scale from the immediate emergency until the recovery phase. It must be pointed out that such data are collected in any case and therefore the main rationale in developing a rationalized process and tool is to ease the data collection and to guarantee that data are not dispersed or lost. Such a system requires data of different formats and type of data (pdf files, pictures and number formats) to be archived.

In the Idea project, specific interface application have been developed for some sectors (see Deliverable E2 and E3: Concept and design of the architecture of an IT system to collect and analyse post-disaster damage data) in a pilot form. The objective of Lode is to take over this previous effort, standardize it and making it available for a number of other sectors that had not been developed in Idea.

From the IDEA results, a step forward has been done with the LODE project developing a technological architecture based on an inclusive data model.
As for the IDEA project, IT developers involved in the elaboration are participating to all the phases of the research, this approach allows both parts (scientist and developer) to better understand each other needs, criticalities and challenges to overcome creating a more fruitful environment for the achievement of the desired results.
In this report we focus specifically on the phase dedicated to the development of the architecture for the Agriculture Sector, which is one of the sectors that had not been dealt with in the IDEA Project and has been therefore chosen to developed and test specifically LODE's objectives. Moreover, this report drives attention on the approach adopted and on the organization of a model which aims at being standard but flexible to embed sector-specific data.
The advancements performed are a result of:

- the solid background developed during the IDEA activities regarding damage and loss data collection and its gaps;
- the detailed study of the agriculture sector;
- the analysis of the international policies for damage data collection for the agriculture sector with a specific regard to the Sendai Framework for Disaster Risk Reduction guidelines;
- the investigation of relevant examples of damage and loss assessments forms and existing practices (four case-studies); and,
- first exploratory studies of other societal sectors and their characteristics and common features when impacted by different disasters.

2. METHODOLOGICAL APPROACH

Since data are typically collected and managed using a traditional file-based approach a relational database anticipates and facilitates the use of data for multiple objectives since it consists in a collection of tables that store interrelated data. By designing a relational database, knowing all variables and data to be collected according to the needs which have been, in this case, explored along the research path for the agriculture sector and will be analyzed more in detail also for other relevant societal sectors, it is possible to create a structure that eliminates redundancy and inconsistency. A relational database management system allows to store and retrieve data represented in tables through different types of queries elaborated in advance to support a range of different purposes.

The conceptualization of the model begins from the conception developed during the IDEA project in conjunction with a specific analysis of the literature review and analysis conducted for the agriculture sector. Specifically, the process has started from the investigation of the agriculture sector damage dynamics and the related policies, followed by the analysis of existing procedures, till the understanding of the missing elements in the process of the agriculture damage data collection, following the steps illustrated in Figure 2.

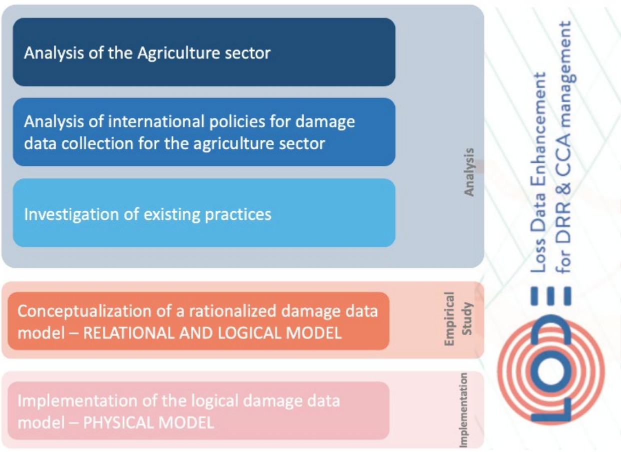

Figure 2. Schematization of the methodological approach

The developed database for the agriculture sector overcomes the following challenges encountered in the IDEA project:

- It overcomes the traditional division between direct and indirect damage, implementing the following models would allow to record and monitor damage both in the immediate emergency as well as afterwards in the recovery phase;
- It is the result of detailed sectoral understanding of damage, the model has been designed understanding how the sector is affected by an event (direct physical damage and incurred costs due

to repairs of structures and machinery or for medical care of the livestock; systemic consequences due to outages and service interruptions; indirect damage and economic damage)

- It is designed with a clear scope, in fact we are focused on damage data that should be empirically gathered on the field. We are not considering data derived from modelling, such as for example economic estimation of losses. We focus on the damage considered as a physical description of how the elements composing a sector have been impacted.

3. CONCEPTUAL DESIGN – relational and logical model

During the damage data conceptualization, a comprehensive set of entities that represent the agriculture sector has been created according to the analysis performed on existing international policies and practices. Those entities are the basic elements of the Entity Relationship Diagram (ERD): a graphical representation used for the conceptual design of database applications. The entities are represented as rectangles, each entity has attributes describing it which have been selected in accordance to the knowledge acquired through the analysis of the hazardous events affecting agriculture and of the existing procedures to collect agriculture damage data. Entities can be related to each other through rhombus (Chen's notation). Relationships among entities have cardinality ratios which specify the number of relationship instances that an entity can participate in (Elmasri & Navathe, 2010), they have been designed considering the interactions between the sector's elements.

The entities are organized in:

I. Set of primary entities (Fig. 3)
II. Set of entities representing the farm components (Fig. 4)
III. Set of damage entities (Fig. 5)

Figure 3. Set of primary entities

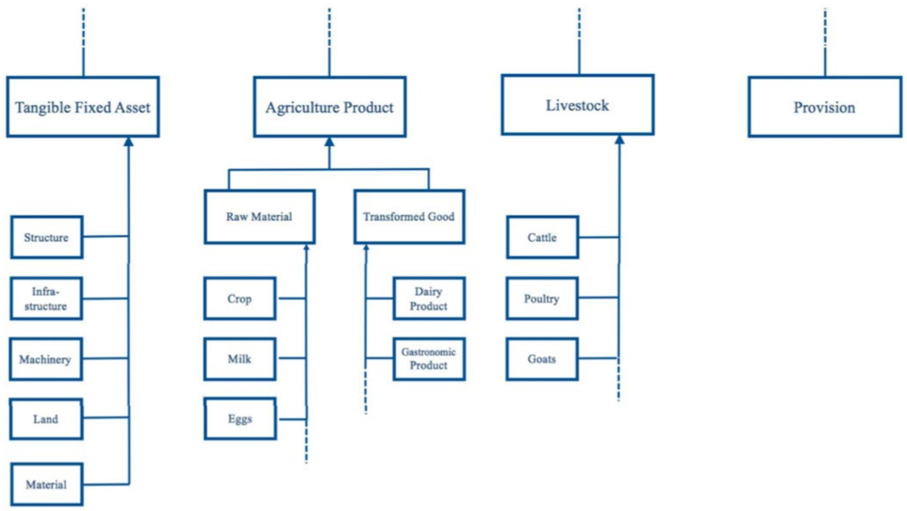

Figure 4. Set of entities representing the farm components and its sub-class entities

Figure 5. Set of damage entities

One of the most relevant features of the model lies in the embraced concept that damages are inter-connected (i.e. if a damage occurs on a tangible fixed asset such as a rural infrastructure, provisions will be consequently affected due to the repair costs), and intra-connected (a damage occurred on agriculture products can happen due to the intra-connection of the damage between raw materials and transformed goods, i.e. if a damage occurs on a raw material, such as milk, transformed goods will be therefore affected due to the shortage of this raw material needed to produce dairy products).

The conceptual model (entity-relationship diagram) designed comprise specific characteristics derived from the accurate study of the different impacting mechanisms that affect the agriculture sector in case of natural hazards, its representation is illustrated in two different figures one representing clearly the direct effects (Fig. 6) and one representing the cascade effects that the model is able to embrace (Fig. 7).

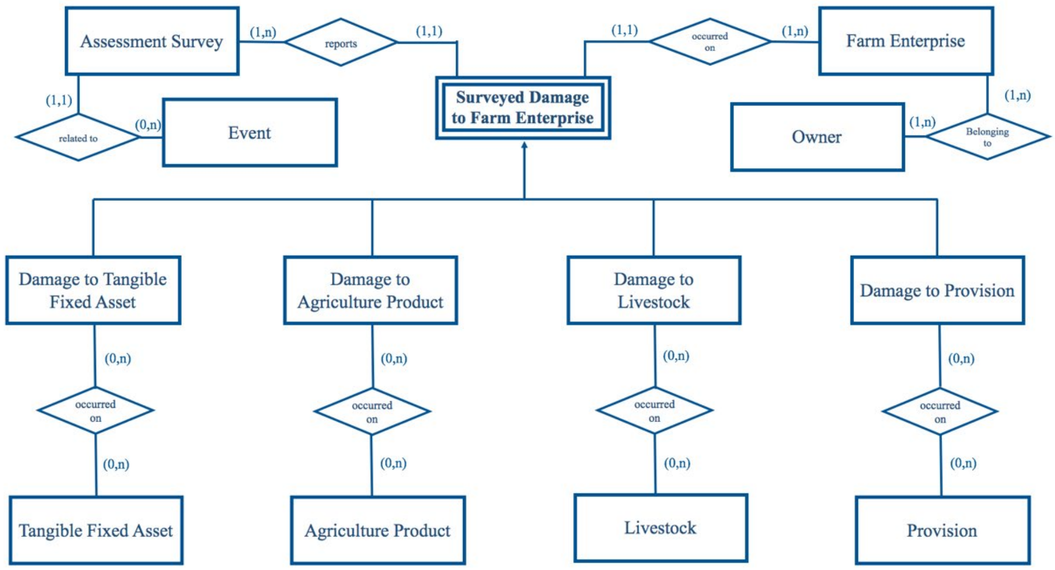

Figure 6. Entity-Relationship Diagram – Direct Effects

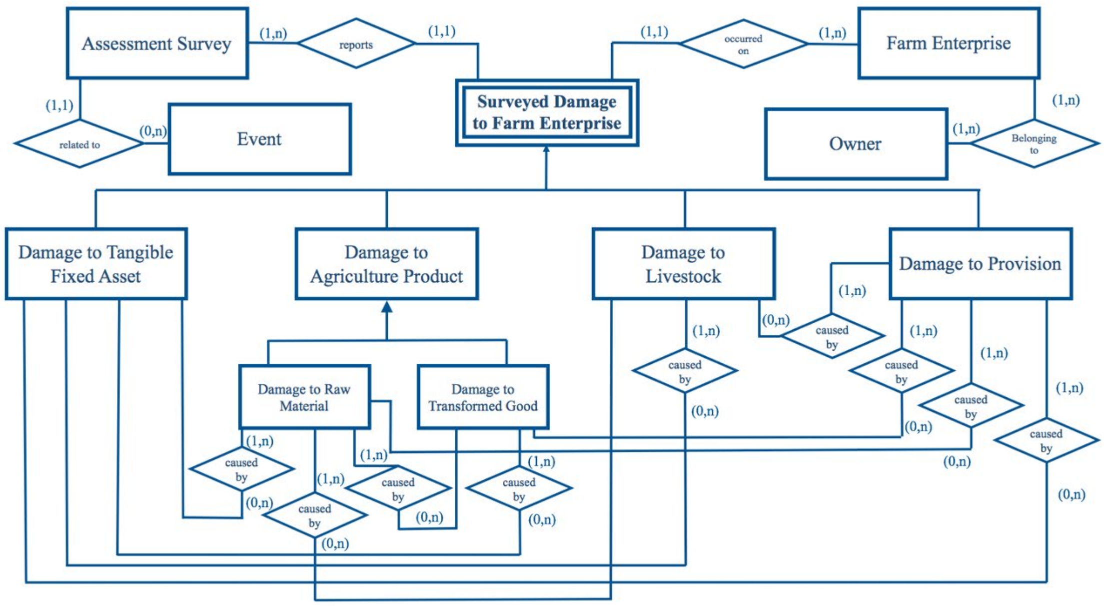

Figure 7. Entity-Relationship Diagram – Cascading Effects

The temporal and spatial characteristics of the damage become crucial for the development of a comprehensive and effective model. The temporal contextualization of the damage itself and its exact location are a main aspect considered in the model. Damages do not happen simultaneously to the event, and they need to be analyzed considering their exact time of occurrence and their evolution till the time of the assessment. The proposed model allows to record two types of dates: the date of occurrence of the damage (if available) and the date in which the damage has been surveyed. Nonetheless, disasters can cause damages to structures and facilities, machinery and equipment but they can also affect (directly or on the long term i.e. diseases) animals, soil, crops; therefore, it is fundamental to be able to accurately assess the damage and determine the effect which could arise at the moment of the event occurrence or after a period of time.

Given this context, the model proposes a methodology that allows the historical damage dynamics reconstruction through the multi-step assessment of damages allowing to represent not only the immediate, direct, physical impact of an event, but also the indirect and systemic consequences related to the inter- and intra-dependencies of the different elements constituting the Agriculture sector.

3.1. IMPLEMENTATION OF THE LOGICAL MODEL – physical model

The development an IT (Information Technology) tool would support the whole process from the data collection to their analysis, bringing numerous advantages. The proposed relational database is a tool that can improve the traditional approaches facilitating the data management from input to output, supporting both reporting and analysis for different purposes with accurate interrelated data.

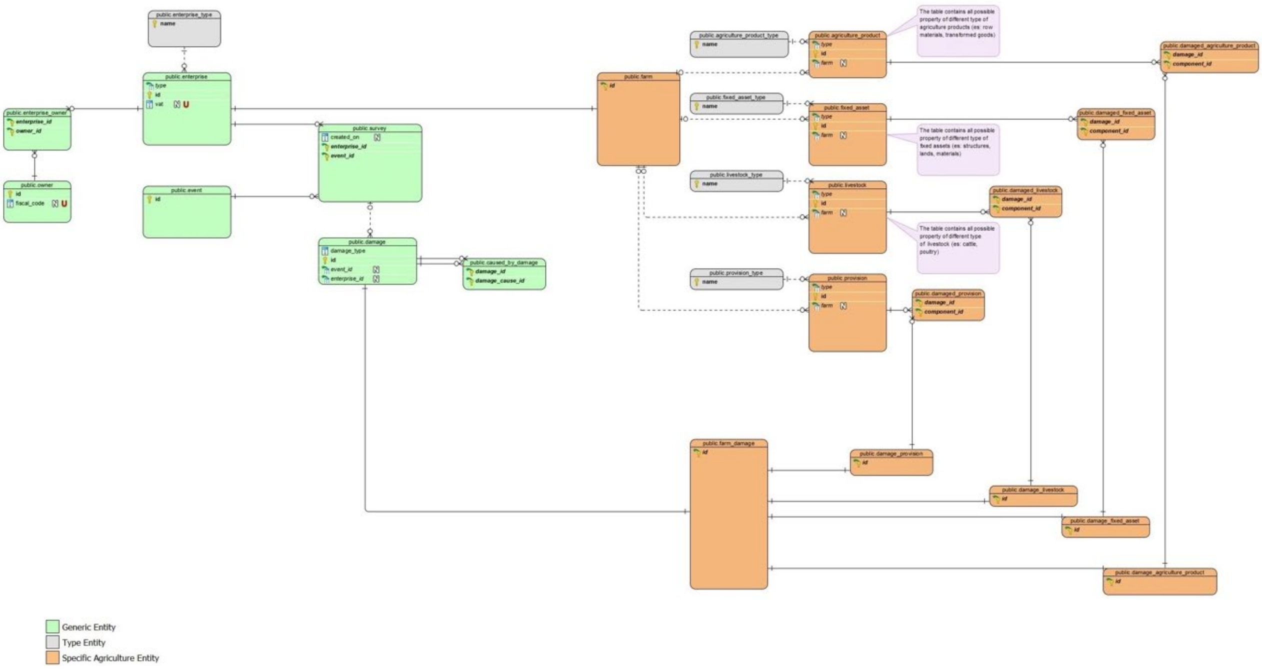

Figure 8. Physical model

Direct work with the developer allowed a collaborative development of a physical model (Fig. 8) which takes into account the logical model but seeks flexibility and standardization with the aim of rationalizing the stakeholder's uses of loss and damage data in both initial collection phase and successive organization and use for different societal sectors.

It has to be highlighted that the main effort consists in maintaining both adherence to the logical model and scalability of the queries strictly necessary for the complex structure we aim at developing.

The physical model has been developed using an Object-relational mapping (ORM). ORM is a programming technique which allows to map software elements to database tables automatically. Using such a technique will allow to have:

- Simplified development because it automates object-to-table and table-to-object conversion, resulting in lower development and maintenance costs;
- Transparent object caching in the application layer, improving system performance; and,
- An optimized solution making an application faster and easier to maintain.

The model showed in fig. 8 has been developed using "VISUAL PARADIGM" tool (see https://www.visual-paradigm.com/guide/data-modeling/what-is-entity-relationship-diagram/) which is not open source, however, DBEaver represent an analogous and still valid open source tool to develop similar models (DBEaver https://dbeaver.io/).

This programming technique involves an effort when translating the logical representation of the objects into an atomized form to store in the database which preserves the specific characteristics of the objects and their relationships. The high level of abstraction could create difficulties when considering how to link and match an object system to a relational database. This is why all the development phases and ongoing evolution will be followed and guided by partners and stakeholders.

4. MAIN REPLICABLE -fundamental- CHARACHTERISITICS

Passing from the reality to its modeling implies numerous challenges and several schematization of complex relationships, however, the system under development has been already designed with some fundamental features that are representative of every societal sectors dynamics. The main characteristics that we are comprising in the development and that will be replicated also for the other sectors are:

(i) cascading and domino effects tracing;
(ii) time of occurrence of the damages and time of assessment;
(iii) spatial dimension of the damage; and
(iv) standardization and flexibility.

The system, according to both logical and physical models, allows to keep the relationships between damages and their time of occurrence. Assets and type of damages change, they are different for each considered sector, but the possible connection between damages itself - dependency relationship - doesn't vary (Fig. 9).

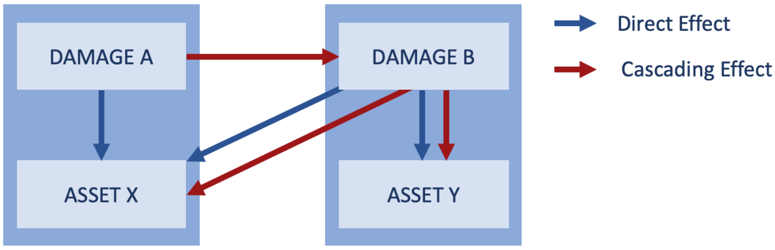

Figure 9. Damages dependency relationship

As mentioned in chapter 3, the temporal contextualization of the damage itself and its exact location are a main aspect considered in the model, characteristics that will be repeated for the other sectors. The proposed model allows to record two types of dates: the date of occurrence of the damage (if available) and the date in which the damage has been surveyed, in addition to the spatial coordinates of the damage itself.

Finally, the system has been shaped in the most possible standard way, in fact in this specific case of the Agriculture Sector, every possible asset or good of the sector is filed according to the European Codes NACE (Statistical classification of economic activities in the European Community) which consist in a four-digit classification that provides an European framework for collecting and presenting a large range of data for economic activities (in the fields of economic statistics). A fixed registry, recognized at the European Level could bring numerous advantages especially for future comparisons and analysis of data, therefore this approach will be maintained also in the development of the system for the other sectors.

5. INTEGRATIONS TO BE CARRIED OUT

During the meetings held for the LODE Project improvements to be implemented have been highlighted considering the different needs of the stakeholders and the opinions of the partners. We believe, according to the IDEA findings (see Deliverable E2 and E3: Concept and design of the architecture of an IT system to collect and analyse post-disaster damage data), that all the stakeholders and partners should actively participate and intervene to shape and address the development of the system. Main raised point were related to:

- Rights and data privacy;
- Identification and specification of priorities;
- Sharing reluctance;

According to those first raised issues, and other steps that still need to be carried out, what we will try to include in our development through the future established meetings and workshops is listed below:

- Delineate with a collaborative approach the functional requirements of the database, i.e. proper **use-case diagrams** taking into account rights and data privacy concerns. This means that we will work on the intended behavior of the system. A use-case defines a goal-oriented set of interactions between external actors and the system under consideration, use-cases delineate who does what with the system and for what purpose;
- Discuss and address the **design of the IT user-friendly interface**, which according to the database model will display information according to the needs and priorities that will be identified during future discussions;
- Examine with stakeholders the reason behind the evident **sharing reluctance**; and,
- Prepare **preconceived queries** to perform on the system both for the analysis of the data and the development of the interface.

The described steps and future ones will be carried out following the procedure illustrated in Figure 10 also for other sectors and keeping in mind that the DBMS will interact with the Risk Data Hub under development at the DRMKC at the JRC of the EU Commission.

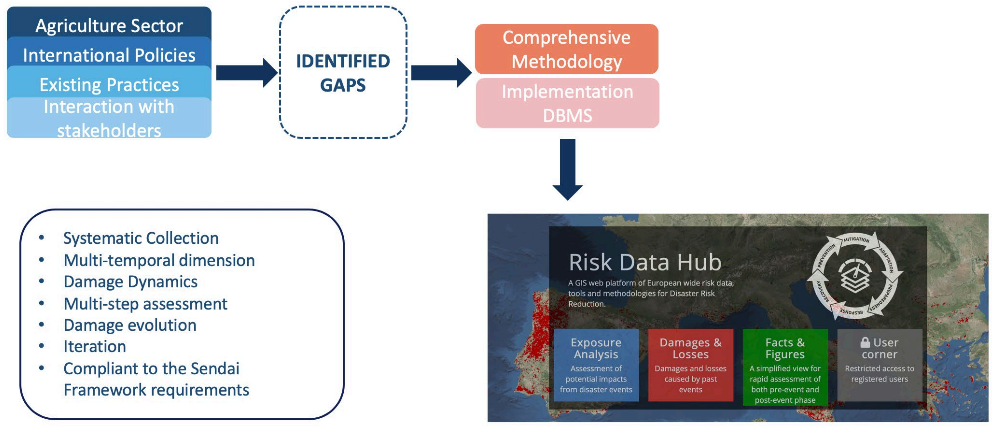

Figure 10. Schematization of the procedure

5.1. FORESEEN IMPLEMENTATIONS and INTEGRATIONS

Since the aim of the LODE project resides in the achievement of a concrete and efficient result, we intent to implement the system with the involved stakeholders. Given the collaboration with the Umbria Civil Protection which has been directly involved in the seismic swarm of 2016-2017, we have had the opportunity to introduce the tool to some selected actors involved in the Agriculture Sector in order to test it and determine its strengths or needed improvements. The system under development has been appreciated for its efficiency in the phase of data insertion and management by the stakeholder responsible of the emergency and recovery management for the agriculture sector in the Umbria region. However the need to integrate the system with other existing databases has been expressed (such as the SIAN - National

Agricultural Information System) in order to ease and avoid the insertion of already accessible data to speed the damage and loss data insertion (see chap. 5).

Once the model will be fully “validate” we will integrate it with the sections we will develop for the other societal sectors (Cultural Heritage, Critical Infrastructures, Economic Activities) as represented in Figure 11.

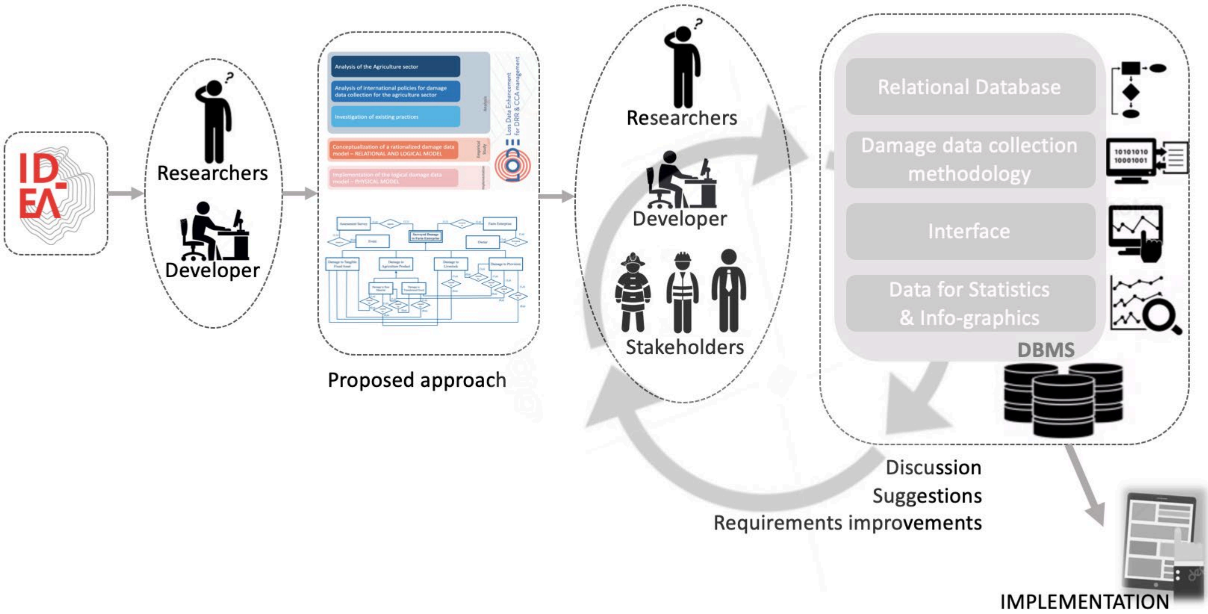

Figure 11. Overview of the process

Moreover, considering the ai of integrating the LODE results with the RDH under development at the DRMKC of the JRC, valuable meetings and discussion have been crucial in understanding essential steps and actions to carry out in order to obtain operational results from LODE. One of the main topic discussed is related to the significance of retrieving information from **existing databases** through a programmed connection of different sources, for instance in the case of the Agriculture or Business sector it would be ideal to have a direct connection with the Chamber of Commerce’s database or for instance, in the case of Italy, to the SIAN (National Agricultural Information System) so that data essential for the identification of the enterprises could be instantly incorporated. However, such an integration would require the development of applications that access data on external databases which often are not freely accessible and it would necessitate to get a specific authorization, which should be requested by the public and governmental organizations.

6. APPLICATION ON-GOING DEVELOPMENTS

With the collaboration of the IT expert, a user-friendly interface has been developed (see Figure 12 and 13). The interface gets shaped on the physical structure of the database developed following the logical model proposed for the agriculture sector. The data base management system developed allows to have a standard structure but enough flexible to comprise the characteristics of the different societal sectors.

This structure will be merged and integrated with the future work concerning other societal sectors such as: telecommunications, power system, cultural heritage, economic activities.

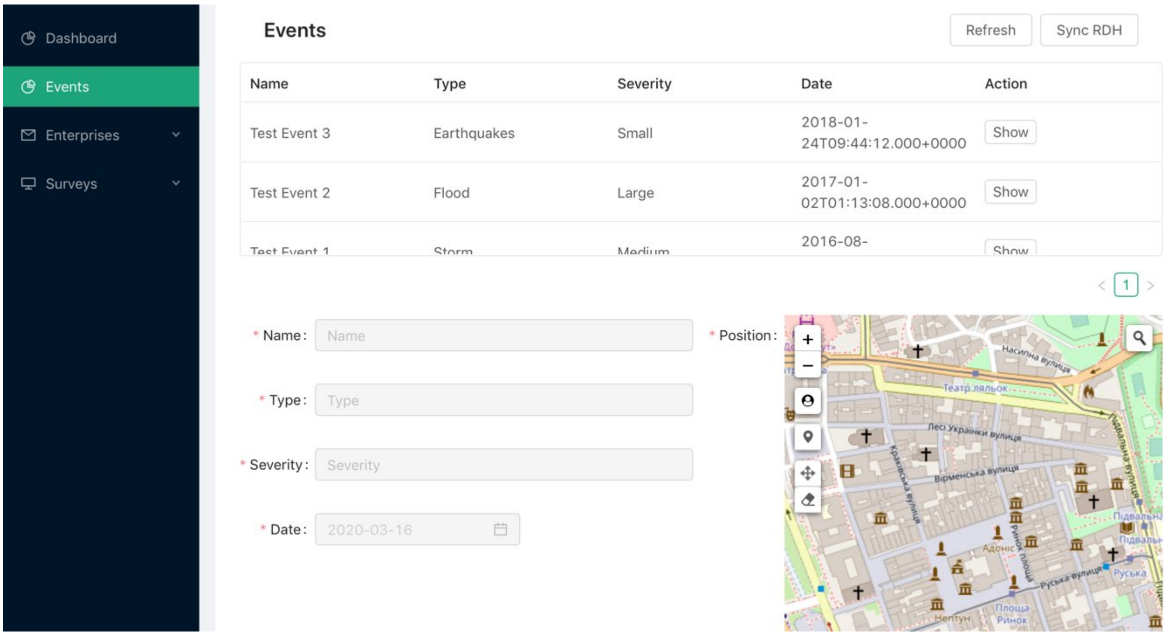

Fig. 12 LODE Damage and Loss Data collection Interface for the Agriculture sector, Event identification

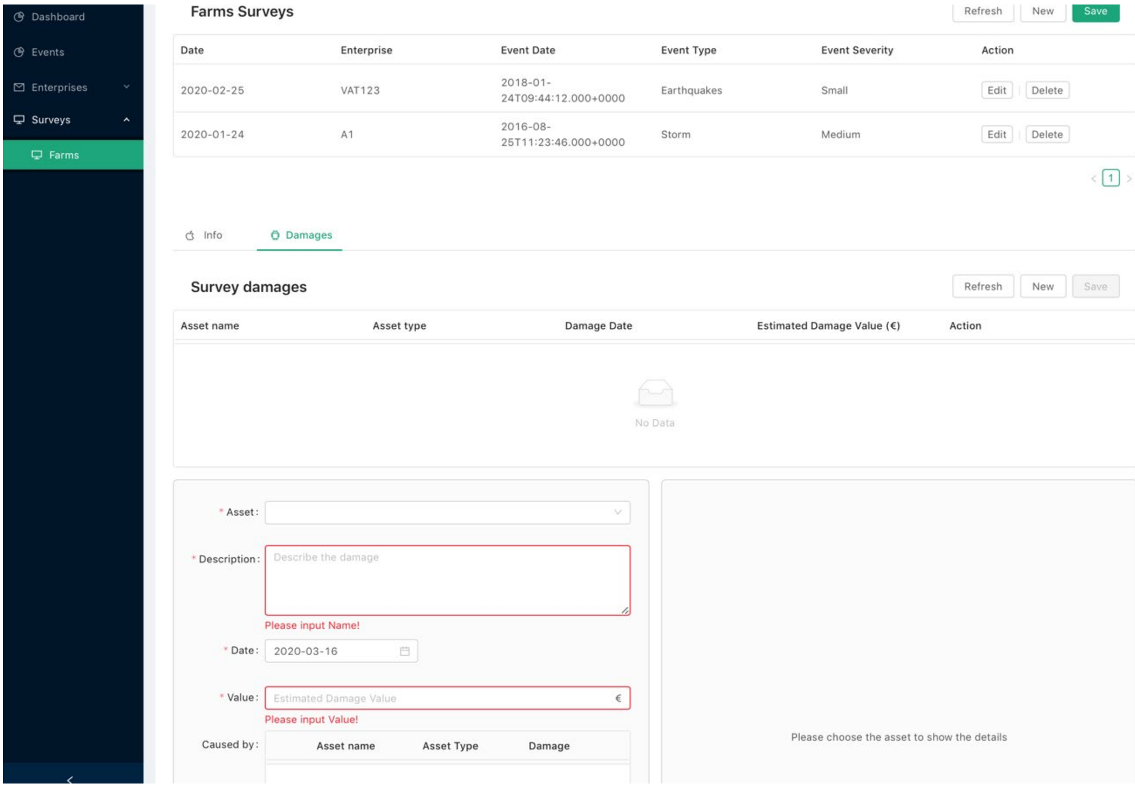

Fig. 13 LODE Damage and Loss Data collection Interface for the Agriculture sector, Damage definition

7. BEHIND THE INTERFACE

The model is being developed according to specific requirements such as flexibility and standardization. A scheme to be used for the development of the model for the other societal sectors (telecommunications, power system, cultural heritage, economic activities) has been developed. Such a scheme preserves the fundamental characteristics highlighted in the development of the Agriculture Damage Data Collection model as main features to allow a comprehensive and accurate collection of crucial data.

The standard classification of entities and their characteristics (i.e. attributes, type of attribute, relation and hierarchy) is shown in fig.14. The class of entities depicted in the tables are the "father entities" to which sub-entities with local specific attributes can be linked inheriting the Father entity attributes and relationships. The specific relationship is reported for every Father Entity (super-class). A Son-entity can have only one Father-entity (from which it inherits the relationships and the attributes) but it can be the Father-entity (which gives attributes and relationships to its Son-entities).

ENTERPRISE (NO PARENT)	
Is the main object of the damage	
Attributes	Types
country	STRING
county	STRING
hamlet	STRING
house_number	STRING
position	POINT
postcode	STRING
road	STRING
state	STRING
town	STRING
description	STRING
name	STRING
vat	STRING
management	TAXONOMY
Relations	
Has OWNER	
Is referenced in SURVEY	

COMPONENT (NO PARENT)	
Is an asset of the enterprise that	
Attributes	Types
country	STRING
county	STRING
hamlet	STRING
house_number	STRING
position	POINT
postcode	STRING
road	STRING
state	STRING
town	STRING
name	STRING
Relations	
Is damaged by DAMAGE	

DAMAGE (NO PARENT)	
Is the possible effect of event on	
Attributes	Types
date	DATE
description	STRING
estimated value	DECIMAL (€)
Relations	
Is damage of COMPONENT	
Is caused by DAMAGE	

EVENT (NO PARENT)	
Is the cause of damages	
Attributes	Types
country	STRING
county	STRING
hamlet	STRING
house_number	STRING
position	POINT
postcode	STRING
road	STRING
state	STRING
town	STRING
date	STRING
name	STRING
severity	STRING
type	STRING

OWNER (NO PARENT)	
Own the ENTERPRISE	
Attributes	Types
email	STRING
fiscal code	STRING
full_name	STRING
phone	STRING
Relations	
Own an ENTERPRISE	

SURVEY (NO PARENT)	
Is the registration of damage	
Attributes	Types
created on	DATE
description	STRING
Relations	
Is about an ENTERPRISE	
Is about an EVENT	

Fig. 14 LODE Damage and Loss Data collection classification of entities and their characteristics

This standard scheme, which will allow the integration of other societal sectors with the base model for application already developed, maintains flexibility specifically required in order to embed sector-specific data. A more detailed overview of the tables and boxes is provided in the Annex.

Reference

Elmasri, R., & Navathe, S. (2010). Fundamentals of Database Systems (6th ed.). Addison- Wesley.

Annex 1
Guidelines for partners to support the development of a relational data model for sectors they are responsible for

1. General description of the guidelines

In the following table some basic information regarding the standardised design of the relational databases for different sectors is provided.
Each sector is represented in one table. The main goal is create a "conceptual data model" for each sector, so describe: entities, attributes, types, taxonomies and relations.
Is important to point out that only elements that are important for damage characterization must be represented.
Table 2 provides a compiled example for the SECTOR-AGRICULTURE that can be used as a template for others sectors.

In the table, a description of the main elements needed to develop an Entity Relationship Diagram is provided and illustrated in the subsequent boxes in figures 1-3. Figures 4-7 represent the same boxes implemented for the agricultural sector.
In the latter, the green cells represent the “father entities” from where we develop all other sub-entities and which will have local specific attributes but will still inherit the Father entity attributes and relationships.
The specific relationship is written for every Father Entity (super-class).

It is important to underline that a Son-entity can have only one Father-entity (from which it inherits the relationships and the attributes) but it can be a Father-entity in its own turn (which gives attributes and relationships to its Son-entities).

Guidelines to develop an entity relationship database	
What is an **entity** ?	In general an **ENTITY** is a thing that exists either physically or logically. An entity may be a physical object such as a house or a car (they exist physically), an event such as a house sale or a car service, or a concept such as a customer transaction or order (they exist logically—as a concept). Entities can be thought of as **NOUNS.**
What is an **attribute** of entity ?	**ATTRIBUTE** of entities is a an **ADJECTIVE** that describe a characteristic of the ENTITY. Examples: an employee entity might have a Social Security Number (SSN) attribute. Every entity MUST have a minimal set of uniquely identifying attributes.
What is the **type of an attribute**?	Is the definition of possible values for the attribute and depends on how such entity is measured (as a time, a geometric

	feature, an economic value, etc.). We can use this list as a reference: TEXT (max length, unit of measurement), INTEGER (max/min value, unit of measurement) DECIMAL (max/min value, unit of measurement) DATE (max/min value) TIME (max/min value, unit of measurement) LIST (provide the taxonomy of possible values, unit of measurement) GEOGRAPHIC (POINT, POLYGON, POLYLINE) The limits and the units of measurement are not mandatory, but if exists and you know it, specify it. The taxonomy is mandatory
What is a **relation** between entities?	A relationship captures how entities are related to one another. Relationships can be thought of as **VERBS**, linking two or more **NOUNS**. Examples: an owns relationship between a company and a computer, a supervises relationship between an employee and a department, a performs relationship between an artist and a song, a proves relationship between a mathematician and a conjecture, etc.
What is a **child entity** ?	Is an entity that describe a more specific variation of another entity (the parent entity). The child entity has all the attributes of the parent entity and others specific attributes. Wen you define a child entity is not necessary repeat all attributes of parent one, but simply specify what is the parent entity. Es. "electric car" is a child entity for "vehicle", as the "vehicle" can has the attribute "tire pressure" but has also a specific attributes that a generic car may not has, for example the "battery charge level". Another child entity of "vehicle" may be "truck".
What **kind of entities** we need to describe?	A base model for application is already developed, so your entities need to fit in it. The main entities you need to describe is a child entities of these ones. You don't need to repeat the parent entity attributes or relation, these are already defined. If you think the parent entities o relation need

	modification we can discuss about it. In GREEN box there are the parent entities. In your child entities specify the parent after the name of entities. A child entity can also be a parent for other entities, but a child entity can has only one parent. A child entity inherit (has at least all) relation of parent entity.
What is a **child entity** ?	Is an entity that describe a more specific variation of another entity (the parent entity). The child entity has all the attributes of the parent entity and others specific attributes. Wen you define a child entity is not necessary repeat all attributes of parent one, but simply specify what is the parent entity. Es. "electric car" is a child entity for "vehicle", as the "vehicle" can has the attribute "tire pressure" but has also a specific attributes that a generic car may not has, for example the "battery charge level". Another child entity of "vehicle" may be "truck".

Sector's main component (i.e. business) (NO PARENT)	
Is the main object of the damage	
Attributes	Types
country	STRING
county	STRING
hamlet	STRING
house_number	STRING
position	POINT
postcode	STRING
road	STRING
state	STRING
town	STRING
description	STRING
name	STRING
vat	STRING
management	TAXONOMY
	Family-run business
	Family-run business with external employee
	Hired management
Relations	
Has OWNER	
Is referenced in SURVEY	

Figure 1. Table representing the main attributes and relations of the PARENT entity

COMPONENT (NO PARENT)	
Is an asset of the enterprise that can be	
Attributes	Types
country	STRING
county	STRING
hamlet	STRING
house_number	STRING
position	POINT
postcode	STRING
road	STRING
state	STRING
town	STRING
name	STRING
Relations	
Is damaged by DAMAGE	

Figure 2. Table representing the attributes and relations that will be inherited by the Component's SONS, COMPONENT is a Main Entity (the FATHER)

DAMAGE (NO PARENT)	
Is the possible effect of event on enterprise	
Attributes	Types
date	DATE
description	STRING
estimated value	DECIMAL (€)
Relations	
Is damage of COMPONENT	
Is caused by DAMAGE	

Figure 3. The attributes and the relations of the entity "damage", which is the father of sub-entities representing specific type of damages

2. Example carried out for the Agricoltural Sector

2.1. Sector general description and entities to describe assets and damage to the latter that are collected during surveys

The work has been carried out starting from the understanding of the global configuration of the sector, essential for identifying the functions of the different elements and the way they are connected to each other (J. Eleutério et al., 2013).
Subsequently the analysis of international policies for damage data collection for the agriculture sector with a specific regard to the Sendai Framework for Disaster Risk Reduction guidelines has been carried out, and existing practices (paper forms developed in different states) for damage data

collection for the specific sector have been analyzed, in order to determine their level of compliance with international policies and guidelines.
Agriculture is considered as an economic sector with specific dynamics and intra- and inter-dependencies.

Agriculture can be easily affected by a large number of extreme events.
Natural disasters, important from an agriculture and livestock point of view, can be divided in (H.P. Das, 2003):
- Geophysical/geological events: earthquake, tsunami, volcanic activity, avalanches, landslides;
- Weather-related: Meteorological events associated with high winds, flooding and storm surges-tropical storm (cyclones, hurricanes, typhoons, etc.), convective storm, local storm, tornados; Hydrological events - flood, mass movement; and Climatological events: extreme temperatures, drought and heatwaves, wildfire, cold spell, frost, snow and ice storms;
- Biological events: animal accident, epidemic, insect infestation (some of which are also related to changes in weather patterns)

Impacts on the Agriculture Sector (classification according to Bremond et al. 2013)
- Instantaneous damage -occurs during or in the immediate aftermath of the event;
- Induced damage -occurs later in time;
- Direct damage –is related to direct exposure;
- Indirect damage –occurs in the area that has not been exposed.

DIRECT INSTANTANEUS DAMAGE
Based on ex-post qualitative studies of flood impacts on agriculture (Pivot et al., 2002) subcategories of direct damage, happened during or in the immediate aftermath of the event, are distinguished:
- Seasonal Crop loss and yield reduction;
- Damage to or destruction of the perennial plant material;
- Fatalities and injuries to farmers/workers AND livestock, poultry, fisheries, wild an
- Loss of livestock products (milk, eggs);
- Damage to soil (erosion, deposit, contamination), land configuration (terraces, lagoons), buildings (storage structures, animal holding structures), machinery and equipment, stored materials (feed, fertilizers, fuel), infrastructure (irrigation systems, drainage systems, roads).

DIRECT INDUCED DAMAGE
Direct induced damage is linked to the scale at which the agricultural activities are analysed. Those damages are:
- Loss of added value due to the loss of yield in the first years after replanting perennial plant material or re-seeding grass;
- Loss of added value due to unavailability of production factors (higher costs);
- Losses from fees (irrigation);
- Cost of relocation or premature sales of livestock;
- Cost of additional food for livestock and additional veterinary and medical expenses;
- Reduced market value of the crop and other agricultural products
- Reduction of herd size…

INDIRECT DAMAGE
The scale to be considered needs to be larger than the farm scale. Farmers who are not directly impacted may suffer disruption in their supply of inputs (including stored fodder) if these activities

have been impacted. Closely related economic sectors may also be disrupted even if they are not directly impacted.

INDIRECT INSTANTANEOUS : Increase in travel time due to damage to infrastructure; Delay or cancellation of supply from the impacted area;

INDIRECT INDUCED: Loss of added value outside the impacted area due to business interruption; Loss of added value outside the impacted area due to damage to infrastructure; Losses due to the impact on economic development and social conditions

Interdependence between damages

As mentioned, the agriculture sector is a dynamic system in nature, therefore the damage dynamics need to be reported.

The model is based on the concept that damages are inter-connected (i.e. if a damage occurs on a tangible fixed asset such as a rural infrastructure, provisions will be consequently affected due to the repair costs), in addition, damages are also intra-connected (a damage occurred on agriculture products can happen due to the intra-connection of the damage between raw materials and transformed goods, i.e. if a damage occurs on a raw material, such as milk, transformed goods will be therefore affected due to the shortage of this raw material needed to produce dairy products).

The knowledge developed on the damages to the Agricultural sector permits to draw the boxes for the development of the database as follows.

References

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Eleutério, J., Hattemer, C., & Rozan, A. (2013). A systemic method for evaluating the potential impacts of floods on network infrastructures. Natural Hazards and Earth System Sciences, 13(4), 983.

Pivot, J.-M., Josien, E., and Martin, P. (2002). Farms adaptation to changes in flood risk: a management approach, J. Hydrol., 267, 12–25

CHILD ENTITY: individual farms (one row for each farm)

COMPONENT of each farm

AGRICULTURE PRODUCT (COMPONENT)	
Attributes	Types
average invested	DECIMAL (0,,€)
expected yield	DECIMAL (0,,€)
gate price	DECIMAL (0,,€)
year production	DECIMAL (0,,Kg)
subtype	TAXONOMY
	Crop
	Milk
	Dairy product
	Gastronomic product
Relations	

Figure 4. Farm's component (agricultural product)

STORED (AGRICULTURAL PRODUCT)	
Attributes	Types
total stored	DECIMAL (0,,Kg)
Relations	

CROP (AGRICULTURAL PRODUCT)	
Attributes	Types
area planted	DECIMAL (0,,mq)
category	TAXONOMY
	Cereals
	Pulses
	Vegetables
	Fruits
	Nuts
	Oilseeds
	Sugars and Starches
	Fibres
	Beverages
	Narcotics
	Spices
	Condiments
	Rubber Forages
	Green and Green leaf manure
growth	TAXONOMY
	Sprout
	Seedling
	Vegetative
	Budding
	Flowering
	Ripening

LIVESTOCK (COMPONENT)	
Attributes	Types
age	INTEGER (0,,100)
breeding_cost	DECIMAL (0,,€)
gate price	DECIMAL (0,,€)
weight	DECIMAL (0,,Kg)
year_production	DECIMAL (0,,Kg)
function	TAXONOMY
	Meat
	Milk
	Eggs
subtype	TAXONOMY
	Cattle
	Poultry
	Goats
Relations	

Figure 5. Farm's component (livestock)

STAFF (COMPONENT)	
Attributes	Types
activities	STRING
details	STRING
number	INTEGER (0,,10000)
Relations	

PROVISION (COMPONENT)	
Attributes	Types
value	DECIMAL (0,,€)
Relations	

Figure 6. Farm's components (staff and provision)

FIXED ASSET (COMPONENT)	
Attributes	Types
Relations	

Figure 7. Fixed assets (land, structures, Infrastructures and machinery)

LAND (FIXED ASSET)	
Attributes	Types
dimension	DECIMAL (0,,mq)
value	DECIMAL (0,,€)
configuration	TAXONOMY
	Terraces
	Swales
	Diversions
	Lagoons
function	TAXONOMY
	Cultivation of seasonal crops
	Perennial crops
	Fallow land
soil	TAXONOMY
	Alfisol
	Andisol
	Aridisol
	Entisol
	Gelisol
	Histosol
	Inceptisol
	Mollisol
	Oxisol
	Spodosol
	Ultisol
	Vertisol
Relations	

STRUCTURE (FIXED ASSET)	
Attributes	Types
age	INTEGER (0,,100)
capacity	DECIMAL (0,,)
dimension	DECIMAL (0,,mq)
value	DECIMAL (0,,€)
function	TAXONOMY
	Farmhouse
	Livestock barn
	Feeds barn
	Products barn
	Machineries barn
	Chicken coop
	Brooder house
	Shed
	Stable
	Silo
	Greenhouse
material	TAXONOMY
	Wood
	Steel
	Stone
	Concrete
Relations	

INFRASTRUCTURE (FIXED ASSET)	
Attributes	Types
age	INTEGER (0,,100)
capacity	DECIMAL (0,,)
dimension	DECIMAL (0,,mq)
value	DECIMAL (0,,€)
function	TAXONOMY
	Farmhouse
	Livestock barn
	Feeds barn
	Products barn
	Machineries barn
	Chicken coop
	Brooder house
	Shed
	Stable
	Silo
	Greenhouse
material	TAXONOMY
	Wood
	Steel
	Stone
	Concrete
Relations	

MACHINERY (FIXED ASSET)	
Attributes	Types
age	INTEGER (0,,100)
capacity	DECIMAL (0,,)
dimension	DECIMAL (0,,mq)
value	DECIMAL (0,,€)
function	TAXONOMY
	Tractor
	Sprayer
	Field cultivator
	Shredders and cutters
	Cotton harvester
	Seeders and planters
	Wheel tractor-scrapper
	Plough
	Baler
	Moving equipment on-site
	Moving equipment off-site
	Machinery lifting
Relations	

DAMAGE CHILD ENTITIES (one row for each child of the same root parent)

DAMAGE_STAFF (DAMAGE)	
Attributes	Types
duration_of_absence	INTEGER(day)
further_details	STRING
n_of_absent	INTEGER
n_of_death	INTEGER
n_of_injured	INTEGER
reason_of_absence	STRING
Relations	

DAMAGE_PROVISION (DAMAGE)	
Attributes	Types
additional_food	DECIMAL (0,,€)
additional_veterinary	DECIMAL (0,,€)
losses_fees	DECIMAL (0,,€)
losses_premature_sale	DECIMAL (0,,€)
losses_value	DECIMAL (0,,€)
relocation_cost	DECIMAL (0,,€)
replanting_cost	DECIMAL (0,,€)
Relations	

DAMAGE_LIVESTOCK (DAMAGE)	
Attributes	Types
desease_description	STRING
n_of_death	INTEGER
n_of_disiased	INTEGER
n_of_injured	INTEGER
n_of_missing	INTEGER
Relations	

DAMAGE_FIXED_ASSET (DAMAGE)	
Attributes	Types
perc_area	INTEGER(0,100)
size	DECIMAL (0,,mq)
Relations	

DAMAGE_AGRICOLTURE_PRODUCT	
Attributes	Types
non_porudced_good_quantity	DECIMAL (0,,Kg)
quality_loss_percentage	INTEGER(0,100)
tot_damage_percentage	INTEGER(0,100)
total_losses_percentage	INTEGER(0,100)
yeld_loss_percentage	INTEGER(0,100)
Relations	