Development of EU harmonized services for recording flood events and associated damages data accommodating Floods Directive and towards the implementation of Sendai Framework

D2.1 Assessment of the extension of Flood-Cat Platform for reporting and exporting data according to UML Loss Data Model that extends the data model published in the INSPIRE Natural Risk Zones Technical Guidelines

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SUMMARY

This report describes the assessment of how the FloodCat Platform has been (and should be) modified towards an INSPIRE directive compliant tools. The INSPIRE directive is an EU initiative to establish an infrastructure for spatial information in Europe that is geared to help to make spatial or geographical information more accessible and interoperable for a wide range of purposes supporting sustainable development.

INSPIRE defines many specification for different purpose. In this report has been taken in account the specifications related to the Metadata and to the Data Specifications on Natural Risk Zones; this Data Specification will be expanded in the Flood Disaster Data Model but this is still not available at the moment.

In the FloodCat Data Model has been designed to be full compliant with the Floods Directive Reporting schema and, as specified by deliverable D1.1, has been modified and analysed also to take in account to the indications suggested by JRC-DLD Guidance and the implementation of the Sendai framework. This report documents the methodology used and the final UML Data Model of the FloodCat Platform.

The present document is organized following the listed themes:

1) General Approach adopted for reporting and exporting Disaster Loss Data by using FloodCat;

2) FloodCat UML Model;

3) Comparison between FloodCat Data Model and the Inspire Data Specifications on Natural Risk Zones;

4) FloodCat INSPIRE Metadata;

5) FloodCat new functionality for exporting and reporting
1. General Approach adopted for reporting and exporting Disaster Loss Data by using FloodCat

FloodCat has been designed to fulfil the Floods Directive Reporting schema and can be considered a Disaster Loss Database. In this area many different inputs and specifications has been released in EU and in the World. The main goal of this project is to harmonize these specifications to let FloodCat be compliant with all of them, with the benefit of having a single platform able to interoperate with different standards for different purpose.

The different inputs to the FloodCat Data Model can be represented in the following schema.

The INSPIRE Loss Data Model and the Sendai Framework are represented in a different colour because still not available or has not been released in the final version.

To consider all these specifications brings a lot of complexity due to different choice that were taken in each document, in terms of field and indicators to be recorded, model of the reality, output indicators. The best solution, maybe the only, has been identified creating a unique Data Model that
can fulfil all the requirements of all the specifications and is able to save them in a disaggregated way that can be later reconstructed under the different specifications.

In a general way each of these specifications shares some information and has some unique information. Using FloodCat is now possible to input all this information and then the user can decide to export or make a report in a specific format. This characteristic is represented in the following schema.

The user inputs data in the FloodCat Platform according to the FloodCat Data Model, that is a sort of superset of all the available input specifications. From the Platform the User can later extract data in the needed format.

The main results of the Pilot Project is the realization of the automatic tools that allow the exporting in the different format/standard of Floods Directive, JRC Guidance, Sendai Framework.
2. FloodCat UML Model

The following schema represents the full UML Class Diagram of the FloodCat Data Model.

![Full Data Model](image)

The main class can be considered the Event Class. The event is a generic flood occurred in a specified area. Each event is characterized by one only Origin (fluvial, pluvial..) and by having impacted only on one Unit of Management. This means that, ie, if a given area was subjected to a fluvial and a marine flood, this will be inserted in two events in FloodCat. The same behaviour happens if an event hits more than one UoM.

From the model point of view the Event Class has an instance of:

- **CategoryOfFlood**: past event or future event as requested by the Flood Directive;
- **SourceOfFlooding**: sources of flooding as expected by the Flood Directive;
- **UnitOfManagement**: UoM as expected by the Flood Directive;

Each Event has a list of child Phenomenon Elements. A Phenomenon is a single and continuous flood that can occur in an Event. This means that in a single Event many episodes may occur. The single Phenomenon can be caused by one or more MechanismOfFlooding, that are related together with the “many to many” entity PhenomMechanism class. The phenomenon holds also the Characteristic Of Flooding as required by the Floods Directive.

The phenomenon has also a Location that should represent the flooded area.

A given phenomenon can cause many damages. Also the damage can be caused by many MechanismOfFlooding, chosen between the MechanismOfFlooding that were associated to the parent Phenomenon. This is again obtained using the “many to many” DamageMechanism Entity.
Finally also the Damage has a Location, that is supposed to be inside the Location of the Phenomenon.

A single Damage is represented by many DamageDetails. The Damage Detail is characterized by a DamageCategory and a Damage SubCategory.

To fulfil all the input specifications some fields were added to single tables and the mapping between the FloodCat Damages category/subcategories and the output required by FloodDirective, JRC and Sendai has been analysed.

The CategoryOfFlood is a very simple entity:

![Figure 3 – Category of Flood](image)

The fields are:

- IdCategory: unique Id;
- Description: text to show;

Also the Source of Flooding is a simple entity:

![Figure 4 - Source of Flooding](image)

The fields are:

- IdSource: unique Id;
- Description: text to show;

The Unit Of Management is represented by this entity:
The fields are:

- UoMId: unique identifier;
- UoMCode: official code of the UoM;
- Description: textual description of the UoM;

The Event entity is represented by this class:
Figure 6 - Event

The fields are:

- **FloodEventCode**: unique event Id;
- **Name**: name of the event;
- **Category**: reference to the Category of Flood;
- **Date**: start date of the event;
- **Duration**: duration of the event in days;
- **Area**: flooded Area in square meters;
- **Length**: length of the exceeding in meter;
- **Recurrence**: estimate of the recurrence of the event;
- **Frequency**: used alternated to recurrence;
- **OtherInfo**: other relevant info about the event;
- **Summary**: summary description of the event;
- **OtherSourceOfFlooding**: text to describe a not codified Source of Flooding;
- **Source**: reference to the Source of Flood;
- **DateUpdate**: last update time reference;
- EventState: flag to know if it is validated or not;
- Descr: description of the event;
- UoM: reference to the Unit of Management;
- UniCode: unique code obtained in a human readable way combining other fields;

Locations are represented in this entity:

![Location Diagram]

**Figure 7 - Location**

The fields are:

- FloodLocationCode: unique location code;
- FloodLocationName: name of the location;
- geom: Geometry of the location;
- type: used to recognize between polygons and points;

Again, the characteristic of flooding is a simple entity:

![FloodCharacter Diagram]

**Figure 8 - FloodCharacter**

The fields are:

- IdCharacters: unique identifier;
- Description: textual description;

The phenomenon entity is represented by this class:
The fields are:

- IdPhenomenon: unique identifier;
- PhenomenonName: textual name;
- Characters: reference to the Characteristic of Flooding;
- OtherCharacters: textual description of the Characteristic of Flooding if different from the ones codified;
- LocationCode: reference to the Phenomenon location;
- EventCode: reference to the parent Event;
- PhenomState: flag to know if is validated or not;
- Descr: textual description of the Phenomenon;
- OtherMechanism: textual description of the Mechanism of Flooding if not included in the codified ones;

The Machanism of flooding is represented by this class:
The fields are:

- IdMechanism: unique identifier;
- Description: textual description;

Phenomenon and Mechanism are related using PhenomMechanism class:

The fields are:

- IdPhenomMechanism: unique identifier;
- OtherMechanism: optional free text to link not codified mechanism;
- IdPhenomenon: reference to the phenomenon;
- Mechanism: reference to the Mechanism;

Damages are represented by this entity:
The fields are:

- **IdDamage**: unique identifier;
- **DamageName**: name of the damage;
- **LocationCode**: reference to the location;
- **IdPhenomenon**: reference to the parent phenomenon;
- **DamageDate**: date of the damage;
- **Desc**: description of the Damage;
- **OtherDamageDescription**: other relevant information about the damage;
- **DegreeTotalDamageGDP**: estimate of the degree of the damage in respect to the GDP;
- **DamageDetails**: list of children damage details;

Damage mechanism are related to the parent table with the DamageMechanism class:
The fields are:

- **IdDamageMechanism**: unique identifier;
- **IdDamage**: reference to the damage;
- **OtherMechanism**: free text to link not codified mechanisms;
- **Percentage**: percentage of this mechanism in the occurrence of the damage;
- **PhenomMechanism**: reference to the parent PhenomMechanis table;

The Damage Details are represented by this entity:

The fields are:
- IdDamageDetails: unique identifier;
- IdDamage: reference to the parent damage;
- IdCategory: reference to the Damage Category;
- IdSubCategory: reference to the Damage Sub Category;
- NumericValue: numeric value related to the selected subcategory associated to this detail;
- EconomicValue: economic value related to the selected subcategory associated to this detail;
- Descr: description of the Damage;
- DamageClass: damage class as required by the Flood Directive;

The DamageCategory is a simple entity:

```
<annotations>
DamageCategory
(from acrotoc.rest.api.floodcat.entities)
</annotations>
```

```
| annotations | IdCategory: Integer |
| annotations | Description: String |
```

**Figure 15 - Damage Category**

The fields are:

- IdCategory: the unique identifier;
- Description: textual description;

The DamageSubCategory is represented by this class:

```
<annotations>
Damage_SubCategory
(from acrotoc.rest.api.floodcat.entities)
</annotations>
```

```
| annotations | IdSubCategory: Integer |
| annotations | DamageCategory: DamageCategory |
| annotations | Description: String |
```

**Figure 16 – DamageSubCategory**

The fields are:
- IdSubCategory: unique identifier;
- DamageCategory: reference to the parent Category;
- Description: textual description;
3. Comparison between FloodCat Data Model and the Inspire Data Specifications on Natural Risk Zones

The INSPIRE Loss Data Model that should expand the Data Specifications on Natural Risk Zones has not been yet released. A preliminary analysis has been done between FloodCat Data Model and the Data Specifications on Natural Risk Zones.

This Data Model, at least in the core part, is represented by this schema:
As can be deducted from the name of the specification this entities are designed to represent the generic Risk Zone and not a Disaster Loss Database. The main hierarchy is represented by the abstract classes:

- AbstractRiskZone: represent a risk zone;
- AbstractHazardArea: represent the area of a hazard;
- AbstractExposedElement: represent an exposure;
- AbstractObservedEvent: represent an event occurred in the hazard area;

This model can be considered “opposite” to the DLS models like the one in FloodCat: this is focused on the Risk Area while DLD are usually focused on the Events.

It is anyway possible to map the FloodCat entities in the INSPIRE entities, but some logic decision has to be taken and some trade off must be accepted.

The logical mapping can be the following:

<table>
<thead>
<tr>
<th>Inspire Data Specifications on Natural Risk Zones</th>
<th>FloodCat Data Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>AbstractRiskZone</td>
<td>This is the missing concept in FloodCat. Can be considered as the UoM, or can be given by the user to extract data from the Database.</td>
</tr>
<tr>
<td>AbstractHazardArea</td>
<td>The Hazard area can be obtained as a merge of all the phenomenon areas of the events that intersects the risk zone.</td>
</tr>
<tr>
<td>AbstractExposedElement</td>
<td>Can be obtained as the merge of all the damages of the events that intersects the risk zone. But is only a subset of the exposed elements, being the ones that has been damaged.</td>
</tr>
<tr>
<td>AbstractObservedEvent</td>
<td>Can be obtained by the list of events that intersects the Hazard Area.</td>
</tr>
</tbody>
</table>

Data are technically interoperable but probably not useful from a logical point of view. A similar solution is described in the INSPIRE Data Specification for Natural Hazard in Annex B.2 where a Use Case describing the Production of Flood Risk Maps is described. Also in the B.2 Use Case the actor is supposed to input data like the Risk Zone and the Flood Extent to obtain the reporting map.
In the Annex B.2 there is also a table that illustrate how the terms/contents that are used in Floods Directive (2007/60/EC) are addressed in the core feature types model for NZ that is here reported for the main entities covered by FloodCat DataModel:

<table>
<thead>
<tr>
<th>FD Terminology</th>
<th>NZ Terminology</th>
</tr>
</thead>
<tbody>
<tr>
<td>UoM</td>
<td>-</td>
</tr>
<tr>
<td>Flood Location</td>
<td>HazardArea and/orRiskZone</td>
</tr>
<tr>
<td>TypeOfFlood</td>
<td>SpecificRiskOrHazardType</td>
</tr>
<tr>
<td>Recurrence</td>
<td>LikelihoodOfOccurence</td>
</tr>
<tr>
<td>Frequency</td>
<td>LikelihoodOfOccurence</td>
</tr>
<tr>
<td>Degree_TotalDamageHumanHealth</td>
<td>LevelOfHazard</td>
</tr>
<tr>
<td>Degree_TotalDamageXYZ</td>
<td>LevelOfHazard</td>
</tr>
<tr>
<td>Fatalities</td>
<td>LevelOfHazard</td>
</tr>
</tbody>
</table>

The correspondence is very close to the previous proposed table.

The same INSPIRE Data Specification for the Natural Risk Zones has also another link with the Flood Directive that is in appendix D. The appendix extends the Natural Risk Zones Data Specification to fulfil the FD requirements and demonstrates how this road can be followed. In this extension the InundatedLand object is derived from the AbstractObservedEvent and can be so included in the list of events belonging to an Hazard Area. Damages of the Flood Directive are included as a list member of the InundatedLand in the entity called ObservedConsequences, a new introduced class.

This solution, as said, is an extension of the original Natural Risk Zones Data Model that fits better to the Flood Directive and FloodCat Data Model: observed consequences are introduced and are the natural target of the Damages. This is true for the FD model, where damages are aggregated in only four different categories (Environment, Human Social, Cultural Heritage, Economic Activity), while in the FloodCat model both roads may be followed considering that Damages are described in a very more detailed way that can also be associated to exposed elements. The problem with this interpretation is that from FloodCat should be possible to extract only exposed elements that were damaged and not the full list, considering that the database has no information about what was not hitted.
This analysis should be finalized when the INSPIRE Flood Disaster Data Model will be released but what can be concluded is that FloodCat Data Model can interoperate with the starting point of this specification so is likely that will be interoperable also with the new Data Model.

4. FloodCat INSPIRE Metadata

Using the FloodCat platform is also possible to add some static layers to help the user analysis. All the included layers are linked to their INSPIRE Metadata.

To add a layer to the map the user has to move the mouse over the icon highlighted with the red circle in the next figure:

![Figure 17 - Access to static layers](image_url)

The list of available layers appears:
Each layer has in (i) icon: clicking on this icon opens in a new window the INSPIRE compliant Metadata of the layer.
Figure 19 - Sample of INSPIRE Metadata for a layer in the Italian Platform

Metadata are available for every static layer included in the platform.

5. FloodCat new functionality for exporting and reporting

From the user interface point of view the output of this activity is encapsulated in the new “Export” button that let the user choice the format and export data from the FloodCat.
In the main page of FloodCat a new download button has been added:

Once the user clicks on the button the system shows an export dialog:
The user can choose the requested Template to use for export. At the moment are available:

- Flood Directive Schema: the XML FD format;
- JRC Minimum Requirements: excel file with the JRC Minimum requirements;
- JRC Extension 1: excel file with the JRC extension 1;
- Sendai Indicators: first attempt of the Sendai indicators;

Once the template is chosen the user has to click ok to download the files.
An example of download with JRC minimum requirements is reported below.