DESTRIERO

A DEcision Support Tool for Reconstruction and recovery and for the IntEroperability of international Relief units in case Of complex crises situations, including CBRN contamination risks

D3.1 – DESTRIERO DATA SOURCE IDENTIFICATION REPORT

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02.01	Minor comments , general review	08/09/2015	A. Escalera
02.02	Template revision and Final release	09/09/2015	E. Francioni A. Escalera

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EXECUTIVE SUMMARY

The current deliverable is included in Work Package 3. This package has as general goals the following:

- Design a common data exchange reference model in order to achieve semantic data interoperability
- Define a standard data format, able to share the same semantic

More precisely, this deliverable has achieved the following particular goals:

- Identify the different data sources (e.g. sensors) to be shared among the organisations involved in a crisis
- Provide the standard data format and metadata in order to facilitate interoperability

The process followed to come to the final set of metadata has been organized around several questions. These questions together with their answers have produced as a result the final deliverable.

Question 1: What issues DESTRIERO will have to deal with?

Basically, the answer to this question can be summarised with only one word: Disasters. Section 3 is focused in this concept and it includes a definition of the most common disaster that DESTRIERO will have to face in the future.

Question 2: How DESTRIERO will gather information about the issues?

Once it is clear that DESTRIERO will have to manage disasters, the following question is focused in defining how DESTRIERO could get information about them.

In a generic way it was determined that different data sources could be used to provide information to be used inside DESTRIERO. Section 4 includes a taxonomy to classify different types of data sources depending mainly in the type of information provided.

Question 3: What could be affected by these issues?

As an important part of the metadata, the objects or entities affected by the disasters should be also taken into account. With this question the possible objects affected are identified (section 5.3).

Question 4: How could help in these issues?

Once the disasters, the data sources and the affected entities have been defined, the following step is to determine who could help in the relief activities. As a summary, the relief tasks will be carried out by organisations (governmental and NGOs). Section 5.4 includes a description of the organisations used as resources in the relief tasks.

After the definition of all the main groups of information, it is necessary to put all of them together in the same communications paradigm. In this case it has been decide to use an ontology to model all the knowledge involved in the relief tasks and including all the previous groups of objects described above.

The Figure 1 – Research process represents the process followed to accomplish the research tasks in this deliverable.

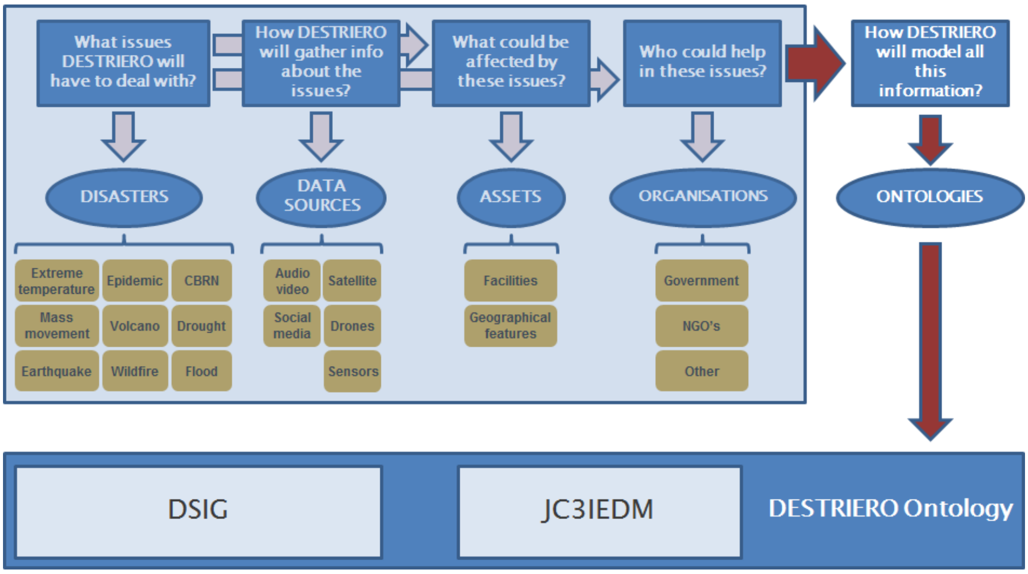

Figure 1 – Research process

The final ontology will be a mixture between several entities from JC3IEDM and the own defined DSIG ontology.

An ontology is an explicit representation of a shared conceptualization that is made up of several elements:

- Classes: represent concepts
- Properties or relations: represent how the classes are related between them
- Individuals: represent single instances of a class

The ontologies provide also additional capabilities:

- Rules: antecedent-consequent statements for inference. Example

```
Antecedent (TypeOf(F) is Building and  Status (F) is Heavily Damaged)
Consequent (RebuildTime(F) is 6 months)
```

- Queries: get information or knowledge from the model. Example

```
TypeOf(F) is CBRN and  IsInside(Location(F), Location(disaster)) -> Count(F)
```

The defined ontology uses OWL language (Web Ontology Language) to define the ontology. This language is XML-based and is endorsed by the W3C consortium.

The DESTRIERO Ontology is in a very early stage so it shall be developed in the following tasks. It is also modifiable so new elements could be added later on (even in other WP beyond WP3):

- New classes could be added (e.g. a new disaster sub-type)
- New attributes (e.g. end-date time for the flood disaster sub-type)
- Existing elements could be removed

Regarding the DSIG, it models the disasters structure (hierarchy based on type-subtype relationships) including also the Data Sources model (Information and Sensors) and it is linked with the JC3IEDM model (through JC3IEDM ontology).

One important part of the DESTRIERO ontology is based on Joint Consultation Command & Control Information Exchange Data Model (JC3IEDM).

This model can be used freely and has become a standard 'de facto' between C2 systems (including non NATO countries). Although it was created for military use, civil capabilities have been added during the last versions (CIMIC objects, liaison officer)

This data model manages:

- Objects: organisations, personnel, materiel, features and facilities
- Actions (tasks and events): military, terrorism, natural disasters, accidents…

1 INTRODUCTION

The *DESTRIERO data source identification report* is a deliverable included in the task 3.1 Identification of data sources (Field units and sensors). This document will be the input of the task 3.2 (*Interoperability Data Model*). It identifies the different data sources from which relevant information could be available for the DESTRIERO project to be shared among different collaborating stakeholders (henceforth referred to as end-users of the DESTRIERO system) involved in Post-Crisis Damage and Needs Assessment (PDNA) and Reconstruction and Recovery Planning (RRP) of the disaster situation described in the deliverable D2.2 [1]. In this vein, this document also proposes a high-level data model in terms of an ontology which can serve as a first step in the definition of the interoperability data model and the interoperability information model to be implemented in the task 3.2 (*Interoperability Data Model*) and in the task 4.2 (*Interoperability Information model*), respectively. That is, this approach aims at implementing an ontology which will provide interoperability among heterogeneous information systems involved in the recovery and reconstitution of the affected area(s) by a specific disaster situation. The challenge is that the meaning of the information and the purpose of the information exchange are understood identically everywhere and at all times [2].

The ontology-based approach will enable us to add semantics to the interoperability data model and detect semantic ambiguities, uncertainties and contradictions. Furthermore, the interoperability data model formalized in terms of ontologies can be used to specify constraints, infer new knowledge and increase good decision-making and good performance. Ontologies can be defined as explicit representations of a shared conceptualization [3] [4]. The term "shared" indicates that an ontology captures some consensual knowledge, and the term "conceptualization" means an abstract, simplified view of a shared domain of discourse (i.e. the real-world) [5]. There may be several conceptualizations of the same domain and therefore several ontologies [6]. In order to integrate multiple ontologies, we can define a shared ontology that contains mapping and relationships of equivalence among the different ontologies of the same application domain. With the support of a reasoning engine, we could define reasoning rules that make inference on the information in the shared ontology [7]. There are several techniques for mapping and translating between multiple ontologies such as databases techniques [8] and Bayesian networks [9]. A state of the art on ontology mapping can be found in [10].

More formally, an ontology defines the vocabulary of a problem domain and a set of constraints (axioms or rules) on how terms can be combined to model specific domains. An ontology is typically structured as a set of concept definitions and relations between them. Ontologies are machine-processable models that provide the semantic context, enabling natural language processing, reasoning capabilities, domain enrichment, domain validation, etc.

The proposed ontology-based Data Sources Information Gathering (DSIG) model is shown in Figure 2. The DSIG Ontology is input to the DESTRIERO system, where ontology-based reasoning could be done in conjunction with historical data stored in a knowledge base.

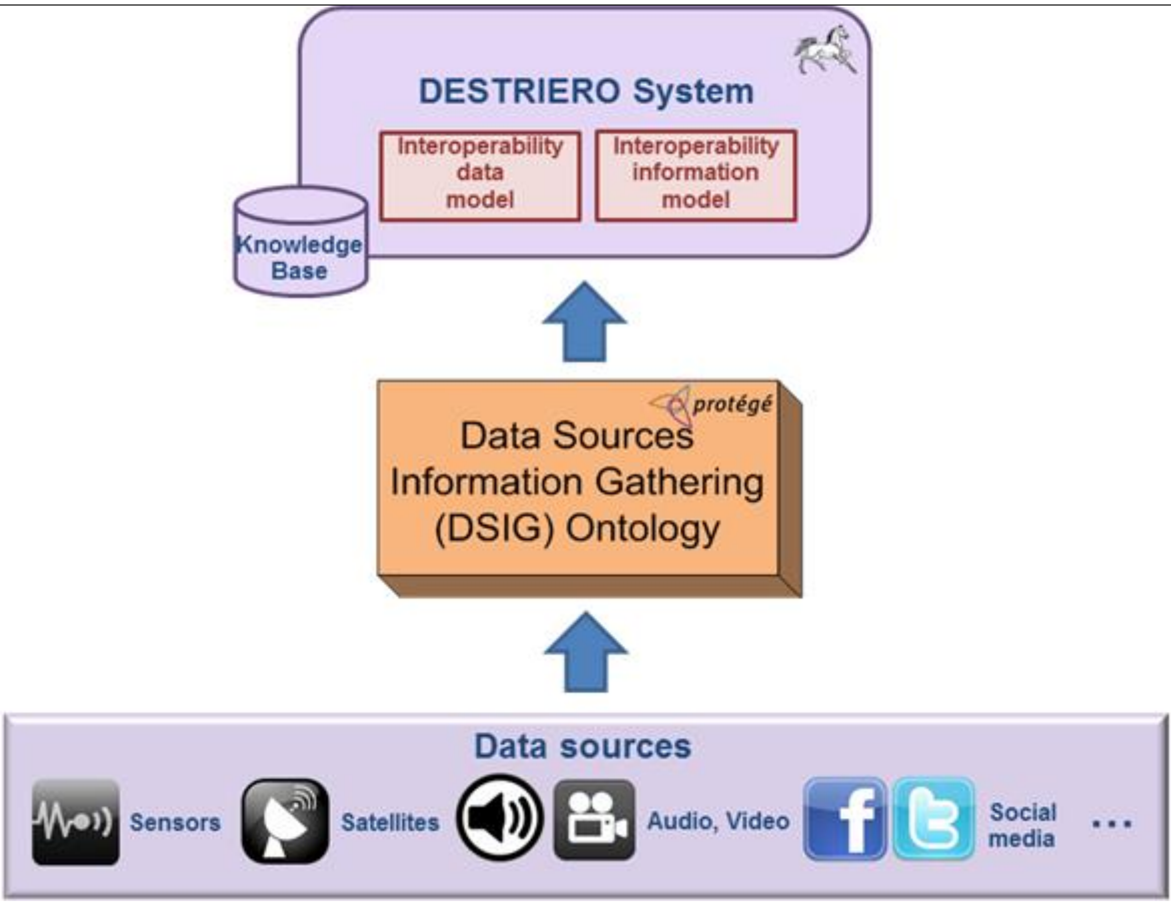

Figure 2 – General architecture of the Data Sources Information Gathering (DSIG) model

1.1 Document Organisation

This document is structured as follows:

- Section 1 (INTRODUCTION) provides a general description of this document as a whole, the references used and a table with the acronyms that appear on it.
- Section 2 (DAMAGE ASSESSMENT) provides a definition of damage assessment and a description of the data fusion model taken as a reference for this phase.
- Section 3 (DISASTERS) provides a list with the different types of disasters that are taken into account for the DESTRIERO project in the damage assessment phase of the scenario proposed in the deliverable 2.2 [1].
- Section 4 (DATA SOURCES) provides a description of the data sources that could provide information for the DESTRIERO system in the damage assessment phase of the scenario proposed in the deliverable 2.2 [1].
- Section 5 (HIGH-LEVEL INTEROPERABILITY DATA MODEL) provides a description of a high-level interoperability data model that can be used as a starting point for the task 3.2 (Interoperability data model) led by *Asociación de Empresas Tecnológicas Innovalia* (INNO) and the task 4.2 (Interoperability Information model) led by *Fraunhofer Gesellschaft zur Förderung der angewandten Forschung e.V.* (FHG).

- Section 6 (ONTOLOGY) provides an early stage definition of the ontology proposed as solution for the common language used in DESTRIERO. This ontology shall be developed in future tasks especially in the task 3.2 (Interoperability data model) lead by INNO.
- Section 7 (SENSORS INFORMATION MODEL) provides a description of the sensor information. This information could be used to define the final data model that will manage the sensors as existing objects and the information provided by them
- Section 8 (CONCLUSIONS AND RECOMENDATIONS) provides a list of the key points raised during the preparation of this deliverable

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1.3 Table of Acronyms

Acronym	Description
A/V	Audio and video
AI	Avian influenza
AIDS	Acquired Immune Deficiency Syndrome
AM	Amplitude Modulation
AMPS	Advanced Mobile Phone System
API	Application Programming Interface
BEGe	Broad Energy Germanium
BPMN	Business Process Model and Notation
C2IS	Command and Control Information System
CBRN	Chemical, Biological, Radiological and Nuclear
CEEP	The Centre for Excellence in Emergency and Preparedness
D/F PT	Dew/Frost point
DCPS	Data-Centric Publish-Subscribe
DDS	Data Distribution Service for Real Time Systems

Acronym	Description
DFD	Data Flow Diagram
DSIG	Data Sources Information Gathering
DVD	Digital Video Disk
ERD	Entity Relationship Diagram
FEMA	Federal Emergency Management Agency
FHG	Fraunhofer Gesellschaft zur Förderung der angewandten Forschung e.V.
FOC	Full Operational Capability
GCC	Galileo Control Centre
GLONASS	Global Navigation Satellite System
GSM	Global System for Mobile communications
GPS	Global Positioning System
GSS	Galileo Sensor Station
GWL	Gateway-Link
HAZMAT	Hazardous material
HD	High Definition
HPGe	High Purity Germanium
HIV	Human Immunodeficiency Virus
IDOL	Institute of Distance & Open Learning
IDP	Internally Displaced Person
IFFN	International Forest Fire News
IFRC	International Federation of Red Cross and Red Crescent Societies
IMU	Inertial Measurement Units
INNO	Asociación de Empresas Tecnológicas Innovalia

Acronym	Description
INS	Inertial Navigation System
IOC	Initial Operational Capability
IOV	In-Orbit Validation
IP	Internet Protocol
IR	Infra-red
ISL	Inter-Satellite-Link
ISO	International Organization for Standardization
JC3IEDM	Joint Consultation, Command and Control Information Exchange Data Model
LADAR	Laser Radar
MEO	Medium Earth Orbit
MIT	Massachusetts Institute of Technology
MTP	Media Transfer Protocol
MUL	Mobile-User-Link
NATO	North Atlantic Treaty Organization
NWCG	National Wildfire Coordinating Group
OECD	Organisation for Economic Co-operation and Development
OGC	Open Geospatial Consortium
OWL	The Web Ontology Language
PDNA	Post-Crisis Damage and Needs Assessment
PIR	Passive Infrared
PPM	Parts Per Million
QoS	Quality of Service

Acronym	Description
QPS	Queensland Police Service
RADAR	Radio Detection And Ranging
RDF	Resource Description Framework
RDF-S	RDF Schema
RH	Relative Humidity
RID	Radionuclide Identifier
RRP	Reconstruction and Recovery Planning
SAR	Synthetic Aperture Radar
SARS	Severe Acute Respiratory Syndrome
SD	Secure Digital
SODAR	Sonic Detection and Ranging
SONAR	SOund Navigation And Ranging
SUMO	Suggested Upper Merged Ontology
SWRL	Semantic Web Rule Language
SysML	Systems Modelling Language
TB	Tuberculosis
UN-SPIDER	United Nations Platform for Space-based Information for Disaster Management and Emergency Response
UAV	Unmanned Aerial Vehicle
UML	Unified Modelling Language
UNEP	United Nations Environment Programme
USB	Universal Serial Bus
VCR	Video Recorder

Acronym	Description
VP-UML	Visual Paradigm for UML
WHO	World Health Organization
WMO	World Meteorological Organization
XML	Extensible Markup Language

2 DAMAGE ASSESSMENT

The impact of natural disasters to the global environment is becoming more and more severe over the last decades. Besides, the number of disasters is dramatically increasing, as well as the cost to the global economy and the number of people affected [11]. Figure 3 illustrates the world map of natural disasters 2012 provided by Munich Reinsurance Company[1].

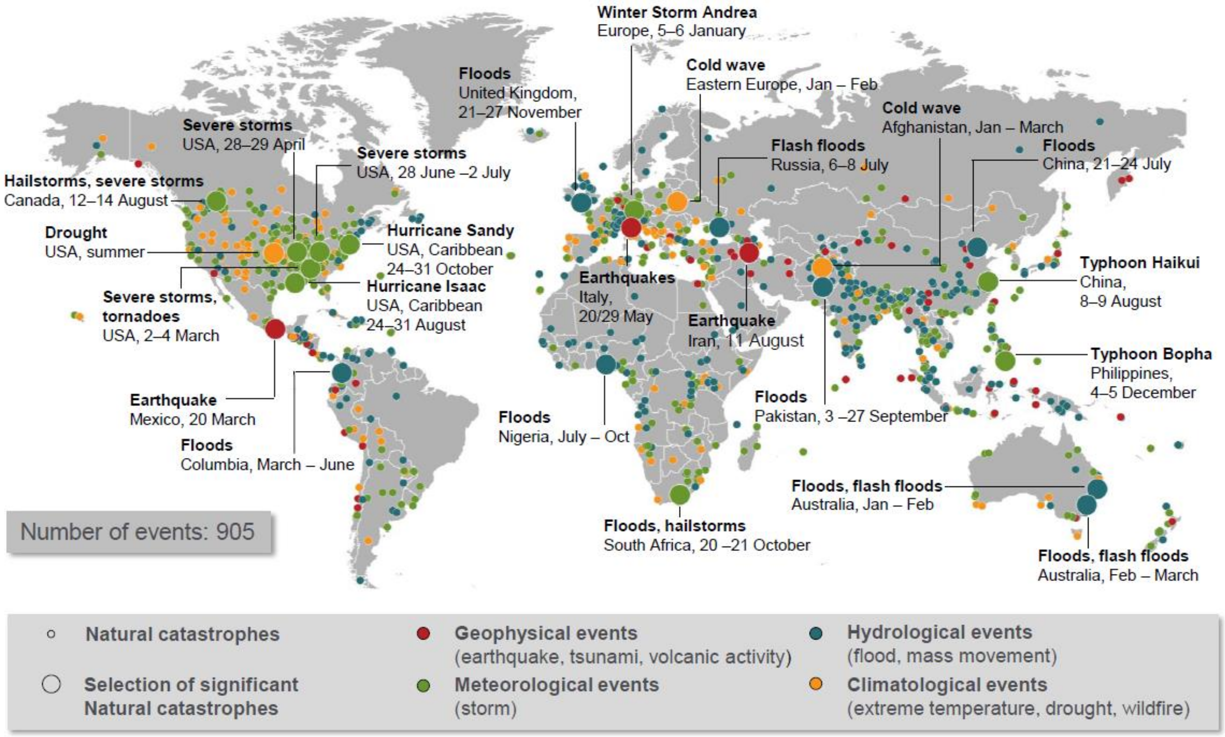

Figure 3 – World map of natural disasters 2012

The World Health Organisation (WHO[2]) defines a disaster as "any occurrence that causes damage, destruction, ecological disruption, loss of human life, human suffering, deterioration of health and health services on a scale sufficient to warrant and extraordinary response from outside the affected community or area." Thus, the organisation and management of resources and responsibilities to address response and recovery crisis situations are of major importance. However, it is important to notice that disaster management comprises only those activities conducted once a disaster has taken place, and excludes those activities conducted before, such as prevention, mitigation and preparedness [12]. The following phases represent the activities to be performed after the occurrence of a disaster:

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1 http://www.munichre.com/app_pages/www/@res/pdf/NatCatService/annual_statistics/2012/2012_mrnatcatservice_natural_disasters2012_worldmap_en.pdf?2

2 www.who.int

- *Response*. Activity that provides emergency services and public assistance during or immediately after a disaster in order to save lives, to reduce health impacts, to ensure public safety and to meet the basic subsistence needs of the people affected.
- *Rehabilitation*. Operations and decisions taken after a disaster with a view to restoring a stricken community to its former living conditions, in particular with a view to restoring life lines and key services.
- *Reconstruction*. Activity composed of actions taken to re-establish a community after a period of rehabilitation subsequent to a disaster. Actions would include construction of permanent housing, full restoration of all services, and complete resumption of the pre-disaster state.
- The *restoration* and *improvement*, where appropriate, of facilities, livelihoods and living conditions of disaster-affected communities, including efforts to reduce disaster risk factors. The recovery activity begins soon after the response and rehabilitation phases have ended.

Damage assessment is part of the disaster management activity and represents an appraisal of the effects of a disaster situation on one or more locations to determine residual capability for further action in support of planning for recovery and reconstitution.

According to the scenario described in the deliverable D2.2 [1], the processing of the information collected by different sources after a disaster occurrence is performed in the time frame from T+96 hours to T+2 weeks. This is the period of *damage assessment*, and this is when data fusion has to be performed in order to know what is happening in the affected area(s) and to make correct decisions. That is, the fusion of data from sensors and other heterogeneous data sources can be employed to support human decision-making by refining and reducing the quantity of information that end-users need to examine to achieve timely, robust, and relevant assessments and projections of a specific disaster situation [13]. Since data fusion is the process that enables us to deal with the association, correlation, and combination of data and information from single and multiple sources to achieve refined position and identity estimates, and complete and timely assessments of situations and threats, and their significance [14], this is considered a critical task for successful *damage assessment* and the starting point for situation awareness.

Situation awareness can be defined as "the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future" [15]. Situation awareness provides the knowledge about a dynamically changing environment, and the adoption of adequate tools to achieve that knowledge is required (see Figure 4). Situation awareness entails a broad range of information about objects and items, and their relationships, so monitoring and management of the associated knowledge are key for disaster management.

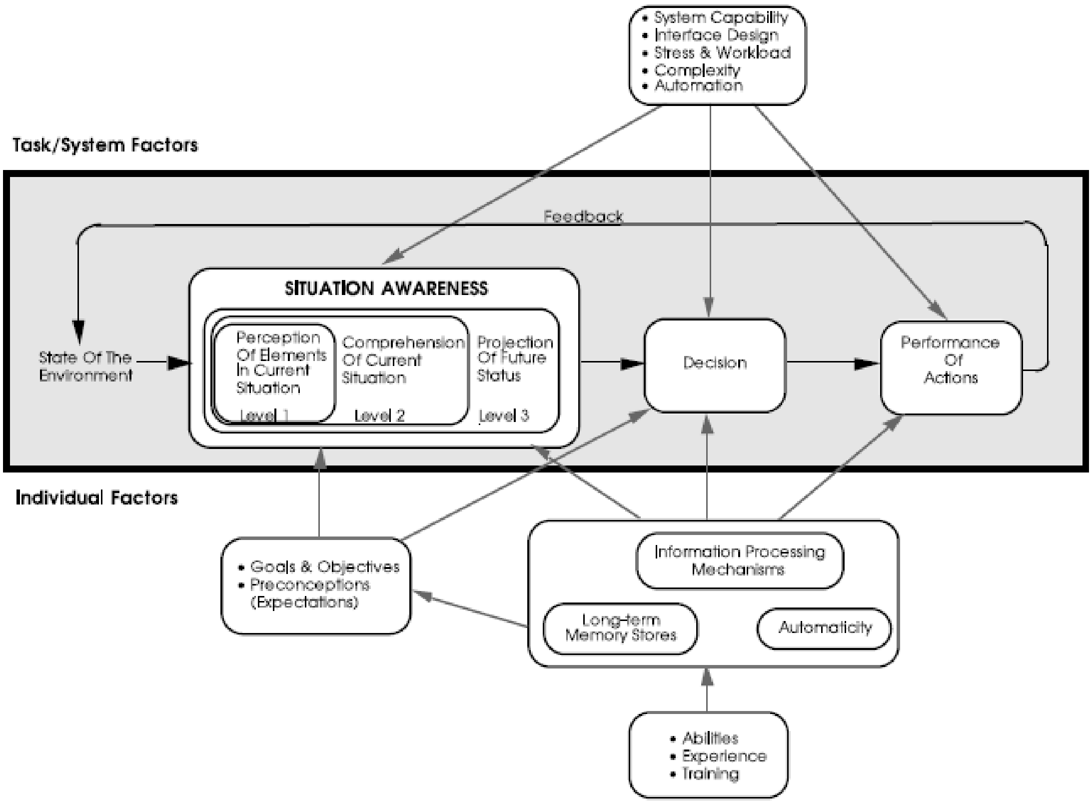

Figure 4 – Model of situation awareness in dynamic decision-making (from [16])

Situation awareness represents the Level 2 (*Situation Assessment*) of information fusion in the Joint Directors of Laboratory (JDL) data fusion model ([17]). This data fusion model maintained by the JDL Data Fusion Group is the most widely-used method for categorizing data fusion-related functions.

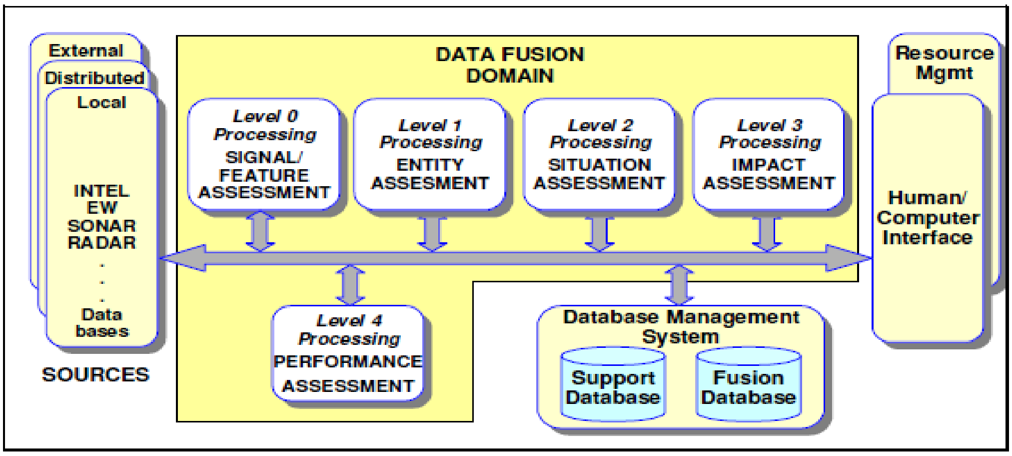

Figure 5 – JDL data fusion model

The task 3.1 of the DESTRIERO project is focused in the level 0 of the JDL data fusion model, because this is the level where data sources are detected and characterized. The JDL data fusion levels are summarised in [17].

Level	Name	Description
0	Signal/Feature Assessment	Estimation and prediction of signal or feature states.
1	Entity Assessment	Estimation and prediction of entity parametric and attributive states (i.e. of entities considered as individuals).
2	Situation Assessment	Estimation and prediction of the structures of parts of reality (i.e. of relations among entities and their implications for the states of the related entities).
3	Impact Assessment	Estimation and prediction of the utility/cost of signal, entity or situation states - including predicted impacts given a system's alternative courses of action.
4	Performance Assessment	Estimation and prediction of a system's performance as compared to given desired states and measures of effectiveness.

Table 1 – Fusion levels

On the other hand, sources and human/computer interface concepts of the JDL data fusion model are defined by Hall & Llinas as follows [18]:

- *Sources of Information*. Sources indicate that a number of sources of information may be available as input including local and distributed sensors, reference information, geographical information, knowledge base, Intelligence data (HUMINT, SIGINT, etc.).
- *Human Computer/Interface*. This interface allows human input such as commands, information requests, human assessments of inferences and reports from human operators. Besides, it includes methods to assist humans in direction of attention, and overcoming human cognitive limitations (e.g. difficulty in processing negative information).

3 DISASTERS

As mentioned earlier, disasters are occurrences that result in death or injury to humans, and damage or loss of valuable goods, such as buildings, communications systems, agricultural land and forest. In this chapter we list the different types of disasters which could occur after the disaster situation proposed in the deliverable 2.2 [1], and that are taken into account for the DESTRIERO project in the *damage assessment* phase of this scenario. The different disasters are described in the next subsections, and their definitions, except for the Chemical, Biological, Radiological and Nuclear (CBRN) contamination definition, are extracted from the United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER) [19].

At this point it is important to remark that in the following subsections only those disasters considered as more common have been detailed. Of course there are more categories of disasters that have not been analysed in this document due to their low probability of occurrence. In any case, the final solution implemented shall be able to manage any kind of disaster including those defined in this document and the rest of disaster under a *generic category*.

3.1 CBRN incident

An accidental Chemical, Biological, Radiological and Nuclear (CBRN) incident is an event caused by human error or natural or technological reasons, such as spills, accidental releases or leakages [20]. Outbreaks of infectious diseases, such as Severe Acute Respiratory Syndrome (SARS), or pandemic influenza are examples of biological incidents (see Figure 6).

CBRN incidents may include all or some of the following characteristics [20]:

- Potential for mass casualties.
- Potential for loss of life.
- Potential for long term effects.
- Creation of an extremely hazardous environment.
- Relative ease and cheapness of production.
- Initial ambiguity and/or delay in determining the type of material involved.
- Potential use of a combination of CBRN materials each presenting different response requirements.
- Narrow time frame in which to administer lifesaving interventions/treatments.
- Need for immediate medical treatment for mass casualties.
- Need for immediately available specialised pharmaceuticals.
- Need for specialised detection equipment.
- Need for timely, efficient and effective mass decontamination systems.
- Need for organised, trained and equipped health service personnel to immediately augment local Fire-HAZMAT teams.
- Need for pre-coordination within health services to establish medical treatment protocols, to stock pharmaceuticals and to determine treatment requirements.

- Need to establish coordinated incident management/response procedures for such incidents.
- Need to ensure early warning systems for hospitals.
- Need to establish early those who are affected and those at risk.
- Need for active case finding versus passive case finding.
- Need to work closely with Police on site and at health care facilities, as they perform their legal duties in relation to victim identification/registration and evidence gathering.
- Need for a pro-active media policy to ensure the community is informed and thus its anxiety allayed.

Countermeasures include [20]:

- Technical equipment such as respirators that can detect chemical agents and masks that prevent exposure.
- Medical therapy and, for some agents, prophylaxis.
- Organisational strategies, such as specially developed intelligence systems, standard operating procedures, and training.
- Instruments of international law.
- Decontamination activities focused in the removal of contaminants such as micro-organisms or hazardous materials, including chemicals, radioactive substances, and infectious diseases.
- Quarantine used to separate and restrict the movement of persons

Figure 6 – CBRN incident (Source: CEEP[3])

The four types of sub events included in this category have been traditionally managed all together. In fact the same specialized organisations from civil protection or the army are trained to mitigate the effects of all these types of disasters.

However, a more detailed classification could be done in order to give more precise information about each one of the different types of CBRN events.

3.1.1 Chemical events

[40] The use intentionally or unintentionally of Chemical agents can produce casualties (non-persistent), or contaminate ground and/or equipment (persistent). Both may have a similar effect on personnel depending upon factors such as volume, dissemination means and meteorological conditions.

After an attack or accident by chemical agents, two types of hazard can be encountered by personnel depending on their position relative to the release area. These are a liquid hazard, a vapour hazard or both a liquid and a vapour hazard.

3.1.2 Biological events

[40] A biological event can be produced by biological material either in the form of biological agents or Toxic Industrial Biological, which will present a hazard to persons and/or material if released into the atmosphere. The amount of material released may vary from very small to extreme large quantities. Toxic Industrial Biological is ordinarily held only in very small quantities. Furthermore, the need to preserve their viability demands special environmental

[3] http://www.ceep.ca/education/Decontamination%20Czar.pdf

controls, enabled by containment and physical security measures. Finally, the inherent fragility of biological organisms makes it unlikely that they would survive the dynamic and thermal effects of explosions or fire. In light of these considerations, it is unlikely that personnel will encounter viable Toxic Industrial Biological except where they enter specially designed medical or industrial facilities including biological laboratories, and even then the hazard may be restricted to specially assigned rooms or compartments.

One of the most typical ways to disseminate biological agents is using Aerosols. Aerosols are finely divided liquids or solids suspended in the atmosphere. The behaviour of aerosol clouds is essentially similar to that of vapour clouds. However, because of their higher density, aerosol clouds are more stable. They stay nearer to the surface of the ground, while tending to lose some material by precipitation onto any surface with which they come into contact. In a tactical aerosol release after an intentional attack, the aerosol cloud (after initial formation) will travel downwind at a rate determined by wind speed. The cloud will lengthen and widen as it travels downwind. Personnel near the release point will encounter a more concentrated cloud. However, personnel located farther downwind (even though exposed to a less concentrated agent cloud) will be exposed for a longer period of time, so unprotected personnel may inhale a higher total dose. The peak danger area will be located in the area where the cloud stays intact while at the same time is at its maximum width and length. This distance is approximately the maximum downwind hazard prediction for a chemical agent; therefore, it is vital to determine whether or not the release is biological or chemical as casualties may occur as far as four to five times the maximum downwind hazard area distance of chemical agents.

The following examples illustrate aerosol dissemination by a number of methods:

- Bursting Type Munitions. When a biological projectile or bomb bursts on the ground or in the air, the filling (either a liquid slurry or dry powder) is initially dispersed in all directions. An effective ground bursting munitions will project the majority of the filling into the air to form an aerosol cloud. Air bursting munitions may also form an aerosol cloud that will behave in a similar manner to a spray release. The agent may also be designed to fall to the ground as a surface contaminant much like persistent chemical agents. The dimensions of the aerosol cloud will be influenced by the means of delivery, the weather conditions, and the terrain.
- Spray Tanks/Generators. Aircraft/vehicle spray tanks, or aerosol generators, may also be employed to form an aerosol cloud. This form of release is likely to take place as covertly as possible.
- Biological Bunker or Production Facility. Damage to a storage bunker containing biological agents intended for use in biological warfare (stockpiled munitions containing biological agents) or to production facilities for such agents containing active agent containers may result in smaller release areas and lower quantities than if they had been dispersed from a weapon. However, due to the duration of the release, and the likelihood of having an elevated plume, the dispersed material at hazardous levels may travel downwind for many hours.

- Transport. Damage to containers or munitions of biological agents being transported by road, rail, or boat may result in a release. The release area will be localized, and the amount of viable agent dispersed will likely be less than that dispersed from an efficient biological weapon. However, since many biological agents only require a few inhaled organisms to infect a person the downwind distance of the hazard area may still be considerable.
- Toxic Industrial Biological. These releases can be accidental, or from an attack or due to collateral damage to a facility producing or storing infectious material. Possible facilities include hospitals and other medical installations and research, production, storage or recycling facilities for the pharmaceutical or agricultural industries. A release could also occur in the transport of these materials.

3.1.3 Radiological events

[40] Radiological releases include releases caused by accident, collateral damage or deliberate sabotage from nuclear, industrial or medical installations in which radioactive material is held. Relevant installations may include, but are not limited to any of the following:

- power-generating nuclear reactors
- research reactors
- nuclear fuel fabrication, reprocessing and enrichment plant
- nuclear fuel element stores
- fissile material stores
- radioactive waste storage facilities
- radioactive material production and storage of such material
- medical, industrial or educational/research facilities

Radiological releases also include intentional or unintentional transportation accidents, e.g. transport of radioactive material by road, rail or ship.

Releases from nuclear plant are characterized in terms of the amount of radioactivity and the nature of the radioactive materials that could be released, which depend on which part of the plant is affected. The radioactive material released from nuclear reactors will be in the form of gases, fine particulate (aerosols) and possibly fuel fragments, which give rise to a range of radioactive emissions.

Other fuel-cycle facilities contain radiological material in a variety of forms, including non-condensable gases, vapours, liquids and solids.

In reactor accident scenarios, the release of radioactivity could occur over several hours or even days. The release does not necessarily occur at a constant rate throughout the release duration.

The release could be controlled by the plant operators, in which case the release may be from the stack and would be included with process steam. There would be no other indication of

release other than by detection using suitable radiation detection equipment. Uncontrolled releases may be accompanied by fire and explosions and could be indicated by external signs of damage to the plant.

Figure 7 – Fukushima reactor after the tsunami disaster (source: fukushimaupdate[4])

Outside the nuclear industry, radioactive materials are widely used in industrial and medical facilities. Radioactive materials used for industrial and medical applications tend to comprise of a single radionuclide incorporated into equipment designed to deliver a specific type of radiation.

Radioactive sources are also often used for education and research in university departments.

3.1.4 Nuclear events

[40] Nuclear detonations produce radioactive clouds, which rise to heights dependent, in principal, upon the energy released, and also on the type of burst. Once the debris is injected into the atmosphere, it is rapidly spread through the atmosphere by diffusive processes, and eventually deposited on the surface.

The process of removal of radioactive debris from the atmosphere and its deposition at the surface may be divided into three phases:

- Immediate - the depositing of heavy debris within half an hour of the burst, which occurs mostly in the area in which physical damage is sustained.

[4] http://fukushimaupdate.com/

- Medium range - that which is deposited between half an hour and approximately twenty hours after a nuclear explosion out to the ranges of some hundreds of kilometres from the point of burst in the case of megaton weapons.
- Long range - the slow removal of very small particles, which may continue for months or even years, particularly after a high yield thermo nuclear explosion. This is diffused and eventually deposited over a very large area of the earth's surface.

In general, medium range fallout represents the most significant hazard to personnel. The effects of immediate fallout are normally greatly overshadowed by initial radiation, blast and thermal effects in the vicinity of nuclear bursts, and the radiological dose from long-range fallout does not reach tactically significant levels. Medium range fallout can cover an area of several hundred square kilometres and constitutes a definite hazard; it should be avoided or protective measures taken against it. In subsequent paragraphs the term fallout will concern only medium range fallout, unless otherwise specifically stated.

3.2 Drought

Drought can be defined as an extended period of deficient rainfall relative to the average for a specific region (see Figure 8). Drought can be defined according to meteorological, hydrological, and agricultural criteria[5]:

- *Meteorological*. Drought is usually based on long-term precipitation departures from normal, but there is no consensus regarding the threshold of the deficit or the minimum duration of the lack of precipitation that make a dry spell an official drought.
- *Hydrological*. Drought refers to deficiencies in surface and subsurface water supplies. It is measured as stream flow, and as lake, reservoir, and ground water levels.
- *Agricultural*. Drought occurs when there is insufficient soil moisture to meet the needs of a particular crop at a particular time. A deficit of rainfall over cropped areas during critical periods of the growth cycle can result in destroyed or underdeveloped crops with greatly depleted yields. Agricultural drought is typically evident after meteorological drought but before a hydrological drought.

[5] http://earthobservatory.nasa.gov/Features/DroughtFacts/

Figure 8 – Drought (Source: FEMA[6])

Impacts/damages

Impacts are commonly referred to as direct or indirect. Reduced crop, rangeland and forest productivity, increased fire hazard, reduced water levels, increased livestock and wildlife mortality rates, and damage to wildlife and fish habitat are examples of direct impacts. The consequences of these impacts represent indirect impacts. For example, a reduction in crop, rangeland, and forest productivity may result in reduced income for farmers and agribusiness, increased prices for food and timber, unemployment, reduced tax revenues because of reduced expenditures, increased crime, foreclosures on bank loans to farmers and businesses, migration, and disaster relief programs. Direct or primary impacts are usually biophysical. In a conceptual context, the more removed the impact from the cause, the more complex the link to the cause. In fact, the web of impacts becomes so diffuse that it is very difficult to come up with financial estimates of damages. The impacts of drought can be classified into economic, environmental, or social.

Many economic impacts occur in agriculture and related sectors, including forestry and fisheries, because of the reliance of these sectors on surface and subsurface water supplies. In addition to obvious losses in yields in crop and livestock production, drought is associated with increases in insect infestations, plant disease, and wind erosion. Droughts also bring increased problems with insects and diseases to forests and reduce growth. The incidence of forest and range fires increases substantially during extended droughts, which in turn places both human and wildlife populations at higher levels of risk[7].

Emergency actions

- Gather all the available drought information for your community.
- Identify information gaps.
- Target water management needs.
- Implement water conservation strategies.
- Provide support to local government in managing community water supplies.

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[6] http://www.ready.gov/natural-disasters
[7] http://www.drought.unl.edu/risk/impacts.htm

- Communicate with the public.

3.3 Earthquake

An earthquake occurs when there is a shaking and vibration at the surface of the Earth, caused by underground movement along a fault plane or by volcanic activity (see Figure 9). The scale of earthquake is commonly measured by *Richter scale* which compares the maximum heights of the seismic waves at a distance of 100 kilometres from the point on the Earth's surface directly above where the earthquake originated within the Earth, the *epicentre*[8]. The Richter scale is then classified into categories called *magnitudes*, which are the estimation of the energy released by an earthquake.

An earthquake happens because the Earth's tectonic plates are always moving and floating on molten rock. An earthquake can last few seconds to a few minutes, and can be followed after-shocks.

The Earth's outer shell is composed of seven major and some smaller plates, which are constantly in a dynamic state, pushing against, pulling away from, or grinding past one another. Forces build up as the plates attempt to move in relation to each other. When the adhesions along the fault give way, stored energy is released in the form of earth tremors, volcanic activity etc. Types of plate movements and principal effects of earthquake are the following[9]:

- Oceanic plates pulling away from each other leads to hot volcanic material being expelled from cracks to form mid-ocean ridges.
- Oceanic plates colliding with and forced under continental plates leads to mountain ranges being pushed up, accompanied by earthquakes and volcanic eruptions.
- Collisions of continental plates force up mountain ranges, release compression energy in quakes.

[8] http://www.ga.gov.au/hazards/earthquake/index.jsp
[9] http://www.cdera.org/doccentre/fs_earthquakes.php

Figure 9 – Earthquake (Source: International Business Times[10])

Impacts/damages

There are several primary impacts of earthquake[11]:

- Total or partial destruction of structures.
- Blockage or breakage of transport activities.
- Interruption of water supply.
- Breakage of sewage disposal systems.
- Loss of public utilities (e.g. electricity and gas).

Earthquakes will give various effects of damages (it depends on the scale). An example of massive damages of earthquake was on 2004 when an earthquake occurred in Sumatra-Indonesia. It was not only affected Indonesia, but also several countries such as Thailand and Sri Lanka.

Emergency actions

- *Indoor*. Take cover under a heavy desk or table. If you get under a table and it moves, try to move with it. It would be better if you stay away from falling objects, glasses, hanging objects, huge furniture that can be fallen. If you are in a public building, do not rush for the doorways and do not use elevators.
- *Outdoors*. Move away from buildings and utility wires. The greatest danger from falling debris is just outside doorways and close to outer walls. Once in the open, stay there until the shaking stops.
- *Automobile*. Stop as quickly and safely possible but not under potential materials that could fall but into an open space. When you drive on, watch for hazards created by the

[10] http://www.ibtimes.co.uk/phillipines-earthquake-pictures-6-7-magnitude-death-295088
[11] http://www.cdera.org/doccentre/fs_earthquakes.php

earthquake, such as breaks in the pavement, downed utility poles and wires, a fallen overpasses and bridges.

Mitigation

Actions include[12]:

- Developing construction techniques that are seismic resistant.
- Conducting a program to introduce improved construction techniques to the building industry and the general public.
- Determining which sites are safe for construction through analysis of the soil type and geological structure.
- Instituting incentives to remove unsafe buildings and buildings on unsafe sites or, more probably, to upgrade their level of safety.
- Instituting incentives to encourage future development on safer sites and safer methods of construction through:
- Land use controls (zoning).
- Building codes and standards and means of enforcing them.
- Favourable taxation, loans, or subsidies to qualify buildings, methods and sites.
- Land development incentives.
- Reducing possible damage from secondary effects by: (i) identifying potential landslide sites and restricting construction in those areas; (ii) installing devices that will keep breakages in electrical lines and gas mains from producing fires; and (iii) verifying the capability of dams to resist earthquake forces, and upgrading as necessary.

3.4 Epidemic

An epidemic is defined as the occurrence of an illness or health-related event that is unusually large or unexpected. Epidemics are commonly caused by a disease of infectious or parasitic origin (see Figure 10). Infectious diseases such as cholera, meningococcal meningitis, typhoid and viral haemorrhagic fever represent critical threats to the affected area(s). The concept epidemic can be applied to any pronounced rise in the occurrence of a disease, but is not restricted to sudden outbreaks.

[12] http://www.cdera.org/doccentre/fs_earthquakes.php

Figure 10 – Epidemic (Source: China's War on Strong Earthquake[13])

Based on International Federation of Red Cross and Red Crescent Societies (IFRC), epidemic is categorized as biological hazards. An epidemic is then unusual increase in the number of cases of an infectious disease which already exists in a certain region or population. It can also refer to the appearance of a significant number of cases of an infectious disease in a region or population that is usually free from that disease. Epidemics may be the consequence of disasters of another kind, such as tropical storms, floods, earthquakes and droughts. Epidemics may also affect animals, which cause local economic disasters. The next classification is based on IFRC[14]:

- *Avian Flu*. Avian influenza (AI) is a viral infection primarily affecting birds (e.g. chickens, ducks and geese), but also other species such as pigs and tigers. Rarely, bird flu can cause severe infections in humans. There are many different strains or varieties of AI viruses. They are a sub-group of influenza viruses, which includes the flu virus that causes seasonal outbreaks in humans around the world every year.
- *Cholera*. Cholera is mainly spread by drinking water contaminated by faeces. The fatality rate for severe, untreated cases is 50 per cent, when treated this drops to one per cent. The incubation period is 1-12 days and severe cases need hospitalisation. Less severe cases can be treated with rehydration therapy on an outpatient basis. Only 10 per cent of those infected present symptoms.
- *Dengue Fever*. Dengue or break-bone fever and dengue haemorrhagic fever are transmitted by "day biter" mosquitoes. Dengue fever is rarely fatal. The haemorrhagic variety, if untreated, can result in a 40-50 per cent mortality rate. With hospital care and fluid therapy, this can be brought to below five per cent.
- *Ebola and Marburg*. Two distinct viral diseases with similar symptoms. Both have a high fatality rate (up to 90 per cent for Ebola) and are extremely contagious (transmission

[13] http://english.chinamil.com.cn/site2/special-reports/2008-05/21/content_1265223.htm
[14] http://www.ifrc.org/en/

is through contact with all body fluids and organs, use of contaminated needles and syringes, and the aerosol route). Extraordinary precautions should be taken to prevent contamination of all those involved in assisting patients. The reservoir of the two viruses is unknown.

- *Malaria*. Malaria is transmitted by the bite of the anopheles mosquito, a dusk to dawn biter. Where the disease is endemic, the local population has some degree of immunity. The people at greatest risk are those from a non-malarial area, such as internally displaced persons (IDPs) or refugees. They can be protected by a weekly dose of a malaria suppressive drug. Of the four types of malaria, falciparum can be rapidly fatal and needs prompt treatment.
- *Measles*. This is a highly communicable viral infection that can result in a very high mortality rate, especially among children and undernourished populations. A prompt and comprehensive vaccination program at the start of an outbreak can help limit its spread. If vaccine supplies are limited, the first priority is malnourished and hospitalized children, the next priority six-month to two-year-old children. A reliable cold chain is essential for vaccine storage. Isolation or quarantine is impractical.
- *Meningococcal Meningitis*. Meningococcal meningitis is an acute bacterial disease. Epidemic waves occur at irregular, unexplained intervals. Chiefly affects children and young adults, especially those in crowded living conditions. The disease is transmitted by direct contact with nose and throat discharges. Infected individuals should be separated from others and their immediate contacts put under close health surveillance.
- *Yellow Fever*. Yellow fever is a deadly and fast-spreading mosquito-borne virus occurring only in parts of Africa and South America. The disease is highly communicable. Action to control an epidemic should include: (i) mass vaccination of people at risk; (ii) screening and spraying of patients' rooms or hospital wards to prevent mosquito access; (iii) elimination or use of larvicide on all existing or potential mosquito breeding sites; and (iv) spraying with insecticide of all houses in the community. Vaccination provides ten-year immunity.
- *HIV/AIDS*. Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome (HIV/AIDS) will kill more people this decade that all the wars and disasters in the past 50 years. Since the AIDS epidemic began, 25 million people have died and more than 40 million are now living with HIV and AIDS. In 2001 alone, five million people became infected worldwide.
- *Tuberculosis*. Tuberculosis (TB) is the single most deadly infectious disease and kills two million people each year. Of the eight million new cases annually, 95 per cent are in developing countries. Asia and sub-Saharan Africa are the hardest hit, but Eastern Europe has recently seen a major increase in the incidence and deaths related to TB after many years of steady decline. An estimated 75 per cent of people with TB are between the ages of 15-44, which is seriously damaging socio-economic development.

Impacts/Damages

The immediate effect of epidemics is of course that they cause illness and death. Secondary effects are social and political disruption and economic loss. Epidemics may worsen already traumatic or life-threatening situations such as those found in famine situations and in IDP / refugee camps.

Mitigation

Mitigation is based on mitigation action for animal and human epidemic, because both the source of epidemics is still a risk for human beings. For animal epidemics, first, increasing compliance with the health or rabies certificate requirements would go a long ways towards prevention. Second, vaccinating animals in an effort to prevent diseases within the local populations should be considered.

Mitigation for human epidemic include: (i) maintaining sewage and waste disposal systems; (ii) promoting and funding both childhood and adult immunization programs; (iii) supporting and providing health education in the schools and on a community level to address disease transmission and prevention; (iv) targeting the mechanism of transmission of individual diseases, such as drug usage for diseases like HIV infection and Hepatitis B; (v) maintaining strict health standards for food service employees and eating establishments; (vi) maintaining strict health standards for food products; (vii) using accepted and recommended infection control practices in medical facilities. The community education programs should be targeted in particular at high risk groups for blood borne pathogens and sexually transmitted diseases.

3.5 Extreme temperature

Changes in temperature extremes tend to follow mean temperature changes in many parts of the world. Although they happen more slowly and are more difficult to see than a tornado or an earthquake, "heat waves" (see Figure 11) and "cold snaps" (see Figure 12) are deadly natural hazards. Extreme heat and cold occur somewhere in the world every year and can afflict nearly every location on Earth. Heat waves are periods of unusually high temperatures, usually lasting three days to three weeks. Typically, heat waves are characterized by temperatures of 35°C (95°F) or higher, although lower temperatures accompanied by high humidity levels can also be considered a heat wave. Excessively dry and hot conditions can provoke dust storms and low visibility. Droughts occur when a long period passes without substantial rainfall. A heat wave combined with a drought is a very dangerous situation. Cold snaps are commonly three days to three weeks in duration, with temperatures usually falling below -15°C (5°F). A cold snap is a weather phenomenon that is distinguished by marked cooling of the air, or the invasion of very cold air, over a large area. It can also be prolonged period of excessively cold weather, which may be accompanied by high winds that cause excessive wind chills, leading to weather that seems even colder than it is. Cold snaps can be preceded or accompanied by significant winter weather events, such as blizzards or ice storms. Other names of a cold snap include cold wave and deep freeze.

Figure 11 – Heat wave (Source: Inhabitant[15])

Figure 12 – Cold snap (Source: The Guardian[16])

Temperature extremes are most common in the mid-latitude regions, especially near the interior of large continents, such as North America. Here, without the moderating effects of the oceans, winter minimum temperatures can drop below -20°C (-4°F) and above 40°C (104°F) for several weeks. In the mid-latitude regions, temperature extremes are most common June through August, and December through February. In Polar Regions and the higher mid-latitudes, extreme low temperatures can occur anytime between late fall and early spring. In the lower mid-latitudes, extreme high temperatures are common from late spring through early fall. Much like high latitudes, high altitudes are frequently subject to extreme low

[15] http://inhabitat.com/climate-change-blamed-for-australias-recent-extreme-heat-and-flooding/
[16] http://www.theguardian.com/world/video/2014/jan/06/us-midwest-life-threatening-cold-snap-video

temperatures. In alpine areas, which are typically above 3500 metres (11,500 feet) depending on latitude, extreme low temperatures can occur for nine months or more during a year.

1) Heat wave

Impacts/damages

People living in urban areas may be at greater risk from the effects of a prolonged heat wave than people living in rural regions. Heat wave impacts are widespread. While a large number of deaths may not occur in a single city every year, the cumulative impacts across broad regions over several days to weeks can result in heavy loss of life. Many more hundreds of deaths are associated with excessive heat attributed to heart attack, stroke, and also respiratory stress. Most deaths occur in urban areas where concrete, asphalt, and physical structures raise temperatures in urban heat islands, and night time temperatures remain above average. Heat waves also impact farming and ranching through loss of cattle and other livestock. Below are several impacts caused by heat waves [21]:

- Illnesses caused by exposure to high temperatures include heat cramps, fainting, heat exhaustion, heatstroke, and death.
- Population at increased risk especially older and younger people, risk of dehydration, low fitness/excessive exertion, etc.
- Another reason of death during heat wave is because of living alone. Studies designed to investigate why some people died during the 1995 and 1999 heat waves in Chicago found that the strongest risk factor was living alone, particularly for those who did not leave home daily.

Emergency Action

- Stay indoors as much as possible and limit exposure to the sun.
- Stay on the lowest floor out of the sunshine if air conditioning is not available.
- Consider spending the warmest part of the day in public buildings such as libraries, schools, movie theatres, shopping malls, and other community facilities. Circulating air can cool the body by increasing the perspiration rate of evaporation.
- Eat well-balanced, light, and regular meals. Avoid using salt tablets unless directed to do so by a physician.
- Drink plenty of water. Persons who have epilepsy or heart, kidney, or liver disease; are on fluid-restricted diets; or have a problem with fluid retention should consult a doctor before increasing liquid intake.
- Limit intake of alcoholic beverages.
- Dress in loose-fitting, lightweight, and light-coloured clothes that cover as much skin as possible.
- Protect face and head by wearing a wide-brimmed hat.
- Check on family, friends, and neighbours who do not have air conditioning and who spend much of their time alone.
- Never leave children or pets alone in closed vehicles.

- Avoid strenuous work during the warmest part of the day. Use a buddy system when working in extreme heat, and take frequent breaks.

2) Cold snap

Impacts/damages

Sudden cold snaps can have detrimental effects on human beings. A cold snap that is unexpected can cause frost bites, hypothermia or other serious medical aliments. A lot of damage is caused to animals and wildlife. When a cold wave comes along with heavy and incessant snowfall, animals may not be able to graze and thus die out of starvation. In order to feed livestock, farmers have to pay high prices for buying their food. There can be cases of damage when water pipelines freeze and burst. There is a rise in the demand for fuels and electricity.

Emergency actions

- Stay indoors as much as possible.
- Listen to the radio or television for weather reports and emergency information.
- Conserve fuel, if necessary, by temporarily closing off heat to some rooms.
- Eat to supply heat to the body and drink non-alcoholic beverages to avoid dehydration.
- Wear several layers of loose fitting, lightweight; warm clothing rather than one layer of heavy clothing. The outer garments should be tightly woven and water repellent.
- Carry a "basic vehicle emergency kit" in the trunk of your vehicle.

3.6 Flood

A flood can be defined as a general and temporary condition of partial or complete inundation of normally dry land areas from overflow of inland or tidal waters from the unusual and rapid accumulation or runoff of surface waters from any source (see Figure 13). Floods can have both positive and negative impacts. They can bring welcome relief for people and ecosystems suffering from prolonged drought, but also are estimated to be the most costly natural disaster. Flooding occurs most commonly from heavy rainfall when natural watercourses do not have the capacity to convey excess water. However, floods are not always caused by heavy rainfall. They can result from other phenomena, particularly in coastal areas where inundation can be caused by a storm surge associated with a tropical cyclone, a tsunami or a high tide coinciding with higher than normal river levels. Dam failure, triggered for example by an earthquake, will result in flooding of the downstream area, even in dry weather conditions.

Figure 13 – Flood (Source: The Telegraph[17])

Impacts/damages

Flood damage refers to all varieties of harm caused by flooding. It encompasses a wide range of harmful effects on humans, their health and their belongings, on public infrastructure, cultural heritage, ecological systems, industrial production and the competitive strength of the affected economy. Some of these damages can be specified in monetary terms, others (the so called intangibles) are usually recorded by non-monetary measures like number of lives lost or square meters of ecosystems affected by pollution. Flood damage effects can be further categorized into direct and indirect effects. Direct flood damage covers all varieties of harm which relate to the immediate physical contact of flood water to humans, property and the environment. This includes, for example, damage to buildings, economic goods and dykes, loss of standing crops and livestock in agriculture, loss of human life, immediate health impacts, and contamination of ecological systems. Indirect or consequential effects comprise damage, which occurs as a further consequence of the flood and the disruptions of economic and social activities.

This damage can affect areas quite a bit larger than those actually inundated. One prominent example is the loss of economic production due to destroyed facilities, lack of energy and telecommunication supplies, and the interruption of supply with intermediary goods. Other examples are the loss of time and profits due to traffic disruptions, disturbance of markets after floods (e.g. higher prices for food or decreased prices for real estate near floodplains), reduced productivity with the consequence of decreased competitiveness of selected economic sectors or regions and the disadvantages connected with reduced market and public services.

[17] http://www.telegraph.co.uk/news/picturegalleries/uknews/10548683/UK-weather-in-pictures-Britain-hit-by-high-tides-floods-and-strong-winds.html

Emergency actions

- Get an emergency supply kit which includes items like non-perishable food, water, a battery-powered or hand-crank radio, extra flashlights and batteries.
- Make a plan for family in case separate each other, to make a contact and meeting point when separate.
- Stay informed on current situation.
- Be aware that flash flooding can occur, and if there is possibility will happen, then move to a higher ground.
- Be aware of streams, drainage channels, canyons, etc.
- Move furniture in house to an upper floor.
- Disconnect all electricity appliances and do not touch electrical equipment when it is wet.
- Do not walking through moving water and do not drive as well.

Mitigation

The aim on planning the mitigation against flood is to reduce human suffering caused by flood and increase the sense of security of flood victims. Mitigation against flood can be measured through several alternatives for instance constructing flood proof houses, planting, government planning, etc. But there are other non-technical issues that should be considered on flood mitigation. First, community habits especially waste disposal. Many communities are not aware of this issue and for instance dispose tons of waste in nearby rivers. Second, identify the vulnerable people. Third, identify the most important things to carry during a flood. Fourth is the community knowledge on flood orientation, including safe areas, etc.

3.7 Mass Movement

Mass movements are massive failures of slope masses including rock, debris, soils and snow/ice (see Figure 14). These mass movements are sometimes associated with other disaster such as earthquakes, floods, thunderstorms and heavy rainstorms. Mass movements also associated with manmade hazards like construction roads, buildings, structures, infrastructure facilities, etc. Mass movements are also known as a variety of processes exit by which materials can be moved through the hillslope system because of instability of it. Mass movements will be occurred based on several factors and will be different for different place. Mass movements are affected on the gradient of the slope, climate, rock type and structure, physical setting and geological and geomorphologic outlines. One of the common mass movements is landslide. A landslide is the movement of rock, debris or earth down a slope. They result from the failure of the materials which make up the hill slope and are driven by the force of gravity. Landslides are known also as landslips, slumps or slope failure. Landslides can be triggered by natural causes or by human activity. They range from a single boulder in a rock fall or topple to tens of millions of cubic meters of material in a debris flow. They can vary also in their extent, with some occurring very locally and impacting a very small area or hillslope while others affect much larger regional areas. The distance travelled by landslide

material also can differ significantly with slides travelling from a few centimetres to many kilometres depending on the volume of material, water content and gradient of the slope.

Figure 14 – Mass movement (Source: PhysicalGeography[18])

The basic types of landslide movement are:

- *Fall*. This is generally characterized by a rapid to extremely rapid rate of movement with the descent of material characterized by a freefall period. Falls are commonly triggered by earthquakes or erosion processes.
- *Topple*. This is characterized by the tilting of rock without collapse, or by the forward rotation of rocks about a pivot point. Topples have a rapid rate of movement and failure is generally influenced by the fracture pattern in rock. Material descends by abrupt falling, sliding, bouncing and rolling.
- *Flow*. This is the most destructive and turbulent form of landslide. Flows have a high water content which causes the slope material to lose cohesion, turning it into slurry. They are channelled by the landscape and move rapidly.
- *Slide*. This is one of the most common forms of failure and can be subdivided into translational and rotational slides. Rotational slides are sometimes called slumps because they move with rotation. Translational slides have a planar, or two dimensional surface of rupture. Slides are most common when the toe of the slope is undercut. They have a moderate rate of movement and the coherence of material is retained, moving largely intact or in broken pieces.
- *Spread*. This phenomenon is characterized by the gradual lateral displacement of large volumes of distributed material over very gentle or flat terrain. Failure is caused by liquefaction which is the process when saturated loose sediment with little or no

[18] http://www.physicalgeography.net/fundamentals/10x.html

cohesion such as sands or silts are transformed into a liquid like state. This process is triggered by rapid ground motion most commonly during earthquakes.

Another common mass movement is land subsidence. Land subsidence occurs when a big mount of ground water have been withdrawn from certain types of rocks. The rocks compact because the water is responsible for holding the ground up. When the water is withdrawn, the rocks fall in on it. Common causes of land subsidence are from human activity such as: (i) pumping water, oil, and gas from underground reservoirs; dissolution of limestone aquifers (sinkholes); (ii) collapse of underground mines; (iii) drainage of organic soils; and (iv) initial wetting of dry soils (hydrocompaction).

1) Landslide

Impacts/damages

- Anything on top of or in the path of a landslide will suffer damage.
- Rubble may block roads, lines of communication or waterways. Indirect effect may include loss of productivity of agricultural or forest lands.
- Flooding.
- Reduced property values, destruction of buildings.
- Casualties- fatalities may occur due to slope failure.

Emergency actions

- Stay alert and awake. Many debris-flow fatalities occur when people are sleeping. Be aware that intense, short bursts of rain may be particularly dangerous, especially after longer periods of heavy rainfall and damp weather.
- If you are in areas susceptible to landslides and debris flows, consider leaving if it is safe to do so. Remember that driving during an intense storm can be hazardous. If you remain at home, move to a second story if possible. Staying out of the path of a landslide or debris flow saves lives.
- Listen for any unusual sounds that might indicate moving debris, such as trees cracking or boulders knocking together. A trickle of flowing or falling mud or debris may precede larger landslides. Moving debris can flow quickly and sometimes without warning.
- If you are near a stream or channel, be alert for any sudden increase or decrease in water flow and for a change from clear to muddy water. Such changes may indicate landslide activity upstream, so be prepared to move quickly. Don't delay! Save yourself, not your belongings.
- Be especially alert when driving. Embankments along roadsides are particularly susceptible to landslides. Watch the road for collapsed pavement, mud, fallen rocks, and other indications of possible debris flows.

Mitigation

- Capture and drainage of water before it reaches potential slope area.

- Underground drainage by using sub-surface pipes.
- Land Reform by terracing/re-shaping.
- Reforestation, planting of deep rooting trees to prevent surface slips.
- Ground cover with grass or agricultural crops.
- Use of Gabion construction to protect water course valleys and control the flow of water down slope.

2) Land subsidence

Impacts/damages

- Changes in elevation and slope of streams, canals, and drains.
- Damage to bridges, roads, railroads, storm drains, sanitary sewers, canals, and levees.
- Damage to private and public buildings.
- In some coastal areas, subsidence has resulted in tides moving into low-lying areas that were previously above high-tide levels.
- Failure of well casings from forces generated by compaction of fine-grained materials in aquifer systems.

Mitigation

- Identify and map areas with soil and geologic hazards and soil contamination.
- Require development proposals to assess soils and geologic hazards such as soil contamination, erosion, landslide and earth fissures from land subsidence.
- Require prevention measures when locating public facilities in areas subject to soils or geologic hazards, in order to avoid extraordinary maintenance or replacement cost.

3.8 Volcano

Volcano is a mountain opening downwards to the reservoir of molten rock towards the surface of Earth (see Figure 15). Volcanoes are made by the accrual of igneous products. As the pressure from gases in the molten rock becomes intense, the eruption takes place. The volcanic eruption can be either quiet or volatile. Its aftermaths include flowing lava, flat landscapes, poisonous gases and fleeing ashes and rocks. The secondary disaster after the eruption such as debris flows are often triggered by rainfall after the volcanic eruption.

Figure 15 – Volcano (Source: BBC[19])

There are three different classes of volcanoes: *shield volcano*, *composite volcano* and *caldera volcano*. A volcano is classified as *shield volcano* when magma is very hot and runny, gases can escape and eruptions are gentle with considerable amounts of magma reaching the surface to form lava flows. Shield volcanoes have a broad, flattened dome-like shape created by layers of runny lava flowing over its surface and cooling. Because the lava flows easily, it can move down gradual slopes over great distances from the volcanic vents.

Composite volcano, also known as stratum-volcano, is characterized by an explosive eruption style. When magma is slightly cooler it is thick and sticky, or viscous, which makes it harder for gas bubbles to expand and escape. The resulting pressure causes the magma to foam and explode violently, blasting it into tiny pieces known as volcanic ash. These eruptions create steep sided cones.

Finally, a volcano is classified as *caldera volcano* when it erupts so explosively that little material builds up near the vent. Eruptions partly or entirely empty the underlying magma chamber which leaves the region around the vent unsupported, causing it to sink or collapse under its own weight. The resulting basin-shaped depression is roughly circular and is usually several kilometres or more in diameter. Although caldera volcanoes are rare, they are the most dangerous. Volcanic hazards from this type of eruption include widespread ash fall, large pyroclastic surges and tsunami from caldera collapse.

Impacts/damages

- Mediated trauma, crush type injuries, and lacerations can be caused by explosion and contact with volcanic mass.
- Hot ash, gases, rock and magma cause skin and lung burns, asphyxiation, conjunctivitis or corneal abrasion.
- Breathing the gases and fumes can cause acute respiratory distress.
- Acid rain provokes eyes and skin irritation.
- In the case of ash fall, particularly in fine particles, bronchial asthma and other chronic respiratory conditions can be aggravated in children as well as in adults. Death is highly

[19] http://www.bbc.co.uk/science/earth/natural_disasters/volcano

improbable. Nonetheless, it can occur in persons with serious symptoms if they do not protect themselves from the ashes.

- Ashes can have toxic consequences (i.e. gastrointestinal problem) due to ingestion of contaminated food or water.
- Ashes can have mechanical consequences. The weight of ash may cause collapse of building (i.e. trauma).
- Damage on health infrastructures and water systems can be severe. Problem of communication (ashes create serious interference) and transportation (poor visibility and slippery roads) are likely to happen.

Emergency actions

Before the eruption:

- Demarcation and evacuation of areas of risk.
- Formulation of and familiarization with search and rescue plans.
- Preparation of hospital emergency plans to cope with large influx of patients with burns, lung damage and trauma.
- Identification of facilities to collect and analyse ash for toxic elements and drinking water quality.
- Facilities and equipment for monitoring air.
- Plans for procurement of emergency supplies.
- Report any and all unusual physical changes around volcanoes to the Seismic Research Unit, e.g. the drying up of vegetation, rumbling sounds, earthquakes, landslides and other possible abnormalities.

During the Eruption:

- Pay attention to warnings, which would include evacuation notices and escape from area as quickly as possible.
- Listen to the radio for information and advice.
- Find shelter, but not in a building with low-pitched or flat roof, if heavy ash is falling.
- Avoid basements and closed spaces where gases may accumulate.
- Wear protective clothing over head and body if you have to move in an ash shower.
- Breathe through a handkerchief.
- Always carry a flashlight, even during the daytime.

Mitigation

Volcanic mitigation can be maintained into structural and non-structural measures. In structural measures, various facilities are installed to minimized damage by volcanic mudflow, pyroclastic flow and lave flow as well as sediment-related disaster caused by rainfall. To establish the non-structural measures such as a warning and evacuation system in parallel with structural measure is also an important way. Some preparations that can be made such

as hazard maps, monitoring camera, establishment of permanent danger zone and educate people about volcano risks, improving warning and evacuation system.

3.9 Wildfire

A wildfire is an unplanned, unwanted wild land fire including unauthorized human-caused fires [22] (see Figure 16). Vegetation fires are caused by slash and burn land clearing, clearing of plantations following logging operations, and by natural events such as lightning or extreme drought. During dry seasons fires usually reach a peak and can present a trans boundary problem when prevailing winds disperse the smoke across borders to other countries [23].

Figure 16 – Wildfire (Source: The Guardian[20])

There are three different classes of wildland fires. A *surface fire* is the most common type and burns along the floor of a forest, moving slowly and killing or damaging trees. A *ground fire* is usually started by lightning and burns on or below the forest floor. Finally, c*rown fires* spread rapidly by wind and move quickly by jumping along the tops of trees.

Wildland fires are usually signalled by dense smoke that fills the area for miles around.

Impacts/damages

- Destruction of vegetated and eventually inhabited areas and construction sites.
- Ecological and economical losses.
- Large amount of scorched and barren land.
- Affected areas may not to return to their initial conditions (i.e. before the fire) for decades. If the wildland destroyed the ground cover, then erosion becomes one of several potential problems.

[20] http://www.theguardian.com/world/2012/jun/27/colorado-springs-waldo-canyon-wildfire

- Smoke and other emissions contain pollutants that can cause significant health problems.
- The short-term effects contain destruction of timber, forage, wildlife habitats, scenic vistas, and watersheds.
- The long-term effects contain reduced access to recreational areas, destruction of community infrastructure and cultural and economic resources.

Emergency actions

Bushfires are usually fought by numerous trained volunteers and a core of professional firefighters with vehicle -mounted equipment (in accessible terrain). Observation is often provided by light aircraft and helicopters. Water-bombing is also provided by helicopters with buckets which lift water from dams, lakes or swimming pools. They are effective in stopping spot fires ignited by windborne firebrands, sometimes kilometres ahead of the main fire-front. This greatly assists and contributes to the safety of firefighting crews. In large bushfires, bulldozers and graders are used to create emergency firebreaks ahead of fire fronts. Back-burning from firebreaks is frequently effective in slowing or stopping the spread of fire.

Mitigation

Mitigation includes any activity that prevents an emergency, reduce the chance of an emergency happening, or lessen the damaging effects of unavoidable emergencies. Investing in preventive mitigation steps now such as installing a spark arrestor on your chimney, cleaning roof surfaces and gutters regularly and using only fire resistant materials on the exterior of your home will help reduce the impact of wildland fires in the future.

4 DATA SOURCES

In this chapter we identify the data sources which can provide high-level information fusion for damage assessment of the affected area(s) which will benefit decision-making. The next subsections list the data sources to be taken into account for the DESTRIERO project and the information that they could provide.

4.1 Sensors

A sensor could be defined as a device for the measurement of physical quantities that responds to a physical, chemical, biological, or electrical stimulus and generates an electrical output signal which is a function of the input stimulus [24]. In short, sensors are entities capable of observing a phenomenon and returning an observed value [24]. There are a great variety of sensor types from simple visual thermometers to complex electron microscopes to radiometers on-board Earth orbiting satellites. In some cases, sensing may be accomplished by a person rather than a device, and the result may be a category rather than a numeric quantity [24].

Sensors are designed to measure specific properties within a given sample space. When these measurements are taken, an observation is generated, that may be immediately processed or stored. In its lowest level, this observation is typically a proxy measurement of some property that is different from the desired physical property, itself. For example, an observation may be the height of mercury in a thermometer or the voltage across a circuit. In order for these observations to be related to a more useful physical property, a new observation must be derived using known sensor calibration functions and perhaps other processing algorithms [24].

Damage assessment in the affected area(s) by a disaster situation requires the fusion of information from heterogeneous data sources including sensors. Data fusion techniques combine data from multiple sensors and related information to achieve more specific inferences than could be achieved using a single, independent sensor [25]. The fusion of data from multiple sensors provides several advantages over data from a single sensor:

- The combination of the observations (e.g. identical radars tracking a moving object) will result in an improved estimate of the target position and velocity.
- The use of the relative placement or motion of multiple sensors can improve the observation process. For example, two sensors that measure angular directions to an object can be coordinated to determine the position of an object by triangulation.
- Observability is improved. Broadening the baseline of physical observables can result in significant improvements.

One mechanism that can be used to facilitate the data communication in sensor network is the Data Distribution Service for Real Time Systems (DDS). DDS specification standardizes the software Application Programming Interface (API) by which a distributed application can use

Data-Centric Publish-Subscribe (DCPS) as a communication mechanism. DDS provides several advantages such as [26]:

- Based on a simple "publish-subscribe" communication paradigm.
- Flexible and adaptable architecture that supports "auto-discovery" of new or stale endpoint applications.
- Low overhead (it can be used with high-performance systems).
- Deterministic data delivery.
- Dynamically scalable.

The next subsections describe different sensors types that could be used as a data sources for the DESTRIERO project. Table I summarizes the relations between the different disasters and the sensors that could be useful to take into account for the DESTRIERO system.

Disaster	Sensor
CBRN-incident	Camera (picture or video for damage assessment). FROG-4000 and GUARDION (chemical sensors) NDIS and Fido B2 (Biological sensors). Colibri (Hand-held health physics instrument). Gamma camera (radiation localization, displays radioactivity in real time). Falcon 5000 (radionuclide identifier).
Drought	Camera (picture or video for damage assessment).
Earthquake	Camera (picture or video for damage assessment). Extensometer (structural damage assessment).
Epidemic	Camera (picture or video for damage assessment).
Extreme temperature	Camera (picture or video for damage assessment).
Mass movement	Camera (picture or video for damage assessment). Inclinometer (monitoring of subsurface movements and deformations).
Volcano	Camera (picture or video for damage assessment).
Wildfire	Camera (picture or video for damage assessment).

Table 2 – Relationships between disasters and sensors

4.1.1 CBRN sensors

A CBRN sensor is a device that transforms chemical information, ranging from the concentration of a specific sample component to total composition analysis, into an analytically useful signal [27]. In the following sections some sensors and devices for detecting biological, chemical and radiological contamination on the field will be described.

The information from these sensors could be integrated in the DESTRIERO system being very useful to the decision makers in order to know in which areas will be able to enter the recovery and reconstructions teams in a secure way and which areas are dangerous for persons. In addition, some of these sensors can provide the type of nuclides present in the disaster area in order to know the durability of the contamination.

4.1.1.1 FROG-4000 (sensor for Chemical agents)

FROG-4000[21] is a hand held micro system for detection of chemical agents as benzene, toluene, ethyl benzene, and xylenes (BTEX) and other volatile organic compounds (VOCs) in water, air, and soil.

FROG-4000TM miniaturizes components used for analytical chemistry. The system incorporates a micro pre-concentrator that is coated with a designer nano-porous material. The micro pre-concentrator has an integrated heater for thermal desorption. It separates target analyses in less than 5 minutes. The micro GC column also has an integrated heater for temperature ramp chromatography.

Figure 17 – FROG-4000

Ramping the temperature reduces the analysis time and aids in the separation of late eluting compounds. The detector is a miniature PID (10.6 eV). Chemical name and concentration can be viewed on FROG-4000's LCD display, or the user may watch the chromatogram real time on a computer.

[21] http://www.defiant-tech.com

FROG-4000TM includes a micro-SD card to store results from the field. Data can be downloaded from the SD card for further analysis at a later time.

4.1.1.2 GUARDION (sensor for Chemical agents)

GUARDION[22] is a portable Chemical Identifier whose more important features are the following:

- Utilizes Gas Chromatography/Mass Spectrometry (GC/MS) technology to identify volatile and semi-volatile organic compounds including CWA and TIC
- Start up and ready to operate in 5 minutes or less
- Analysis in 3 minutes or less allows for up to 30 sample runs on a single battery charge
- Universal sample collection technique accommodates gas, liquid, and solid sampling

GUARDION is hand-portable and ruggedized for use in a hot zone or extreme environments. It can analyse 12-15 samples per hour.

GUARDION includes CWA and TIC libraries as well as a hazards database for rapid decision support and can operate from a single battery charge for up to 3 hours.

The GUARDION vacuum system includes a ruggedized, low-maintenance turbo molecular pump that does not need to be replaced. The direct GC to MS interface eliminates the need for bake-out, minimizing logistical burden.

Figure 18 – GUARDION

GC/MS is considered the "gold standard" for chemical identification. This technique can identify single or multiple substances within complex samples. Additionally, it can identify trace compounds that can go undetected by other technologies.

[22] http://www.smithsdetection.com

4.1.1.3 NDIS - Nano Intelligent Detection System (sensor for Biological agents)

NDIS[23] is a biological agent detector whose main features are the following:

- Confirms the identity of 10 bio agents & simulants in under 15 minutes
- Identifies up to 5 agents per test strip with only 100 uL of sample fluid
- Eliminates false negatives due to the Hook Effect
- Assays have 2 year shelf life over a wide temperature range
- Easy-to-use reader even in poor lighting while wearing PPE

Figure 19 – NDIS (Nano Intelligence Detector System)

The NIDS handheld reader is a palm-sized, portable, ruggedized optical scanning device that takes all of the guess work out of interpreting Handheld Assay results by different responders in field conditions with poor lighting and limited visibility while wearing PPE. The reader stores up to 3,000 test results, including a preserved scanned image of each test, on a Removable 2GB flash memory.

NIDS handheld bio-threat commercial assays are currently available to identify: Bacillus anthracis (Ba), Yersinia pestis (Yp), Franciscella tularensis (Ft), Vaccinia virus (VAC), Ricin, Botulinum Toxin A (Bot A), Botulinum Toxin B (Bot B) and Staphylococcal Enterotoxin B (SEB).

PC Computing Platform

It is possible to power the reader from a PC through the Mini-USB Port integrated in the sensor. This port can be used also to manage data, update firmware and change settings using the NIDS stand-alone reader PC Software supplied with the system.

[23] http://www.smithsdetection.com/

Packaging

This device is provided as a ruggedized unit designed for field portable use. No tools are required to access battery compartment. It has a sealed micro-SD card and mini-USB port.

The base is removable for easy cleaning and decontamination and it includes 3M lint free cloth for cleaning optical scanner window.

4.1.1.4 Fido B2 (sensor for Chemical agents)

Fido B2[24] is a mature biological sensor with top-of-the-line sensitivity. Fido B2 is designed to run continuously in the background with minimal interaction. From long-term, fixed installations to short, mission-based tactical applications, the Fido B2 offers a flexible field-ready solution for bio-aerosol monitoring:

- Provides near real time warning capability for biological aerosol threats
- Government validated with over 3,000,000 hours of run time in relevant environments
- Alert can automatically trigger a particulate sampler for subsequent identification
- Operates unattended 24/7 without consumables
- Complete self-diagnostic system
- Battery or line powered with up to 16 hour run time per battery charge
- Easily integrated with most building monitoring and control systems
- Alert algorithms validated for both indoor and outdoor environments
- Detects all four classes of bio-organisms: spores, vegetative, virus, and toxins

[24] http://www.flir.com/

Figure 20 – Fido B2

The Fido B2 is a continuous air monitor that provides early warning for the presence of biological aerosol threats. The system combines both trigger and sample collection features into one integrated system that serves as a "smart" collector. Instead of randomly or continuously sampling the air onto a collection surface, the system will only trigger the collector when there is a high probability of a biological agent present. This greatly reduces the costs of consumables and number of samples to process and identify.

The Fido B2 facilitates timely containment, treatment and remediation for concentrated levels of biological aerosols. Possible agents released in a bio-threat attack can include bacterial spores (such as B. anthracis, which causes anthrax), bacteria (such as Y. pestis, which causes plague), viruses (such as smallpox) and toxins (such as ricin).

Minimal training is required for operating the Fido B2. It can operate as a standalone unit, meaning the operator simply places the sensor at the location of interest, turns on the power, and leaves it to monitor autonomously for a bio-alarm signal. Alternatively, the Fido B2 can operate as part of a network configuration to form the "first tier" of a building air-security system. Communication and response can be managed through existing building control systems or an independent network.

4.1.1.5 Gamma Camera (sensor for radioactive activity detection)

The gamma camera[25] is a real-time portable gamma-ray imaging system that creates images of two different wavelengths of photons (visible and gamma) and superimposes them. This

[25] http://www.canberra.com/products/insitu_systems/gamma-imaging-systems.asp

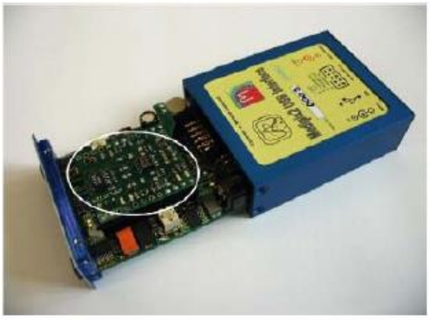
allows the user to locate gamma radiation arriving at the sensor. The GAMPIX gamma camera is based on three main components:

- The Timepix chip. This pixelated chip, developed by the CERN in the frame of the international collaboration Medipix, is hybridized with a 1 mm or 2 mm thick CdTe substrate. The active area is divided into 256 × 256 pixels (55 µm side) working in single photon counting mode, each pixel being an individual detector with its own electronics (analogue and digital part).
- The coded mask. This multi-pinhole collimator enables to improve drastically the sensitivity of the camera but requires a decoding step in order to convert the raw image into a decoded gamma image. Several parameters can be adjusted (thickness, rank), according to the need of the end-users, in order to improve the performances of the gamma camera for a given application.
- The Universal Serial Bus (USB) interface. GAMPIX can be connected in a very easy way to a standard laptop, which greatly simplifies its use.

Figure 21 illustrates the three main components of a gamma camera. The gamma camera will have a minimum weight of 4 kg.

Timepix chip

Coded mask of rank 13.2 mm thick



USB interface

Figure 21 – Components of a gamma camera

The combination of the three components shown in Figure 21 for the GAMPIX gamma camera corresponds to a technological breakthrough in comparison with the CARTOGAM system. These components have been integrated in a camera's body, including a visible camera, required for the superimposition of the gamma image with the visible image. Figure 22 illustrates the GAMPIX gamma camera.

Figure 22 – The GAMPIX gamma camera

4.1.1.6 Colibri (sensor for radioactive agents)

Colibri[26] (see Figure 23) is a comprehensive health physics instrument that performs numerous radioprotection daily duties. The large colour touch screen reports in real time, error-free measurements for up to eight Smart Probes (seven via Bluetooth and one via CSP standard cable) while always displaying dose-rate at worker location.

[26] http://www.canberra.com/products/hp_radioprotection/pdf/Colibri-VLD_C39518.pdf

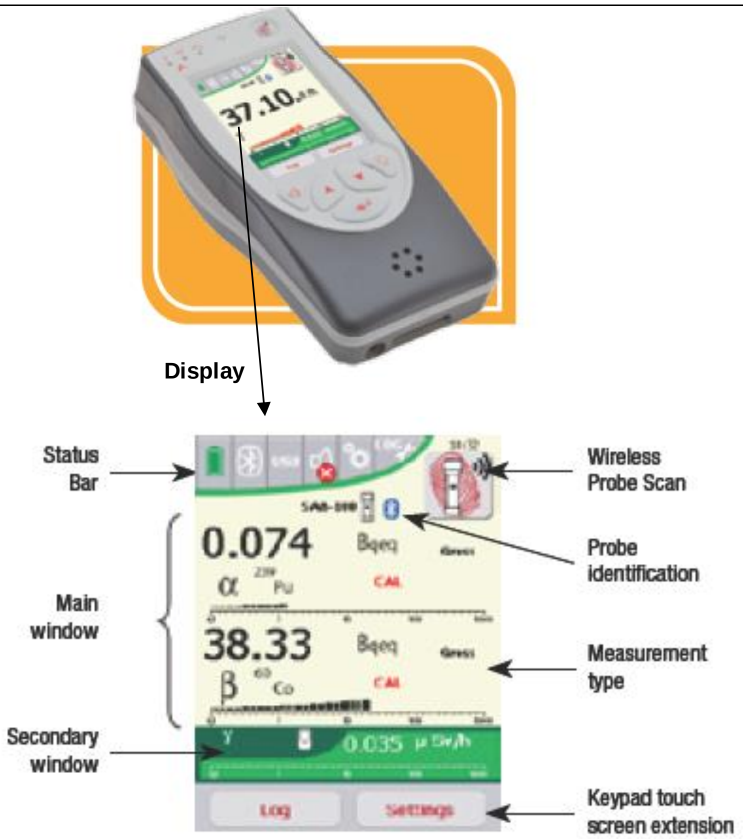


Figure 23 – Colibri

Colibri provides both fast reacting semi-log bar graph and averaged digital reading for each measurement window. The main window displays either the internal detector dose-rate or the external probe read-out and the secondary window shows the cumulated dose or the Colibri dose-rate when one or multiple external probes are connected.

It can be worn on the belt with a permanent smooth clip, or held comfortably in the hand using the finger strap and secure wrist strap. The Colibri's speaker emits alarm sounds as well as other audible signals. In the event of a radiation hazard, regardless of working conditions, an alarm will sound along with a flashing LED and vibrator. The standard available off the shelf Bluetooth headset will better support source and contamination location in noisy environments. Colibri TTC integrates a GM detector with superior Time- To-Count technique that covers never achieved dose rate range from background up to 10 Sv/h reducing the risk of saturation in unexpected high dose rate situations. Dose-rate is automatically stored every five seconds in a date stamped internal file allowing for post analysis.

4.1.1.7 Falcon 5000 (sensor for radioactive agents)

The Falcon 5000®[27] (see Figure 24) is a state-of-the-art portable Radionuclide Identifier (RID) based on a High Purity Germanium (HPGe) detector. It quickly and accurately answers: "Is there a radiation source present?", "Where is it?", and importantly "What isotopes are emitting the radiation?" The Falcon 5000 accomplishes these goals by combining the best resolution HPGe detector technology with ultra-low microphonic electrical cooling. In addition to the highest resolution detector on the market, the Falcon 5000 integrates a unique BEGe detector that is superior in efficiency and lower in cost than standard coaxial detectors. The Falcon 5000 is a highly powerful and customizable field spectroscopy system.

Figure 24 – Falcon 5000

Once the Falcon 5000 has been configured, the user simply starts the measurement, uses the Locate function to find the increased radiation field, and then looks at the NID page for the results. The spectrum can be viewed at any time to determine if the NID results match the collected spectrum for consistency. The main objective is to get the right answer, regardless of whether the user is an expert or novice.

<u>The Detector</u>

The heart of the Falcon 5000 is the unique combination of a Broad Energy, high purity Germanium detector (BEGe) paired with an extremely low noise, reliable electrical cooler utilizing Pulse Tube cooling technology that is new to the spectroscopy field. Combining these two critical technologies provides the best possible energy resolution and measurement range.

This is extremely important when trying to measure a wide range of radionuclides such as Americium-241 at 60 keV and Thallium-208 with energies as high as 2614 keV. Of course, no HPGe measurement is possible without a reliable cooling source. The "state-of-the-art"

[27] http://www.canberra.com/products/hp_radioprotection/falcon-5000.asp

mechanical cooler used in the Falcon 5000 breaks new ground in mechanical cooling performance.

Supporting Equipment

An internal energy compensated GM tube is included for continuous monitoring of the dose rate. Also included in the Falcon 5000 assembly is a GPS, battery management system and communication network for interfacing to the control unit. An optional neutron measurement is available from a moderated 3He tube. The control unit/user interface is implemented on a Tablet PC running Windows® XP operating system. This platform enables the user to easily collect and analyse spectra, calibrate the detector, and customize the MCA for special applications.

PC Computing Platform

The full function tablet PC which operates the Falcon 5000 communicates with the detector unit via Wi-Fi® or optional direct connect via RJ-45 Ethernet cable, this information will be transmitted to DESTRIERO system in pseudo real time in order to provide the more updated information to the managers.

The benefits in the field will be seen with every use:

- Easy gamma analysis through increased processing speed and large colourful displays.
- No fighting with limited display space and low resolution graphics.
- All the processing power of a PC for sophisticated, quick, spectroscopy analysis.

Packaging

- Strap for easy carrying in the field.

Hard travel case for safe shipping and carrying. The Falcon 5000 is remarkably easy to use in the field. Behind the scenes, however, it uses CANBERRA's time tested signal processing and gamma spectral analysis, which was previously available only in high-end laboratory systems.

4.1.2 Cameras

One of the main information source for taking decisions on damage assessment and recovery and reconstruction are images (pictures or videos) taken from the field. For obtaining this kind of information DESTRIERO system will need access to pictures and videos taken from specific types of cameras. In the following paragraphs a general description of the cameras that could be integrated with DESTRIERO system are shown.

There are two kinds of cameras that could provide images to the DESTRIERO system. The first type is composed by portable cameras which can be mounted either in a helmet or in a Unmanned Aerial Vehicle (UAV). The second type of cameras are handheld and can be used

by the engineers teams deployed on the field for assess the damages of buildings or infrastructures.

Portable cameras

With these type of cameras units on the field can send images while they are working or UAVs can take images from isolated or dangerous/contaminated areas. The main features that these cameras should have are the following:

- Helmet or UAV attached.
- Support standard streaming protocols such as RTP/RTSP.
- Robust codifications with low bandwidth such as H264.
- Low power consumption.
- Wireless capabilities for real time video transmission.
- Easy and flexible installation (plug and play).
- Security capabilities: Password protection, IP address filtering, HTTPS encryption, IEEE 802.1X network, access control, Digest authentication, User access log.
- IP and NEMA standards compliant (for temperature, humidity, dust, etc.).

The images taken from these cameras could be either being send via wireless means (e.g. Wi-Fi) to the nearest DESTRIERO node (e.g. laptop on a firemen truck) or stored and uploaded after that to a server available for DESTRIERO system.

Some examples of these types of cameras can be seen in Figure 25.

Figure 25 – Portable cameras operating from a helmet and from an UAV

Handheld cameras

With this kind of cameras engineers' teams can take images and videos while they assess the damage of building or infrastructures on the field. These images would be uploaded to a server available for DESTRIERO system in order to be accessed at any time by the decision makers. The main features that these cameras should have are the following:

- High Secure Digital (SD) storage capacity.
- High Definition (HD) quality.
- Full HD 1080/60i/60p/24p.
- Pixel Gross : Approx. 24.7 megapixels.
- USB Port(s) : mini-AB/USB2.0 Hi-speed (mass-storage/Media Transfer Protocol (MTP)).

One example of these types of cameras can be seen in Figure 26.

Figure 26 – Handheld camera

Infra-red cameras (IR)

Thermal imaging provides recovery and reconstruction agencies with critical insight not available from standard colour photography. This kind of imaging could be used for giving important information that would not be available with normal cameras, e.g. how much liquid is in a storage tank or making inferences of tanks (fuel or water) that are full, tanks that are empty and tanks that are leaking.

In addition, IR cameras could help in some specific recovery tasks by giving information on how extent a fuel leak is or the risk of fire in the affected area(s). Figure 27 illustrates some examples of these mentioned uses.

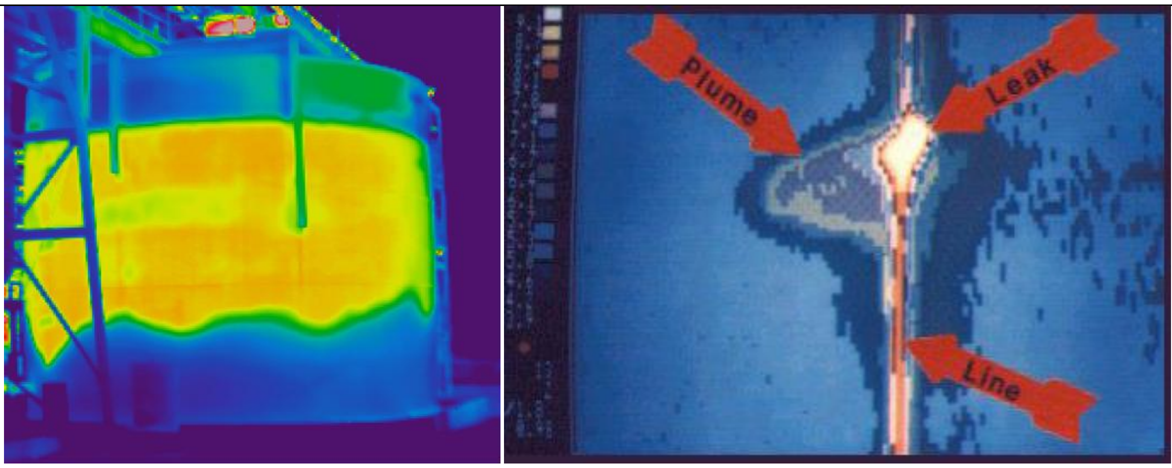


Figure 27 – Infra-red camera

4.1.3 Global Positioning Systems

Current global positioning systems allow the location whatever kind of building, infrastructure or person with a high accuracy. This fact makes that global positioning system, such as the U.S. Global Positioning System (GPS[28]) and GALILEO[29] (the European global navigation satellite system), are very useful for the recovery and reconstruction tasks.

DESTRIERO system needs to know the location of several kind of critical infrastructures and buildings place in the disaster area in order to help the managers in charge of reconstruction and recovery to perform better their job.

In addition, units deployed on the field need to be located along with vehicles working in the recovery and reconstruction issues. This kind of location is needed in order to give the managers a clear idea on what resources are deployed on the field and in which part of the disaster area they are located. This way the management of this resources is quicker and more efficient.

For positioning all the above mentioned assets and units potable positioning devices (GPS and/or GALILEO compliant) are attached the vehicles and persons and they will provide different locations to the nearest DESTRIERO node.

4.1.4 Motion sensors

Motion sensors are devices capable of detecting motion in free space, and it would be very useful for the DESTRIERO system in the damage assessment phase.

[28] http://www.gps.gov/systems/gps/
[29] http://www.esa.int/Our_Activities/Navigation/The_future_-_Galileo/What_is_Galileo

4.1.4.1 Extensometer

An extensometer is a sensor used to measure changes in the length of an object. Therefore, extensometers could be used in the DESTRIERO system as a device that can provide valuable information for structural damage assessment.

An electrical extensimeter translates the variation of length in a variation of an electrical measure. It can be resistive, capacitive or inductive. For instance, the resistive extensimeter is made of a thin metallic grid applied on a plastic material. It can be applied on the surface of an object, to measure its deformations. Practically, the thin wire of the extensimeter follows the deformations of the surface to which it is applied, lengthening and shortening accordingly. The change of length of the wire corresponds to a variation of its electrical resistance, and then used to measure the entity of the deformation.

A particular instrument to measure the change of the length of a crack in a structure is the fissurometer (see the example in Figure 28. It is a simple resistive potentiometer that measures the movements of the structure over time along a given direction, usually perpendicular to the crack to be observed.

Figure 28 – An example of fissurometer

4.1.4.2 Inclinometer

An inclinometer is a motion sensor used to monitor subsurface movements and deformations. They are usually made of a cylindrical thin and long case, which are drowned in the terrain to be measured. The movement of the ground causes the casing to deform, hence to measure the entity of the movement itself.

This kind of sensor could be useful for the DESTRIERO system in order to detect zones of movement in the affected area(s) and establish whether movements are constant, accelerating, or responding to remedial measures. Besides, inclinometers could be used for the verification of the stability of dams, dam abutments, and upstream slopes during and after impoundment.

4.2 Satellite Imaging Sensors

Satellite imaging sensors are devices, mounted on orbiting platforms, able to collect information about the Earth's surface. There are two kinds of imaging sensor system:

- Active sensors emit their own electromagnetic radiation and measure the intensity of the return signal which is reflected by the Earth's surface.
- Passive sensors detect the amount of natural radiation emitted or reflected by the Earth's Surface. Sunlight is the most common source of radiation.

The measurements acquired by the sensors are registered as digital numbers, transmitted to ground stations and processed to obtain an image representing the objects in the observed scene. The kind of information which can be extracted from satellite images depends on several sensors' properties:

- spatial resolution, which refers to the size of the smallest object that can be resolved on the ground.
- wavelength bands employed in the image acquisition
- the temporal resolution, i.e. how frequent given location on the earth can be imaged by the imaging system

There are many image analysis techniques available and the methods used to extracted useful information from satellite images. In many cases, image segmentation and classification algorithms are used to delineate different areas in an image into thematic classes. The resulting product is a thematic map of the study area. This thematic map can be combined with other databases of the test area for further analysis and utilization. In the following will be describe the main types of satellite imaging sensors.

4.2.1 Optical Sensors

Optical remote sensing makes use of visible, near infrared and short-wave infrared sensors to form images of the earth's surface by detecting the solar radiation reflected from targets on the ground. Different materials such as water, soil, vegetation, buildings and roads reflect visible and infrared light in different ways. Thus, the targets can be differentiated by their spectral reflectance signatures in the remotely sensed images. They have different colours and brightness when seen under the sun. The interpretation of optical images requires the knowledge of the spectral reflectance signatures of the various materials (natural or man-made) covering the surface of the earth. There are also infrared sensors measuring the thermal infrared radiation emitted from the earth, from which the land or sea surface temperature can be derived.

Optical/thermal imaging systems can be classified according to the number of spectral bands used:

- Monospectral or panchromatic (single wavelength band, "black-and-white", grey-scale image) systems. The sensor is a single channel detector sensitive to radiation within a

broad wavelength range. If the wavelength range coincides with the visible range, then the resulting image resembles a "black-and-white" photograph taken from space. The physical quantity being measured is the apparent brightness of the targets. The spectral information or "colour" of the targets is lost.

- Multispectral (several spectral bands) systems. The sensor is a multichannel detector with a few spectral bands. Each channel is sensitive to radiation within a narrow wavelength band. The resulting image is a multilayer image which contains both the brightness and spectral (colour) information of the targets being observed.

4.2.1.1 Disadvantages

The main limitation of optical imaging sensors is that its acquisition mechanism depends on the solar radiation reflected by the Earth's surface, as explained in the previous paragraph. This implies that optical imaging sensors are not able not acquired images all weather conditions (i.e. at cloudy weather) and at every hour of the day.

4.2.1.2 Applications

The main applications of optical imagery are:

- Topography and cartography: extracting features like building footprint, roads, etc. using automatic algorithm (i.e. classification) or by visual interpretation.
- Agriculture, forestry, and botany: monitoring the biomass of land vegetation, monitoring the health of crops, mapping soil moisture, forecasting crop yields.
- Hydrology: assessing water resources from snow, rainfall and underground aquifers.
- Disaster warning and assessment: monitoring of floods and landslides, monitoring volcanic activity, assessing damage zones from natural disasters.
- Planning applications: mapping ecological zones, monitoring deforestation, monitoring urban land use.
- Military: developing precise maps for planning, monitoring military infrastructure, monitoring ship and troop movements.

4.2.2 Synthetic Aperture Radar (SAR)

Synthetic Aperture Radar (SAR) image data provide information different from that of optical sensors operating in the visible and infrared regions of the electromagnetic spectrum. SAR data consist of high-resolution reflected returns of radar-frequency energy from terrain that has been illuminated by a directed beam of pulses generated by the sensor. The radar returns from the terrain are mainly determined by the physical characteristics of the surface features (such as surface roughness, geometric structure, and orientation), the electrical characteristics (dielectric constant, moisture content, and conductivity), and the radar frequency of the sensor. By supplying its own source of illumination, the SAR sensor can acquire data day or night without regard to cloud cover.

Synthetic aperture radar imaging systems can be classified according to the combination of frequency bands and polarization modes used in data acquisition, e.g.:

- Single frequency (L-band, or C-band, or X-band)
- Multiple frequency (Combination of two or more frequency bands)
- Single polarization (VV, or HH, or HV)
- Multiple polarization (Combination of two or more polarization modes)

Since the physical mechanisms responsible for this backscatter is different for microwave, compared to visible/infrared radiation, the interpretation of SAR images requires the knowledge of how microwaves interact with the targets.

Due to the cloud penetrating property of microwave, SAR is able to acquire "cloud-free" images in all weather. This is especially useful in the tropical regions which are frequently under cloud covers throughout the year. Being an active remote sensing device, it is also capable of night-time operation.

4.2.2.1 Advantages

The main advantages of SAR sensors are technology are:

- Illumination: SAR is an active system. It illuminates the Earth surface and measures the reflected signal, generating microwave images of the surface. Therefore images can be acquired day and night, completely independent of solar illumination, particularly important at high latitudes (polar night).
- Weather independence: The microwaves emitted and received by the ERS SAR are at much longer wavelengths (5.6 cm) than optical or infrared waves. Microwaves can therefore easily penetrate clouds, and images of the surface acquired irrespective of local weather conditions.
- Unique parameters: Images provided by optical sensors contain information about the surface layer of the imaged objects (i.e. colour), while microwave images provide information about the geometric and dielectric properties of the surface (i.e. roughness) or volume (i.e. chemical composition, moisture) studied, allowing unique properties of the target to be revealed.
- Hidden features: The penetration depth of an incident wave depends partly on its wavelength. Because of their long wavelength, microwaves are able to penetrate not only clouds but also features such as soil, sand, snow (in very dry conditions) or the canopy of a forest, thus providing information about hidden features.

4.2.2.2 Disadvantages

Radar images have certain characteristics that are fundamentally different from images obtained by using optical sensors such as Landsat, SPOT or aerial photography. These specific characteristics are the consequence of the imaging radar technique, and are related to radiometry (speckle, texture or geometry).

During radar image analysis, the interpreter must keep in mind the fact that, even if the image is presented as an analogue product on photographic paper, the radar "sees" the scene in a very different way from the human eye or from an optical sensor; the grey levels of the scene

are related to the relative strength of the microwave energy backscattered by the landscape elements.

Shadows in radar image are related to the oblique incidence angle of microwave radiation emitted by the radar system and not to geometry of solar illumination. The false visual similarity between the two types of images usually leads to confusion for beginners in interpretation of radar images.

4.2.2.3 Applications

Observations of the Earth using the SAR (Synthetic Aperture Radar) have a wide range of practical applications, such as:

- On the sea and oceans:
    - Most of the man-made illegal or accidental spills are well visible on radar images. Ships can be detected and tracked from their wakes. Also natural seepage from oil deposits can be observed. They provide hints to the oil industries. Scientists are studying the radar backscatter from the ocean surface related to wind and current fronts, to eddies, and to internal waves. In shallow waters SAR imagery allows to infer the bottom topography.
    - The ocean waves and their direction of displacement can be derived from the SAR sensor. This provides input for wave forecasting and for marine climatology.
    - At high latitudes, SAR data is very useful for regional ice monitoring. Information such as ice type and ice concentration can be derived and open leads detected. This is essential for navigation in ice-infested waters.
- On the land:
    - The ability of SAR to penetrate cloud cover makes it particularly valuable in frequently cloudy areas such as the tropics. Image data serve to map and monitor the use of the land, and are of gaining importance for forestry and agriculture.
    - Geological or geomorphological features are enhanced in radar images thanks to the oblique viewing of the sensor and to its ability to penetrate - to a certain extent - the vegetation cover.
    - SAR data can be used to geo-refer other satellite imagery to high precision, and to update thematic maps more frequently and cost-effective, due to its availability independent from weather conditions.
    - In the aftermath of a flood, the ability of SAR to penetrate clouds is extremely useful. Here SAR data can help to optimize response initiatives and to assess damages.
    - An emergent technique Interferometric SAR (InSAR) can be used, under suitable conditions, to derive elevation models or to detect small surface movements, of the order of a few centimetres, caused by earthquakes, landslides or glacier advancement.

4.2.3 Earth Observation products description

The following table describes the basic information which can be associated with a satellite image:

Parameter	Description	Note
Sensor Name	The name of the sensor used to acquire the image	-
Sensor Type	Sensor type. The value of this field could be for example: - OPTICAL - RADAR	-
Sensor Operational Mode	Each sensor has different acquisition modes. Values fields can assume are mission specific.	-
Sensor Resolution	Sensor spatial resolution	-
Extent	The polygon containing the area covered by the image	-
Center of Scene	The coordinates of the centre of the area covered by the images	-
Start Acquisition Time	Start time of the acquisition	-
End Acquisition Time	End time of acquisition	-
Orbit Direction	Orbit direction when image has been acquired. It could be ascending or descending.	-
Acquisition Station	The acquisition station where image has been downloaded.	-
Incidence Angle	Acquisition global incidence angle given in degrees.	-
Cloud Cover Percentage	The percentage of image covered by cloud	Only for optical images

Table 3 – Earth Observation products

4.2.4 Satellite images in disaster management

Mitigation of natural disasters can be successful only when adequate knowledge is obtained about the expected frequency, character, and magnitude of hazardous events. Some types of disasters, like, floods or earthquakes may originate very rapidly and may affect large areas. The use of synoptic earth observation methods has proven to be especially suitable in the field of disaster management. An important aspect in terms of satellite monitoring involves assessment of the damage incurred during the disaster. Satellite technology can also help in identifying escape routes and locations for storage of temporary housing.

Remotely sensed data can be used very effectively, for:

- Quickly assessing severity and impact of damage due to flooding, earthquakes, oil spills and other disasters;
- Planning efficient escape routes from coastal areas during hurricane season;
- Charting quickest routes for ambulances to reach victims;
- Locating places for shelter for victims or refugees;
- Calculating population density in disaster-prone areas;
- Rapidly identifying hardest-hit disaster areas in order to provide early warning of potential disasters;
- Pre-disaster assessments to facilitate planning for timely evacuation and recovery operations during a crisis;
- Monitoring reconstruction or rehabilitation after a major disaster; and
- Developing, maintaining or updating accurate base maps.

The following table illustrates how optical and SAR images can be used in the different type of disasters:

Disaster type	**Satellite data category**	**Description**
Floods	SAR	Water targets have a specific behaviour with respect to SAR sensors, as generally calm water results in a very low value of backscattering due to the reflection of the SAR signal and it is easily detectable using semi-automated feature extraction techniques. SAR sensors have the capability to acquire under every weather and light condition increasing the collection opportunities in case of floods that are generally coupled with bad weather conditions and consequently persistent cloud coverage.
Wild fires	Optical multispectral	Optical multispectral sensors offer the opportunity to well discriminate burnt forest areas as the vegetation has different behaviours in the NIR (Near Infrared) and SWIR (Short Wave Infrared) spectral band according to the chlorophyll content and can therefore be used in order to detect burnt areas. Generally NIR and SWIR spectral bands are combined in the red and green channels, while the red and Green spectral bands are combined in the green and blue channels. This technique applies for both crown and surface forest fires

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and demonstration under grant agreement no. 312721

Disaster type	**Satellite data category**	**Description**
Earthquake	Optical multispectral, very high resolution	Earthquake damage assessment from EO data is based on the comparison of a co-seismic image pair in order to identify damage indicators such as debris or roof discontinuity. Therefore the use of very high resolution optical multispectral images is the optimum solution.
	SAR, very high resolution	The use of SAR data (especially in X band) can bring valuable information in case of absence of suitable optical images or in case of persistent cloud coverage after the earthquake. The analysis of co seismic coherence coupled with the change in terms of signal intensity allows the coarse identification of damaged areas at a higher level of aggregation as well as the detailed damage assessment on isolated assets such as harbour piers, bridges, etc.
Landslides	Optical multispectral, very high resolution	The use of optical data allows the visual identification of the affected areas through a pre-post event comparison
	SAR, very high resolution	The use of SAR data is feasible if a suitable pre event image is available for interferometric analysis
Volcano eruptions	Optical	Medium resolution (30m<resolution<100m) optical multispectral sensors offer the opportunity to detect and analyse the eruptive plume component and analyse the surface thermal behaviour of active volcanoes estimating its thermal flux Very high resolution (resolution<5m) optical multispectral data will be used to identify pyroclastic flows and lava flows.
Man-made Industrial Accident/Nuclear	Optical multispectral, very high resolution	Very high resolution optical images are used to assess the damages to the major elements of a nuclear plant (reactors, cooling towers, storage areas, power plants) in order to provide elements to determine their functionality. Multispectral images are generally used to improve the detection capabilities

Disaster type	Satellite data category	Description
	Optical panchromatic only, very high resolution	Same considerations as very high resolution optical multispectral images, with the limitation of the absence of the colour information.
	SAR, very high resolution,	Multitemporal very high resolution SAR images can provide useful elements to the damage assessment to large and isolated structures in nuclear plants (e.g. reactors) inferring information from the regularity of SAR shadows in the combined pre-post event multitemporal image.
Man-made Industrial Accident/Other	Optical multispectral, very high resolution	Other industrial spills on the land are detected using appropriate band combinations that allow the separation of the industrial spill affected area from the non-affected one. The higher number of available spectral bands is a value.
Humanitarian crisis (e.g. IDP camps mapping)	Optical multispectral, very high resolution	The general mapping scope in case of humanitarian crisis is to give an updated picture of particular elements such as IDP camps, cross border checkpoints, etc. and, eventually, their evolution over time. The analysis of such structures requires the correct identification and mapping of targets that are suitable to be detected with VHR optical multispectral images

Table 4 – Use of optical and SAR images in the different type of disasters

4.3 Audio and video

Damage assessment requires accurate information and in this context, audio and video (A/V) (television, radio, internet, phone calls...) could be important means of obtaining useful information about the affected area(s). Also, remote monitoring of the affected area(s) could be performed through live A/V feeds by the DESTRIERO end-users. Furthermore, since smart video analysis techniques may detect and alert when something wrong is happening, the DESTRIERO system could use these techniques and manage and consolidate the resulting information in order to bring better security during the planning and reconstruction phase. Podcasts and YouTube videos are examples of audio and video data sources that could be very useful for the end-users of the DESTRIERO system. A podcast is a digital audio or video file or recording, usually part of a themed series that can be downloaded from a website to a media

player or computer. YouTube[30] is a video-sharing website, created by three former PayPal employees in February 2005 and owned by Google since late 2006, on which users can upload, view and share videos.

4.4 Social media

In damage assessment it is very important to get reliable information from sources that are in a unique position to find information that is not present elsewhere and that can provide knowledge about some aspects of the affected area(s). For this reason, social media represent another source of useful information on damage assessment. Social media can be defined as "a form of new media that facilitates social interaction and communication through the use of online internet-based platforms." [31]. Social networks, such as Facebook and Twitter may help DESTRIERO end-users identify vulnerabilities, trends and threats in order to determine the appropriate response reducing risk in the affected area(s). For example, the Federal Emergency Management Agency (FEMA[31]) reported that during and following Hurricane Sandy[32], "users sent more than 20 million Sandy-related Twitter posts, or 'tweets', despite the loss of cell phone service during the peak of the storm." According to *The Pew Research Centre*, another example was following the *Boston Marathon* bombings, when one quarter of Americans reportedly looked to social networking sites, such as Facebook and Twitter, for information [32].

In this context, the Queensland Police Service (QPS) Media and Public Affairs Branch began a trial use of social media accounts Facebook, Twitter and YouTube in May 2010. QPS remarks that there are several benefits of social media in disaster management [33]:

- It is immediate and allowed Police Media to proactively push out large volumes of information to large numbers of people ensuring there was no vacuum of official information.
- The QPS Facebook page became the trusted, authoritative hub for the dissemination of information and facts for the community and media.
- Large amounts of specific information could be directed straight to communities without them having to rely on mainstream media coverage to access relevant details.
- The QPS quickly killed rumour and misreporting before it became "fact" in the mainstream media, mainly through the #mythbuster hashtag.
- It provides access to immediate feedback and information from the public at scenes.
- The mainstream media embraced it and found it to be a valuable and immediate source of information.
- It provided situational awareness for QPS members in disaster-affected locations who otherwise had no means of communications.

[30] http://www.youtube.com/
[31] http://www.fema.gov
[32] Hurricane Sandy (unofficially known as "Superstorm Sandy") was the deadliest and most destructive hurricane of the 2012 Atlantic hurricane season, as well as the second-costliest hurricane in United States's history.

Various international organisations and government agencies have also used social media platforms and technologies to enhance their capabilities in crisis management. For example, the New York City's Office of Emergency Management uses *Sahana*[33] to manage its all hazards sheltering plan involving over 500 shelters capable of housing over 80,000 persons during a crisis. Another example is *Ushahidi*[34], downloadable software that enables people to submit eyewitness reports during a disaster that can then be displayed onto a map. This software was successfully deployed during the 2010 Haiti earthquake to *crowdsource*[35] data from people on the ground to aid relief efforts. Finally, *SensePlace2*[36] is another example of a map-based web application that integrates multiple text sources (news, RSS, blog posts) that can then be translated onto a map to allow emergency responders to easily filter through by place or time, so as to analyse changing issues and perspectives.

4.5 Drones

An Unmanned Aerial Vehicle (UAV), also known as drone (see Figure 29), is "an aircraft either controlled by 'pilots' from the ground or increasingly, autonomously following a pre-programmed mission." [34]. Drones can be categorized into two groups [34]: (i) drones that are used for reconnaissance and surveillance purposes; and (ii) drones that are armed with missiles and bombs. In our context, information from diverse sources as sensors on a drone, reconnaissance reports and satellite imagery can be integrated to obtain-high level knowledge of objects in the affected area by natural disasters including their spatial and temporal interrelationships, and to generate predictions.

Figure 29 – Civilian drone (Source: Digital Trends[37])

[33] http://sahanafoundation.org/
[34] http://www.ushahidi.com/
[35] To outsource work to an unspecified group of people, typically by making an appeal to the general public on the internet.
[36] http://www.geovista.psu.edu/SensePlace2/
[37] http://www.digitaltrends.com/cool-tech/philip-steel-drone-hunting-license-deer-trail/

5 HIGH-LEVEL INTEROPERABILITY DATA MODEL

In the damage assessment phase, depending of the end-users of a specific disaster situation, semantic concepts (i.e. the meaning of things) will likely differ. Therefore, for the DESTRIERO end-users, a formal interoperability knowledge model that provides support to damage assessment is required. Semantic interoperability is defined as "the ability of two or more computerized systems to exchange information for a specific task and have the meaning of that information accurately and automatically interpreted by the receiving system, in light of the task to be performed." [2]. In this sense, common representation of semantics through ontologies represents one step towards information interoperability. The Web Ontology Language (OWL) is a standard that belongs to a family of knowledge representation languages prepared for the Semantic Web. OWL has reached the status of World Wide Web Consortium (W3C) recommendation. From a technical point of view, OWL extends the Resource Description Framework (RDF) and RDF Schema (RDF-S), allowing us to integrate a variety of applications using the Extensible Markup Language (XML) as interchange syntax. RDF is a language for representing information about resources in the World Wide Web such as the title, author, and modification date of a Web page, among others. Therefore, due to its RDF basis, OWL ontologies can be associated to any other form of information expressed on the Semantic Web, and it allows the integration of the resulting specifications with a variety of e-business frameworks and business modelling languages.

OWL ontologies are composed of: (i) classes, as sets of individuals, (ii) individuals, as instances of classes (i.e. objects of the domain), and (iii) properties as binary relations between individuals. It is possible to specify property domains, cardinality ranges, and reasoning on ontologies. Also, some reasoners (e.g. Pellet[38]) can be used to infer additional facts about the knowledge that has been explicitly stated in OWL ontologies. Reasoning in OWL can be performed at a class, property, or instance level, and reasoning examples include class membership, equivalence of classes, consistency, classification of the information, obtaining additional properties using transitiveness or equivalence, etc. Reasoners use Rules and Queries to obtain these additional facts mentioned before.

In this section, we formalize the proposed the DSIG Ontology using OWL. This model relies on the concepts formerly described in Section 4. It is worth highlighting that some of the DSIG Ontology concepts are based on and have been adapted from concepts of the Joint Consultation, Command and Control Information Exchange Data Model (JC3IEDM39) [35], and some other concepts have been included after the study phase accomplished during this task. From here on, we use the prefixes 'dsig' and 'jc3' to refer to the namespaces of the DSIG Ontology or JC3IEDM Ontology respectively.

[38] http://clarkparsia.com/pellet

[39] JC3IEDM specifies the minimum data set required for interoperability between Command and Control Information Systems (C2ISs) and the information exchange mechanism. Information available at: https://mipsite.lsec.dnd.ca/Pages/Documentsoverview.aspx

The open source Protégé-OWL tool has been selected in this task as an ontology editor to create and import the required ontologies. The open source Protégé[40] tool is an example of a widespread ontology development environment. The Protégé-OWL editor is an extension of Protégé that provides support to OWL. The Protégé-OWL editor enables users to load and save OWL and RDF(S) ontologies, edit and visualize classes, properties, taxonomies and several restrictions, as well as class instances (i.e. the actual data in the knowledge base). It also includes the Semantic Web Rule Language (SWRL) tab which is an extension for editing and executing SWRL rules in conjunction with the Jess[41] rule engine. Figure 30 represents an excerpt of the DSIG Ontology using the Protégé 3.5 ontology editor tool.

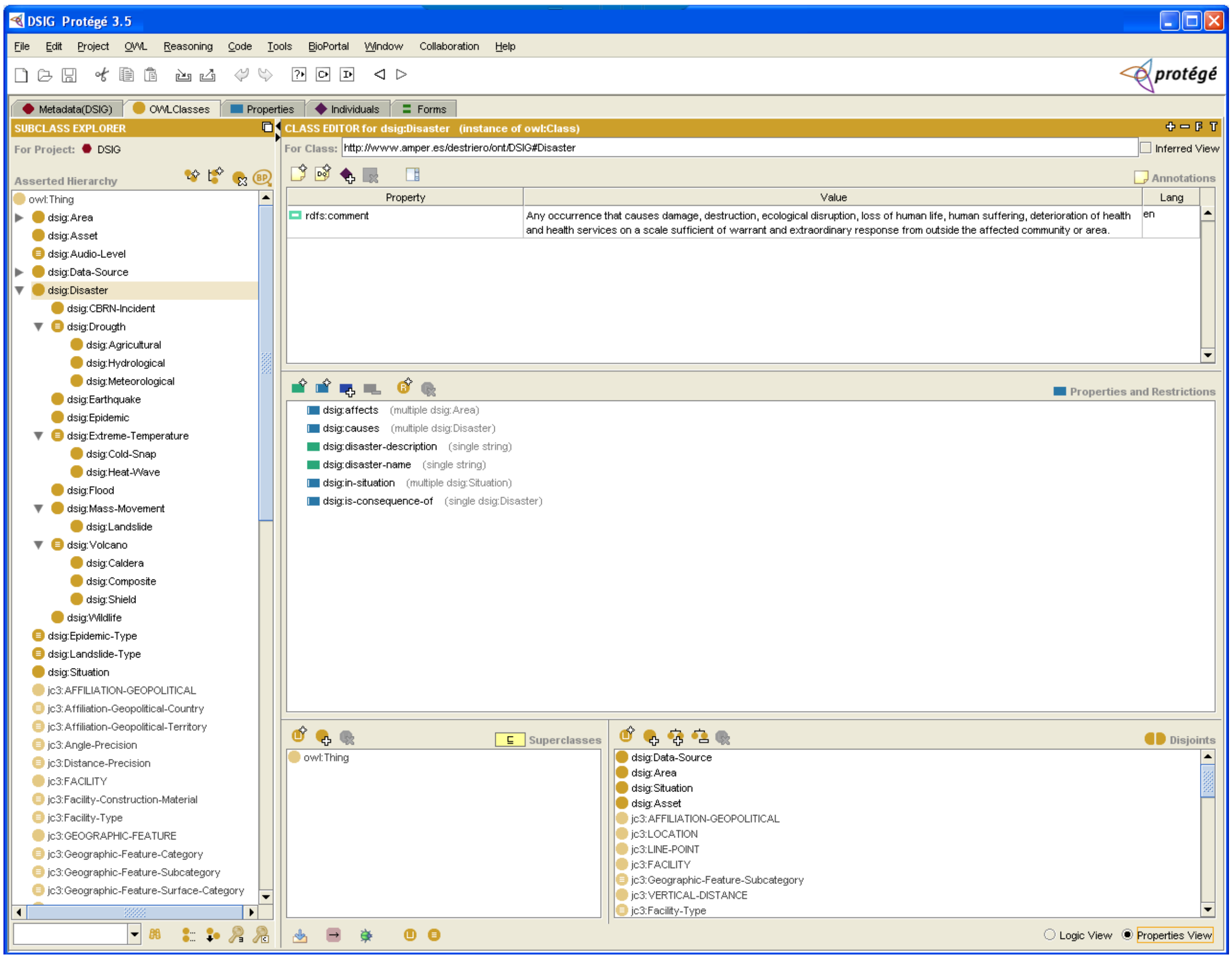

Figure 30 – Excerpt from the DSIG Ontology using the Protégé 3.5 ontology editor tool

On the other hand, we use Unified Modelling Language (UML) class diagrams to present the proposed ontology in a graphical way. These diagrams have been generated by the free

40 http://protege.stanford.edu/
41 http://www.jessrules.com/

version of the Visual Paradigm for UML[42] tool (community edition for non-commercial use). Visual Paradigm for UML (VP-UML) is a software design tool designed for agile software projects. VP-UML supports modelling standards such as UML, Systems Modelling Language (SysML), Entity Relationship Diagram (ERD), Data Flow Diagram (DFD), Business Process Model and Notation (BPMN), etc. VP-UML facilitates building software and systems that excel in user experience by supporting effective use case identification, requirements gathering, flow of events, wireframing[43], requirement specification generation, etc. In this vein, UML classes represent OWL concepts, UML associations correspond to *object properties*, UML attributes represent *datatype properties*, and UML inheritance is used for subclass relationships.

Figure 31 shows a general overview of the DSIG Ontology (see chapter 6 for complete listing of the concepts which are available on the ontology).

[42] http://www.visual-paradigm.com/product/vpuml/

[43] A website wireframe, also known as a page schematic or screen blueprint, is a visual guide that represents the skeletal framework of a website.

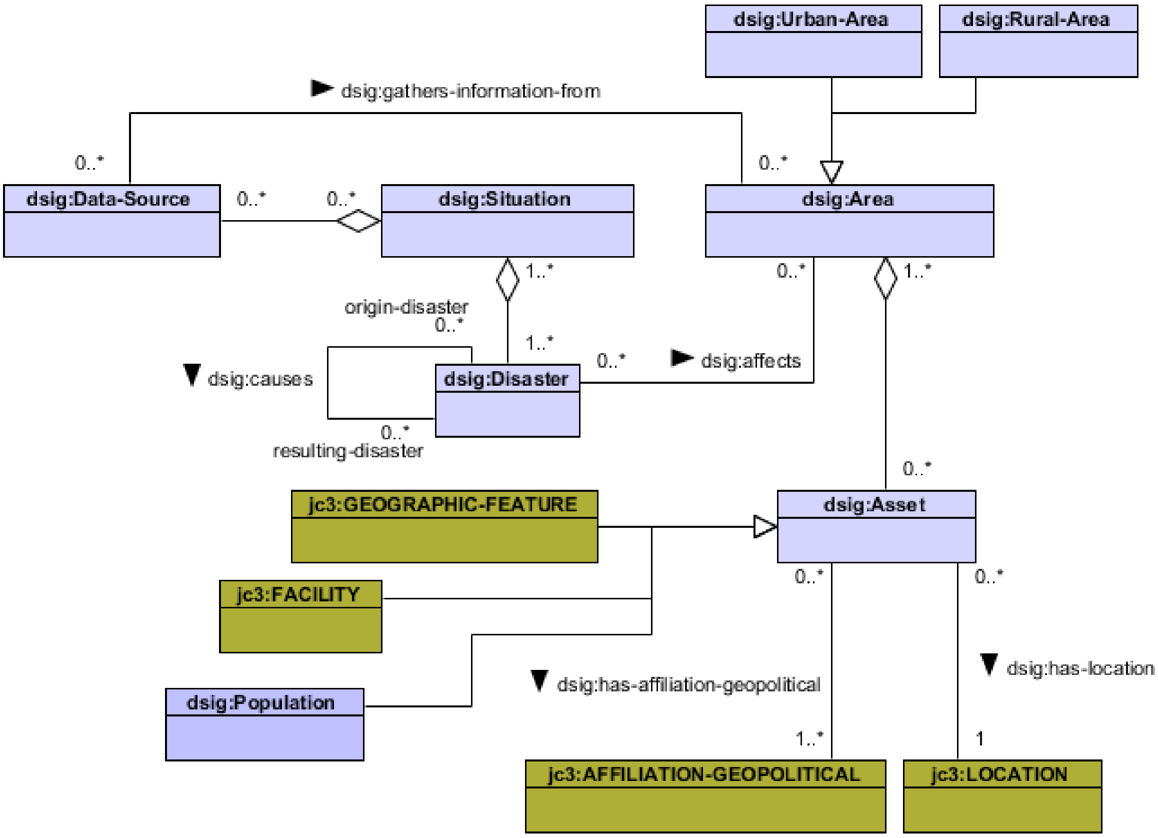

Figure 31 – UML class diagram representing an overview of the DSIG Ontology

The architecture of the DSIG Ontology is based on a *situation*. A *situation* in our context is defined as the combination of circumstances at a certain moment consisting of one or more *disasters* having certain properties or bearing certain relations to each other. A *situation* is comprised of *data sources* that provide useful information about the state of the affected *area*(s). An *area* is defined as the geographical region of administrative responsibility which has been affected by a specific situation. *Areas* are classified into *urban areas* and *rural areas*. An *urban area* is a developed area, constituting, forming, or including a city, town, or borough, or part of such. A *rural area* represents a geographic area that is located outside *urban areas*. On the other hand, *Areas* are composed of *assets* that represent the items of economic value. *Assets* are classified into *facilities* and *geographic features* which have a *location* and specific *geopolitical affiliations*.

5.1 Disasters

A disaster represents any occurrence that causes damage, destruction, ecological disruption, loss of human life, human suffering, deterioration of health and health services on a scale sufficient of warrant and extraordinary response from outside the affected community or area. Besides, a disaster could cause other disasters as a consequence of its effects on the Earth. We use this class to classify the disasters that are considered in our domain, as shown in Figure 32 (we discuss the types of disasters in more detail in Section3).

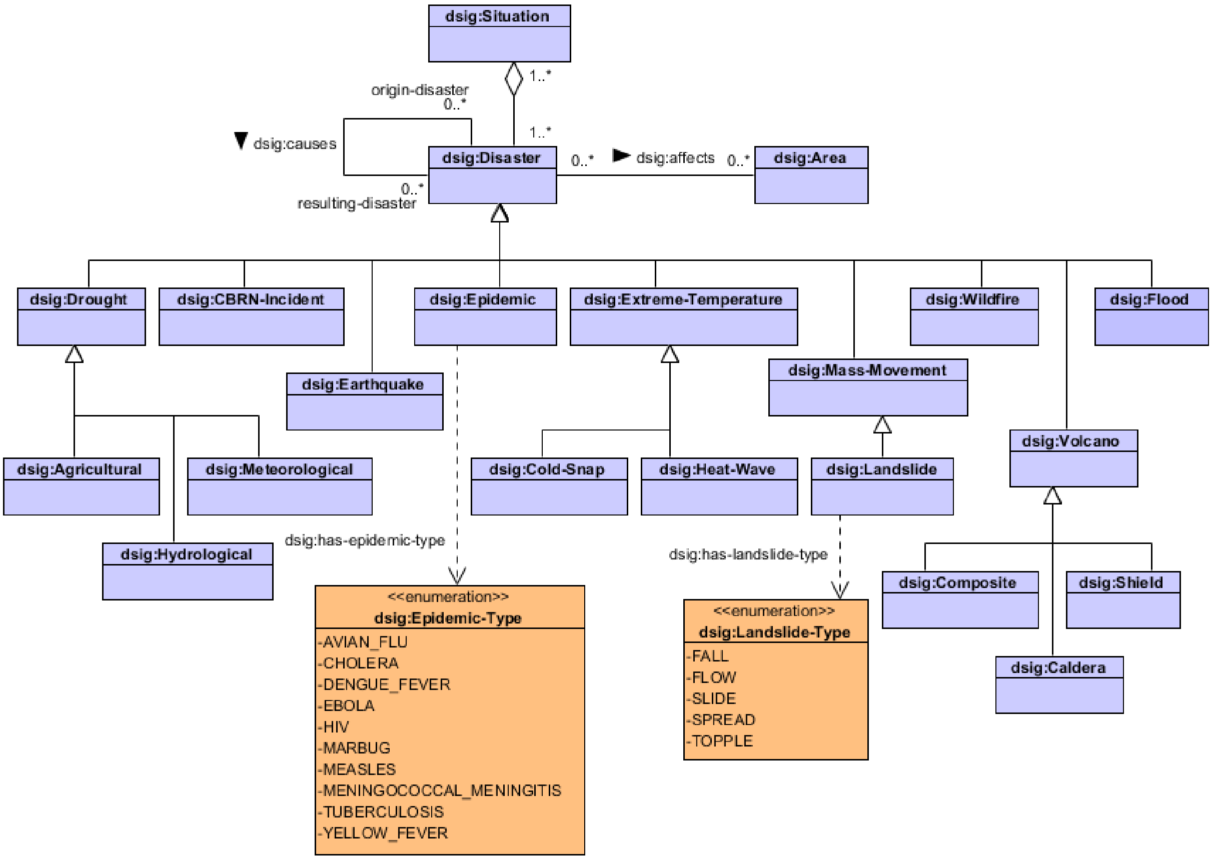

Figure 32 – UML class diagram representing the DSIG Ontology disaster knowledge

5.2 Data sources

A data source represents a valuable source of information from the affected area(s) in a specific situation. We use this class to classify the data sources that are considered in our domain, as shown in Figure 33 (the types of data sources are described in more detail in Section 4).

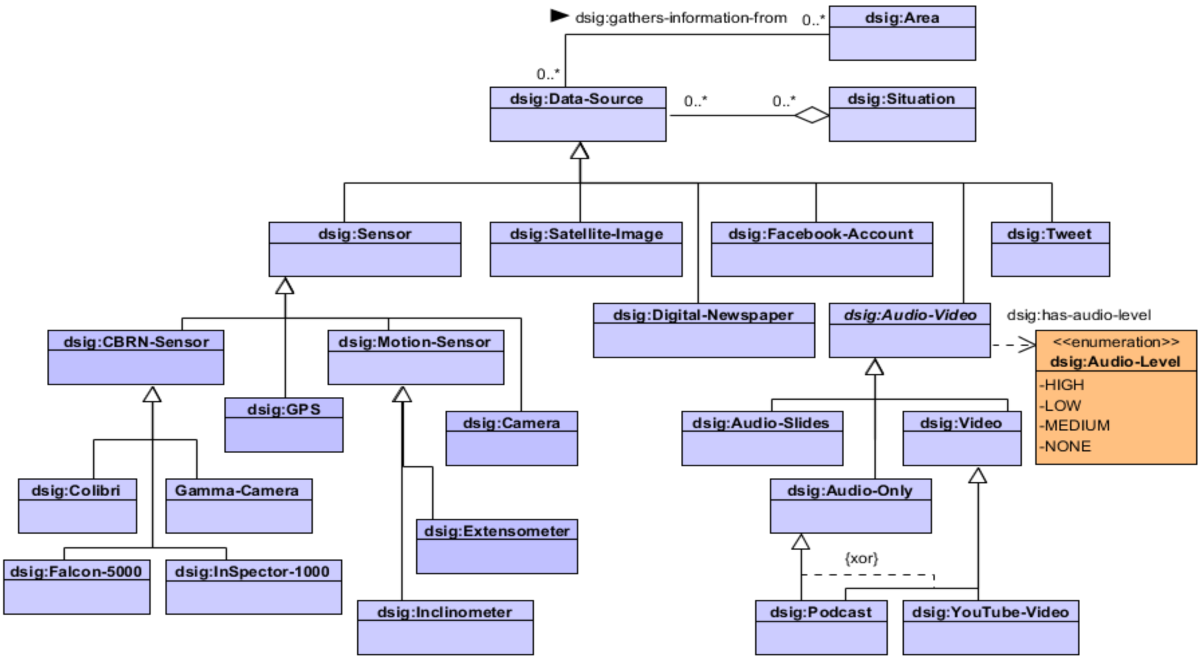

Figure 33 – UML class diagram representing the DSIG Ontology data source knowledge

5.3 *Assets*

An asset represents any item affected due to a disaster in a specific situation. As mentioned earlier, assets are classified into population, facilities and geographic features which have a location and specific geopolitical affiliations (see Figure 34).

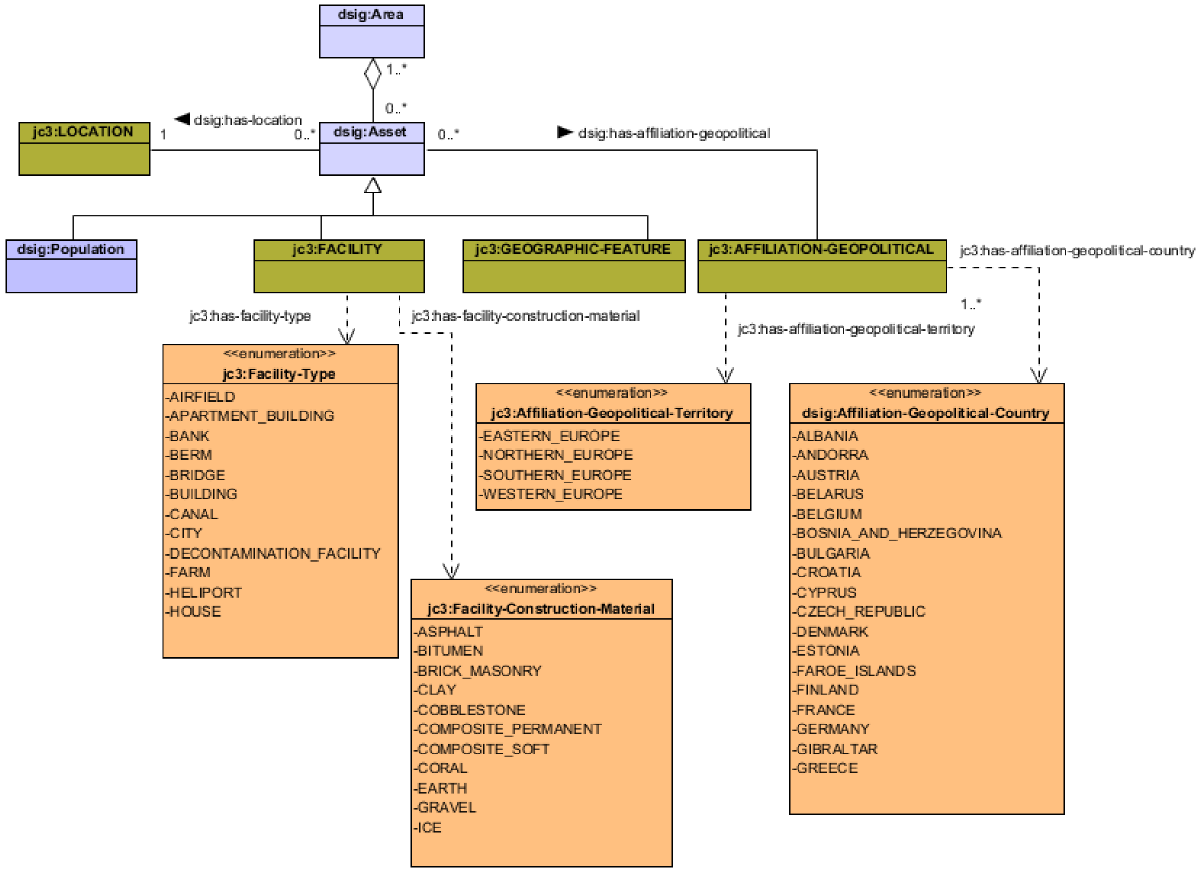

Figure 34 – UML class diagram representing an excerpt of the DSIG Ontology asset knowledge

5.3.1 Population

Population includes all the groups of person or individuals that are located in the area of influence of the disaster and have been affected by the consequences of the disaster. These groups or individuals are categorized according the following subclasses (see Figure 35).

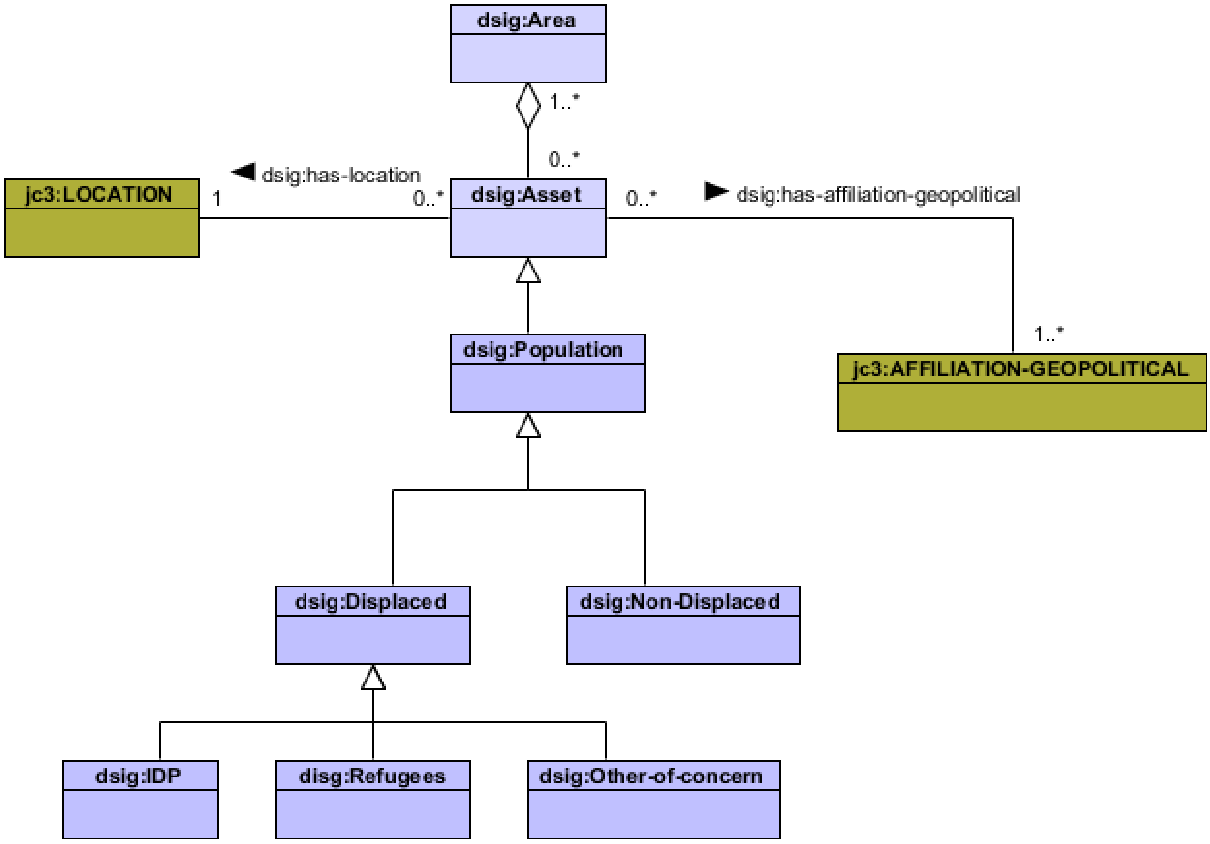

Figure 35 – UML class diagram representing the DSIG Ontology asset knowledge regarding Population

5.3.1.1 Displaced

This category includes all the persons or groups that have been displaced from their original residences.

The following table summarizes the sub-categories that have been defined:

Sub-Category	Description
IDP	Internal Displaced Person (IDP) are defined as persons or groups of persons who have been forced or obliged to flee or to leave their homes or places of habitual residence, in particular as a result of or in order to avoid the effects of armed conflict, situations of generalized violence, violations of human rights or natural or human-made disasters, and who have not crossed an internationally recognized State border ([39]).
Refugees	A refugee is someone who owing to a well-founded fear of being persecuted for reasons of race, religion, nationality, membership of a particular social group or political opinion,

Sub-Category	Description
	is outside the country of his nationality, and is unable to, or owing to such fear, is unwilling to avail himself of the protection of that country. This group also includes the Asylum Seeker defined as someone who says he or she is a refugee, but whose claim has not yet been definitively evaluated ([39]).
Other-of-concern	In this group are included all the persons who have been displaced by the emergency and form part of the humanitarian caseload, but do not fall into either of the above categories([39]).

Table 5 – Displaced population sub-categories

5.3.1.2 Non-Displaced

This category includes all the persons or groups that have not been displaced from their original residences but they have been affected somehow by the disaster.

5.3.2 Facility

The JC3IEDM concept FACILITY is defined as "something that is built, installed or established to serve some particular purpose and is identified by the service it provides rather that by its content." Each instance of FACILITY has a type modelled using the *jc3:has-facility-type* property and a construction material (i.e. the specific value that represents the major material used in building the specific FACILITY) modelled using the *jc3:has-facility-construction-material* property.

5.3.3 Geographical-feature

The JC3IEDM concept GEOGRAPHIC-FEATURE is defined as "a feature describing terrain characteristics to which civilian significance is attached" (see Figure 36). The *jc3:has-geographic-feature-category* and *jc3:has-geographic-feature-subcategory* properties specify the class and the detailed class, respectively, of the GEOGRAPHIC-FEATURE. The *jc3:has-geographic-feature-vegetation-category* and *jc3:has-geographic-feature-vegetation-subcategory* properties specify the general and the detailed vegetation class, respectively, on a specific GEOGRAPHIC-FEATURE. The *jc3:has-geographic-feature-surface-category* property specifies the type of surface of the GEOGRAPHIC-FEATURE. The *jc3:has-geographic-feature-surface-composition* property specifies the composition of the surface of the GEOGRAPHIC-FEATURE. The *jc3:has-geographic-feature-terrain* property specifies a tract of land.

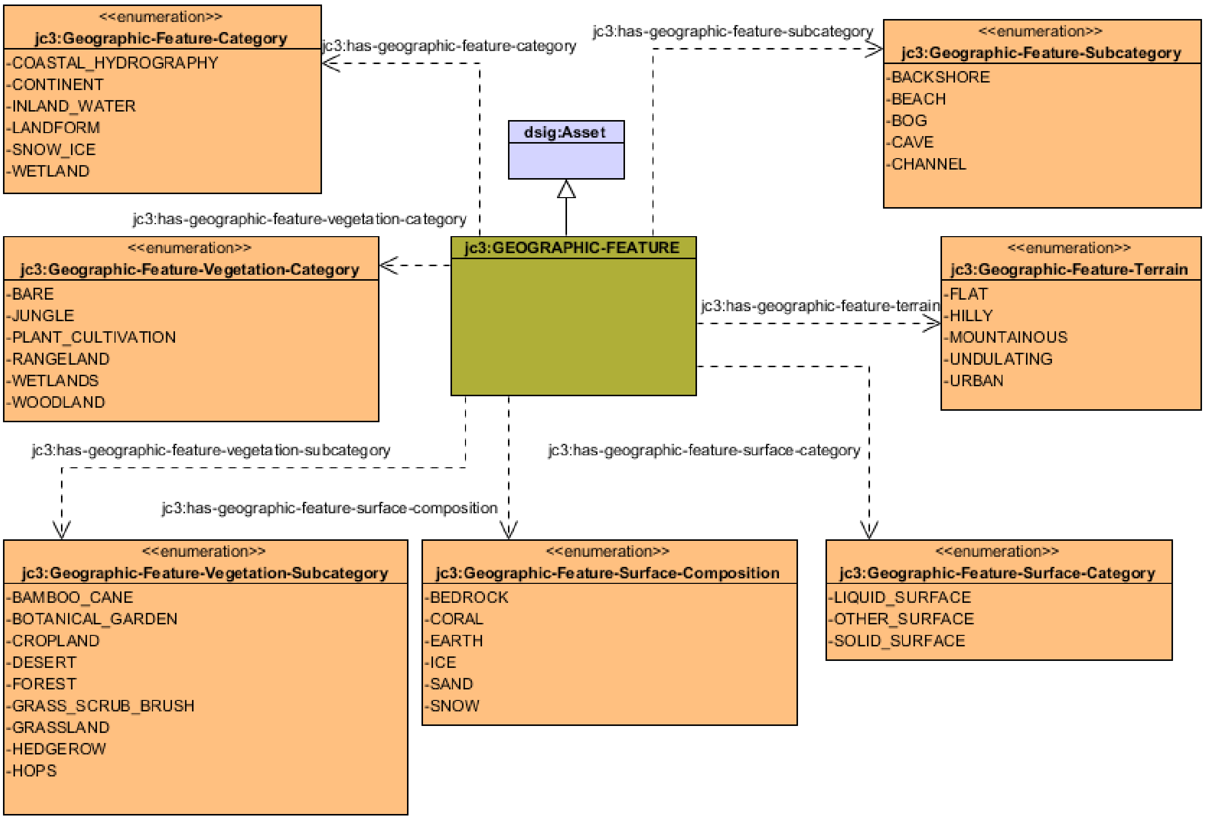

Figure 36 – UML class diagram representing the DSIG Ontology geographic feature knowledge

5.4 Resources

A resource represents any item involved in the relief tasks after a disaster. Resources are classified into organisations and materiel which have a location and specific geopolitical affiliations (see Figure 37).

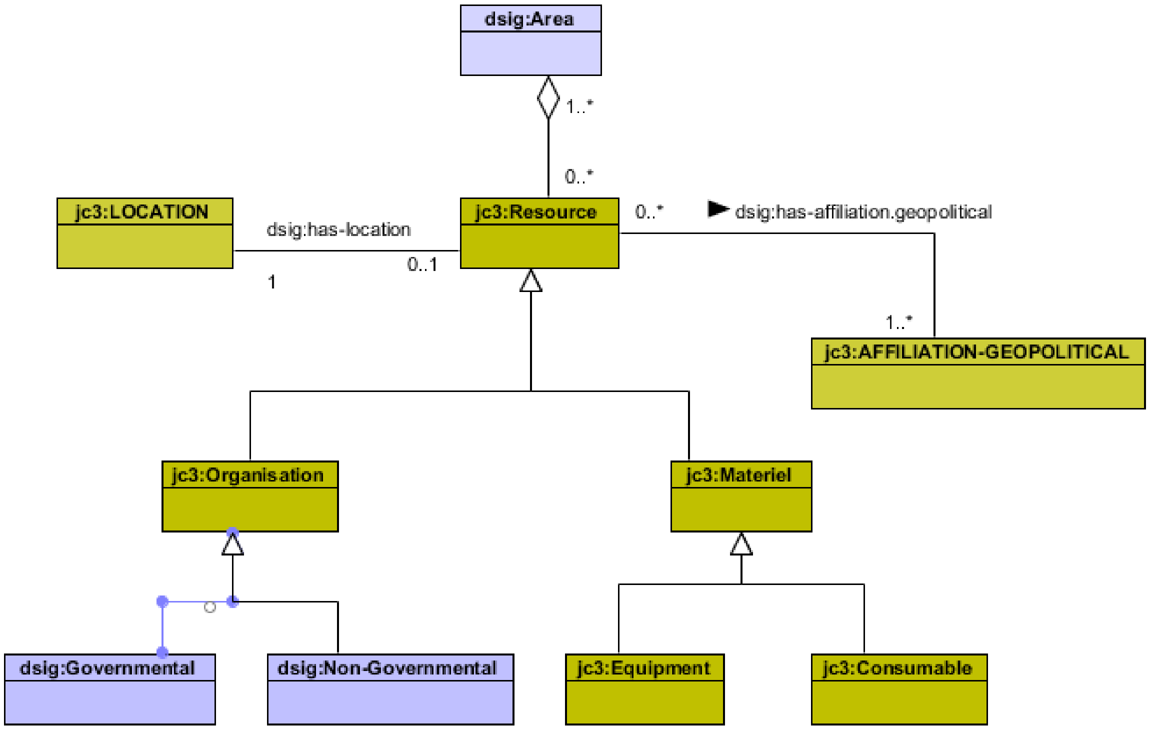

Figure 37 – UML class diagram representing the DSIG Ontology resource knowledge

5.4.1 Organisation

An Organisation can be seen has an active actor that takes part in the relief tasks over one or several areas after a disaster.

The JC3IEDM organisation concept is defined as "An OBJECT-ITEM that is an administrative or functional structure".

Two more specific classes are inherited from the Organisation class, one to represent those organisations depending on governmental institutions (e.g.: Army, Police, Firemen...) and other to represent the NGO's.

5.4.1.1 Governmental

This class includes all the organisations that depend somehow on the government. Typically these organisations include Army, Police, Firemen or Civil Protection.

5.4.1.2 Non-Governmental

This class includes all the organisations that are do not depend on the government. The NGO's organisations shall be managed with this class.

5.4.2 Materiel

The JC3IEDM Materiel concept is defined as "An OBJECT-ITEM that is equipment, apparatus or supplies of interest without distinction as to its application for administrative, civil or combat purposes".

From this class, two more specific classes are derived, one for model Equipment and other for Consumables.

5.4.2.1 Equipment

The JC3IEDM Equipment concept is defined as "A materiel that is not intended for consumption".

Some items that will be modelled with this class are all kind of vehicle, communications and electronic devices.

5.4.2.2 Consumable

The JC3IEDM Consumable concept is defined as "A materiel that is an expendable class of supply".

Within this category the ontology will manage concepts as food, water, all kind of combustibles (gasoline, diesel…), construction supplies (bricks, concrete, beams…)

5.5 Actions

Basically, the post-disaster management are not only related with the management of information regarding who and/or what have been affected (assets) and who and/or what could take part in the relief tasks (resources).

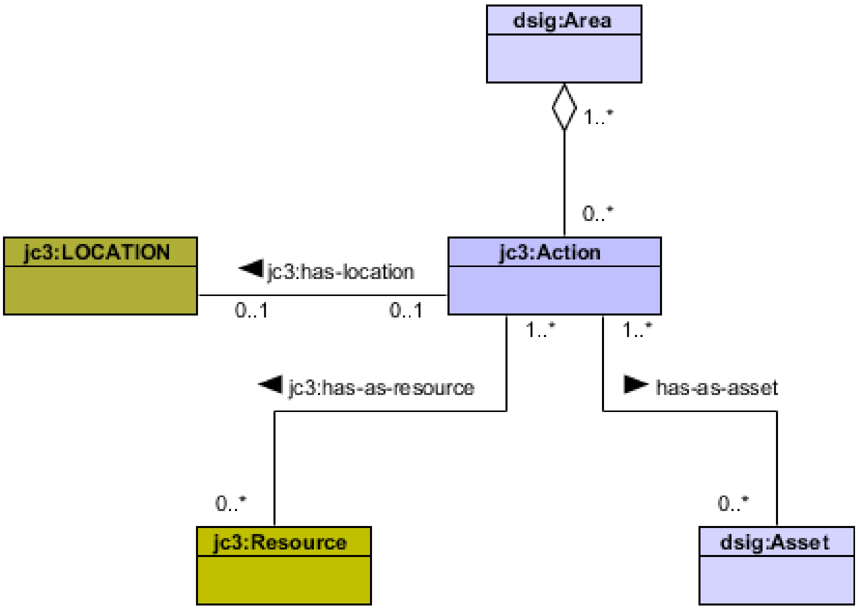

Figure 38 – UML class diagram representing the JC3 Ontology action knowledge

The JC3IEDM Action concept is defined as "an activity, or the occurrence of an activity, that may utilise resources and may be focused against an objective".

In the after-disaster recovery phase, the actors involved in the relief tasks (organisations) should typically use the resources available (materiel) in these tasks.

An action is something that shall be accomplished by one or several organisations using the needed materiel for such a task. All these concepts are managed by the Resource entity.

Typically, an action will be performed over one or several objectives. This concept is managed by the Asset concept.

Some example of actions:

- Debris removal from Hospital
  - Resources:
    - 1 debris clean up team (organisation)
    - 2 diggers
    - 4 trucks
    - 1000 litres of diesel
  - Objectives
    - Hospital
  - Description: Remove all the debris from the Hospital until the affected facility is clear and clean, allowing the start of the rebuild phase
- Hospital rebuild
  - Resources:
    - 2 construction workers teams
    - 4000 kg of concrete
    - 130 brick pallets
  - Objectives
    - Hospital
  - Description: Rebuild the basic hospital structure

5.6 *Meteorology*

As an important part of DESTRIERO system, it shall be possible to manage meteorological information. This type of information can provide the current observed weather conditions or even the forecast for the following hour or days.

Several parameters will be included within this concept:

- Air humidity, pressure and temperature
- Cloud coverage

- Precipitation category and quantity
- Wind speed and direction

This information could be related to one or several areas and also will have a location to clearly specify the place affected by the meteorological conditions.

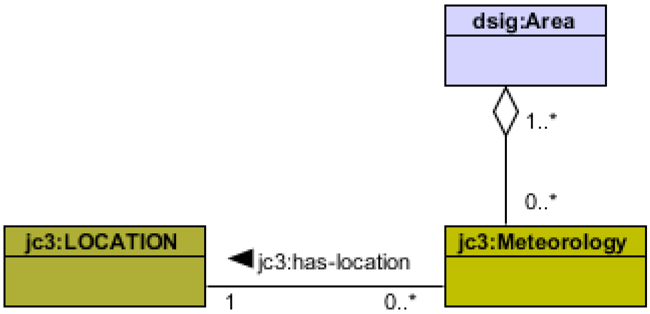

Figure 39 – UML class diagram representing the JC3 Ontology Meteorology knowledge

5.7 Affiliation-geopolitical

The JC3IEDM concept AFFILIATION-GEOPOLITICAL has been adapted to our domain in order to define only European geographic political areas (as used by the United Nations when categorizing geographic regions), and it is defined as "a specification of the European country or political entity to which an area is ascribed." In our context, this class has two properties that specify the European countries (*jc3:has-affiliation-geopolitical-country*) and the European territories in which a specific European country is located (*jc3:has-affiliation-geopolitical-territory*). Besides, each instance of the class Affiliation-Geopolitical-Country that represents a European country in the ontology is defined according two properties: capital city and population (see an example using the Protégé 3.5 ontology editor tool in Figure 40).

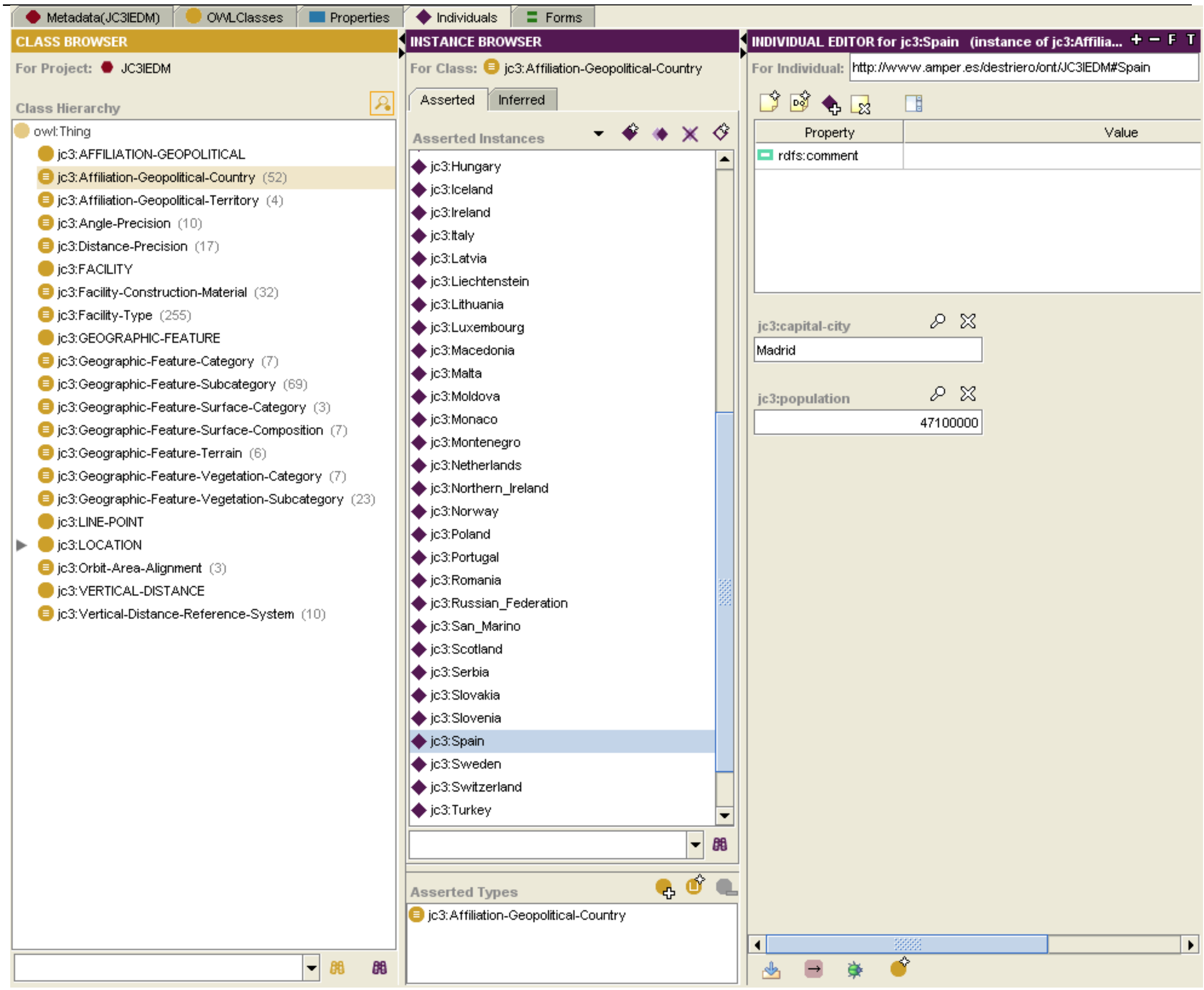

Figure 40 – Definition of European countries using the Protégé 3.5 ontology editor tool

5.8 Locations

Finally, the JC3IEDM concept LOCATION (see Figure 41 – UML class diagram representing the DSIG Ontology location knowledge) is defined as "a specification of position and geometry with respect to a specified horizontal frame of reference and a vertical distance measured from a specified datum. Examples are points, sequence of points, polygonal line, circle, rectangle, ellipse, fan area, polygonal area, sphere, block of space, and cone.

LOCATION specifies both location and dimensionality." We use the *jc3:bounds-on-the-top* and *jc3:bound-on-the-bottom* properties to specify a specific VERTICAL-DISTANCE that defines the altitude or height of the upper and the lower level, respectively, for the GEOMETRIC-VOLUME.

The JC3IEDM concept VERTICAL-DISTANCE is defined as "a specification of the altitude of height of a point or a level as measured with respect to a specified reference datum in the direction normal to the plane that is tangent to the WGS84 ellipsoid of revolution." Each instance of VERTICAL-DISTANCE is defined in terms of a specific reference system modelled

using the *jc3:has-vertical-distance-reference-system* property, and the maximum resolution used for the expression of a linear measure (i.e. the precision of specifying a VERTICAL-DISTANCE) modelled using the *jc3:has-distance-precision* property.

The JC3IEDM concepts POINT, LINE, SURFACE and GEOMETRIC-VOLUME are the subclasses of LOCATION.

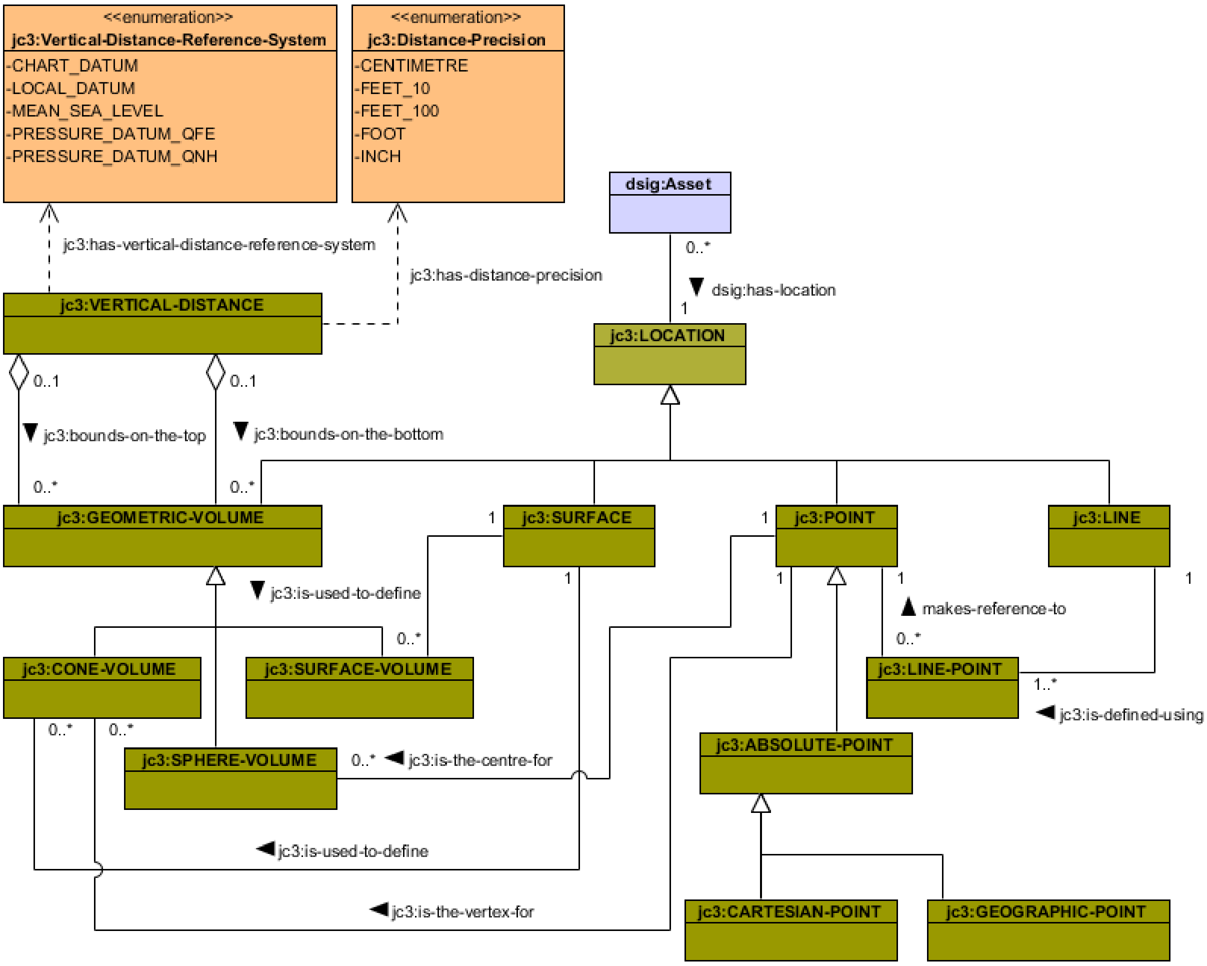

Figure 41 – UML class diagram representing the DSIG Ontology location knowledge

5.8.1 Point

The POINT concept is defined as "a zero dimensional LOCATION." The JC3IEDM concept ABSOLUTE-POINT is the subclass of POINT. The ABSOLUTE POINT concept is defined as "a POINT in a geodetic system." ABSOLUTE-POINT is classified into CARTESIAN-POINT and GEOGRAPHIC-POINT. The CARTESIAN-POINT concept is defined as "an ABSOLUTE-POINT that has its position specified in a three-dimensional Earth-centred Cartesian system." The GEOGRAPHIC-POINT concept is defined as "an ABSOLUTE-POINT that has its position specified with respect to the surface of the World Geodetic System 1984 (WGS 84) ellipsoid." Apart from the definition of different aspects on other types of locations, POINT is used as a LINE-POINT

in specific sequence in defining a particular LINE. LINE-POINT is defined as "a specification of one of an ordered sequence of POINTs used to define the specific LINE."

5.8.2 Line

The LINE concept is defined as "a LOCATION that is defined by two or more POINTs connected by one-dimensional line segments in an ordered sequence." Therefore, a specific LINE is defined in terms of LINE-POINTs (modelled using the *jc3:is-defined-using* property) which are associated with POINTs in specific sequence (modelled using the *jc3:makes-reference-to* property) as shown in Figure 35. As described earlier, LINE is used to define several aspects on some SURFACE subclasses (CORRIDOR-AREA, POLYARC-AREA and POLYGON-AREA).

5.8.3 Surface

The SURFACE concept (see Figure 36) is defined as "a two-dimensional LOCATION." SURFACE is used to define SURFACE-VOLUMEs and CONE-VOLUMEs (modelled using the *jc3:is-used-to-define* property). SURFACE-VOLUME is classified into CORRIDOR-AREA, ELLIPSE, FAN-AREA, ORBIT-AREA, POLYARC-AREA, POLYGON-AREA and TRACK-AREA.

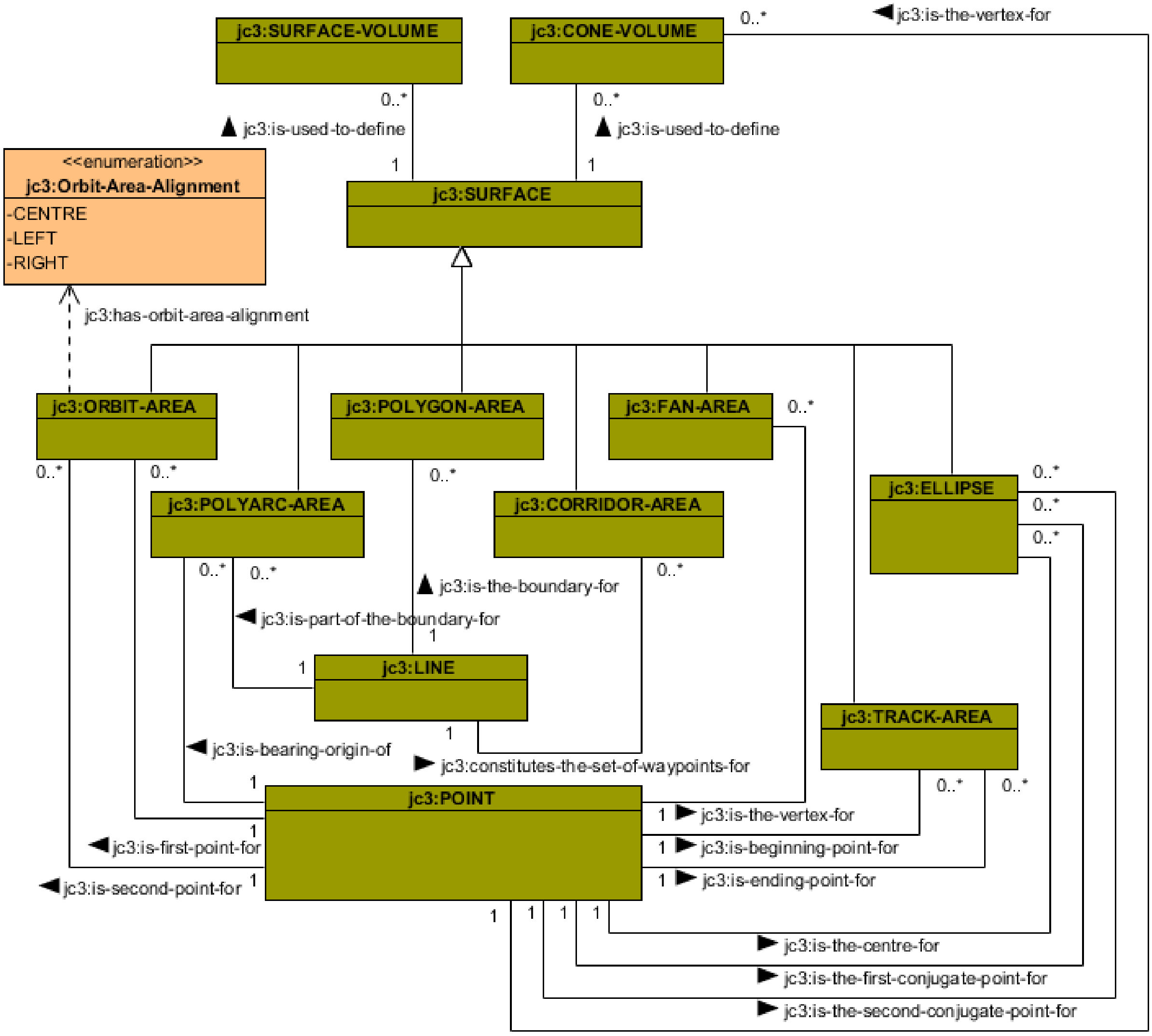

Figure 42 – UML class diagram representing the DSIG Ontology location knowledge – SURFACE

The CORRIDOR-AREA concept is defined as "a SURFACE that is defined by its width and a sequence of POINTs." The sequence of points that constitutes a specific CORRIDOR-AREA is defined using a LINE (modelled using the *jc3:constitutes-the-set-of-waypoints-for* property).

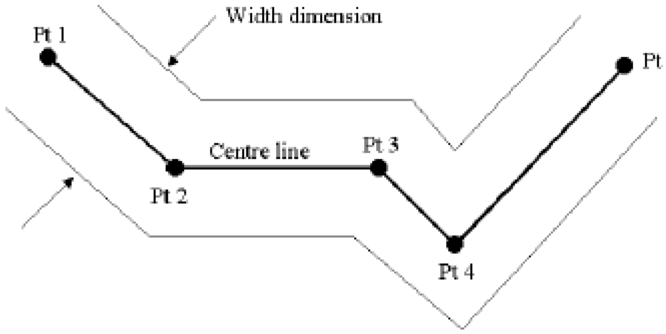

Figure 43 – Corridor-area example

The ELLIPSE concept is defined as "a planar SURFACE in the form of an ellipse." Instances of POINT will define the centre, the first conjugate point and the second conjugate point for a specific ELLIPSE (modelled using the *jc3:is-the-centre-for*, *jc3:is-the-first-conjugate-point-for* and *jc3:is-the-second-conjugate-point-for* properties).

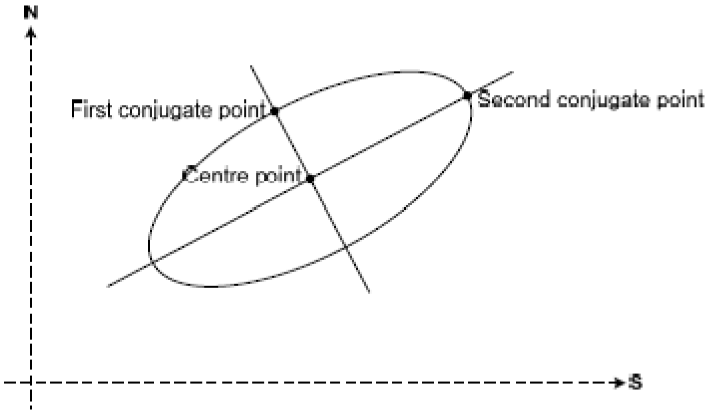

Figure 44 – Ellipse example

The FAN-AREA concept is defined as "a SURFACE that is in the form of a truncated ring sector, lying between and being bounded by the rays emanating from the centre-point of the ring and having specified central angle." The vertex of a specific FAN-AREA is defined using a POINT (modelled using the *jc3:is-the-vertex-for property*).

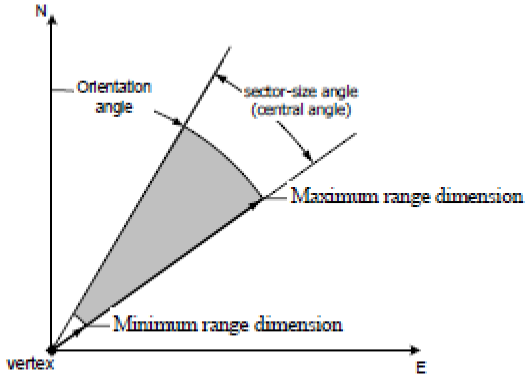

Figure 45 – Fan-area example

The ORBIT-AREA concept is defined as "a SURFACE that is: (i) an open rectangular section defined by its width and the distance between the two specific POINTs; (ii) is closed by two half-circles with radii equal to half the width, and is positioned left, centred, or right with respect to the line formed by the defining points." Each ORBIT-AREA has an alignment (modelled using the *jc3:has-orbit-area-alignment* property), and instances of POINT will specify the two specific points for the ORBIT-AREA (modelled using the *jc3:is-first-point-for* and *jc3:is-second-point-for* properties).

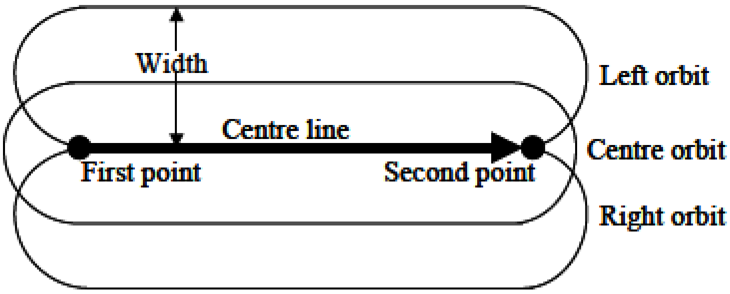

Figure 46 – Orbit-area example

The POLYARC-AREA concept is defined as "a SURFACE that consists of a circular arc and a polygonal segment defined by a specific LINE whose beginning coincides with the initial point of the arc and whose end coincides with the last point of the arc." We use the *jc3:is-part-of-the-boundary-for* property to define the line, and the *jc3:is-bearing-origin-of* property to define the point that represents the initial point of the arc.

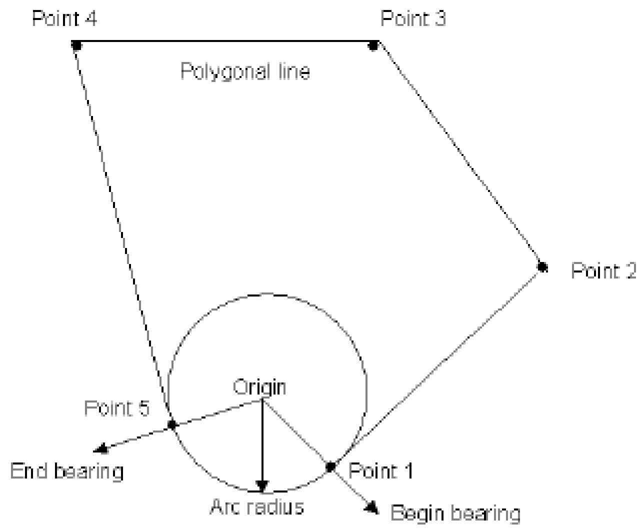

Figure 47 – Polyarc-area example

The POLYGON-AREA concept is defined as "a SURFACE that has its boundaries defined by a specific LINE." We use the *jc3:is-the-boundary-for* property to define the line that represents the boundaries for a specific POLYGON-AREA.

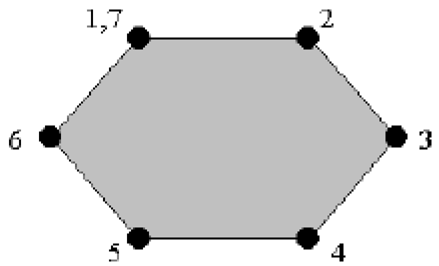

Figure 48 – Polygon-area example

The TRACK-AREA concept is defined as "a SURFACE that is a rectangular section with its length defined by the two specific POINTs and its width by the sum of the widths to the left and right of the connecting line between the two points." We use the properties *jc3:is-beginning-point-for* and *jc3:is-ending-point-for* to define the length for a specific TRACK-AREA.

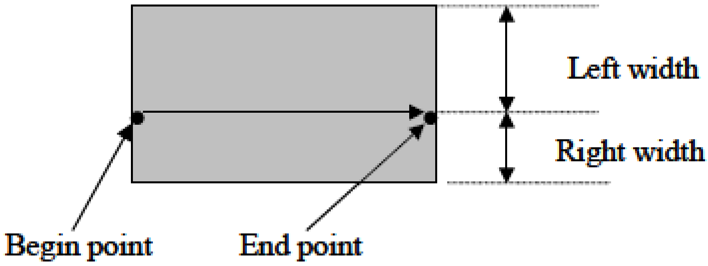

Figure 49 – Track-area example

5.8.4 Volume

The GEOMETRIC-VOLUME concept is defined as "a specific LOCATION that is a three-dimensional bounded space." GEOMETRIC-VOLUME is classified into CONE-VOLUME, SPHERE-VOLUME and SURFACE-VOLUME.

The CONE-VOLUME concept is defined as "A GEOMETRIC-VOLUME whose boundary is swept by a line that has a fixed point and another that moves along the path defined by the border of a specific surface." The vertex of a CONE-VOLUME is defined in terms of a POINT and the cross section is defined by a specific SURFACE.

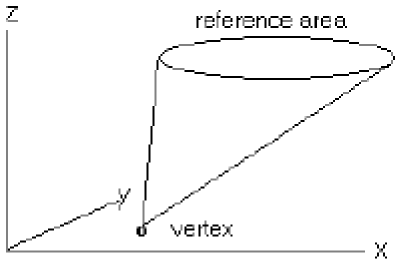

Figure 50 – Cone volume example

The SPHERE-VOLUME concept is defined as "a GEOMETRIC-VOLUME that has its horizontal boundaries defined by the spherical surface determined by the radius and the specified POINT." The centre of a specific SPHERE-VOLUME is defined by a POINT.

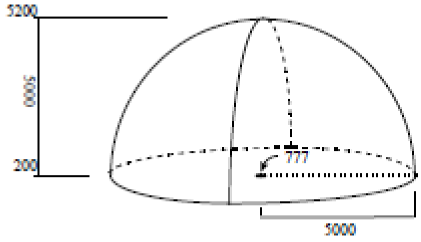

Figure 51 – Sphere volume example

The SURFACE-VOLUME concept is defined as "A GEOMETRIC-VOLUME that has its horizontal boundaries defined by a specific SURFACE."

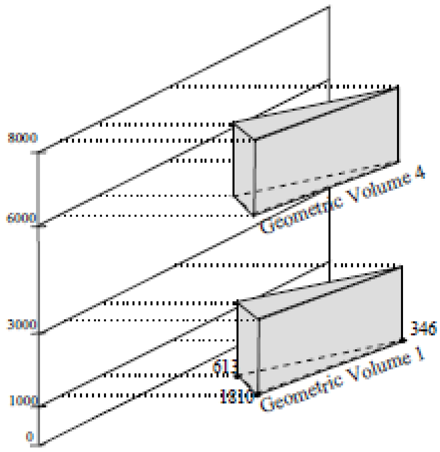

Figure 52 – Surface volume example

6 ONTOLOGY

This section summarizes the DSIG and JC3 Ontologies that we have defined for the damage assessment domain in the recovery and reconstitution of the affected area(s) by a specific disaster situation.

6.1 Classes

Class: ABSOLUTE-POINT
Ontology: JC3IEDM (jc3:)
Description: A POINT in a geodetic system.
Generalization: jc3:POINT
Object Properties: Inherited from jc3:POINT.
Datatype Properties: none.

Class: ACTION
Ontology: JC3IEDM (jc3:)
Description: An activity, or the occurrence of an activity, that may utilise resources and may be focused against an objective
Generalization: owl:Thing
Object Properties: jc3:has-as-resource, dsig:has-as-asset
Datatype Properties: none.

Class: AFFILIATION-GEOPOLITICAL
Ontology: JC3IEDM (jc3:)
Description: Adapted from JC3IEDM: A specification of the European country or political entity to which an area is ascribed.
Generalization: owl:Thing
Object Properties: jc3:has-affiliation-geopolitical-country (single jc3:Affiliation-Geopolitical-Country) and jc3:has-affiliation-geopolitical-territory (single jc3:Affiliation-Geopolitical-Territory).
Datatype Properties: none.

Class: AFFILIATION-GEOPOLITICAL-COUNTRY
Ontology: JC3IEDM (jc3:)
Description: Adapted from JC3IEDM (affiliation-geopolitical-code): Only European geographic-political area (as used by the United Nations when categorizing geographic subregions). This is a special class, because we use the instances of this class as the possible values for the property jc3:has-affiliation-geopolitical-country (see more detail in section 5.3). The predefined instances of this class are the next:
Albania (Tirana, 3200000)
Andorra (Andorra la Vella, 10000)
Austria (Vienna, 8400000)
Belarus (Minsk, 9500000)
Belgium (Brussels, 10800000)

Bosnia_and_Herzegovina (Sarajevo, 3800000)
Bulgaria (Sofia, 750000)
Croatia(Zagreb, 4400000)
Cyprus (Nicosia, 1100000)
Czech_Republic (Prague, 10500000)
Denmark (Copenhagen, 5500000)
Estonia (Tallin, 1300000)
Faroe_Islands-Denmark (Tórshavn, 43000)
Finland (Helsinki, 5400000)
France (Paris, 63000000)
Germany (Berlin, 81600000)
Gibraltar-UK (Gibraltar, 25000)
Greece (Athens, 11300000)
Greenland-Denmark (Nuuk, 56854)
Holy_See (Vatican city, 1000)
Hungary (Budapest, 10000000)
Iceland (Reykjavik, 300000)
Ireland (Dublin, 4500000)
Italy (Rome, 60500000)
Latvia (Riga, 2200000)
Liechtenstein (Vaduz, 40000)
Lithuania (Vilnius, 3300000)
Luxembourg (Luxembourg, 500000)
Macedonia (Skopje, 2100000)
Malta (Valletta, 400000)
Moldova (Chisinau, 4100000)
Monaco (Monaco, 40000)
Montenegro (Podgorica, 600000)
Netherlands (Amsterdam, 16600000)
Northern_Ireland-UK (Belfast, 16900000)
Norway (Oslo, 4900000)
Poland (Warsaw, 38200000)
Portugal (Lisbon, 10700000)
Romania (Bucharest, 21500000)
Russian_Federation (Moscow, 141900000)
San_Marino (San Marino, 30000)
Scotland-UK (Edinburgh, 5200000)
Serbia (Belgrade, 7300000)
Slovakia (Bratislava, 5400000)
Slovenia (Ljubljana, 2100000)
Spain (Madrid, 47100000)
Sweden (Stockholm, 9400000)
Switzerland (Bern, 7800000)
Turkey (Ankara, 73600000)

Ukraine (Kiev, 46000000)
United_Kingdom (London, 62200000)
Wales-UK (Cardiff, 2750000)
Generalization: owl:Thing
Object Properties: none.
Datatype Properties: jc3:capital-city (single string) and jc3:population (single int).

Class: AGRICULTURAL
Ontology: DSIG (dsig:)
Description: Drought occurs when there is insufficient soil moisture to meet the needs of a particular crop at a particular time. A deficit of rainfall over cropped areas during critical periods of the growth cycle can result in destroyed or underdeveloped crops with greatly depleted yields. Agricultural drought is typically evident after meteorological drought but before a hydrological drought.
Generalization: dsig:DROUGHT
Object Properties: Inherited from dsig:Drought.
Datatype Properties: Inherited from dsig:Drought.

Class: AREA
Ontology: DSIG (dsig:)
Description: A geographical region of administrative responsibility which has been affected by a specific situation.
Generalization: owl:Thing
Object Properties: dsig:is-affected-by (multiple dsig:Disaster), dsig:is-composed-of (multiple dsig:Asset) and dsig:is-controlled-by (multiple dsig:Data-Source).
Datatype Properties: dsig:area-description (single string) and dsig:area-name (single string).

Class: ASSET
Ontology: DSIG (dsig:)
Description: Any item of economic value owned by an affected area due to a disaster.
Generalization: owl:Thing
Object Properties: dsig:has-affiliation-geopolitical (multiple jc3:AFFILIATION-GEOPOLITICAL) (minCardinality 1), dsig:has-location (single jc3:LOCATION) (minCardinality 1) and dsig:is-part-of (multiple dsig:Area) (minCardinality 1).
Datatype Properties: dsig:asset-description (single string), dsig:asset-name (single string).

Class: AUDIO-ONLY
Ontology: DSIG (dsig:)
Description: Media file that stores only digital audio data.
Generalization: dsig:AUDIO-VIDEO
Object Properties: Inherited from dsig:Audio-Video.
Datatype Properties: Inherited from dsig:Audio-Video.

Class: AUDIO-SLIDES
Ontology: DSIG (dsig:)
Description: Media files that include an audio recording of a lecture combined with presentation slides.
Generalization: dsig: AUDIO-VIDEO
Object Properties: Inherited from dsig:Audio-Video.
Datatype Properties: Inherited from dsig:Audio-Video.

Class: AUDIO-VIDEO
Ontology: DSIG (dsig:)
Description: Damage assessment requires accurate information and in this context, audio and video (A/V) (television, radio, internet, phone calls...) could be important means of obtaining useful information about the affected area(s). Also, remote monitoring of the affected area(s) could be performed through live A/V feeds by the DESTRIERO end-users. Furthermore, since smart video analysis techniques may detect and alert when something wrong is happening, the DESTRIERO system could use these techniques and manage and consolidate the resulting information in order to bring better security during the planning and reconstruction phase.
Generalization: dsig:DATA-SOURCE
Object Properties: dsig:has-audio-level (single dsig:Audio-Level), dsig:link (single string) and inherited from dsig:Data-Source.
Datatype Properties: dsig:audio-video-category (single string), dsig:audio-video-date (single dateTime), dsig:audio-video-duration (single time), dsig:audio-video-title (single string) and inherited from dsig:Data-Source.

Class: CALDERA
Ontology: DSIG (dsig:)
Description: When it erupts so explosively that little material builds up near the vent. Eruptions partly or entirely empty the underlying magma chamber which leaves the region around the vent unsupported, causing it to sink or collapse under its own weight. The resulting basin-shaped depression is roughly circular and is usually several kilometres or more in diameter. Although caldera volcanoes are rare, they are the most dangerous. Volcanic hazards from this type of eruption include widespread ash fall, large pyroclastic surges and tsunami from caldera collapse.
Generalization: dsig:VOLCANO
Object Properties: Inherited from dsig:Volcano.
Datatype Properties: Inherited from dsig:Volcano.

Class: CAMERA
Ontology: DSIG (dsig:)
Description: Devices that captures images or video.
Generalization: dsig:SENSOR
Object Properties: Inherited from dsig:Sensor.
Datatype Properties: Inherited from dsig:Sensor.

Class: CARTESIAN-POINT
Ontology: JC3IEDM (jc3:)
Description: An ABSOLUTE-POINT that has its position specified in a three-dimensional Earth-centred Cartesian system.
Generalization: jc3:ABSOLUTE-POINT
Object Properties: jc3:has-cartesian-point-x-distance-precision (single jc3:Distance-Precision), jc3:has-cartesian-point-y-distance-precision (single jc3:Distance-Precision), jc3:has-cartesian-point-z-distance-precision (single jc3:Distance-Precision) and inherited from jc3:ABSOLUTE-POINT.
Datatype Properties: jc3:cartesian-point-x-coordinate-dimension (single float), jc3:cartesian-point-y-coordinate-dimension (single float) and jc3:cartesian-point-z-coordinate-dimension (single float).

Class: CBRN-INCIDENT
Ontology: DSIG (dsig:)
Description: An accidental Chemical, Biological, Radiological and Nuclear (CBRN) incident is an event caused by human error or natural or technological reasons, such as spills, accidental releases or leakages.
Generalization: dsig:DISASTER
Object Properties: Inherited from dsig:Disaster.
Datatype Properties: Inherited from dsig:Disaster.

Class: CBRN-SENSOR
Ontology: DSIG (dsig:)
Description: A CBRN sensor is a device that transforms chemical information, ranging from the concentration of a specific sample component to total composition analysis, into an analytically useful signal.
Generalization: dsig:SENSOR
Object Properties: Inherited from dsig:Sensor.
Datatype Properties: Inherited from dsig:Sensor.

Class: COLD-SNAP
Ontology: DSIG (dsig:)
Description: A weather phenomenon that is distinguished by marked cooling of the air, or the invasion of very cold air, over a large area. It can also be prolonged period of excessively cold weather, which may be accompanied by high winds that cause excessive wind chills, leading to weather that seems even colder than it is. Cold snaps can be preceded or accompanied by significant winter weather events, such as blizzards or ice storms. Other names of a cold snap include cold wave and deep freeze.
Generalization: dsig:EXTREME-TEMPERATURE
Object Properties: Inherited from dsig:Extreme-Temperature.
Datatype Properties: Inherited from dsig:Extreme-Temperature.

Class: COLIBRI
Ontology: DSIG (dsig:)
Description: A comprehensive health physics instrument that performs numerous radioprotection daily duties.
Generalization: dsig:CBRN-SENSOR
Object Properties: Inherited from dsig:Sensor.
Datatype Properties: Inherited from dsig:Sensor.

Class: COMPOSITE
Ontology: DSIG (dsig:)
Description: Composite volcano, also known as stratum-volcano, is characterized by an explosive eruption style. When magma is slightly cooler it is thick and sticky, or viscous, which makes it harder for gas bubbles to expand and escape. The resulting pressure causes the magma to foam and explode violently, blasting it into tiny pieces known as volcanic ash. These eruptions create steep sided cones.
Generalization: dsig:VOLCANO
Object Properties: Inherited from dsig:Volcano.
Datatype Properties: Inherited from dsig:Volcano.

Class: CONE-VOLUME
Ontology: JC3IEDM (jc3:)
Description: A GEOMETRIC-VOLUME whose boundary is swept by a line that has a fixed point and another that moves along the path defined by the border of a specific surface.
Generalization: jc3:GEOMETRIC-VOLUME
Object Properties: jc3:has-as-its-vertex (single jc3:POINT) and jc3:is-defined-using-surface (single jc3:SURFACE).
Datatype Properties: none.

Class: CONSUMABLE
Ontology: JC3IEDM (jc3:)
Description: A materiel that is an expendable class of supply.
Generalization: jc3:Materiel
Object Properties: Inherited from jc3: Materiel.
Datatype Properties: Inherited from jc3: Materiel.

Class: CORRIDOR-AREA
Ontology: JC3IEDM (jc3:)
Description: A SURFACE that is defined by its width and a sequence of points.
Generalization: jc3:SURFACE
Object Properties: jc3:is-defined-using-line (single jc3:LINE) and inherited from jc3:SURFACE.
Datatype Properties: jc3:corridor-area-width-dimension (single float).

Class: DATA-SOURCE

Ontology: DSIG (dsig:)
Description: Valuable source of information from the affected area(s) in a specific situation.
Generalization: owl:Thing
Object Properties: dsig:gathers-information-from (multiple dsig:Area) and dsig:provides-information (multiple dsig:Situation).
Datatype Properties: dsig:data-source-description (single string) and dsig:data-source-name (single string).

Class: DIGITAL-NEWSPAPER
Ontology: DSIG (dsig:)
Description: A digital version of a printed newspaper. A newspaper is a weekly or daily publication consisting of folded sheets and containing articles on the news, features, reviews, and advertisements. Newspapers can be digitally published online or as a digital copy on a digital device, such as a mobile phone or an E-Ink reader.
Generalization: dsig: AUDIO-VIDEO
Object Properties: Inherited from dsig:Audio-Video.
Datatype Properties: dsig:digital-newspaper-name (single string), dsig:link (single string) and inherited from dsig:Audio-Video.

Class: DISASTER
Ontology: DSIG (dsig:)
Description: Any occurrence that causes damage, destruction, ecological disruption, loss of human life, human suffering, deterioration of health and health services on a scale sufficient of warrant and extraordinary response from outside the affected community or area.
Generalization: owl:Thing
Object Properties: dsig:affects (multiple dsig:Area), dsig:causes (multiple dsig:Disaster), dsig:in-situation (multiple dsig:Situation) (minCardinality 1) and dsig:is-consequence-of (multiple dsig:Disaster).
Datatype Properties: dsig:disaster-description (single string) and dsig:disaster-name (single string).

Class: DISPLACED
Ontology: DSIG (dsig:)
Description: Persons or groups that have been displaced from their original residences.
Generalization: dsig:Population
Object Properties: Inherited from dsig: Population.
Datatype Properties: Inherited from dsig: Population.

Class: DROUGHT
Ontology: DSIG (dsig:)
Description: An extended period of deficient rainfall relative to the average for a region.
Generalization: dsig:DISASTER
Object Properties: Inherited from dsig:Disaster.
Datatype Properties: Inherited from dsig:Disaster.

Class: EARTHQUAKE
Ontology: DSIG (dsig:)
Description: An earthquake occurs when there is a shaking and vibration at the surface of the Earth caused by underground movement along a fault plane or by volcanic activity.
Generalization: dsig:DISASTER
Object Properties: Inherited from dsig:Disaster.
Datatype Properties: Inherited from dsig:Disaster.

Class: ELLIPSE
Ontology: JC3IEDM (jc3:)
Description: A planar SURFACE in the form of an ellipse.
Generalization: jc3:SURFACE
Object Properties: jc3:has-as-its-centre (single jc3:POINT), jc3:has-as-its-first-conjugate-point (single jc3:POINT), jc3:has-as-its-second-conjugate-point (single jc3:POINT) and inherited from jc3:SURFACE.
Datatype Properties: none.

Class: EPIDEMIC
Ontology: DSIG (dsig:)
Description: The occurrence of an illness or health-related event that is unusually large or unexpected. Epidemics are commonly caused by a disease of infectious or parasitic origin.
Generalization: dsig:DISASTER
Object Properties: dsig:has-epidemic-type (single dsig:Epidemic-Type) and inherited from dsig:Disaster.
Datatype Properties: Inherited from dsig:Disaster.

Class: EQUIPMENT
Ontology: JC3IEDM (jc3:)
Description: A materiel that is not intended for consumption.
Generalization: jc3:Materiel
Object Properties: Inherited from jc3: Materiel.
Datatype Properties: Inherited from jc3: Materiel.

Class: EXTENSOMETER
Ontology: DSIG (dsig:)
Description: A sensor used to measure changes in the length of an object.
Generalization: dsig:Motion-SENSOR
Object Properties: Inherited from dsig:Sensor
Datatype Properties: Inherited from dsig:Sensor

Class: EXTREME-TEMPERATURE
Ontology: DSIG (dsig:)
Description: Changes in temperature extremes tend to follow mean temperature changes in many parts of the world. Although they happen more slowly and are more difficult to see than a tornado or an earthquake, "heat waves" and "cold snaps" are deadly natural hazards. Extreme heat and cold occur somewhere in the world every year and can afflict nearly every location on Earth.
Generalization: dsig:DISASTER
Object Properties: Inherited from dsig:Disaster.
Datatype Properties: Inherited from dsig:Disaster.

Class: FACEBOOK-ACCOUNT
Ontology: DSIG (dsig:)
Description: A Facebook user. Facebook is a social utility that connects people with friends and others who work, study and live around them.
Generalization: dsig: AUDIO-VIDEO
Object Properties: Inherited from dsig:Audio-Video.
Datatype Properties: dsig:facebook-account-name (single string) and inherited from dsig:Audio-Video.

Class: FACILITY
Ontology: JC3IEDM (jc3:)
Description: Adapted from JC3IEDM: Something that is built, installed or established to serve some particular purpose and is identified by the service it provides rather that by its content.
Generalization: owl:Thing
Object Properties: jc3:has-facility-construction-material (single jc3:Facility-Construction-Material) and jc3:has-facility-type (single jc3:Facility-Type).
Datatype Properties: jc3:facility-height-dimension (single float), jc3:facility-length-dimension (single float) and jc3:facility-width-dimension (single float).

Class: FALCON-5000
Ontology: DSIG (dsig:)
Description: A state-of-the-art portable Radionuclide Identifier (RID) based on a High Purity Germanium (HPGe) detector. It quickly and accurately answers: "Is there a radiation source present?", "Where is it?", and importantly "What isotopes are emitting the radiation?" The Falcon 5000 accomplishes these goals by combining the best resolution HPGe detector technology with ultra-low microphonic electrical cooling.
Generalization: dsig:CBRN-Sensor
Object Properties: Inherited from dsig:Sensor.
Datatype Properties: Inherited from dsig:Sensor.

Class: FAN-AREA
Ontology: JC3IEDM (jc3:)
Description: A SURFACE that is in the form of a truncated ring sector, lying between and being bounded by the rays emanating from the centre-point of the ring and having specified central angle.
Generalization: jc3:SURFACE
Object Properties: jc3:has-as-its-vertex (single jc3:POINT) and inherited from jc3:SURFACE.
Datatype Properties: jc3:fan-area-maximum-range-dimension (single float), jc3:fan-area-minimum-range-dimension (single float), jc3:fan-area-orientation-angle (single float) and jc3:fan-area-sector-size-angle (single jc3:POINT).

Class: FLOOD
Ontology: DSIG (dsig:)
Description: The general and temporary condition of partial or complete inundation of normally dry land areas from overflow of inland or tidal waters from the unusual and rapid accumulation or runoff of surface waters from any source.
Generalization: dsig:DISASTER
Object Properties: Inherited from dsig:Disaster.
Datatype Properties: Inherited from dsig:Disaster.

Class: GAMMA-CAMERA
Ontology: DSIG (dsig:)
Description: The gamma camera is a real-time portable gamma-ray imaging system that creates images of two different wavelengths of photons (visible and gamma) and superimposes them. This allows the user to locate gamma radiation arriving at the sensor.
Generalization: dsig:CBRN-SENSOR
Object Properties: Inherited from dsig:Sensor.
Datatype Properties: Inherited from dsig:Sensor.

Class: GEOGRAPHIC-FEATURE
Ontology: JC3IEDM (jc3:)
Description: A feature describing terrain characteristics to which civilian significance is attached.
Generalization: owl:Thing
Object Properties: jc3:has-geographic-feature-category (single jc3:Geographic-Feature-Category), jc3:has-geographic-feature-subcategory (single jc3:Geographic-Feature-Subcategory), jc3:has-geographic-feature-surface-category (single jc3:Geographic-Feature-Surface-Category), jc3: has-geographic-feature-surface-composition (single jc3:Geographic-Feature-Surface-Composition), jc3:has-geographic-feature-terrain (single jc3:Geographic-Feature-Terrain), jc3:has-geographic-feature-vegetation-category (single jc3:Geographic-Feature-Vegetation-Category) and jc3:has-geographic-feature-vegetation-subcategory (single jc3:Geographic-Feature-Vegetation-Subcategory).
Datatype Properties: none.

Class: GEOGRAPHIC-POINT
Ontology: JC3IEDM (jc3:)
Description: An ABSOLUTE-POINT that has its position specified with respect to the surface of the World Geodetic System 1984 (WGS 84) ellipsoid.
Generalization: jc3:ABSOLUTE-POINT
Object Properties: jc3:has-latitude-precision (single jc3:Angle-Precision), jc3:has-longitude-precision (single jc3:Angle-Precision) and inherited from jc3:ABSOLUTE-POINT.
Datatype Properties: jc3:geographic-point-latitude-coordinate (single float) and jc3:geographic-point-longitude-coordinate (single float).

Class: GEOMETRIC-VOLUME
Ontology: JC3IEDM (jc3:)
Description: A specific LOCATION that is a three-dimensional bounded space.
Generalization: jc3:LOCATION
Object Properties: none.
Datatype Properties: none.

Class: GOVERNMENTAL
Ontology: JC3IEDM (jc3:)
Description: An organisation depending on a governmental institution.
Generalization: jc3:Organisation
Object Properties: Inherited from jc3:Organisation.
Datatype Properties: Inherited from jc3:Organisation.

Class: GPS
Ontology: DSIG (dsig:)
Description: No description provided.
Generalization: dsig:SENSOR
Object Properties: Inherited from dsig:Sensor.
Datatype Properties: Inherited from dsig:Sensor.

Class: HEAT-WAVE
Ontology: DSIG (dsig:)
Description: Periods of unusually high temperatures, usually lasting three days to three weeks. Typically, heat waves are characterized by temperatures of 35°C (95°F) or higher, although lower temperatures accompanied by high humidity levels can also be considered a heat wave. Excessively dry and hot conditions can provoke dust storms and low visibility. Droughts occur when a long period passes without substantial rainfall. A heat wave combined with a drought is a very dangerous situation. Cold snaps are commonly three days to three weeks in duration, with temperatures usually falling below -15°C (5°F).
Generalization: dsig:EXTREME-TEMPERATURE
Object Properties: Inherited from dsig:Extreme-Temperature.
Datatype Properties: Inherited from dsig:Extreme-Temperature.

Class: HYDROLOGICAL
Ontology: DSIG (dsig:)
Description: Drought refers to deficiencies in surface and subsurface water supplies. It is measured as stream flow, and as lake, reservoir, and ground water levels.
Generalization: dsig:DROUGHT
Object Properties: Inherited from dsig:Drought.
Datatype Properties: Inherited from dsig:Drought.

Class: IDP
Ontology: DSIG (dsig:)
Description: Persons or groups of persons who have been forced or obliged to flee or to leave their homes or places of habitual residence, in particular as a result of or in order to avoid the effects of armed conflict, situations of generalized violence, violations of human rights or natural or human-made disasters, and who have not crossed an internationally recognized State border.
Generalization: dsig:Displaced
Object Properties: Inherited from dsig: Displaced.
Datatype Properties: Inherited from dsig: Displaced.

Class: INCLINOMETER
Ontology: DSIG (dsig:)
Description: A motion sensor used to monitor subsurface movements and deformations. This kind of sensor can detect zones of movement and establish whether movements are constant, accelerating, or responding to remedial measures. Besides, inclinometers can be used for the verification of the stability of dams, dam abutments, and upstream slopes during and after impoundment.
Generalization: dsig:Motion-Sensor
Object Properties: Inherited from dsig:Sensor.
Datatype Properties: Inherited from dsig:Sensor.

Class: INSPECTOR-1000
Ontology: DSIG (dsig:)
Description: A high-performance, hand-held sodium iodide (NaI) spectrometer for use primarily in first responder, customs, homeland security, and health-physics applications.
Generalization: dsig:CBRN-Sensor
Object Properties: Inherited from dsig:Sensor.
Datatype Properties: Inherited from dsig:Sensor.

Class: LANDSLIDE
Ontology: DSIG (dsig:)
Description: The movement of rock, debris or earth down a slope. They result from the failure of the materials which make up the hill slope and are driven by the force of gravity. Landslides are known also as landslips, slumps or slope failure. Landslides can be triggered by natural causes or by human activity. They range from a single boulder in a rock fall or topple to tens of millions of cubic meters of material in a debris flow.
Generalization: dsig:MASS-MOVEMENT
Object Properties: dsig:has-landslide-type and inherited from dsig:Mass-Movement.
Datatype Properties: Inherited from dsig:Mass-Movement.

Class: LINE
Ontology: JC3IEDM (jc3:)
Description: A LOCATION that is defined by two or more POINTs connected by one-dimensional line segments in an ordered sequence.
Generalization: jc3:LOCATION
Object Properties: jc3:constitutes-the-set-of-waypoints-for (multiple jc3:CORRIDOR-AREA), jc3:is-defined-using-line-point (multiple jc3:LINE-POINT) (minCardinality 1), jc3:is-part-of-the-boundary-for (multiple jc3:POLYARC-AREA) and jc3:is-the-boundary-for (multiple jc3:POLYGON-AREA).
Datatype Properties: none.

Class: LINE-POINT
Ontology: JC3IEDM (jc3:)
Description: A specification of one of an ordered sequence of POINTs used to define the specific LINE.
Generalization: owl:Thing
Object Properties: jc3:is-used-in-the-definition (single jc3:LINE) and jc3:makes-reference-to (single jc3:POINT).
Datatype Properties: jc3:line-point-sequence-ordinal (single int).

Class: LOCATION
Ontology: JC3IEDM (jc3:)
Description: A specification of position and geometry with respect to a specified horizontal frame of reference and a vertical distance measured from a specified datum. Examples are points, sequence of points, polygonal line, circle, rectangle, ellipse, fan area, polygonal area, sphere, block of space, and cone. LOCATION specifies both location and dimensionality.
Generalization: owl:Thing
Object Properties: none.
Datatype Properties: none.

Class: MASS-MOVEMENT
Ontology: DSIG (dsig:)
Description: Massive failures of slope masses including rock, debris, soils and snow/ice.
Generalization: dsig:DISASTER
Object Properties: Inherited from dsig:Disaster.
Datatype Properties: Inherited from dsig:Disaster.

Class: MATERIEL
Ontology: JC3IEDM (jc3:)
Description: An object that is equipment, apparatus or supplies of interest without distinction as to its application for administrative, civil or combat purposes.
Generalization: jc3:Resource
Object Properties: Inherited from jc3:Resource.
Datatype Properties: Inherited from jc3:Resource.

Class: METEOROLOGICAL
Ontology: DSIG (dsig:)
Description: Drought is usually based on long-term precipitation departures from normal, but there is no consensus regarding the threshold of the deficit or the minimum duration of the lack of precipitation that make a dry spell an official drought.
Generalization: dsig:DROUGHT
Object Properties: Inherited from dsig:Drought.
Datatype Properties: Inherited from dsig:Drought.

Class: METEOROLOGY
Ontology: JC3IEDM (jc3:)
Description: The set of weather conditions that are applicable or are supposed they will be applied to a place.
Generalization: owl:thing
Object Properties: jc3:has-cloud-coverage (single Cloud-Coverage-Code), jc3:has-forecast-code (single Forecast-Code) and jc3-has-precipitation-code (single Precipitation-Code).
Datatype Properties: jc3:air-humidiy (single int), jc3:air-pressure (single float), jc3:air-temperature (single float), jc3:datetime (single datetime), jc3:precipitation-rate (single float), jc3:wind-direction (single int) and jc3:wind-speed (single int)

Class: MOTION-SENSOR
Ontology: DGIS (dgis:)
Description: Device capable of detecting motion in free space.
Generalization: dgis:Sensor
Object Properties: Inherited from dgis:Sensor.
Datatype Properties: Inherited from dgis:Sensor.

Class: NON-DISPLACED
Ontology: DSIG (dsig:)
Description: Persons or groups that have not been displaced from their original residences but they have been affected somehow by the disaster.
Generalization: dsig:Population
Object Properties: Inherited from dsig:Population.
Datatype Properties: Inherited from dsig:Population.

Class: NON-GOVERNMENTAL
Ontology: JC3IEDM (jc3:)
Description: An organisation non depending on a governmental institution.
Generalization: jc3:Organisation
Object Properties: Inherited from jc3:Organisation.
Datatype Properties: Inherited from jc3:Organisation.

Class: ORBIT-AREA
Ontology: JC3IEDM (jc3:)
Description: A SURFACE that is: (i) an open rectangular section defined by its width and the distance between the two specific POINTs; (ii) is closed by two half-circles with radii equal to half the width, and is positioned left, centred, or right with respect to the line formed by the defining points.
Generalization: jc3:SURFACE
Object Properties: jc3:has-initial-point (single jc3:POINT), jc3:has-orbit-area-alignment (single jc3:Orbit-Area-Alignment), jc3:has-second-point (single jc3:POINT) and inherited from jc3:SURFACE.
Datatype Properties: jc3:orbit-area-width-dimension (single float).

Class: ORGANISATION
Ontology: JC3IEDM (jc3:)
Description: An object that is an administrative or functional structure.
Generalization: jc3:Resource
Object Properties: Inherited from jc3:Resource.
Datatype Properties: Inherited from jc3:Resource.

Class: OTHER-OF-CONCERN
Ontology: DSIG (dsig:)
Description: Persons who have been displaced by the emergency and form part of the humanitarian caseload, but do not fall into either of the above categories (IDP or Refugees).
Generalization: dsgi:Displaced
Object Properties: Inherited from jc3: Displaced.
Datatype Properties: Inherited from jc3: Displaced.

Class: PODCAST
Ontology: DSIG (dsig:)
Description: A digital audio or video file or recording, usually part of a themed series, which can be downloaded from a website to a media player or computer.
Generalization: dsig:AUDIO-ONLY and dsig:VIDEO. It is important to remark that the dsig:Podcast class can inherit from only a single class, the dsig:Audio-Only class or the dsig:Video class, but not from the two classes at the same time.
Object Properties: Inherited from dsig:Audio-Only and dsig:Video.
Datatype Properties: Inherited from dsig:Audio-Only and dsig:Video.

Class: POINT
Ontology: JC3IEDM (jc3:)
Description: A zero dimensional LOCATION.
Generalization: jc3:LOCATION
Object Properties: **jc3:** is-bearing-origin-of (multiple jc3:POLYARC-AREA), jc3:is-beginning-point-for (multiple jc3:TRACK-AREA), jc3:is-ending-point-for (multiple jc3:TRACK-AREA), jc3:is-first-point-for (multiple jc3:ORBIT-AREA), jc3:is-the-centre-for (multiple jc3:SPHERE-VOLUME or jc3:ELLIPSE), jc3:is-the-first-conjugate-point-for (multiple jc3:ELLIPSE), jc3:is-the-second-conjugate-point-for (multiple jc3:ELLIPSE), jc3:is-the-vertex-for (multiple jc3:CONE-VOLUME or jc3:FAN-AREA) and jc3:is-used-as (multiple jc3:LINE-POINT).
Datatype Properties: none.

Class: POLYARC-AREA
Ontology: JC3IEDM (jc3:)
Description: A SURFACE that consists of a circular arc and a polygonal segment defined by a specific LINE whose beginning coincides with the initial point of the arc and whose end coincides with the last point of the arc.
Generalization: jc3:SURFACE
Object Properties: jc3:has-as-its-bearing-origin (single jc3:POINT), jc3:has-defined-as-part-of-the-boundary (single jc3:LINE) and inherited from jc3:SURFACE.
Datatype Properties: jc3:polyarc-area-arc-radius-dimension (single float), jc3:polyarc-area-end-bearing-angle (single float) and jc3:polyarc-area-end-bearing-angle (single float).

Class: POLYGON-AREA
Ontology: JC3IEDM (jc3:)
Description: A SURFACE that has its boundaries defined by a specific LINE.
Generalization: jc3:SURFACE
Object Properties: jc3:is-bounded-by (single jc3:LINE) and inherited from jc3:SURFACE.
Datatype Properties: none.

Class: POPULATION
Ontology: DSIG (dsig:)
Description: Group of persons or individuals affected by a disaster.
Generalization: dsig:Asset
Object Properties: inherited from dsig:Asset.
Datatype Properties: inherited from dsig:Asset.

Class: REFUGEES
Ontology: DSIG (dsig:)
Description: Someone who owing to a well-founded fear of being persecuted for reasons of race, religion, nationality, membership of a particular social group or political opinion, is outside the country of his nationality, and is unable to, or owing to such fear, is unwilling to avail himself of the protection of that country.
Generalization: dsig: Population
Object Properties: inherited from dsig: Population.
Datatype Properties: inherited from dsig: Population.

Class: RESOURCE
Ontology: JC3IEDM (jc3:)
Description: An object used or involved in the relief tasks of an affected area.
Generalization:
Object Properties: jc3:has-location
Datatype Properties: none.

Class: RURAL-AREA
Ontology: DSIG (dsig:)
Description: A geographic area that is located outside cities and towns (i.e. urban areas).
Generalization: dsig:Area
Object Properties: Inherited from dsig:Area.
Datatype Properties: Inherited from dsig:Area.

Class: SATELLITE-IMAGE
Ontology: DSIG (dsig:)
Description: An image provided by an artificial satellite from space.
Generalization: dsig: AUDIO-VIDEO
Object Properties: Inherited from dsig:Audio-Video.
Datatype Properties: Inherited from dsig:Audio-Video.

Class: SENSOR
Ontology: DSIG (dsig:)
Description: A device for the measurement of physical quantities that responds to a physical, chemical, biological, or electrical stimulus and generates an electrical output signal which is a function of the input stimulus.
Generalization: dsig:DATA-SOURCE
Object Properties: none
Datatype Properties: none.

Class: SHIELD
Ontology: DSIG (dsig:)
Description: When magma is very hot and runny, gases can escape and eruptions are gentle with considerable amounts of magma reaching the surface to form lava flows. Shield

volcanoes have a broad, flattened dome-like shape created by layers of runny lava flowing over its surface and cooling. Because the lava flows easily, it can move down gradual slopes over great distances from the volcanic vents.
Generalization: dsig:VOLCANO
Object Properties: Inherited from dsig:Volcano.
Datatype Properties: Inherited from dsig:Volcano.

Class: SITUATION
Ontology: DSIG (dsig:)
Description: Combination of circumstances at a certain moment consisting of one or more disasters having certain properties or bearing certain relations to each other.
Generalization: owl:Thing
Object Properties: dsig:has-data-sources (multiple dsig:Data-Source) and dsig:includes-disaster (multiple dsig:Disaster).
Datatype Properties: dsig:situation-description (single string) and dsig:situation-name (single string).

Class: SPHERE-VOLUME
Ontology: JC3IEDM (jc3:)
Description: A GEOMETRIC-VOLUME that has its horizontal boundaries defined by the spherical surface determined by the radius and the specified POINT.
Generalization: jc3:GEOMETRIC-VOLUME
Object Properties: jc3:has-as-its-centre (single jc3:POINT).
Datatype Properties: jc3:sphere-volume-radius-dimension (single float).

Class: SURFACE
Ontology: JC3IEDM (jc3:)
Description: A two-dimensional LOCATION.
Generalization: jc3:LOCATION
Object Properties: jc3:surface-is-used-to-define (multiple jc3:SURFACE-VOLUME or jc3:CONE-VOLUME).
Datatype Properties: none.

Class: SURFACE-VOLUME
Ontology: JC3IEDM (jc3:)
Description: A GEOMETRIC-VOLUME that has its horizontal boundaries defined by a specific SURFACE.
Generalization: jc3:GEOMETRIC-VOLUME
Object Properties: jc3:is-defined-using-surface (single jc3:SURFACE).
Datatype Properties: none.

Class: TRACK-AREA

Ontology: JC3IEDM (jc3:)
Description: A SURFACE that is a rectangular section with its length defined by the two specific POINTs and its width by the sum of the widths to the left and right of the connecting line between the two points.
Generalization: jc3:SURFACE
Object Properties: jc3:beginning-is-defined-using-point (single jc3:POINT), jc3:ending-is-defined-using-point (single jc3:POINT) and inherited from jc3:SURFACE.
Datatype Properties: jc3:track-area-left-width-dimension (single float) and jc3:track-area-right-width-dimension (single float).

Class: TWEET
Ontology: DSIG (dsig:)
Description: An online posting, or 'micro-blog' created by a Twitter user.
Generalization: dsig: AUDIO-VIDEO
Object Properties: Inherited from dsig:Audio-Video.
Datatype Properties: dsig:twitter-user (single string) and inherited from dsig:Audio-Video.

Class: URBAN-AREA
Ontology: DSIG (dsig:)
Description: A developed area, constituting, forming, or including a city, town, or borough, or part of such.
Generalization: dsig: AUDIO-VIDEO
Object Properties: Inherited from dsig:Area.
Datatype Properties: inherited from dsig:Area.

Class: VERTICAL-DISTANCE
Ontology: JC3IEDM (jc3:)
Description: A specification of the altitude of height of a point or a level as measured with respect to a specified reference datum in the direction normal to the plane that is tangent to the WGS84 ellipsoid of revolution.
Generalization: owl:Thing
Object Properties: jc3:bounds.on-the-bottom (multiple jc3:GEOMETRIC-VOLUME), jc3:bounds-on-the-top (multiple jc3:GEOMETRIC-VOLUME), jc3:has-distance-precision (single jc3:Distance-Precision), jc3:has-vertical-distance-reference-system (single jc3:Vertical-Distance-Reference-System) and jc3:is-specified-for-absolute-point (multiple jc3:ABSOLUTE-POINT).
Datatype Properties: jc3:vertical-distance-datum-text (single string) and jc3:vertical-distance-dimension (single float).

Class: VIDEO
Ontology: DSIG (dsig:)
Description: The recording, reproducing, or broadcasting of moving visual images.

Generalization: dsig:AUDIO-VIDEO
Object Properties: Inherited from dsig:Audio-Video.
Datatype Properties: Inherited from dsig:Audio-Video.

Class: VOLCANO
Ontology: DSIG (dsig:)
Description: A mountain opening downwards to the reservoir of molten rock towards the surface of earth.
Generalization: dsig:DISASTER
Object Properties: Inherited from dsig:Disaster.
Datatype Properties: Inherited from dsig:Disaster.

Class: WILDFIRE
Ontology: DSIG (dsig:)
Description: An unplanned, unwanted wildland fire including unauthorized human-caused fires.
Generalization: dsig:VOLCANO
Object Properties: Inherited from dsig:Volcano.
Datatype Properties: Inherited from dsig:Volcano.

Class: YOUTUBE-VIDEO
Ontology: DSIG (dsig:)
Description: A video from YouTube. YouTube is a video-sharing website, created by three former PayPal employees in February 2005 and owned by Google since late 2006, on which users can upload, view and share videos.
Generalization: dsig:Video
Object Properties: Inherited from dsig:Video.
Datatype Properties: Inherited from dsig: Video.

6.2 Enumerations

Class: Audio-Level
Ontology: DSIG (dsig:)
Description: The level of audio in the data source.
Data Literals:
HIGH
LOW
MEDIUM
NONE

Class: Affiliation-Geopolitical-Territory
Ontology: JC3IEDM (jc3:)
Description: Added to JC3IEDM: European territories in which an affiliation-geopolitical-country is located.

Data Literals:
EASTERN_EUROPE
NORTHERN_EUROPE
SOUTHERN_EUROPE
WESTERN_EUROPE

Class: Angle-Precision
Ontology: JC3IEDM (jc3:)
Description: Adapted from JC3IEDM (angle-precision-code): The specific value that represents the maximum resolution used for the expression of a value of an angle.
Data Literals:
DEGREE
DEGREE_1-10
MIL
MINUTE
MINUTE_1-10
MINUTE_1-100
MINUTE_1-1000
SECOND
SECOND_1-10
SECOND_1-100

Class: Cloud-Coverage-Code
Ontology: JC3IEDM (jc3:)
Description: Adapted from JC3IEDM (cloud-cover-category-code): The specific value that represents the prevailing class of a specific cloud.
Data Literals:
COMPLETELY_COVERED
LESS_THAN_HALF_COVERED
MORE_THAN_HALF_COVERED
CLOUDS

Class: Distance-Precision
Ontology: JC3IEDM (jc3:)
Description: Adapted from JC3IEDM (vertical-distance-precision-code): The specific value that denotes the precision of specifying a VERTICAL-DISTANCE.
Data Literals:
CENTIMETRE
FEET_10
FEET_100
FOOT
INCH
KILOMETRE
KILOYARD

METRE
METRES_10
METRES_100
METRES_3
METRES_30
METRES_300
MILE
MILIMETRE
NAUTICAL_MILE
YARD

Class: Epidemic-Type
Ontology: DSIG (dsig:)
Description: Type of Epidemic.
Data Literals:
AVIAN_FLU
CHOLERA
DENGUE_FEVER
EBOLA
HIV
MARBUG
MEASLES
MENINGOCOCCAL_MENINGITIS
TUBERCULOSIS
YELLOW_FEVER

Class: Facility-Construction-Material
Ontology: JC3IEDM (jc3:)
Description: Adapted from JC3IEDM (facility-primary-construction-material-code): The specific value that represents the major material used in building the specific FACILITY.
Data Literals:
ASPHALT
BITUMEN
BRICK-MASONRY
CLAY
COBBLESTONE
COMPOSITE_PERMANENT
COMPOSITE_SOFT
CONCRETE
CONCRETE_BLOCKS
CORAL_MATERIAL
EARTH_MATERIAL
GRAVEL
ICE_MATERIAL

LATERITE
MACADAM
MATERIAL_NOT_OTHERWISE_SPECIFIED
MEMBRANE
METAL
MIX
PEBBLE
PERMANENT_SURFACE
PERMANENT_SURFACE_MIX
PIERCED_STEEL
PRE-STRESSED_CONCRETE
REINFORCED_CONCRETE
ROCK_MATERIAL
ROLLED_EARTH
SAND_MATERIAL
SILT
SNOW_MATERIAL
STEEL_MAT
WOOD_TIMBER

Class: Facility-Type
Ontology: JC3IEDM (jc3:)
Description: Adapted from JC3IEDM (facility-type-category-code and facility-category-code): The specific value that represents the class of a type of FACILITY.
Data Literals:
AIRFIELD
ALTERNATE_DECONTAMINATION_FACILITY
ANCHORAGE
APARTMENT_BUILDING
APRON
BANK
BASIN
BATH
BERM
BERTH
BRIDGE
BUILDING
BUILT-UP_AREA
BUNKER
CAMP
CANAL
CASUALTY_COLLECTION_POINT
CEMETERY-GRAVEYARD-BURIAL_GROUND
CHANNEL_PASS_LOCK

CHECK_POINT_POLICE
CHIMNEY-SMOKESTACK
CITY
CIVILIAN_COLLECTION_POINT
CLEARED_WAY-FIREBREAK
COMMUNICATIONS_TOWER
COMPOUND
CONTROL_TOWER
CROPLAND_FACILITY
CROSSING-LEVEL_CROSSING
CROSSING_RAILWAY-RIVER
CULTURAL_SITE
CULVERT
CUT_FACILITY
DAM-WEIR
DECONTAMINATION-FACILITY
DEMOLITION_DEBRIS
DEPOT_BIOLOGICAL
DEPOT_CHEMICALS
DEPOT_MEDICAL
DEPOT_NBC
DEPOT_NOT_OTHERWISE_SPECIFIED
DEPOT_POL
DITCH
DRAINAGE-SEWAGE
DRESSING-STATION
DRY-DOCK
ELECTRICAL_SUPPLY
ELECTRONIC_INSTALLATION
ELECTRONIC_INSTALLATION_RADAR_DOME
EMBANKMENT
FARM
FENCE
FERRY_INSTALLATION
FIRE-FIGHTERS_BARRACKS
FORD_CONCRETE_LINE_BED
FORD_STONE_LINED_BED
FREIGHT_TERMINAL
FUEL_HANDLING_POINT
GARAGE
GAS_PROCESSING_FACILITY
GATE
GOVERNMENTAL_LEADERSHIP
GOVERNMENT_BUILDING

HAMLET
HANGAR
HARBOUR
HELICOPTER_LANDING_PAD
HELIPORT
HIGH-TECHNOLOGY-COMPLEX
HISTORIC_SITE
HOUSE
HUT
IMPROVED_BED_TYPE_UNKNOWN
INDUSTRIAL_INSTALLATION
INSTALLATION
INTERCHANGE-COMPLEX_JUNCTION
JETTY
LIGHTHOUSE
LOADING_PLATFORM
MARKET
MASS_GRAVE
MEDICAL_FACILITY
MEDICAL_FACILITY_HOSPITAL
MEDICAL_FACILITY_HOSPITAL_FIELD
MEDICAL_FACILITY_HOSPITAL_NOT_OTHERWISE_SPECIFIED
MEDICAL_SUPPPORT
METEOROLOGICAL_FACILITY
MONUMENT
MOTORWAY
NBC_OBSERVATION_POST_DISMOUNTED
NETWORK
NUCLEAR_FACILITY
OBSERVATION_POST
OBSERVATION_TOWER
OFFICE
ORCHARD-PLANTATION-FACILITY
PASSENGER_TERMINAL
PETROCHEMICAL_REFINERY
PIER
PIPELINE
POLICE_STATION
POL_POINT
PORT
POWER_PLANT_FOSSIL_FUEL
POWER_PLANT_HYDROELECTRIC
POWER_PLANT_NUCLEAR
POWER_PLANT_THERMAL

POWER_TRANSMISSION_LINE
PROCESSING_FACILITY
PRODUCTION_COMPLEX_AIRCRAFT
PRODUCTION_COMPLEX_CHEMICAL
PRODUCTION_COMPLEX_GENERAL_MOTOR_VEHICLE
PRODUCTION_COMPLEX_PETROLEUM
PUMPING_STATION
QUAY
RAILHEAD
RAILWAY
RAILWAY_CROSSING
RAILWAY_JUNCTION
RAIL_FACILITIES
RAIL_FACILITY_REPAIR
RELAY_FACILITY
RELIGIOUS_FACILITY
RESERVOIR
ROAD
ROAD_JUNCTION
ROW_HOUSE
RUNS
RUNWAY
SCHOOL
SEWAGE_TREATMENT_FACILITY
SHED
SHIPYARD
SHOP
SHORAN_STATION
SLIPWAY
STATION_GENERAL
STEEPLE_SPIRE
TOWER_NON-COMMUNICATIONS
TOWER_TELEVISION_TRANSMITTER
TOWN
TOWN_HALL
TRAFFIC_CONTROL_POST
TRAIL
TRANSLOADING_FACILITY
TRANSPORT_FACILITY
TUNNEL
UNIT_OF_ACCOMMODATION
VEHICLE_STORAGE-PARKING_AREA
VILLAGE
WALL

WASTE_PILE
WATER_SUPPLY
WATER_TOWER
WATER_TREATMENT_FACILITY
WINDMILL
WORSHIP_PLACE

Class: Forecast-Code
Ontology: JC3IEDM (jc3:)
Description: The specific value that represents the prevailing class of specific meteorology information (current weather or forecast weather).
Data Literals:
IS_CURRENT_WEATHER
IS_FORECAST

Class: Geographic-Feature-Category
Ontology: JC3IEDM (jc3:)
Description: Adapted from JC3IEDM (geographic-feature-type-category-code): The specific value that represents the class of the GEOGRAPHIC-FEATURE.
Data Literals:
COASTAL_HYDROGRAPHY
CONTINENT
GEOGRAPHIC_FEATURE_NOT_OTHERWISE_SPECIFIED
INLAND_WATER
LANDFORM
SNOW_ICE
WETLAND

Class: Geographic-Feature-Subcategory
Ontology: JC3IEDM (jc3:)
Description: Adapted from JC3IEDM (geographic-feature-type-subcategory-code): The specific value that represents the detailed class of GEOGRAPHIC-FEATURE.
Data Literals:
BACKSHORE
BEACH
BLUFF-CLIFF-ESCARPMENT
BOG
CAVE
CAY
CHANNEL
COASTLINE
CREVICE-CREVASSE
CUT
DEPRESSION

DRY_GAP
EMBANKMENT-FILL
ESKER
FAN
FAULT
FLOODED_AREA
FLUME
FORD
FORESHORE
GEOTHERMAL_FEATURE
GLACIER
GULLY_GORGE
HARBOUR_NATURAL
HILL
HUMMOCK
ICE_CLIFF
ICE_PEAK_NUNATAK
ICE_SHELF
INLAND_SHORELINE
ISLAN
LAGOON-REEF_POOL
LAKE-POND
LANDSLIDE-SCREE
LAND_SUBJECT_TO_INUNDATION
LARGE_ISOLATED_ROCK_BOULDER_OR_ROCKY_FORMATION
LEDGE
MARSH
MORAINE
MOUNTAIN
MOUNTAIN_PASS
NEARSHORE
PACK_ICE
PINGO
POLAR_ICE
RAPIDS
REEF
RIVER-STREAM
RIVER-STREAM_VANISHING_POINT
RIVER_BANK
ROCK
ROCK_STRATA-ROCK_FORMATION
SALT_PAN
SAND_DUNE-SAND_HILL
SEBKHA

SHORELINE
SNAGS-SUBMERGED_STUMPS
SNOW_FIELD-ICE_FIELD
SPRING-WATER_HOLE
SWAMP
TUNDRA
UNDERGROUND_WATER-PHREATIC_WATER
UNDERMINED_LAND
UNDERWATER_SAND_RIDGE
VALLEY
VOLCANO
VOLCANO_DIKE
WATERFALL
WATER_EXCEPT_INLAND

Class: Geographic-Feature-Surface-Category
Ontology: JC3IEDM (jc3:)
Description: Adapted from JC3IEDM (geographic-feature-surface-category-code): The specific value that represents the type of surface of the GEOGRAPHIC-FEATURE.
Data Literals:
LIQUID_SURFACE
OTHER_SURFACE
SOLID_SURFACE

Class: Geographic-Feature-Surface-Composition
Ontology: JC3IEDM (jc3:)
Description: Adapted from JC3IEDM (geographic-feature-solid-surface-composition-code): The specific value that represents the composition of the surface of the GEOGRAPHIC-FEATURE.
Data Literals:
BEDROCK
CORAL
EARTH
ICE
SAND
SNOW
SURFACE_COMPOSITION_NOT_OTHERWISE_SPECIFIED

Class: Geographic-Feature-Terrain
Ontology: JC3IEDM (jc3:)
Description: Adapted from JC3IEDM (geographic-feature-terrain-code): The specific value that represents a tract of land.
Data Literals:
FLAT
HILLY
MOUNTAINOUS
TERRAIN_NOT_OTHERWISE_SPECIFIED
UNDULATING
URBAN

Class: Geographic-Feature-Vegetation-Category
Ontology: JC3IEDM (jc3:)
Description: Adapted from JC3IEDM (geographic-feature-vegetation-category-code):The specific value that represents the general vegetation class on a specific GEOGRAPHIC-FEATURE.
Data Literals:
BARE
JUNGLE
PLANT_CULTIVATION
RANGELAND
VEGETATION_NOT_OTHERWISE_SPECIFIED
WETLANDS
WOODLAND

Class: Geographic-Feature-Vegetation-Subcategory
Ontology: JC3IEDM (jc3:)
Description: Adapted from JC3IEDM (geographic-feature-vegetation-subcategory-code): The specific value that represents the detailed vegetation class on a specific GEOGRAPHIC-FEATURE.
Data Literals:
BAMBOO-CANE
BOTANICAL_GARDEN
CROPLAND
DESERT
FOREST
GRASS-SCRUB-BRUSH
GRASSLAND
HEDGEROW
HOPS
JUNGLE_COASTAL-ESTUARY
JUNGLE_CULTIVATION
JUNGLE_PRIMARY

JUNGLE_SECONDARY
MARSH_VEGETATION
NURSERY
OASIS
ORCHARD-PLANTATION
SAVANNAH
CRUB-BRUSH-BUSH
SWAMP_VEGETATION
TREES
TUNDRA_VEGETATION
VINEYARD

Class: Landslide-Type
Ontology: DSIG (dsig:)
Description: Type of Landslide.
Data Literals:
FALL
FLOW
SLIDE
SPREAD
TOPPLE

Class: Orbit-Area-Alignment
Ontology: JC3IEDM (jc3:)
Description: Adapted from JC3IEDM (orbit-area-alignment-code): The specific value that represents the placement of a specific ORBIT-AREA with respect to its defining reference axis.
Data Literals:
CENTRE
LEFT
RIGHT

Class: Precipitation-Code
Ontology: JC3IEDM (jc3:)
Description: Adapted from JC3IEDM (precipitation-category-code): The specific value that represents the prevailing class of a specific precipitation.
Data Literals:
DRIZZLE
FREEZING_DRIZZLE
FREEZING_RAIN
HAIL
ICE_CRYSTALS
ICE_PELLETS
NO_PRECIPITATION
RAIN

RAIN_SHOWER
SLEET
SNOW_GRAINS
SNOW_SHOWER
SNOW_SOFT

Class: Vertical-Distance-Reference-System
Ontology: JC3IEDM (jc3:)
Description: Adapted from JC3IEDM (vertical-distance-reference-code): The specific value that represents the reference system for a specific VERTICAL-DISTANCE.
Data Literals:
CHART_DATUM
LOCAL_DATUM
MEAN_SEA_LEVEL
PRESSURE_DATUM_QFE
PRESSURE_DATUM_QNH
PRESSURE_DATUM_STANDARD_ATMOSPHERE
TOPOGRAPHIC_SURFACE
WATER_BOTTOM
WGS84_GEOID
WGS84_REFERENCE_ELLIPSOID

6.3 Object Properties

Property: affects
Ontology: DSIG (dsig:)
Functional: No
Inverse: dsig:is-affected-by
Domain: dsig:DISASTER
Range: dsig:**Errore. L'origine riferimento non è stata trovata.**

Property: beginning-is-defined-using-point
Ontology: JC3IEDM (jc3:)
Functional: Yes
Inverse: jc3:is-beginning-point-for
Domain: jc3:TRACK-AREA
Range: jc3:POINT

Property: bounds-on-the-bottom
Ontology: JC3IEDM (jc3:)
Functional: No
Inverse: none
Domain: jc3:VERTICAL-DISTANCE
Range: jc3:GEOMETRIC-VOLUME

Property: bounds-on-the-top
Ontology: JC3IEDM (jc3:)
Functional: No
Inverse: none
Domain: jc3:VERTICAL-DISTANCE
Range: jc3:GEOMETRIC-VOLUME

Property: causes
Ontology: DSIG (dsig:)
Functional: No
Inverse: dsig:is-consequence-of
Domain: dsig:DISASTER
Range: dsig:DISASTER

Property: constitutes-the-set-waypoints-for
Ontology: JC3IEDM (jc3:)
Functional: No
Inverse: jc3:is-defined-using-line
Domain: jc3:LINE
Range: jc3:CORRIDOR-AREA

Property: contains
Ontology: DSIG (dsig:)
Functional: No
Inverse: dsig:has-location

Domain: dsig:LOCATION
Range: dsig:LOCATION

Property: ending-is-defined-using-point
Ontology: JC3IEDM (jc3:)
Functional: Yes
Inverse: jc3:is-ending-point-for
Domain: jc3:TRACK-AREA
Range: jc3:POINT

Property: gathers-information-from
Ontology: DSIG (dsig:)
Functional: No
Inverse: dsig:is-controlled-by
Domain: dsig:DATA-SOURCE
Range: dsig:DATA-SOURCE

Property: has-affiliation-geopolitical
Ontology: DSIG (dsig:)
Functional: No
Inverse: none
Domain: dsig:AFFILIATION-GEOPOLITICAL
Range: dsig:AFFILIATION-GEOPOLITICAL

Property: has-affiliation-geopolitical-country
Ontology: JC3IEDM (jc3:)
Functional: Yes
Inverse: none
Domain: jc3:AFFILIATION-GEOPOLITICAL
Range: jc3:AFFILIATION-GEOPOLITICAL-COUNTRY

Property: has-affiliation-geopolitical-territory
Ontology: JC3IEDM (jc3:)
Functional: Yes
Inverse: none
Domain: jc3:AFFILIATION-GEOPOLITICAL
Range: jc3:Affiliation-Geopolitical-Territory

Property: has-as-asset
Ontology: DSIG (dsig:)
Functional: Yes
Inverse: none
Domain: jc3:Action
Range: dsig:Asset

Property: has-as-its-bearing-origin
Ontology: JC3IEDM (jc3:)
Functional: Yes
Inverse: jc3:is-bearing-origin-of
Domain: jc3:POLYARC-AREA
Range: jc3:POINT

Property: has-as-its-centre
Ontology: JC3IEDM (jc3:)
Functional: Yes
Inverse: jc3:is-bearing-origin-of
Domain: jc3:POLYARC-AREA
Range: jc3:POINT

Property: has-as-its-first-conjugate-point
Ontology: JC3IEDM (jc3:)
Inverse: jc3:is-the-first-conjugate-point-for
Functional: Yes
Domain: jc3:ELLIPSE
Range: jc3:POINT

Property: has-as-its-second-conjugate-point
Ontology: JC3IEDM (jc3:)
Inverse: jc3:is-the-second-conjugate-point-for
Functional: Yes
Domain: jc3:ELLIPSE
Range: jc3:POINT

Property: has-as-its-vertex
Ontology: JC3IEDM (jc3:)
Functional: Yes
Inverse: jc3:is-the-vertex-for
Domain: jc3:CONE-VOLUME and jc3:FAN-AREA
Range: jc3:POINT

Property: has-as-resource
Ontology: JC3IEDM (jc3:)
Functional: Yes
Inverse: none
Domain: jc3:Action
Range: jc3:Resource

Property: has-audio-level
Ontology: DSIG (dsig:)
Functional: No
Inverse: none
Domain: dsig:AUDIO-VIDEO
Range: dsig:Audio-Level

Property: has-cartesian-point-x-distance-precision
Ontology: JC3IEDM (jc3:)
Functional: Yes
Inverse: none
Domain: jc3:CARTESIAN-POINT
Range: jc3:Distance-Precision

Property: has-cartesian-point-y-distance-precision
Ontology: JC3IEDM (jc3:)
Functional: Yes
Inverse: none
Domain: jc3:CARTESIAN-POINT
Range: jc3:Distance-Precision

Property: has-cartesian-point-z-distance-precision
Ontology: JC3IEDM (jc3:)
Functional: Yes
Inverse: none
Domain: jc3:CARTESIAN-POINT
Range: jc3:Distance-Precision

Property: has-cloud-coverage
Ontology: JC3IEDM (jc3:)
Functional: Yes
Inverse: none
Domain: jc3:Meteorology
Range: dsig:Cloud-Coverage-Code

Property: has-data-sources
Ontology: DSIG (dsig:)
Functional: No
Inverse: dsig:provides-information
Domain: dsig:SITUATION
Range: dsig:DATA-SOURCE

Property: has-defined-as-part-of-the-boundary
Ontology: JC3IEDM (jc3:)
Functional: Yes
Inverse: jc3:is-part-of-the-boundary-for
Domain: jc3:POLYARC-AREA
Range: jc3:LINE

Property: has-distance-precision
Ontology: JC3IEDM (jc3:)
Functional: Yes
Inverse: none
Domain: jc3:VERTICAL-DISTANCE

Range: jc3:Distance-Precision

Property: has-epidemic-type
Ontology: DSIG (dsig:)
Functional: Yes
Inverse: none
Domain: dsig:EPIDEMIC
Range: dsig:Epidemic-Type

Property: has-facility-construction-material
Ontology: JC3IEDM (jc3:)
Functional: Yes
Inverse: none
Domain: jc3:FACILITY
Range: jc3:Facility-Construction-Material

Property: has-facility-type
Ontology: JC3IEDM (jc3:)
Functional: Yes
Inverse: none
Domain: jc3:FACILITY
Range: jc3:Facility-Type

Property: has-forecast-code
Ontology: JC3IEDM (jc3:)
Functional: Yes
Inverse: none
Domain: jc3:Meteorology
Range: jc3:Forecast-Code

Property: has-geographic-feature-category
Ontology: JC3IEDM (jc3:)
Functional: Yes
Inverse: none
Domain: jc3:GEOGRAPHIC-FEATURE
Range: jc3:Geographic-Feature-Category

Property: has-geographic-feature-subcategory
Ontology: JC3IEDM (jc3:)
Functional: Yes
Inverse: none
Domain: jc3:GEOGRAPHIC-FEATURE
Range: jc3:Geographic-Feature-Subcategory

Property: has-geographic-feature-surface-category
Ontology: JC3IEDM (jc3:)
Functional: Yes
Inverse: none

Domain: jc3:GEOGRAPHIC-FEATURE
Range: jc3:Geographic-Feature-Surface-Category

Property: has-geographic-feature-surface-composition
Ontology: JC3IEDM (jc3:)
Functional: Yes
Inverse: none
Domain: jc3:GEOGRAPHIC-FEATURE
Range: jc3:Geographic-Feature-Surface-Composition

Property: has-geographic-feature-terrain
Ontology: JC3IEDM (jc3:)
Functional: Yes
Inverse: none
Domain: jc3:GEOGRAPHIC-FEATURE
Range: jc3:Geographic-Feature-Terrain

Property: has-geographic-feature-vegetation-category
Ontology: JC3IEDM (jc3:)
Functional: Yes
Inverse: none
Domain: jc3:GEOGRAPHIC-FEATURE
Range: jc3:Geographic-Feature-Vegetation-Category

Property: has-geographic-feature-vegetation-subcategory
Ontology: JC3IEDM (jc3:)
Functional: Yes
Inverse: none
Domain: jc3:GEOGRAPHIC-FEATURE
Range: jc3:Geographic-Feature-Vegetation-Subcategory

Property: has-initial-point
Ontology: JC3IEDM (jc3:)
Functional: Yes
Inverse: jc3:is-first-point-for
Domain: jc3:ORBIT-AREA
Range: jc3:POINT

Property: has-landslide-type
Ontology: DSIG (dsig:)
Functional: Yes
Inverse: none
Domain: dsig:LANDSLIDE
Range: dsig:Landslide-Type

Property: has-latitude-precision
Ontology: JC3IEDM (jc3:)
Functional: Yes

Inverse: none
Domain: jc3:GEOGRAPHIC-POINT
Range: jc3:Angle-Precision

Property: has-location
Ontology: DSIG (dsig:)
Functional: Yes
Inverse: dsig:contains
Domain: dsig:LOCATION
Range: dsig:LOCATION

Property: has-longitude-precision
Ontology: JC3IEDM (jc3:)
Functional: Yes
Inverse: none
Domain: jc3:GEOGRAPHIC-POINT
Range: jc3:Angle-Precision

Property: has-orbit-area-alignment
Ontology: JC3IEDM (jc3:)
Functional: Yes
Inverse: none
Domain: jc3:ORBIT-AREA
Range: jc3:Orbit-Area-Alignment

Property: has-precipitation-code
Ontology: JC3IEDM (jc3:)
Functional: Yes
Inverse: none
Domain: jc3:Meteorology
Range: jc3:Precipitation-Code

Property: has-second-point
Ontology: JC3IEDM (jc3:)
Functional: Yes
Inverse: jc3:is-second-point-for
Domain: jc3:ORBIT-AREA
Range: jc3:POINT

Property: has-vertical-distance-reference-system
Ontology: JC3IEDM (jc3:)
Functional: Yes
Inverse: none
Domain: jc3:VERTICAL-DISTANCE
Range: jc3:Vertical-Distance-Reference-System

Property: in-situation
Ontology: DSIG (dsig:)

Functional: No
Inverse: dsig:includes-disaster
Domain: dsig:DISASTER
Range: dsig:SITUATION

Property: includes-disaster
Ontology: DSIG (dsig:)
Functional: No
Inverse: dsig:in-situation
Domain: dsig:SITUATION
Range: dsig:DISASTER

Property: is-affected-by
Ontology: DSIG (dsig:)
Functional: No
Inverse: dsig:affects
Domain: dsig:**Errore. L'origine riferimento non è stata trovata.**
Range: dsig:DISASTER

Property: is-bearing-origin-of
Ontology: JC3IEDM (jc3:)
Functional: No
Inverse: jc3: has-as-its-bearing-origin
Domain: jc3:POINT
Range: jc3:POLYARC-AREA

Property: is-beginning-point-for
Ontology: JC3IEDM (jc3:)
Functional: No
Inverse: jc3:beginning-is-defined-using-point
Domain: jc3:POINT
Range: jc3:TRACK-AREA

Property: is-bounded-by
Ontology: JC3IEDM (jc3:)
Functional: Yes
Inverse: jc3:is-the-boundary-for
Domain: jc3:POLYGON-AREA
Range: jc3:LINE

Property: is-composed-of
Ontology: DSIG (dsig:)
Functional: No
Inverse: dsig:is-part-of
Domain: dsig:**Errore. L'origine riferimento non è stata trovata.**
Range: dsig:**Errore. L'origine riferimento non è stata trovata.**

Property: is-consequence-of
Ontology: DSIG (dsig:)
Functional: No
Inverse: dsig:causes
Domain: dsig:DISASTER
Range: dsig:DISASTER

Property: is-controlled-by
Ontology: DSIG (dsig:)
Functional: No
Inverse: dsig:gathers-information-from
Domain: dsig:**Errore. L'origine riferimento non è stata trovata.**
Range: dsig:DATA-SOURCE

Property: is-defined-using-line
Ontology: JC3IEDM (jc3:)
Functional: Yes
Inverse: jc3:constitutes-the-set-waypoints-for
Domain: jc3:CORRIDOR-AREA
Range: jc3:LINE

Property: is-defined-using-line-point
Ontology: JC3IEDM (jc3:)
Functional: No
Inverse: jc3:is-used-in-the-definition
Domain: jc3:LINE
Range: jc3:LINE-POINT

Property: is-defined-using-surface
Ontology: JC3IEDM (jc3:)
Functional: Yes
Inverse: jc3:surface-is-used-to-define
Domain: jc3:CONE-VOLUME and jc3:SURFACE-VOLUME
Range: jc3:SURFACE

Property: is-ending-point-for
Ontology: JC3IEDM (jc3:)
Functional: No
Inverse: jc3:ending-is-defined-using-point
Domain: jc3:POINT
Range: jc3:TRACK-AREA

Property: is-first-point-for
Ontology: JC3IEDM (jc3:)
Functional: No
Inverse: jc3:has-initial-point
Domain: jc3:POINT
Range: jc3:ORBIT-AREA

Property: is-part-of
Ontology: DSIG (dsig:)
Functional: No
Inverse: dsig:is-composed-of
Domain: dsig:**Errore. L'origine riferimento non è stata trovata.**
Range: dsig:**Errore. L'origine riferimento non è stata trovata.**

Property: is-part-of-the-boundary-for
Ontology: JC3IEDM (jc3:)
Functional: No
Inverse: jc3:has-defined-as-part-of-the-boundary
Domain: jc3:LINE
Range: jc3:POLYARC-AREA

Property: is-second-point-for
Ontology: JC3IEDM (jc3:)
Functional: Yes
Inverse: jc3:has-second-point
Domain: jc3:POINT
Range: jc3:ORBIT-AREA

Property: is-specified-for-absolute-point
Ontology: JC3IEDM (jc3:)
Functional: No
Inverse: none
Domain: jc3:VERTICAL-DISTANCE
Range: jc3:ABSOLUTE-POINT

Property: is-the-boundary-for
Ontology: JC3IEDM (jc3:)
Functional: No
Inverse: jc3: is-bounded-by
Domain: jc3:LINE
Range: jc3:POLYGON-AREA

Property: is-the-centre-for
Ontology: JC3IEDM (jc3:)
Functional: No
Inverse: jc3: has-as-its-centre
Domain: jc3:POINT
Range: jc3:ELLIPSE and jc3:SPHERE-VOLUME

Property: is-the-first-conjugate-point-for
Ontology: JC3IEDM (jc3:)
Functional: No
Inverse: jc3:has-as-its-first-conjugate-point

Domain: jc3:POINT
Range: jc3:ELLIPSE

Property: is-the-second-conjugate-point-for
Ontology: JC3IEDM (jc3:)
Functional: No
Inverse: jc3:has-as-its-second-conjugate-point
Domain: jc3:POINT
Range: jc3:ELLIPSE

Property: is-the-vertex-for
Ontology: JC3IEDM (jc3:)
Functional: No
Inverse: jc3:is-the-vertex-for
Domain: jc3:POINT
Range: jc3:CONE-VOLUME and jc3:FAN-AREA

Property: is-used-as
Ontology: JC3IEDM (jc3:)
Functional: No
Inverse: jc3:makes-reference-to
Domain: jc3:POINT
Range: jc3:LINE-POINT

Property: is-used-in-the-definition
Ontology: JC3IEDM (jc3:)
Functional: Yes
Inverse: jc3:is-defined-using-line-point
Domain: jc3:LINE-POINT
Range: jc3:LINE

Property: makes-reference-to
Ontology: JC3IEDM (jc3:)
Functional: Yes
Inverse: jc3:makes-reference-to
Domain: jc3:LINE-POINT
Range: jc3:POINT

Property: provides-information
Ontology: DSIG (dsig:)
Functional: No
Inverse: dsig:provides-information
Domain: dsig:DATA-SOURCE
Range: dsig:SITUATION

Property: surface-is-used-to-define
Ontology: JC3IEDM (jc3:)

Functional: Yes
Inverse: jc3:is-defined-using-surface
Domain: jc3:SURFACE
Range: jc3:CONE-VOLUME and jc3:SURFACE-VOLUME

6.4 Data type Properties

Property: area-description
Ontology: DSIG (dsig:)
Functional: Yes
Domain: dsig:**Errore. L'origine riferimento non è stata trovata.**
Range: string

Property: area-name
Ontology: DSIG (dsig:)
Functional: Yes
Domain: String
Range: string

Property: asset-description
Ontology: DSIG (dsig:)
Functional: Yes
Domain: String
Range: string

Property: asset-name
Ontology: DSIG (dsig:)
Functional: Yes
Domain: String
Range: string

Property: audio-video-category
Ontology: DSIG (dsig:)
Functional: Yes
Domain: dsig:AUDIO-VIDEO
Range: string

Property: audio-video-date
Ontology: DSIG (dsig:)
Functional: Yes
Domain: dsig:AUDIO-VIDEO
Range: dateTime

Property: audio-video-duration
Ontology: DSIG (dsig:)
Functional: Yes
Domain: dsig:AUDIO-VIDEO

Range: time

Property: audio-video-title
Ontology: DSIG (dsig:)
Functional: Yes
Domain: dsig:AUDIO-VIDEO
Range: string

Property: data-source-description
Ontology: DSIG (dsig:)
Functional: Yes
Domain: dsig:DATA-SOURCE
Range: string

Property: data-source-name
Ontology: DSIG (dsig:)
Functional: Yes
Domain: dsig:DATA-SOURCE
Range: string

Property: digital-newspaper-name
Ontology: DSIG (dsig:)
Functional: Yes
Domain: dsig:DIGITAL-NEWSPAPER
Range: string

Property: disaster-description
Ontology: DSIG (dsig:)
Functional: Yes
Domain: dsig:DISASTER
Range: string

Property: disaster-name
Ontology: DSIG (dsig:)
Functional: Yes
Domain: dsig:DISASTER
Range: string

Property: facebook-account-name
Ontology: DSIG (dsig:)
Functional: Yes
Domain: dsig:FACEBOOK-ACCOUNT
Range: string

Property: link
Ontology: DSIG (dsig:)
Functional: Yes
Domain: dsig:AUDIO-VIDEO and dsig:DIGITAL-NEWSPAPER

Range: string

Property: situation-description
Ontology: DSIG (dsig:)
Functional: Yes
Domain: dsig:SITUATION
Range: string

Property: situation-name
Ontology: DSIG (dsig:)
Functional: Yes
Domain: dsig:SITUATION
Range: string

Property: twitter-user
Ontology: DSIG (dsig:)
Functional: Yes
Domain: dsig:TWEET
Range: string

Property: capital-city
Ontology: JC3IEDM (jc3:)
Functional: Yes
Domain: jc3:AFFILIATION-GEOPOLITICAL-COUNTRY
Range: string

Property: cartesian-point-x-coordinate-dimension
Ontology: JC3IEDM (jc3:)
Functional: Yes
Domain: jc3:CARTESIAN-POINT
Range: float

Property: cartesian-point-y-coordinate-dimension
Ontology: JC3IEDM (jc3:)
Functional: Yes
Domain: jc3:CARTESIAN-POINT
Range: float

Property: cartesian-point-z-coordinate-dimension
Ontology: JC3IEDM (jc3:)
Functional: Yes
Domain: jc3:CARTESIAN-POINT
Range: float

Property: corridor-area-width-dimension
Ontology: JC3IEDM (jc3:)
Functional: Yes
Domain: jc3:CORRIDOR-AREA

Range: float

Property: facility-height-dimension
Ontology: JC3IEDM (jc3:)
Functional: Yes
Domain: jc3:FACILITY
Range: float

Property: facility-length-dimension
Ontology: JC3IEDM (jc3:)
Functional: Yes
Domain: jc3:FACILITY
Range: float

Property: facility-width-dimension
Ontology: JC3IEDM (jc3:)
Functional: Yes
Domain: jc3:FACILITY
Range: float

Property: fan-area-maximum-range-dimension
Ontology: JC3IEDM (jc3:)
Functional: Yes
Domain: jc3:FAN-AREA
Range: float

Property: fan-area-minimum-range-dimension
Ontology: JC3IEDM (jc3:)
Functional: Yes
Domain: jc3:FAN-AREA
Range: float

Property: fan-area-orientation-angle
Ontology: JC3IEDM (jc3:)
Functional: Yes
Domain: jc3:FAN-AREA
Range: float

Property: fan-area-sector-size-angle
Ontology: JC3IEDM (jc3:)
Functional: Yes
Domain: jc3:FAN-AREA
Range: float

Property: geographic-point-latitude-coordinate
Ontology: JC3IEDM (jc3:)
Functional: Yes
Domain: jc3:GEOGRAPHIC-POINT

Range: float

Property: geographic-point-longitude-coordinate
Ontology: JC3IEDM (jc3:)
Functional: Yes
Domain: jc3:GEOGRAPHIC-POINT
Range: float

Property: line-point-sequence-ordinal
Ontology: JC3IEDM (jc3:)
Functional: Yes
Domain: jc3:LINE-POINT
Range: int

Property: orbit-area-width-dimension
Ontology: JC3IEDM (jc3:)
Functional: Yes
Domain: jc3:ORBIT-AREA
Range: float

Property: polyarc-area-arc-radius-dimension
Ontology: JC3IEDM (jc3:)
Functional: Yes
Domain: jc3:POLYARC-AREA
Range: float

Property: polyarc-area-begin-bearing-angle
Ontology: JC3IEDM (jc3:)
Functional: Yes
Domain: jc3:POLYARC-AREA
Range: float

Property: polyarc-area-end-bearing-angle
Ontology: JC3IEDM (jc3:)
Functional: Yes
Domain: jc3:POLYARC-AREA
Range: float

Property: population
Ontology: JC3IEDM (jc3:)
Functional: Yes
Domain: jc3:AFFILIATION-GEOPOLITICAL-COUNTRY
Range: int

Property: sphere-volume-radius-dimension
Ontology: JC3IEDM (jc3:)
Functional: Yes
Domain: jc3:SPHERE-VOLUME

Range: float

Property: track-area-left-width-dimension
Ontology: JC3IEDM (jc3:)
Functional: Yes
Domain: jc3:TRACK-AREA
Range: float

Property: track-area-right-width-dimension
Ontology: JC3IEDM (jc3:)
Functional: Yes
Domain: jc3:TRACK-AREA
Range: float

Property: vertical-distance-datum-text
Ontology: JC3IEDM (jc3:)
Functional: Yes
Domain: jc3:VERTICAL-DISTANCE
Range: string

Property: vertical-distance-dimension
Ontology: JC3IEDM (jc3:)
Functional: Yes
Domain: jc3:VERTICAL-DISTANCE
Range: float

7 SENSORS INFORMATION MODEL

This section includes detail about the information provided by the different sensors suggested for the use in the DESTRIERO system.

7.1 CBRN Sensors

7.1.1 FROG-4000

Field	Description
Agent	Name of the Chemical agent identified
Concentration	Value of the agent concentration measured in ppb (parts per billion)
Measure duration	Quantity of time used in the detection (measured in seconds)
Measure datetime	Datetime in which the detection was done

Table 6 – FROG-4000 information

An example in a human readable format should be something like this:

Variable	**Value**
Agent	BENZE
Concentration	45ppb
Measure duration	84.00s
Measure datetime	2013-06-08 08:45:00

7.1.2 GUARDION

Field	Description
Agent	Name of the Chemical agent identified
Result	Positive/Negative
Measure datetime	Datetime in which the detection was done

Table 7 – GUARDION information

An example in a human readable format should be something like this:

Variable	**Value**
Agent	TOLUE
Result	Positive
Measure datetime	2013-06-08 18:35:00

7.1.3 NDIS (Nano Intelligent Detection System)

Field	Description
Agent	Name of the Biological agent identified
Result	Positive/Negative
Measure datetime	Datetime in which the detection was done

Table 8 – NDIS (Nano Intelligent Detection System) information

An example in a human readable format should be something like this:

Variable	**Value**
Agent	ANTHRAX
Result	Positive
Measure datetime	2013-06-08 18:35:00

7.1.4 Fido B2

Field	Description
Agent	Name of the Chemical agent identified
Result	Positive/Negative
Measure datetime	Datetime in which the detection was done

Table 9 – Fido B2 information

An example in a human readable format should be something like this:

Variable	**Value**
Agent	RICIN
Result	Positive
Measure datetime	2013-06-08 18:35:00

7.1.5 Gamma Camera

Field	Description
Gamma/Visible image	Indicator for gamma or visible image
Longitude	Longitude of the sensor location in WGS84 decimal degrees
Latitude	Latitude of the sensor location in WGS84 decimal degrees

Field	Description
Heading	Direction toward the camera is located measured clockwise from the north
Image	Binary field with the image captured
measure datetime	Datetime in which the image was captured

Table 10 – Gamma camera information

An example in a human readable format should be something like this:

Variable	**Value**
Technique ID	16 *(sensor identifier)*
Gamma OR visible	1/0
Longitude	-2.64007
Latitude	40.6073
Heading	45º
Image	*<Binary field with capture0001.jpg>*
Measure datetime	2013-06-08 06:30:00

7.1.6 Colibri

Field	Description
Longitude	Longitude of the sensor location in WGS84 decimal degrees
Latitude	Latitude of the sensor location in WGS84 decimal degrees
User	
Measure	
Measure datetime	Datetime in which the measure was done
Unit of measure	
Integrated dose	
Integrated dose unit of measure	
Calibration coefficient	
Calibration source	

Field	Description
Calibration validity	
Probe name	
Probe serial	
Detector information	
Firmware	
Colibri Serial Number	

Table 11 – Colibri information

7.1.7 Falcon 5000

Field	Description
Nuclides quantity	Variable number indicating the quantity of radioactive emitting nuclides that were detected
Nuclides List	List with the names of the detected nuclides
Longitude	Longitude of the sensor location in WGS84 decimal degrees
Latitude	Latitude of the sensor location in WGS84 decimal degrees
Dose rate	The photon ambient dose equivalent rate measured with an internal GM tube
Unit of measure	Unit of measure used by the sensor (e.g. microSv/h)
measure datetime	Datetime in which the measure was done

Table 12 – Falcon 5000 information

An example in a human readable format should be something like this:

Variable	**Value**
Technique ID:	17
Number of nuclides:	5
Nuclides list:	[K-40, Co-60, Ba-133, Cs-137, Am-241]

Longitude:	72.767028
Latitude:	41.507582
Dose rate:	0.19 microSv/h
Measure datetime	2013-06-09 06:30:00

7.2 Cameras

Field	Description
Start Longitude	Longitude of the sensor location in WGS84 decimal degrees in the start point of the record
Start Latitude	Latitude of the sensor location in WGS84 decimal degrees in the start point of the record
End Longitude	Longitude of the sensor location in WGS84 decimal degrees in the end point of the record
End Latitude	Latitude of the sensor location in WGS84 decimal degrees in the end point of the record
Start datetime	Start Datetime of the record
End datetime	End Datetime of the record
Video record	Binary field with the record

Table 13 – Cameras information

7.3 Global Positioning Systems

Field	Description
Longitude	Longitude of the sensor location in WGS84 decimal degrees
Latitude	Latitude of the sensor location in WGS84 decimal degrees
location datetime	Datetime in which the location was received

Table 14 – Global Positioning System information

An example in a human readable format should be something like this:

Variable	**Value**
Technique ID:	18
Longitude:	72.767028
Latitude:	41.507582
Location datetime	2013-07-09 08:30:00

8 CONCLUSIONS AND RECOMMENDATIONS

- The most common types of disasters have been analysed. However it is possible that new disasters could appear in the future. It should be taken into account that the system must include a category to manage generic disaster (e.g. Miscellaneous)
- The main goal achieved is to put into the same language all the different groups of information analysed in the deliverable (disasters, data sources, entities affected …)
- An Ontology has been defined to join together all this concepts
- This ontology will allow not only the data and information representation in the same common language, it will also provide inferring and data querying capabilities
- JC3IEDM data model is proposed as an important basis for the ontology proposed
- The ontology provided is in a very early stage. It must be developed in further tasks
- Regarding the Data Sources included in the deliverable it must be further analysed how the data sources itself and the information provided could be managed by the data model. The final feasibility of these data sources will depend on the results of this analysis