Towards an interoperable data model for forest fire reports

María Hernández, Susana Montero, David Díez, Ignacio Aedo and Paloma Díaz
Laboratorio DEI. Computer Science Department
Universidad Carlos III de Madrid
{mhjuan, smontero,ddiez,aedo,pdp}@inf.uc3m.es

ABSTRACT

The creation of action statistics of fire extinction services is a common activity in the management of forest-fires emergencies. The compilation of action data and the elaboration of statistics based upon those data allow drawing relevant information about forest fires emergencies and fire extinction services. The creation of action statistics requires the exchange of heterogeneous data, with different granularity and detail, among scattered sources. This paper introduces a Forest Fire Report Data Model devoted to be a data reference model for sharing and exchanging forest fire reports in order to achieve syntactic interoperability among independent systems. The definition of the model has been based on the review of forest fire statistics made by different agencies as well as the experience gained in developing an information system, called SIU6, for the creation of action reports of fire extinction services commissioned by the Spanish Civil Defense Organization.

Keywords

Interoperability, data model, XML schema, EDXL-DE, forest fire.

INTRODUCTION

A forest fire is any no-structured fire that occurs in the wildland. Forest fires are very common in various parts of the world. According to the FAO (FAO, 2006), there were 4000 million forest hectares in 2005, which represents 30% of the surface of Earth and Spain is the European country with a higher number of forest fires (The European Commission, 2008). Moreover, fire has catastrophic impacts, including forest degradation leading to economic, social and environmental damage. The study of forest-fire hazards helps us in the preparedness and management of responses.

Fire extinction services produce reports of every one of their actions. These reports record the actions of the fire department personnel, related agencies, and civilians involved, as well as the resources used and the victims. Different organizations can cooperate in these reports to inject information, consolidate it (when different teams or stations work together to mitigate the fire) or share it. Moreover, some specific data from reports can be selected to analyze the economic, ecological and social impact and to improve the fire risk assessment. This cooperation is not as smooth as expected since organizations use systems that are not always compatible. For example, in Spain, each region is responsible for its own emergencies that are managed using one or more applications to store and manage the forest fires reports with their own format. Later, they send the needed data, no reports, to the Ministry of the Environment and to the Ministry of Internal Affairs (Spanish Civil Defense Organization – DGPCE -) in order to perform a number of statistics.

In this paper, we present a Forest Fire Report Data Model intended to be a data reference model for sharing and exchanging forest fire reports in order to achieve interoperability among different organizations. The aim of this data model is twofold. Not only avoiding syntactic conflicts between outputs from different Information Systems for Forest Fire Management and Systems for Generating Statistics in an automatic way (in this case, only a subset of action's data is needed), but also providing a data model that is flexible and scalable enough to share data with different granularity and detail (for example, different organizations work together to elaborate an unique report). Moreover, this data model has been developed to be a payload for EDXL-DE messages (OASIS, 2006) like other specific languages such as EDXL-HAVE (OASIS, 2006).

This paper proceeds by relating our work to previous research related to standards for emergency information system interoperability. Then reports and statistics for forest fires from different organizations are analyzed in order to create a more complete data model. After presenting the analysis, the forest fire data model is described. Finally, the paper presents the main conclusions of this research and future work.

STANDARDS FOR EMERGENCY INFORMATION SYSTEM INTEROPERABILITY

In the emergency area, there are some approaches for emergency information system interoperability based on XML schemas and gathered in two groups: domain specific and general. In the former group, we can find languages and standards, such as CWML (cyclone warnings), TWML (tsunami warnings), IEEE 1512 (traffic incidents) (IEEE, 2003) and VEDS (Vehicular Emergency Data Set) (ComCARE, 2004). Apart from this, CWML and TWML are languages for specific warnings. The IEEE 1512 standard is used for sharing information between different organizations. These organizations are the emergency participants. IEEE 1512 provides a set of messages for communicating the participants during emergency. These messages are useful for managing emergencies, for example traffic incidents, but are not useful after emergency. Finally, VEDS is a standard for the transmission of telematics data to emergency response agencies, but it does not gather information about the resources used in the vehicular emergency. In this former group, we have not found any proposal for forest fire emergencies.

In the later group, CAP (Common Alert Protocol) (OASIS, 2005) is a protocol that can be used to send emergency warnings. A CAP message contains some information for explain people what has happened. It is possible to use CAP for forest fire warnings, but not to send more detail information about the forest fire emergency. EDXL (Emergency Data eXchange Language) (OASIS, 2005) facilitates emergency information sharing and data exchange across organizations. EDXL is compounds other standards: EDXL-DE (OASIS, 2006), EDXL-RM (OASIS, 2008), EDXL-HAVE (OASIS, 2006) and CAP (OASIS, 2005). EDXL-DE (EDXL-Distribution Element) may be considered as a container and it facilities the routing of emergency messages writes on XML format. This standard provides routing information such as incident, sender, and geography and distribution type. The EDXL-RM (EDXL-Resource Messaging) and EDXL-HAVE (EDXL-Hospital Availability Exchange) are two EDXL specific standards, but they cannot be used to send forest fire information, because of the former is for resources information and the later is for hospital information. Since EDXL-DE standard is considered as a container, the payload message can be a CAP message, an EDXL-RM message, an EDXL-HAVE message, or any emergency message written on XML format. All these standards have in common a strategic decision to adopt XML as the main standard for data integration including provision of XML schemas.

After this review, we have not found any appropriate standard to exchange data about forest fire emergencies. Therefore, a combination of both approaches has been adopted. Our aim is to define a data model devoted to the exchange and sharing of data that is flexible and scalable enough to share information with different granularity and detail. Moreover, considering the specifications of current standards, the data model is encoded in XML schema in order to be a payload for EDXL messages.

ANALYSIS OF REPORTS AND STATISTICS FOR FOREST FIRES

The data model here presented is the result of an analysis of two different sources: our experience gained in developing information system for emergency management and the review of forest fire statistics from different organizations.

The acquisition of action data by fire extinction services is a complex and tedious process. In order to simplify this process, the SIU6 system had been developed. SIU6 is an information system developed in partnership between the DGPCE and the *Universidad Carlos III de Madrid*. The development of SIU6 was guided by a user-centered design method. The project team included representatives for fire extinction services as well as emergency management experts. This system is used for the acquisition of action data through the set up, modification and validation of action reports by fire extinction services. SIU6 automates and brings up to date the '*unified action report'*. Thus, the '*unified action report'* has helped us as a starting point for defining our model. This report has given us information about actions of fire fighters, in particular on forest fires we have found: type of fire, origin of fire, topography, resources, victims and information about managing the actions. In addition, we have learnt the kind of data that are important for mitigating forest fires: number of hectares burned, date of forest fire, number of resources (these data are important to generate statistics).

We have also analyzed forest fire statistics from different organizations, such as USFA and NIFC (United States of America), AFAC (Australia), JRC (European Union), Spanish Ministry of the Environment and DGPCE. In Table 1, we show the organizations analyzed and the forest fire information useful for statistics. The aim of this table is to point out which elements are more common to all these organizations. Rows in Table 1 classify data under this category. Columns represent the organizations analyzed. At last, there are three types of cells in Table 1. There is a *tick* inside a cell if the organization uses the same set of data for this category. Cells have a "≈" if the organization does not use the same group of data for this category. Finally, empty cells mean, the organizations do not use the category on their statistics.

	ORGANIZATION				
STATISTIC DATA	USFA / NIFC	AFAC	JRC	Ministry of the Environment	DGPCE
Chronology	≈			≈	✓
Time Period	≈	≈	✓	✓	✓
Emergency Area	✓	✓	✓	✓	✓
Resources	✓	✓	✓	✓	✓
Fire Type			✓	✓	✓
Origin	✓	✓	✓	✓	✓
Topography	≈	≈	✓	✓	✓
Land Type					✓
Victims	✓		≈	≈	✓
Communicating Type				✓	✓

Table 1. Data sources

As seen in Table 1, many coincidences were found between statistics from the previous organizations. However, some data is not used by all organizations. The most relevant case is about *Victims.* USFA/NIFC and DGPCE organizations make statistics with the sex, age, state, type and count of victims. The rest of organizations use a part of these data (state, type and count) or, directly, they do not generate statistic's victims. Another example is *Time Period* data. Only European statistics (JRC and Spain) use information about the final date and the final hour. Since our aim is to create a flexible and modular data model, we have merged both the general and specific forest fire information recorded in reports, and the most complete statistics in order to cover all organizations of Table 1.

A DATA MODEL FOR FOREST FIRE REPORTS

Figure 1 shows the Forest Fire Report Data Model elements. First of all, we explain the used nomenclature. In our model, there are three types of cardinality: (1) One to zero or more (1 - *), (2) One to one or more (1 - +) and (3) One to zero or one (1 – 0...1).

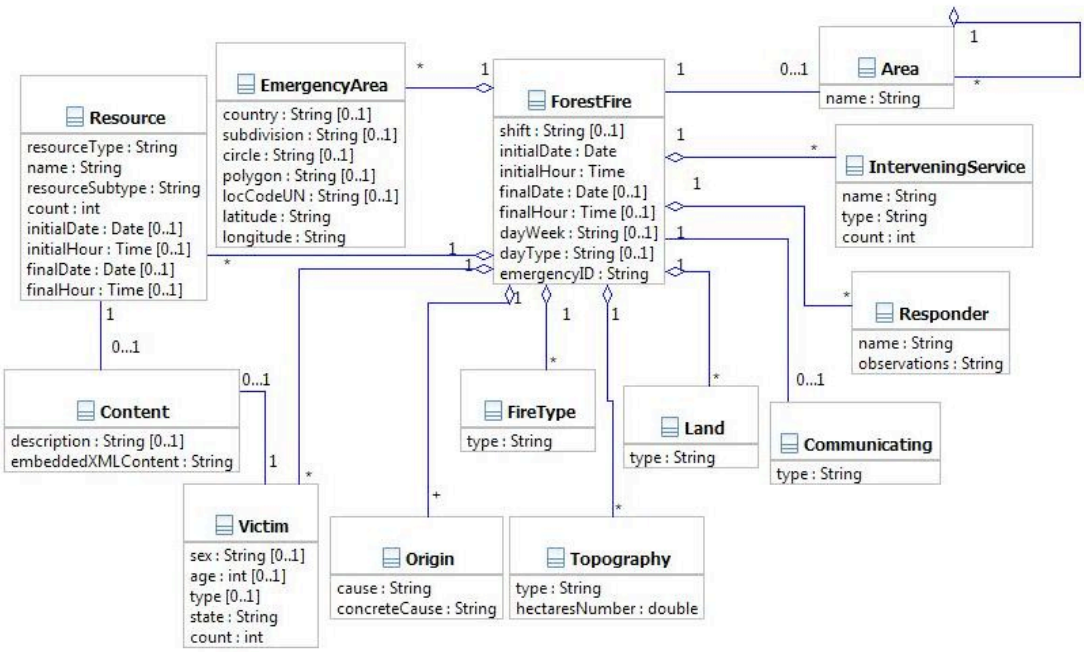

Figure 1. Forest Fire Report Data Model

In our model, we have merged data from two sources: data from Table 1 and forest fire data gathered on '*unified action report*'. In the first source, we found elements such as **Resource**, **EmergencyArea**, **Origin**,

Topography, and **Victim**. In the second source, we obtained the same elements as Table 1, besides rest of elements that compound our model (for example **InterveningService**, **Responder** and **Area**). Next, we will explain the elements of our model. We will take more attention in **Resource**, **Area** and **Victims**.

- The **Resource** element represents the used resources in the emergency by the responders. The fields of **Resource** have been obtained in the data review from statistics and forest fire report. We have included type (for example material, human) and subtype of resource (for example firehose) of resource, the number of resources and the initial and final date of use. Because of there are a lot of data about resources, we have used **Content** element for extending data resources.
- The **Victim** element has the same philosophy as **Resource** element. We provide general data about victims: sex, age, state (victim's harm), type (for example civil, fire fighter) and count. This information can be enlarged with **Content** element.
- The **Area** element represents the fire fighter station action zone, in Spain the fire fighter's Spanish region. An area is composed by a set of regions. These regions, in turn, can be areas.
- The **Content** element allows us to expand resource and victim information. The *embeddedXMLContent* field stores additional data. Although this field is a string, the stored data in the field must have a XML format.

General information about the emergency (when the emergency occurred and the emergency duration) is stored on **ForestFire** element. **EmergencyArea** indicates us where the emergency was produced. **Communicating** element represents people who notify fire fighters that there is a forest fire. Next set of elements represents specific fire data. These elements are **FireType** (like crown, ground), **Origin** (the fire causes), **Topography** (for example grass, conifer) and **Land** (for example shady side). Last data set is management information. The elements belong to this set are: **InterveningService** and **Responder**. **InterveningService** element stores information about services that there are not fire fighters. Last element is **Responder**. This element has information about the fire fighters used in forest fire emergency.

The primary purpose of the Forest Fire Report Data Model is to provide a XML standard for exchanging forest fire reports. This XML standard has been specifically designed as payload of the EDXL-DE. As the EDXL-DE's primary objective is to facilitate the routing emergency messages to recipients, routing and distribution information is found only in the EDXL-DE envelope. Figure 2 shows an example of our model embedded in EDXL-DE. Our model is included inside *embeddedXMLContent* tag. The content of green box in Figure 2 has to be an XML format which compliments the Forest Fire Report Data Model.

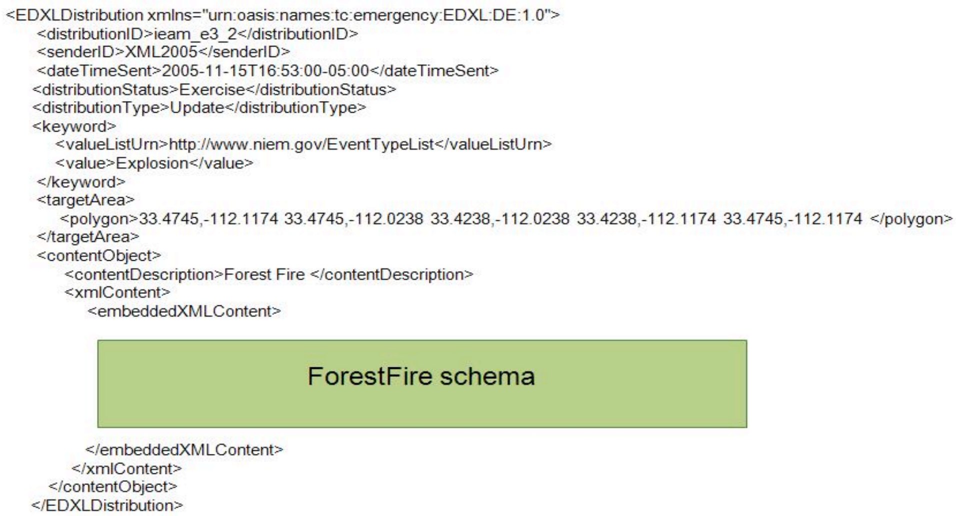

Figure 2. Forest Fire Schema embedded in EDXL-DE.

CONCLUSION

This paper has presented a data model devoted to sharing and exchanging forest fire reports as a result of a study of different sources: (i) languages and standards for emergency information system interoperability, (ii) data gathered in a forest fire emergency by fire fighters and (iii) forest fire statistics from international organizations. The Forest Fire Report Data Model provides the capability of aggregating information in order to be used between different organizations. This capability facilitates the filtering information and enables the statistic generation with information more or less detailed. Moreover, the data model has been encoded in XML Schema to be a payload for EDXL.

Next work consists of two tasks: to prove, first, the syntactic interoperability of our data model and to advance towards semantic interoperability. For the first task, we are developing a web service. This service will be used to enable intercommunication between different systems using our data model: two different systems to collect information from fire fighters performance and another system devoted to generate statistics following the requirements of the DGPCE (ESA6). In addition, we will use different granularity on the data to prove flexibility and scalability of our model. For the second task, we will study the use of thesaurus or ontology languages to describe the data model and the mechanisms needed to achieve semantic interoperability.

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