Thinking OpenGIS Web Services (OWS) for the dissemination of natural hazards data

S. Schmitz[1], T. Glade[1], G. D. Dellow[2], K. Greve[1]
1 Departement of Geography, University of Bonn, Germany
2 Institute of Geological & Nuclear Sciences, Wellington, New Zealand
Corresponding author: ssschmitz@uni-bonn.de

ABSTRACT : The non-interoperability of different spatial datasets hinders the integration of geoscience data from several distributed sources. OpenGIS Web Services (OWS) as defined by the Open Geospatial Consortium (OGC) offer a solution to this problem. Based on the presentation of a prototypical implementation of OWS for New Zealand landslide data, a vision of OWS more widely applied within the natural hazards domain is set out employing principles of a Service-Oriented Architecture (SOA). This is intended to help raise awareness for the advances of this emerging new technology within the natural hazards community and trigger further implementations.

KEYWORDS : Data interoperability, OpenGIS Web Services, Natural hazards, Landslides, Service-Oriented Architecture, Web Map Service

1. Basic considerations

Considerable efforts are made to understand and manage natural risk. Many institutions are involved in this process and communication between the involved parties is crucial. However, various actors dealing with natural hazards and risk are in many cases hindered to cooperate efficiently. This is also due technological barriers, often becoming manifest in the non-interoperability of different spatial datasets on natural hazards and risk with each other [Annoni et al. 2005]. The issue of non-interoperability is addressed and analysed utilising examples from within the landslides domain.
For instance, problems may arise, when trying to build up a landslide inventory from several distributed sources, in which data is held in various formats. Another example is the installation of a sensor network to monitor or closely examine a landslide, in which sensors may conform to a proprietary interface only. This will restrict the use of monitoring data to client applications conforming to that specific interface. Finally, non-interoperability of systems and data formats poses a significant problem if one is interested in a continuous calculation of landslide susceptibility, hazard or risk using the most recent data available from distributed sources, which may be gained from a local early warning system.

Since 1994, the issue of non-interoperability between different spatial datasets is being dealt with by the Open Geospatial Consortium (OGC). The World Wide Web (WWW) has been recognised by the OGC as an unprecedented opportunity to overcome non-interoperability of different spatial datasets. Heavily influenced by the rapid development of Web Services technology and the concept of Service-Oriented Architectures (SOA) within Information Technology (IT), through efforts driven by the OGC a new approach to dealing with spatial information has emerged, which is termed the Spatial Web [McKee 2003]. It is based on the idea to achieve interoperability between different spatial datasets through standardisation of interfaces to functionalities related to spatial information. Earlier initiatives focused mainly on unifying file and file exchange formats. The technological backbone of this OpenGIS idea are Web Services, which encapsulate a specific functionality related to spatial information. Interfaces to these OpenGIS Web Services (OWS) are defined by the OGC in close collaboration with the International Organisation for Standardisation's Technical committee 211 (ISO /TC211) through OpenGIS Implementation specifications. They have been described as "a kind of digital 'lingua franca'" enabling geographic data and processing resources from multiple sources and vendors to interact with each other [McKee 1999]. OWS can be described in five categories including Data Services, Processing Services, Portrayal Services, Registry Services and Application Services [OGC 2003]. In order to enable multiple Services to actually exchange information, a common encoding for transport, modelling and storage of geographic information has been designed – the Geography Mark-Up Language GML [OGC 2004].

In recent years, numerous initiatives have formed to build spatial data infrastructures (SDI) based on OWS in order to make spatial information and processing resources more widely accessible to and more frequently used by institutions and people. Spatial data and information from within the natural hazards domain, however, only in few cases are integrated into SDI and are only seldom available through OWS.
One effort to change this, is the electronic Geophysical Year 2007/2008 (eGY) aiming at "accelerating the adoption of modern and visionary practices for managing and sharing data and information" within geosciences (http://www.egy.org). Many geo-scientists do not seem to be aware of possibilities brought about by the technological developments briefly outlined above. Based on the presentation of a prototypical implementation of OWS for landslide data in the following, perspectives of OWS more widely applied within the natural hazards domain will be given in the final section. This is intended to help raise awareness for the advances of this emerging new technology and trigger further implementations.

2. Prototypical implementation of OWS for landslide data

[Schmitz 2006] conducted a research study concerned with the web-based dissemination of landslide data collected under the scope of the GeoNet project. GeoNet is a monitoring project for geological hazards in New Zealand [Cowan 2001]. A prototype was built implementing a Portrayal Service (Web Map Service – WMS) for New Zealand landslide data along with a conforming client application [OGC 2001]. Both proprietary (ESRI ArcIMS®, server-side) and Open Source software (deegree iGeoPortal, client-side) have been used. Capabilities of this prototype were compared with those of a solution not making use of OWS technology against previously elaborated background requirements for the process of disseminating GeoNet data. Requirements included to provide a source of data rather than only a view onto it, conformance to relevant standards for the exchange of spatial data and the need for interoperability with other spatial datasets in a variety of formats.
The implemented prototype proved superior over the solution not making use of OWS in addressing these key requirements. However, several restrictions apply including the issue of making users aware of data disseminated through OWS. Closely connected with this is the need for other OWS to be implemented for New Zealand spatial data to enhance data availability and distribution. Both issues may be resolved when implemented Services were embedded into a functioning SDI. Finally, case study results could only be obtained for visual representations of landslide data, not the data itself. It is recommended to further employ OWS to make GeoNet data available.

3. Perspectives

These promising results motivate to commonly apply OWS within the natural hazards domain. It will be briefly shown how exemplary non-interoperability problems introduced in the beginning may be resolved.
An architecture for a landslide inventory may be composed of several Data Services (Web Feature Service -WFS) implemented by several institutions willing to contribute data [OGC 2005]. A common GML Application Schema would have to be defined. In that way, data could be integrated from distributed sources without the need for a central database minimising data redundancies and keeping responsibility for data with those, that collected it in the first place. A top-level WFS for landslide data cascading those implemented by the various institutions may be implemented to provide unified access to all data sources. The implemented WFS may be used by several Application Services (Fig.1).

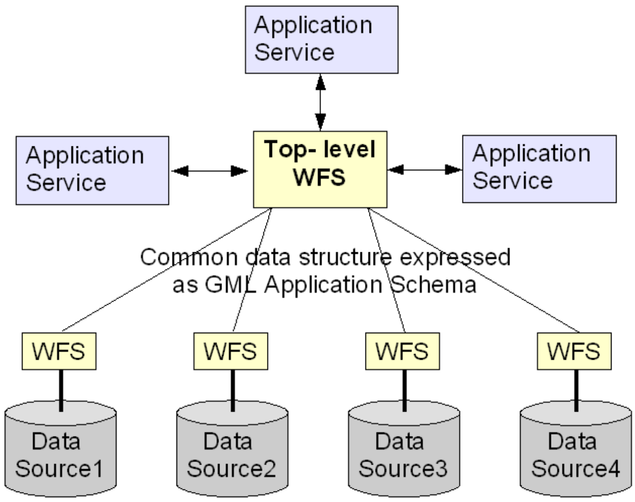

Fig. 1. OWS architecture for the integration of distributed data sources

Thinking about a sensor network, in which sensors conform to a proprietary interface, the SensorWeb Enablement Initiative within OGC comes to mind. Herein, a specification for a Service is under development that provides an interface to manage deployed sensors and retrieve sensor data (Sensor Observation Service – SOS) [OGC 2006]. By wrapping SOS around proprietary sensor interfaces, access to sensors and data collected through them could be greatly enhanced.
The requirement to continuously calculate specific results using respective models (e.g. susceptibility, hazard or risk models) could be met through the implementation of a Processing Service (Web Processing Service – WPS), which is an encapsulated processing algorithm [Schut, Whiteside 2005]. A WPS could be fed by several Data Services and would be capable of regularly generating new spatial information from these.
It has to be noted, that Application Services are able to independently use published and available Services within their own context and logic. This leads to a scenario of freely moving data, processing and portrayal resources within the natural hazards domain encapsulated as OWS arbitrarily available for use by Application Services. In analogy to SOA, the roles of Service Provider, Service Consumer and Service Broker may be allocated (Fig. 2).

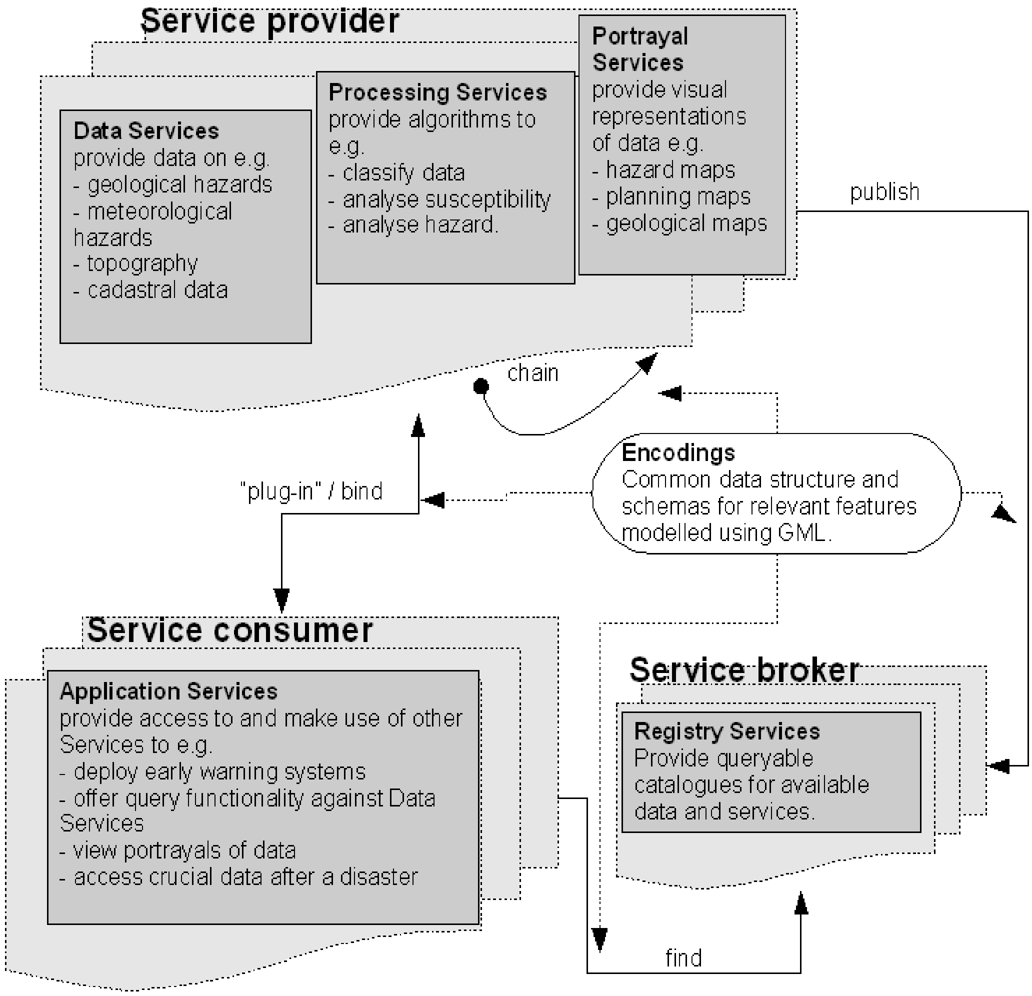

Fig. 2. Scenario of a natural hazards sector partitioned into Services provided or consumed through OWS and employing principles of a Service-oriented architecture (SOA)

Even though unresolved issues such as semantic interoperability across different domains remain, the scenario presented calls for prototypical implementations within the natural hazards domain.

REFERENCES

Annoni, A. et al., 2005. Orchestra: Developing a Unified Open Architecture for Risk Management Applications, In *Geo-Information for Disaster Management* (ed. by P. van Oosterom, S. Zlatanove, E.M Fendel,), 1-17, Berlin

Cowan, H. et al., 2001: GeoNet, In *New Zealand Geophysical Newsletter (58), 21-29*, Wellington

McKee, L., 1999. Inside the OpenGIS specification, OGC White Paper, http://www.opengeospatial.org/press/?page=papers

McKee, L., 2003. The Spatial Web, OGC White Paper, http://www.opengeospatial.org/press/?page=papers

Open Geospatial Consortium (OGC), 2006. Sensor Observation Service, Reference number OGC® 05-088r1

Open Geospatial Consortium (OGC), 2005. Web Feature Service Implementation Specification, Version 1.1.0, OpenGIS document OGC 04-094

Open Geospatial Consortium (OGC), 2001. Web Map Service Implementation Specification Version 1.1.1, OpenGIS document OGC 01-068r2

Open Geospatial Consortium (OGC)2004. OpenGIS® Geography Markup Language (GML) Encoding Specification, Version 3.1.1, OpenGIS document 03-105r1

Open Geospatial Consortium (OGC), 2003. OpenGIS Web Services Architecture, Version 0.3, OpenGIS document OGC 03-025

Schmitz, S., 2006. The Spatial Web and the natural hazards sector - a case study using New Zealand landslide data. Diploma thesis, Department of Geography, University of Bonn, Bonn

Schut, P., Whiteside, A., 2005. Web Processing Service, OGC Discussion Paper, Version 0.4, OpenGIS document 05-007r4