Title: Disaster Mapping 2.0
Subtitle: Collaborative Post-disaster Damage Mapping via Geo-webservices

[Introduction]

In recent years we have seen an increase in the number of major disasters and the damage they inflict, in both human suffering and economic cost. To mitigate the consequences, better post-disaster management tools are needed. GIS plays a major role in disaster management, and today's technological developments in GIS and collaborative web-based mapping, using interoperable geo-webservices and user-generated content, could take disaster mapping one important step further.

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Post-disaster Mapping by UNOSAT

UNOSAT is the UN Institute for Training and Research (UNITAR) Operational Satellite Applications Programme. The main goal of the project was to see how the current post-disaster mapping operations by UNOSAT, under the International Charter "Space and Major Disasters", could benefit from modern GIS and collaborative, web-based mapping technology. The Charter aims at providing a unified system of space-data acquisition and delivery to those affected by natural or man-made disasters. It is widely seen as a successful example of international humanitarian assistance following disasters.

Since the start of the Charter in 1999, activations have increased in number, helped by a recent growth in Charter membership. With the technology currently used, data flow is largely mono-directional: Post-disaster maps are produced at the UNOSAT offices, without the opportunity to include input from other stakeholders. The resulting map products are disseminated through a website, where end users can view and download them in print-optimised PDF format (Figure 1).

Static Challenges

Because the Charter maps are static, one-off products, there is little possibility for additional validation and annotation to add local knowledge and additional information. This approach is poorly suited to meet the changing needs of increasingly specialized players in the disaster arena. It would be an important step forward to move away from static map data provision to a more dynamic, distributed and collaborative environment.

Thus an appropriate application framework has to be developed to enable multiple stakeholders in various locations to 1) customize the post-disaster information, 2) add value by providing feedback or access to their own additional information, and 3) collaborate with other agencies involved in the disaster aftermath. This requires *geospatial collaboration*, which seems technically feasible with the current state of spatial analysis and geo-processing tools. We wanted to see if and how this could be realised for the UNOSAT Charter situation by developing a proof-of-concept application using geo-webservices and Web 2.0 collaborative technology.

Geo-webservices and Web 2.0

Any collaborative environment requires the use of interoperable tools. Interoperability among systems can be achieved by using service-oriented architectures. Within the GIS world, these are generally called *geo-webservices*. Examples of commercial, *proprietary* geo-webservices are Google Earth/Maps, Yahoo Maps and Microsoft Virtual Earth.

For our project we looked into the use of *non-proprietary* systems, using the Open Standards that have been developed for geo-webservices in the Open Geospatial Consortium (OGC). We think this approach can connect the various disaster management agencies, allowing more customized delivery of data and information as well as allowing stakeholders and end users to add value by providing their own information, thus creating new synergies.

The notion of having end users contribute to the information flow of such a system is called *user-generated content,* or *neogeography,* and is considered part of the second generation World Wide Web: Web 2.0. We also wanted to test if techniques from this Web 2.0 world would be suitable for a collaborative disaster mapping system; therefore we decided to test if a connection to geo-tagging tools such as Flickr could be achieved.

Using Case Scenarios

We developed two scenarios: In the first scenario, end users of post-disaster maps were allowed to spatially annotate these maps. Using a simple web browser, they could add notes or remarks that are geo-tagged, i.e. linked to a fixed point in the map. These spatial annotations are made available in the web portal, and therefore can be viewed by other users.

The mapping agency can use the users' geo-tagged remarks to improve and enrich their data and to actively seek help, for instance by posing questions such as, "Does anybody know if this building is still standing?" or "Is this road passable?". The content of the spatial annotations is not limited to text; we also included links to existing photo-sharing services (such as Flickr) or other geo-webservices (e.g. Google Maps).

For the second scenario, we imagined a more limited user group, such as stakeholders who were asked to collaborate actively on the production of post-disaster data. These users required a thick client (a graphical client application that runs on the user's operating system), such as QGIS or ArcGIS, to help with data processing in our use case for delineation of damaged areas. These inputs are used to process the data for the final damage maps; hence a secure access and validation mechanism needs to be in place.

The Prototype

We produced a proof-of-concept prototype that can be tried at http://geoserver.itc.nl/laban/, based on data from the May 2006 earthquake in Yogyakarta (Indonesia). The general architecture for the prototype is shown in Figure 2. (We built the implementation using open source software throughout: The base data are raster images and a PostGIS database, served as OGC Web Map Services by the UMN MapServer middleware. The client was built using OpenLayers, an open source JavaScript library for displaying map data in web browsers, with no server-side dependencies. OpenLayers implements a JavaScript API for building rich web-based geographic applications.) Figure 3 shows it used for the scenario 1 use case. .

We think the prototype shows that, by using off-the-shelf open source components, it is possible to quickly build geo-webservices and web clients that can help achieve the collaborative post-disaster mapping we set out for. Geo-webservices and Web 2.0 technology can mobilise different people from different organisations, help collect large amounts of heterogeneous data and integrate them within a short time.

Further Reading

Maiyo, L., Kerle, N. & Köbben, B. (2009), *Collaborative post-disaster damage mapping via geo-webservices*, in M. Konencny, et al. (eds), 'Cartography and Geoinformatics for Early Warning and Emergency Management: Towards Better Solutions', number Pr-1/09-02/58, Masaryk University, Prague, pp. 386–395.

Biography of the Authors

Barend Köbben received his MSc degree in Geography, specialising in Cartography, from Utrecht University in The Netherlands. He is now Senior Lecturer at ITC. His teaching and research interests are geo-webservices and open source WebGIS and WebCartography.

Laban Maiyo received his MSc degree in Geo-information Science and Earth Observation for Environmental Modelling and Management, an Erasmus Mundus co-operation between ITC and the universities of Lund, Southampton and Warsaw. He is now working in his native country, Kenya.

Dr. Norman Kerle received a Masters degree in Geography from the University of Hamburg (Germany) and the Ohio State University (US), and a PhD in Geography (volcano remote sensing) from the University of Cambridge, UK (2002). He is now Assistant Professor at ITC.

Figure Captions

Figure 1*, Present delivery of PDF maps to end-users from UNOSAT website.*

Figure 2*, The prototype architecture.*

Figure 3*, Screen dump of the prototype being used to annotate a road as being passable by using text input and a link to a geo-tagged photo.*

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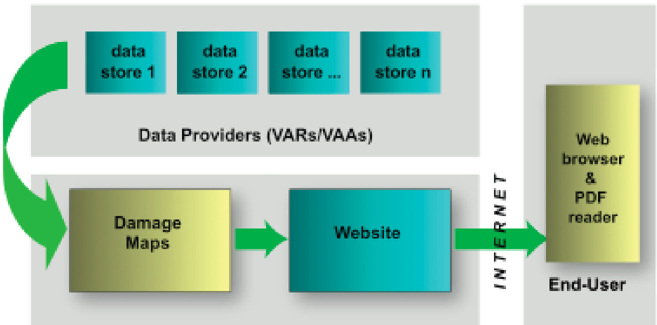
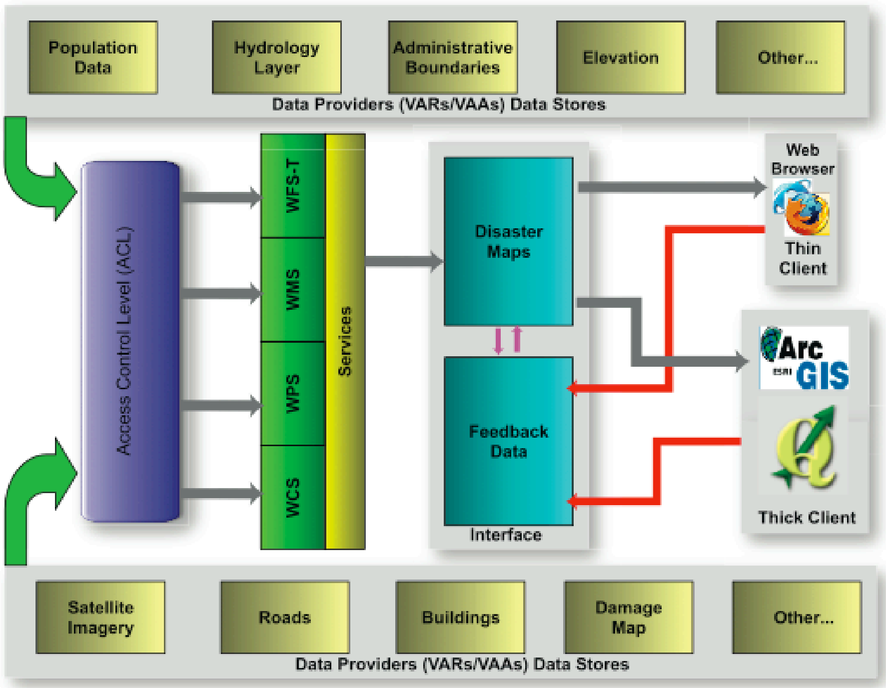
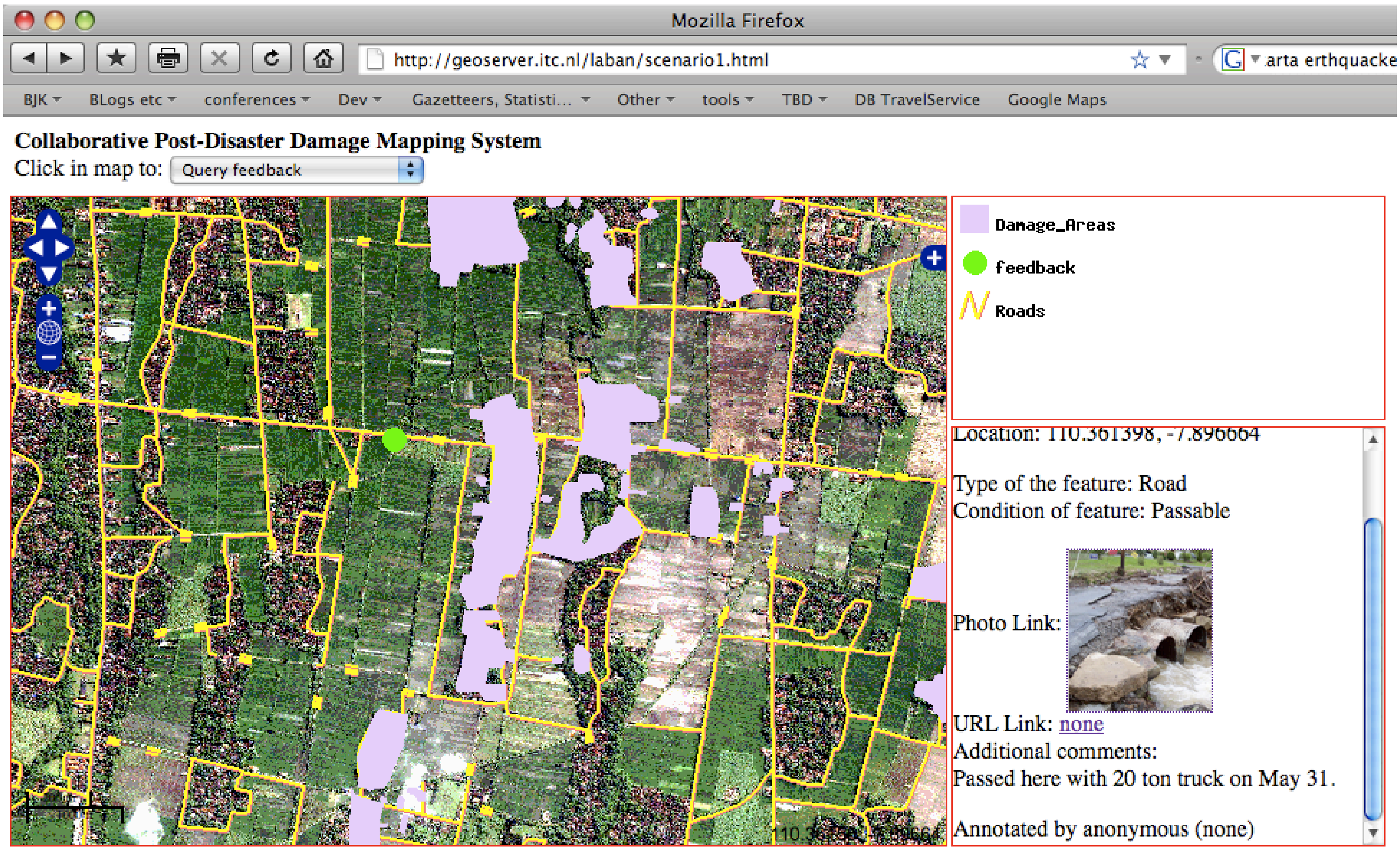
NOTE: if space permits, an additional photograph on the 2006 Yogyakarta earthquake could be used, such as the ones found on
http://images.google.nl/images?&q=Yogyakarta%20earthquake
or
http://www.guardian.co.uk/gall/0,,1784449,00.html


data store 1
data store 2
data store ...
data store n
Data Providers (VARs/VAAs)
Damage Maps
Website
INTERNET
Web browser & PDF reader
End-User


Population Data
Hydrology Layer
Administrative Boundaries
Elevation
Other...
Data Providers (VARs/VAAs) Data Stores
Access Control Level (ACL)
WFS-T
WMS
WPS
WCS
Services
Disaster Maps
Feedback Data
Interface
Web Browser
Thin Client
Arc GIS
Thick Client
Satellite Imagery
Roads
Buildings
Damage Map
Other...
Data Providers (VARs/VAAs) Data Stores


Mozilla Firefox
http://geoserver.itc.nl/laban/scenario1.html
arta erthquacke
BJK
BLogs etc
conferences
Dev
Gazetteers, Statisti...
Other
tools
TBD
DB TravelService
Google Maps
Collaborative Post-Disaster Damage Mapping System
Click in map to:
Query feedback
Damage_Areas
feedback
Roads
Location: 110.361398, -7.896664
Type of the feature: Road
Condition of feature: Passable
Photo Link:
URL Link: none
Additional comments:
Passed here with 20 ton truck on May 31.
Annotated by anonymous (none)