Conflicts in Neogeography Maps

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ABSTRACT: Creating maps, in web 2.0 environments, also called neogeography maps involves map mash-up techniques by which selected base map (Google Maps or OpenStreetMap or alike) is combined with the data collected by users. Unlike traditional maps, these maps are not often designed in balance (and by cartographic experts). Therefore, the maps often suffer from conflicts when the collected data is put together with the base map. The base map and the topic layers themselves suffer from 'internal' conflicts as well. This paper clearly illustrates these conflicts with categorization. A case study (Haiti Crisis Map) was selected to provide solutions for conflicts considering the *damage assessment* use and implemented through a web map. The improved map was tested against the original map. The study revealed that the original map have considerable amount of conflicts which were reduced in improved map.

KEYWORDS: Conflicts, Neogeography Maps, OpenLayers, User Test, Web Map Interface

1 Introduction

Web 2.0 has greatly influenced the way users can exploit geographic information (GI). The GI users contribute is known as user-generated geo-content (UGGC) (Das 2010, URL 1). The domain where users create, visualize, disseminate and make use of GI using web 2.0 applications is known as neogeography (Turner 2006) and the associated products are neogeography maps. Wikimapia, OpenStreetMap, Google Maps are some better known examples where users contribute GI (Goodchild 2009). Neogeography is seen as a major development in GI Science (Goodchild 2007) and, compared to established processes of handling GI it offers cheaper and faster options (Haklay, Singleton et al. 2008). However, it does not replace but complement authoritative data sources (Goodchild 2008; Das 2010).

Many neogeography maps are created based on the mash-up principle. An available base map (as base layer) is combined with UGGC (as topic layer). Such a two-layer principle is not unknown to cartography. Most thematic maps include some topography to put the theme in context and allow a map reader to orientate. Maps like these are mostly designed in balance by cartographic experts. This is not necessarily the case with the neogeography maps, and this makes them suffer from varying degree of conflicts between the base map and the topic layer. However, it is also possible that the base maps and topic layers themselves suffer from 'internal' design conflicts.

The conflict between base map and topic layer can be due to inappropriate content of the base map. This can be related to for instance symbolization styles and map scale. The topic layer is often not complied according to best cartographic practices. In addition the choice of symbology is limited, and not necessarily appropriate for the topic. The maps are often cluttered and multiple features are added in a single map.

In the next section, we provided additional background on conflicts. In section 3, we presented the case study of the Haiti Crisis Map. In this section, the target use and users are described along with their tasks. After the identification of some conflicts, a set of solutions were designed and implanted in a web map interface. Section 4 dealt with the user test where both the original and newly designed maps were evaluated. The paper ends with discussion and conclusions.

2 Conflicts

Several terms, such as spatial conflicts, graphic conflicts, and map conflicts, are used to describe the conflicts in maps and there are no agreed-upon definitions for them. Here we refer to conflicts within map layer, and conflicts between map layers, and distinguish between the source of the conflict, being generalization, design, or function.

2.1 Generalization Conflicts

This type of conflicts arises due to lack of or 'inappropriate' cartographic generalization. The level of detail of either or both the base map and topic layer result in visual clutter. It implies that within a layer point symbols touch and overlap each other (Figure 1a) (Ware and Jones 1998). Zoom in or out might make the problems even worse.

Figure 1: a - Lack of generalization; b - Improper generalization; c - 3x zoom from middle map

A solution for the topic layer is to aggregate the points into clusters which are represented by points or markers (Huang and Gartner 2012). This solution does not always work well - the map remains cluttered with too many overlapped symbols (Figure 1b). The cluttering is even more when the users start to zoom in to the area in figure 1b (Figure 1c).

The conflicts may arise within base map as well. The in-built automatic generalization of base map is linked to different zoom levels (Touya 2012), and is not always appropriate. The level of detail at a particular zoom level can still have too much content appropriate for the scale (Figure 2a). Conflict between layers is often due to different levels of generalization applied (Figure 2b and 2c).

Figure 2: a - Regular OSM; b and c - Different levels of generalization

2.2 Design Conflicts

Neogeography map suffer from design conflict because the symbolization does not adhere to cartographic design rules (Field, O'Brien et al. 2011). The designs conflicts can be found in both the topic layer and base map. The topic layer are often characterized by the use of ‘monotonous balloon’ which are disproportionate in size and do not follow the zoom levels (Figure 3a).

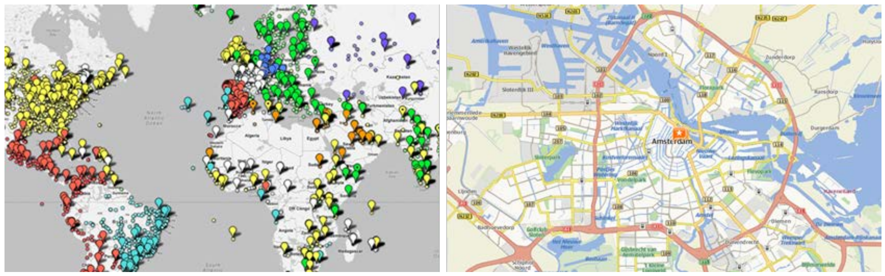


Figure 3: a - Newspaper map; b - Yahoo maps

Base maps available for use in neogeography maps are almost never designed for that task. However, in order to make effective and legible neogeography maps, the selection of appropriate base maps is important (Frye 2009). The design styles applied often tend to suppress the topic layer on top of the base map (Figure 3b) and not all contents are required (emphasized) to support the topic. Since the base map contents are visualized in one single layer, the base map contents cannot be reduced and thus the contents within the base map sometimes conflicts with one another. Insufficient graphical distinction (van Elzakker and van de Berg 2010), between the base map and the topic layer lead to conflicts too.

2.3 Functional Conflicts

Functional conflicts occur due to the limited *functional properties* of base maps and topic layer environment or due to the effects of using a function. The first group is related to the impossibility to distribute content of either base map or topic over multiple layers. This makes it impossible to maintain the visual hierarchy (Toomanian, Harrie et al. 2011) according to relative importance. The second group is related to the way the presentation of selections is implemented. The interface allows users to click on map features that pop up an information window to show attributes (additional information). These windows are often unnecessarily large hiding major portions of the map.

3 Case Study: Solving Conflicts in the Haiti Crisis Map

Whether the conflicts within a neogeography map are problematic depends on the its use. It is impossible to provide solutions if the rationale for creating the map and its uses are unknown. Moreover, providing solutions for all the conflicts described here is out of scope of this paper. This research considers Haiti Crisis Map as a case study where attempts are made to elaborate the conflicts, and to offer possible solutions considering the target use and users with further implementations and evaluations.

3.1 The Map and its Use

The Haiti Crisis Map (Figure 4a) was created by crisis mappers after the earthquake in January 2010 to map the damage-related (crisis) information. Its objective was to assist individuals for daily-life activities, relief operators for mitigation purposes and organizations for action planning and damage assessment. The crisis information as topic layer contains seven features (map key in Figure 5b) which are created by tagging already existing features in the openstreetmap (OSM), which is used as base map (Figure 4b). It uses the same number of zoom levels (0 – 18) as OSM. By default, the map opens with zoom level 14 (equivalent scale is 1: 35000) centered on Port-au-Prince.

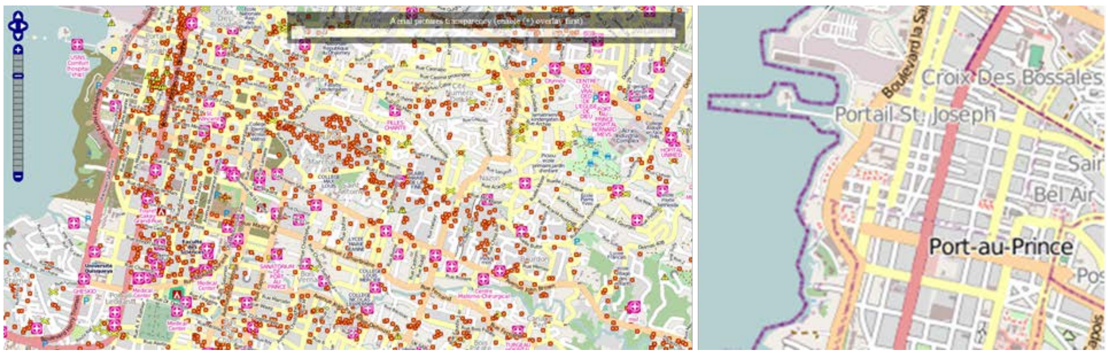


Figure 4: a - Haiti Crisis Map-project and b - The base map (OSM)

The table below (Table 1) summarizes the existing use cases, the users and the tasks they executed.

Table 1: Use case scenario – target users and uses and their tasks for Haiti Crisis Map

Organizations	*Users*	*Use*	*Tasks*	*Links*
Inveneo (an NGO) /Red Cross	Members/Field Workers	Response to Earthquake	Finding sites, route planning & navigation	URL2, URL3
ITHACA/WFP/UNITAR/IMMAP	Experts	Damage Assessment	To see damage distribution	URL4 to URL7
Colombian Team / Fairfax County Team	Search and Rescue Operators	Search and Rescue Operations	To locate damaged features	URL8, URL9
UNOCHA	Public	Earthquake Report	Use the Haiti map for situation reporting	URL10

To study the conflicts in more depth, damage assessment was selected as a use case with the following tasks in mind (i) to locate damage-related features and get additional information; and (ii) to get an overview of spatial distribution of features. These tasks were later used in an evaluation and will be further discussed in section 5.

3.2 Conflicts

In the Haiti Crisis Map, the topic layer often conflicts with base map contents due to inappropriate ***generalization.*** The in-built automatic generalization of OSM is not properly adapted to various zoom levels. All content is always shown (Figure 4b) but cannot be clearly perceived at default zoom level.

Design creates two major conflicts because both base map and topic contents are visualized using bright coloured symbols resulting in a lack of visual hierarchy between base and topic. The symbols in both layers are unnecessarily big and not properly scaled to certain zoom level. The topic does not ***function*** as separate layer, and is rendered along with the base map. Interaction is not possible as well.

3.3 Three Phase Solutions for Conflicts

Generalization – With the default zoom level in mind the OSM has been generalized. The number of *point features* within OSM is reduced. Because those point features, (parking lot, hospitals and churches) are conflicted with the topic, as they are visualized using relatively large symbols and strong colours which become unreadable at low zoom level. *Polyline features* like tertiary road and further below (residential, living street etc.) are eliminated from the map. Merging is used to generalize the *polygon features*. For example - park, garden, village green are merged into one type of polygon with *light green* indicating vegetative areas. The *labeling (texts)* has also been generalized based on relevance.

Designs – To increase the graphical distinction, **base map** *point features* are symbolized using reduced size and subdued colours (light gray and light brown). The *polyline features* are shown using subdued colours too. The polygon features (for example ocean, land use etc.) are visualized using few subdued colours (5 instead of many) to improve the visual hierarchy (Figure 5a). The original **topic layer** used pictorial symbols for seven damage-related features (Figure 5b). Pictorial symbols tend to take more space and have been replaced by geometric symbols (Figure 5c).

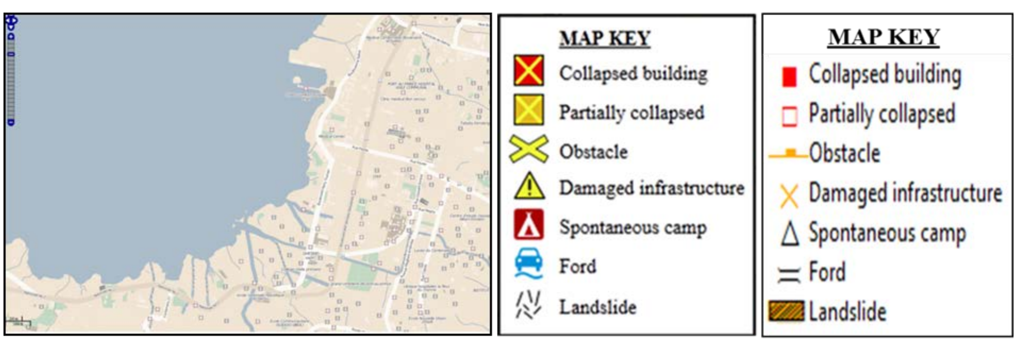


Figure 5: Cartographic designs: a- Improved base map (OSM); b – Old symbols; c- New symbols

Functionality – The topics are now displayed as separate layers that allow users to switch it on and off. It partly improves the visual hierarchy as the users get an impression of having topic layer placed on top of base map and partly improves the conflicts as users can now regulate the amount of topic contents.

3.4 Implementation

The base map (OSM) is generalized using *CloudMade style Editor*. It allows anyone to customize the style of regular OSM coverage through two techniques – I) highlight or suppress any map contents at any particular zoom level and II) changing the colours of symbols used for the map contents (URL11). This first technique is used to apply generalization that meet the criteria for reducing the conflicts at zoom level 14. The generalization done is only suitable for the default zoom level (14) and thus cannot be considered suitable for all zoom levels. It cannot also overrule the automated generalization of OSM.

For the design of base map contents, *CloudMade* is used to change the colours of contents and to change the symbology of line features (such as road and canal). Thematic symbols (for topic layer) are redesigned using ArcGIS after downloading the data from *Geofabrik* as shapefiles. Seven separate layers (for damage-related information) were created. The map layers (shapefiles) after design (in ArcGIS) were later published online as a service using ArcGIS server. During publishing the map layers, data were uploaded to the server and different mapping services (WMS and WFS) for each layer were created. However, for the implementation (to create the interface), only WMS layers were used.

An open-source JavaScript library, *OpenLayers* is used to implement the proposed solutions through creating a new web map interface (Figure 6). OpenLayers is used for several reasons such as - (a) it is used for both OpenStreetMap and the original Haiti Crisis Map; (b) it allows the re-designed OSM from CloudMade platform to be integrated and any change made in base map (OSM from CloudMade platform) is being instantly updated in the interface; (c) there are no issues of "API Key' with OpenLayers.

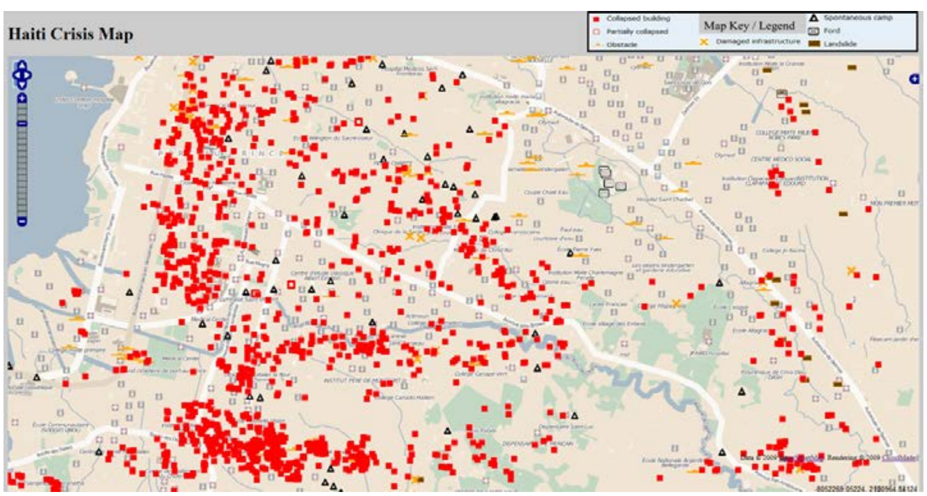


Figure 6: Implementation of solution design for Haiti Crisis Map – New interface

4 User Tests

The aim of the user tests was to evaluate the improved neogeography map (the web map interface) against the original Haiti crisis map. Therefore, one group of test persons (TPs)

–the control group- worked with the original Haiti map, whereas a second group of TPs had to execute tasks with the improved version of the map.

4.1 Test Persons

From the possible uses of the Haiti Crisis Map (as described in section 3.1), we selected damage assessment as the use case for the user testing. For this use case, the typical users are experts (scientists, researchers, action planners, etc.). It appeared to be difficult to locate such experts in a non-crisis situation in another part of the world. Because we selected observation during task execution as the most appropriate test method (see section 4.2), physical presence of the TPs was required. Therefore, we defined a persona, reflecting the characteristics of the target users, in terms of damage assessment experience, geographic expertise and knowledge of neogeography mapping and OSM. On the basis of these criteria, 16 TPs were selected from the staff and student (PhD & MSc) population at the Faculty ITC of the University of Twente. These TPs were equally divided in a random fashion into two groups of 8 – group 1 and group 2. Table 2 gives an overview of the characteristics of the TPs in the two groups. The user tests were completed with one TP at a time and TPs were asked not communicate with each other before participation.

Table 2: Test Person Characteristics (number in brackets represents number of TPs)

	Damage assessment experience	*Domain of expertise*	*Experience in domain (in years)*	*Knowledge of neogeography mapping + OSM*
Group 1	Yes (2) No but have ideas (5) No (1)	Geo-informatics (GI) (3) GI + Mapping (1) GI + Disaster Management (DM) (1) Mapping + Governance (1) GI + Planning (1) Natural Resources + GI (1)	0 – 5 (2) 5 -10 (4) More (2)	Yes (5) Yes and OSM (2) No but OSM (1)
Group 2	Yes (5) No but have ideas (1) No (2)	Geo-informatics (GI) (4) GI + Mapping (1) GI + DM (1) GI + Mapping + DM(1) Geology & Remote Sensing (1)	0 – 5 (4) 5 -10 (3) More (1)	Yes (2) Yes and OSM (2) No but OSM (2) No (2)

4.2 Test Methods

The applied test methodology was a combination of observation (of the TPs executing tasks) and questionnaires. TPs were requested to follow instructions given and complete a questionnaire. For their observation, several techniques were used. *Screen Capturing* was used to record the user's interactions with the map and for task timing analysis. TechSmith's *SnagIt* software was used for this purpose. The *think aloud* technique was used to supplement the screen logging, as screen logging cannot record the verbal thinking process. *Video recording* (with a HandyCam) was used to record both the user's voice and the screen. Before the actual user tests, two pilot tests were conducted to refine the tasks and questions as well as some solution designs.

The tests consisted of three parts. Pre-test information was collected through a questionnaire in *part 1*. This information was important to know more about the characteristics of the TPs and to confirm that they could truly represent the persona as defined in section 4.1. The central part of the user tests was *part 2*, in which TPs were assigned two tasks and 11 questions to answer. *Task 1* was to locate the damage-related information and to answer two questions (related to design aspects). *Task 2* was to identify the spatial distribution of damage-related information and to answer nine questions (related to design and generalization as well as functionality aspects). The relevance of the default zoom level for damage assessment and the visual hierarchy (between the base map and the topic) were considered as well. The objective of this part of the user test was to learn about the conflicts in both maps and find out to what extent the improved map resolved these conflicts. Post-test information was collected in *part 3* after the TPs had finished the assigned tasks. This part was kept for a subjective evaluation of the maps on the basis of seven criteria – effectiveness, efficiency, usefulness, TPs reaction (interactivity), satisfaction, functionality and consistency. For each criterion, TPs had to answer multiple questions.

5 Analysis, Results and Discussion

The answers given to all questions were analyzed and the screen capturing (and video recording) was used to note down the time taken to complete each task and question. User behaviors and expressions were also noted. For the thinking aloud analysis, the audio files were played back and the user comments (as well their expressions about difficulties and confusions) were listed.

5.1 Tasks and Questions

For *part 2*, a *task timing analysis* was executed. Data from video recordings and screen capturing were analyzed by calculating the average time needed for the tasks and questions for all TPs for both maps. The results are shown in Figure 7a. The answer status (whether the answer was correct or complete) was also considered.

The average time for the completion of each task / question is relatively less for (the improved) Map 2, with a few exceptions. In Task 1, the users of Map 2 answered quickly (with nearly 100% correctness), compared to those of (the original) Map 1. In Question 1 / Q1 (to identify the part of Haiti which has most landslides), Map 1 users took much longer time and some TPs could not even find the landslides. Two users identified the landslide features, but they could not visually estimate the distribution (confirmed by screen capturing and thinking aloud), resulting in incorrect answers. In Q2 (to identify the type of damage that occurred most in the NW of Port-au-Prince), users of Map 1 produced 50% error. Comparing the execution of Task 1 for both maps clearly indicates that users of the original Haiti Crisis Map (Map 1) considerably suffer from the design conflicts, whereas the performance with the improved Map 2 is much better.

However, the results for the execution of Task 2 are more mixed – for 5 out of 9 questions, Map 2 users needed the same or more time than the Map 1 users. For Q8 (Which layer has the most features?) and Q9 (Is it useful to have layer switching?), the time is almost equal – but for Q8, Map 2 users produced less error (12.5% compared to 37.5% for Map 1). Layer switching is not possible in Map 1 but test persons indicated they need this functionality. So this functionality improvement worked better in Map 2.

For answering Q1 (whether the TP gets an overview of the spatial distribution), Q4 (whether the default zoom level is correct to get such overview) and Q7 (whether the visual hierarchy is present) of Task 2, Map 2 users took more time. But, in the case of Q1, no negative answers were given by the users of Map 2, whereas the use of Map 1 resulted in three negative answers. So the design of Map 1 may again be questioned. The answers to Q4 were exactly the same for both groups, but the analysis of the answers to Q5 (Which zoom level is correct to get an overview of the spatial distribution?) indicates that Map 2 users mostly agree with the default (50%), whereas 25% of users either wanted to zoom out or to zoom in from the default zoom level respectively. But for Map 1, only 1 user agreed with the default zoom level; 3 other users preferred a higher zoom level and the remaining 4 test persons preferred such a low zoom level until the symbols completely disappeared. So it is proven that in Map 2 most users could get an overview of the spatial distribution at default zoom level and, therefore, both the improved design and generalization worked quite well.

The answers to Q7 indicate that the visual hierarchy was mostly improved in Map 2 (as 7 users agreed versus 3 users of Map 1). For the rest, in answering Q2 (give a description of the spatial distribution), Q3 (Which part of the area has most damage-related features?) and Q6 (Is it easy to identify the features?), the Map 2 users took less time and gave more positive feedback. To sum up, after comparing the results of the execution of Task 2 by the test persons, Map 2 demonstrated a considerable level of improvement of the conflict situations that were noticeable in Map 1.

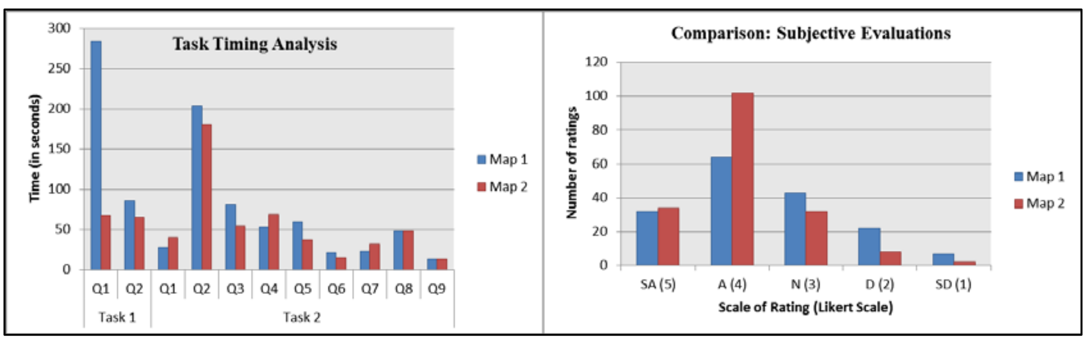
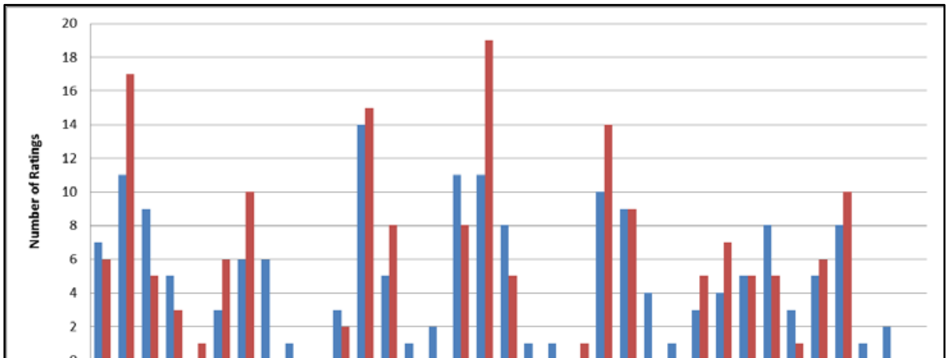


Figure 7: a - Task timing analysis and b - Comparative analysis of total evaluation ratings for both maps

For the data collection on the seven evaluation criteria in *part 3* of the user test, use was made of a *Likert scale* (Albaum 1997) with five points (5 = Strongly Agree / SA; 4 = Agree / A; 3 = Somewhat dis(agree) / N; 2 = Disagree / D; 1= Strongly Disagree / SD). The absolute results are presented in Figure 8. Based on the collected data, we analyzed the ratings for each questions under each evaluation criteria for further comparison of the results from both groups.

Cross-reference analysis strengthened the test results presented above: although the number of SA ratings is almost equal for both maps, the number of 'Agree' ratings is much higher for Map 2 (see the summary in Figure 7b). And, compared to Map 1, very few Map 2 users gave negative judgments. A criteria-wise comparison of the ratings for both maps (Figure 8) further supports the earlier results. It is again confirmed that the Map 1 users had faced difficulties as this map has a fair amount of conflicts and in Map 2 those conflicts are, at least partly, resolved.

During the subjective evaluation, users provided several comments. These comments are related to the conflicts described previously and are useful indicators for further improvements. Below, they are summarized for both maps.



	Effectiveness					Efficiency				
	SA (5)	A (4)	N (3)	D (2)	SD (1)	SA (5)	A (4)	N (3)	D (2)	SD (1)
Map 1	7	11	9	5	0	3	6	6	1	0
Map 2	6	17	5	3	1	6	10	0	0	0

	Usefulness					TPs reaction				
	SA (5)	A (4)	N (3)	D (2)	SD (1)	SA (5)	A (4)	N (3)	D (2)	SD (1)
Map 1	3	14	5	1	2	11	11	8	1	1
Map 2	2	15	8	0	0	8	19	5	0	0

	Satisfaction					Fuctionality					Consistency				
	SA (5)	A (4)	N (3)	D (2)	SD (1)	SA (5)	A (4)	N (3)	D (2)	SD (1)	SA (5)	A (4)	N (3)	D (2)	SD (1)
Map 1	0	10	9	4	1	3	4	5	8	3	5	8	1	2	0
Map 2	1	14	9	0	0	5	7	5	5	1	6	10	0	0	0

Figure 8: Number of TP ratings for 7 evaluation criteria.

Map 1

Users commented that the base map is too detailed and that the contents of the topic layer disappear at low zoom level (< 13). They said the contents should be shown for all zoom levels. It may be concluded that the generalization of the base map is not adjusted to the assigned tasks. With respect to the design, TPs remarked that the symbol sizes should be same and the colours should be more associative. Landslide symbols were not easy to identify at all. The symbols for collapsed buildings and partially collapsed buildings were said to have little visual difference and needed a more distinct design. These are clear indications of the design conflicts as described in section 2. TPs also indicated that Map 1 needed more functionality, such as attribute windows, a legend for base map contents and additional zooming functions.

Map 2

One user still found the base map too detailed and suggested to include multiple base maps. Test persons stated that the symbols should be reduced in size and should be made scalable, because at low zoom level they are overlapping at places. It was said that the height and width of the symbol for obstacles should become the same. TPs also asked to change the colour and shape of either the symbol for collapsed buildings or that for the partially collapsed buildings. So, although the design of Map 2 was already improved, users suggested that it needs to be improved further. Users suggested to improve the functional tools as well – a more noticeable button for layer switching, functions for attribute and metadata as well as selection tools. They also required a tool that can change the hierarchy of topic layers and an inset window for an overview map. Obviously, these functions were also missing in Map 1.

5.2 Thinking Aloud

The recorded user voices were played back to augment the results from *part 2* of the test. After analyzing the recordings, some additional findings could be identified.

Map 1
During the completion of Task 1, users really found difficulties to see the landslide symbols. Additionally, they were also concerned about the symbols (shape, size and colour) used for other topics and made clear that at the default zoom level, the symbols are completely mixed up. The same colour (yellow) was used for the features spontaneous camps, partially collapsed buildings and damaged infrastructure and a similar shape was used for collapsed buildings and partially collapsed buildings. As a result, the damage-related features cannot be visually differentiated well enough. One of the TPs pointed out that the base map needs a legend as well.

Sometimes, users had difficulties, which have been taken into account in the interpretation of the results. While answering the question of visual hierarchy, two of them asked themselves - "How I know this?", although they already agreed that Map 1 had a visual hierarchy. So, in this regard, their answers should be considered as biased. Two users were also confused about directions. In the end, one of them pointed out that the map lacks a north arrow. They were confused about the meaning of 'downtown'. Other users had difficulties in understanding the zoom level.

Map 2
Users mostly agreed that the symbols in Map 2 are easy to identify, but one TP was not sure whether there were some landslide symbols, hidden behind the symbols for collapsed buildings. Users suggested to make the symbols smaller to reduce the conflicts. A TP, who indicated that zoom level 11 is good for getting an overview of the spatial distribution, specified at the same time that the default zoom level is good if we concentrate on the central part of the area. Two users mentioned that the symbols are very distinct except at places where they are overlapping. The user who was neutral about visual hierarchy said that it works well between base map and topic but not within the topic contents.

Some users found difficulties in locating the northwestern part of Port-au-Prince in Task 1: they repeatedly asked about the geographic extent of the city. One user was confused about the questions on spatial distribution – this user repeatedly read aloud the questions and emphasized the term "spatial distribution". Another user overlooked the tool for layer switching (which can be activated by clicking on '+'), she thought that this button was for zooming in as well.

6 Conclusions

In this paper an attempt was made to solve generalization, design and functionality conflicts in the Haiti Crisis Map, an example of a neogeography map. Conflicts are directly related to the purposes (tasks) and the questions that users want to answer. In this case we worked with the Haiti Crisis Map for the purpose of damage assessment. We hypothesized the conflicts and proposed solutions in an improved web map interface. User testing was done with both the improved and the original map.

The research has proved that the users of the original Haiti Crisis Map had difficulties in completing the tasks and questions that were asked. For most questions, the users of the original map either took more time or they provided incorrect answers and negative feedback. The improved map was found to have a better generalization of the base map, design and functionality. However, users also indicated that more functionality could be useful and that the topic layer design needs to be improved further as it still creates problems especially in cluttered areas.

Thus, there are many scopes for further improvements for the Haiti Crisis Map. The generalization of the base map is not implemented and tested for other zoom levels, except for the default one. This study did not consider the generalization of the topic layer, which is important to reduce the clutter. We do not think that the conflict typology is complete - it needs to be investigated further. The conflicts should be tested using more use cases, amongst which two (route planning and situation reporting) are planned for future. Future research may also consider conflicts in neogeography maps with other geometric features (line and polygon) than just point features.

References

Albaum, G. (1997) The Likert scale revisited: an alternate version. *Journal of the Market Research Society* 39, 2, pp. 331-348.

Das, T. (2010) Visualization of User-Generated Geo-Content (UGGC). *Proceedings of GIScience 2010 doctoral colloquium*. Zurich, Switzerland, J.O. Wallgrün, A.-K. Lautenschütz. - Heidelberg : Akademische Verlagsgesellschaft, pp. 11-16.

Field, K., J. O'Brien, Cartwright, W. (2011) Exploring cartographic design in social-network map mashups. *Proceedings of ICC Conference 2011*, Paris, France.

Frye, C. (2009) A Design for a Legible Map Mashup. *The Future of Maps and the Internet*, *Meeting of the ICA Commission on Maps and the Internet*, November, Viña Del Mar, Chile.

Goodchild, M. F. (2007) Citizens as sensors: the world of volunteered geography. *GeoJournal* 69, 4, pp. 211-221.

Goodchild, M. F. (2008) Assertion and Authority: The Science of User-Generated Geographic Content. *Proceedings of the Colloquium for Andrew U. Frank's 60th Birthday*, GeoInfo 39, Department of Geoinformation and Cartography, Vienna University of Technology, Austria.

Goodchild, M. F. (2009) NeoGeography and the nature of geographic expertise. *Journal of Location Based Services,* 3, 2, pp. 82-96.

Haklay, M., A. Singleton, Parker, C. (2008) Web mapping 2.0: the Neogeography of the Geoweb. *Geography Compass,* 2, 6, pp. 2011-2039.

Huang, H. and G. Gartner (2012) A Technical Survey on Decluttering of Icons in Online Map-Based Mashups. *Online Maps with APIs and WebServices,* pp. 157-175.

Toomanian, A., Harrie, L., Olsson, P.O. (2011) Cartographic Enhanced Geoportals. *Proceedings of ICC Conference 2011*, Paris, France.

Touya, G. (2012) What Is the Level of Detail of OpenStreetMap? W*orkshop: Role of Volunteered Geographic Information in Advancing Science: Quality and Credibility*, USA.

Turner, A. (2006) Introduction to neogeography. *O'Reilly Media*, *Inc.*, USA

van Elzakker, C. and W. van de Berg (2010) Topographic base maps for physical planning maps: user research for generalization. *Special joint symposium of ISPRS technical commission IV and AutoCarto 2010*, USA.

Ware, J. M. and C. B. Jones (1998) Conflict reduction in map generalization using iterative improvement. *GeoInformatica* 2, 4, pp. 383-407.

URLs

URL1. *Challenges of User Generated Geo-Content* http://www.directionsmag.com/podcasts/challenges-of-user-generated-geo-content/124992

URL2. *Inveneo in Haiti Crisis*. http://www.inveneo.org/?q=haiti-support

URL3. Red Cross Response to Haiti. http://lists.openstreetmap.org/pipermail/talk/2010-January/047462.html

URL4. *ITHACA*. http://www.ithacaweb.org/about/mission/

URL5. *WFP*. Alternative Map for Damage Assessment in Haiti http://documents.wfp.org/stellent/groups/public/documents/newsroom/wfp215477.jpg

URL6. *UNITAR*. http://www.unitar.org/unosat/haiti-earthquake-2010-remote-sensing-based-building-damage-assessment-data

URL7. *IMMAP*. http://www.immap.org/index.php?do=map_view&id=76&cat=12

URL8. *Talk of Colombian Rescue Team*. http://www.mail-archive.com/talk@openstreetmap.org/msg26244.html

URL9. *Fairfax Rescue Team to Haiti Response*. http://wiki.openstreetmap.org/wiki/Talk:WikiProject_Haiti#Fairfax_County_Urban_Search_.26_Rescue_Team_Using_Garmin_downloads

URL10. *More Info about UNOCHA Haiti Project*. http://oneresponse.info/Disasters/Haiti/Pages/default.aspx

URL11. *CloudMade Style Editor*. http://developers.cloudmade.com/projects/show/style-editor

(All links were last accessed on 15th August, 2012)

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