



**Using VGI for 2012
flood mapping in
Slovenia**

M. Triglav-Čekada and
D. Radovan

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Using volunteered geographical information to map the November 2012 floods in Slovenia

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Abstract

Volunteered geographical information represents a promising field in the monitoring and mapping of natural disasters. The contributors of volunteered geographical information have the advantage that they are at the location of the natural disaster at exactly the time when the disaster happened. Therefore, they can provide the most complete account of the extent of the damage. This is not always possible when applying photogrammetric or remote-sensing methods, as prior to the data acquisition an order to carry out the measurements has to be made. On 5 and 6 November 2012 almost half of Slovenia was badly affected by floods. The gathering of volunteered geographical information in the form of images and videos of these floods will be presented. Two strategies were used: (1) a public call for volunteered contributions and (2) a web search for useful images and their authors. The authorship of these images was verified with every contributor, and with the help of the volunteered images 12% of the most severely affected river sections were mapped. Altogether, 1195.3 ha of flooded areas outside of the usual riverbeds along a total river length of 48 km were mapped. The results are compared with those from satellite mapping of the same floods.

1 Introduction

Knowledge about the extent of natural disasters is important for disaster management; this is because natural disasters cannot be prevented, and mitigation of their impact is the only option. Disaster management includes risk reduction by means of spatial planning, technical measures and an improvement of public awareness (Poser and Dransch, 2010). The public, on the other hand, can help to define the extent of natural disasters through volunteered geographical information (McDougall, 2012). In this article, using the Slovenian flood of November 2012 as an example, the flood-extent mapping resulting from volunteered geographical information is presented.

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The extent of floods can be measured by different remote-sensing methods, from aerial photogrammetry to high-resolution satellite data (e.g., Lane et al., 2003; Schumann et al., 2011). Such missions have to be carried out within a maximum of a few days of the event, as the floods recede quickly. Unfortunately, in this period, bad weather usually hinders the successful acquisition of optical satellite or aerial photogrammetric data. In addition, the limited spatial resolution of satellite data may hinder the detection of small flooded areas in vegetated, commercial or residential areas (McDougall and Temple-Watts, 2011). The order of the flood-data acquisition cannot be completed during the time of the disaster: therefore, only some kind of post-maximum extent of the natural disaster can be measured using traditional means.

On the other hand, so-called volunteered geographical information can record a natural disaster at the exact time of its maximum extent, as the contributors usually live in the vicinity and are affected by it. Additionally, this volunteered geographical information is not hindered by weather conditions. Volunteered geographical information, as defined by Goodchild (2007), describes humans as sensors giving voluntarily temporal and spatial geographical information in the form of images, videos, sounds and text messages. Some data are already geolocated automatically, while others can be geolocated during the time of the data processing. In the case of floods the volunteered geographical information can help fill the gaps in the satellite imagery (Schnebele and Cervone, 2013) or can be used as stand-alone information (Poser and Dransch, 2010; McDougall and Temple-Watts, 2012). The volunteered geographical information can also be used for assessing the extent of other natural disasters, for example, the New Zealand earthquake of 2011 and the Japanese tsunami of 2011 (McDougall, 2012).

Almost every year, local heavy rain induces floods in Slovenia to a lesser or greater extent. Due to the country's diverse topography, which causes extensive climatic variability over short distances, these floods are mainly local. The floods tend to happen in late summer and autumn (Rusjan et al., 2009). However, the heavy rains between 4 and 5 November 2012 caused extensive floods, affecting areas of all the major rivers covering the majority of the northern half of Slovenia on 5 and 6 November 2012. Be-

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“GIO EMS Mapping products” showing flooded areas at general-overview topographic scales of 1 : 45 000 and 1 : 55 000, presented in Fig. 1 in a yellow colour. For some smaller parts inside those areas detailed maps on a scale of 1 : 15 000 were also available. The GIO EMS mapping products are based on satellite images and were produced in rush mode (EMS mapping portal, 2013). The acquisition of satellite images of the flooded areas and the production of flood-extent maps were triggered with the activation of the GIO EMS system by the authorised user – the Administration for Civil Protection and Disaster Management of the Ministry of Defence of the Republic of Slovenia.

For this research only satellite mapping products were available; there were no raw satellite images. Satellite mapping products consist of vector or raster flood maps, which present the borders of flooded areas, the main rivers, roads and settlements. The flooded areas are extracted from the satellite images by means of semi-automatic classification processing techniques. The other general information is derived from Wikimapia, Openstreetmap and Geonames (rivers, roads, settlements). The new vector data is presented on the older satellite images in false colours with a ground sampling distance of 2.5 m (Fig. 4b and d). The estimated thematic accuracy of this product is 85 % or better, although it may be lower in urban and forested areas. The satellite mapping products, which from now on will be called satellite maps, are referred to the most prominent city on the satellite image and are numbered in Fig. 1: Ljubno (1), Dravograd (2), Ptuj (3), Ormož (4) and Krško (5). The flooded areas were derived from COSMO-SkyMed images (COSMO-SkyMed, 2013) with a ground sampling distance of 5 m for Ptuj, Ormož, Krško, Dravograd or TerraSAR-X images (TerraSAR-X, 2013) with a ground sampling distance of 3 m for Ljubno. The images for Ptuj and Ormož were acquired one day after the floods; for Krško it was two days, Dravograd, three days, and Ljubno, four days after the floods.

3 Methodology

For the collaborative gathering of volunteered geographic information in the form of images and videos two strategies were used: (1) a public call for volunteered contributions and (2) a web search for useful images. The useful images enabled flood-area mapping by means of an interactive orientation of images based on a digital terrain model (DTM). The results will be compared with the flooded areas presented on satellite maps.

3.1 Collaborative gathering of the volunteered images

On the web page and *Facebook* profile of the *Geodetic Institute of Slovenia* (GIS, 2012) an open call to gather volunteered geographic images covering the 2012 floods was published the second day of the floods on 6 November 2012. With the help of extensive social networking, the information on the call propagated quickly through the social media. A major increase in the collaboration of the public was observed in the number of visits to both profiles over the next few days. In the first four days after the publication of the call the web page had seven times more views than on ordinary days. The views of the *Facebook* profile were even more numerous. In the first week after the announcement, the number of daily views rose to 16 times as many views as on ordinary days. A maximum of 700 views per day was observed during the first few days after the announcement.

The majority of contributors posted data on the floods when the floods were still “headline news”, less than one week after the floods. Some occasional contributions happened even after those dates, mainly when the action was reported on television and radio. The action stopped two months after the floods when no more contributions were received. The first results in the form of flood maps were published on the web page and *Facebook* profiles two weeks after the event. The final results were published in the same way four months after the floods. The first results and the final results were also presented on national television.

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To illustrate the kinds of images we were searching for, an example was provided on the *Facebook* and web pages, showing a 2010 flood image accompanied by the acquired flood extent derived from that image. An additional text described the kinds of images we were searching for (GIS, 2012):

“If you have an image of flooded areas covering as wide an area as possible, taken from a higher standpoint (e.g., from the upper floor of a building, from a hilltop) please send it to (poplave@gis.si). It is better if at least two to three roads or part of a hill is recognisable on the image.

Please add the following information in the e-mail:

- a broad description of the area that is shown on the image
- the date and the approximate time when the image was taken
- the approximate standpoint (location of imaging)
- the author of the image.”

Special care was taken to ensure that all the data gained as a result of the call were checked in terms of authorship.

We received a total of 15 contributions, with 5 contributors sending images taken by somebody else. This was discovered when we asked the contributor whether he was the author of the images. In the majority of cases when the contributor sent images from somebody else it was impossible to find out who was the author, as the source was e-mailing from a “friend of a friend”. If the contributor was also the author of the image, he/she usually agreed that his/her intellectual property (in this case the image) could be used for free for research purposes. If the contributor sent images from an unidentified author, the images were not used.

3.2 Web search for volunteered images

Simultaneously, during the first two weeks after the floods a search of various social media networks (*Youtube*, *Mojalbum*) and local web news was made to find already-

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available images of the floods, which could have the potential for flood-extent mapping. When such an image or video was found we tried to contact the author of the image. Even though different licenses for using *Facebook*, *Youtube* and other social media networks' data already exist and mainly define open access to such data, national legal property laws provide more strict regulations, especially concerning the intellectual property of images (Scassa, 2013). Therefore, caution was necessary, as some authors present their images on web networks in order to attract attention from television and printed media, who they hope might purchase their images. Without contacting such a person, we were not in a position to know if he/she was willing to offer his/her image for free. We contacted six potential contributors of appropriate images. Only one author refused to allow his images to be used for research purposes for free.

Different local media, public clubs and local fire brigades also gathered images of floods. Some of them were aware of the problems regarding authorship, and the possible unapproved usage of such images, the others were not. Those who were aware had on their web pages, which presented the images from different authors, additional disclaimers, mainly stating something like this “You may not use these images without the approval of the image’s author”.

In general it was found that much more time was needed to obtain a reply from an author of a potentially useful image found by a web search than to get an approval for voluntarily given images. In the first case, it usually took two steps: first the owner of the web page was contacted and asked for information about the image author, then the author was contacted. The authors were sometimes hidden behind their nicknames. To reach the author of *Youtube* material, you can only write a comment under the video and then wait for the author to respond.

3.3 Selection of images for mapping

All the contributed images could be used to map the floods. Some of them reveal smaller areas, while others cover larger areas. To map the floods as soon as possible, it was decided that in the first place only the most appropriate images should be used.

The other images, showing narrower scenes, were classified as images for documentation and were not used for the mapping.

The results and selected images were presented on our web pages and *Facebook* site (GIS, 2012). However, those images that might violate privacy were excluded, as proposed by Scassa (2013). Therefore, images showing people were not used in any presentation.

Altogether, 15 contributors with confirmed authorship provided useful collaborative visual data, consisting of 102 terrestrial and aerial images and one aerial video. Some 45% of them were classified as potentially useful for flood-extent mapping. For the actual flood mapping, 22 images and 12 sequences from the video were used, representing only 21 % of the gathered images.

3.4 Mapping floods in 3-D

To acquire a 3-D boundary of the floods an interactive method for the absolute orientation of the images based on the digital terrain model (DTM) was used. The method is roughly described below, while the details can be found in Triglav-Čekada et al. (2011) and Rönholm et al. (2003).

The absolute orientation parameters of an individual image (i.e., the 3-D location of the standpoint, the three angles of the image orientation and the scale) were derived with a manual interactive search for the best fit of the superimposed 3-D points of the DTM onto the details seen on the image. When the image is orientated correctly, the superimposed DTM points fit to the distinct details seen on the image very well. Karjalainen et al. (2006) proposed an interactive orientation based solely on vector brake lines (roads, rivers); therefore, our method was also amended with break lines (Fig. 2). The 3-D boundary of the flooded area is measured by selecting individual 3-D points from the superimposed DTM.

The photogrammetrically derived DTM with a cell size of 5 m × 5 m was used for the orientation of the images and the acquisition of flooded areas. It was produced in 2006 and it covers the entire country of Slovenia. The accuracy of the DTM is variable, as

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flood-describing locations were found in the overview of the web sources. Altogether, the most affected sections sum up to more than 400 km of the Soča, Sava, Krka, Savinja, Paka, Meža, Mislinja and Drava rivers. This estimation is in good agreement with the general description of the floods prepared by ARSO based on the hydrological responses of the rivers (ARSO, 2013).

The pink areas in Fig. 1 represent the mapped flooded areas from the volunteered images. The areas for which we have images but are not useful for the flood-extent mapping using our method are marked with pink dots. In total, 48 km or 12 % of the most affected river sections were covered by acceptable volunteered images. Even though this share is not very high, it covers the majority of the most affected river segments. From these most affected rivers just the flooding of the Savinja and Sava rivers has not been covered at all. Altogether, 1195.3 ha of flooded areas outside of the normal river banks were mapped from volunteered images (Table 1). The total flooded area, where also the area of the normal river bed is included, accounts for 1439.4 ha.

In Fig. 3 the flooding of the Drava river from Drava lake to Formin is presented (marked with (g) in Fig. 1 and Table 1). It represents the most extended flooded area in our research, with a coverage of 900.5 ha. Seven images from three different contributors were used for the acquisition of the flood borders. Four images were taken from the air to show the extent of the flood imaging for the local television, with three from the hills on the south side of the Drava river.

4.2 Comparison with satellite maps

For some of the flooded areas, satellite maps were available. Unfortunately, the satellite maps were based on satellite images taken a day or even four days after the floods, when the majority of the water had already receded. Therefore, only the remaining disconnected water ponds were found on the satellite maps. With some generalization (i.e., aggregation) those water ponds could be connected in larger flooded areas only for the satellite maps of Ptuj and Ormož (marked with (3) and (4) in Fig. 1), for which the original satellite images were acquired on 7 November 2012, one day after the floods.

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ceptable and ready-to-use images for flood mapping with our method. It resulted in the employment of a smaller number of images from a smaller number of contributors and to map a broader area.

The first web search was performed within two weeks of the floods. Five months after the floods the web search was repeated to assess the total area of flooding. In the second search more structured web pages with image collections were also found. These image collections contained some potentially useful images for flood mapping on areas that were not covered by the first gathering of images. Therefore, for the future gathering of volunteered images for flood-mapping purposes it would be useful to repeat a web-search strategy, even a few months after the flooding. This might result in a greater share of useful images and a greater coverage of the flooded areas. Together with the images, very useful texts of local news were also found, which enabled a general localization of the extent of the flood. Such texts are a very useful part of the volunteered geographic information, which should be collected in future investigations.

As already mentioned by Scassa (2013), great care has to be taken to verify the authorship of the volunteered images and the resulting privacy issues. Additional guidelines need to be written for this purpose. The first rule, which must be obeyed, is that you always have to verify with the contributor of the image whether he or she is the author. In our case, one-third of the volunteer contributors sent us images from somebody else. In any circumstances, the author of the image should be aware of the dissemination and usage of his/her work. Therefore the author's approval is a must.

When finding useful images on the web, one also has to obtain the author's permission for free and open usage for the agreed task.

Even though the collaborating author provides an image and confirms that he/she is the real author, the user should always take care that no person or his/her recognisable belongings are on that image when the image is intended for publication. Even though this might be legally acceptable, it is not ethical from the point of view of privacy. Therefore, as already mentioned by Scassa (2013), any close-ups of courtyards and

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individuals or groups of people should be excluded. Such images can be used solely as internal information or as documentation.

From the described point of view, the least problematic images are those showing broader areas (e.g., the panorama of a valley) or are taken from an elevated area or from the air (Fig. 2).

It is also important that the results of volunteered geographical information gathering are open to the general public and that the contributors are informed about the publication of results. This gives the contributors confirmation that their generous action was used for something worthwhile, and that it was beneficial for society. Prompt information might also help to motivate them to collaborate in similar future actions.

When having established fair personal contacts with the contributors, new opportunities could open up. The contributors could also be asked to photograph the consequences of the floods after the water has receded completely. With such a strategy, the volunteered geographical information can also be used to conduct multi-temporal studies of natural-disaster development.

Even though volunteered geographic information is free of charge, it needs extensive organizational efforts to acquire useful images for extensive flood mapping. If we rely only on volunteered images, some flooded areas can be missed completely. Therefore, to get a complete picture of the behaviour of a natural disaster other photogrammetrical or remote sensing sources should also be included in the study.

6 Conclusions

The flash floods of 5 and 6 November 2012 affected almost half of Slovenia. On 6 November 2012, an attempt to gather volunteered geographic information was begun. The images and video were gathered using two strategies: volunteered contributions to public calls and a web search of potentially useful images, with their authors being contacted. Volunteered images from 15 contributors enabled the flood mapping of 12% of the most affected river sections and data coverage of 1195.3 ha of flooded areas.

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The results of the flood coverage using volunteered images were compared to the available GIO EMS mapping products, i.e., satellite maps. When judging the success of satellite flood mapping it was concluded that 18 % of the most affected river sections were successfully mapped by it, due to the fact that the satellite images were acquired one to four days after the floods. The satellite images, on the other hand, covered 32 % the most affected river sections. There was only 5 km of overlap between the successful satellite and volunteered flood mapping. From this research we can conclude that the volunteered image gathering represents a comparable, or even more accurate, alternative to satellite imagery. The volunteered images have, compared to the satellite images, some additional advantages. They give more detailed and more real-time results, as they represent the floods at the moment of the highest water. On the other hand, the results from the volunteered images do not give results as quickly as the automatic classification of water bodies from satellite images. Therefore, the future development of volunteered geographic information usage should strive for more automation in the post-processing.

The final success of volunteered geographical image gathering depends mainly on the possibility to gather the necessary images for flood-mapping purposes. Triggering an early social-networking action for collaborative image gathering plays a crucial role in obtaining coverage of areas that are as complete as possible.

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References

ARSO: Hidrološko poročilo o poplavah v dneh med 4. in 6. novembrom 2012 (Hydrological report on the floods between 4 and 6 November 2012 – in Slovenian), available at: <http://www.arso.gov.si/vode/poro%c4%8dila%20in%20publikacije/Poplave%205.%20->

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Scassa, T.: Legal issues with volunteered geographic information, *Can. Geogr.*, 57, 1–10, 2013.

5 Schumann, G. J.-P., Neal, J. C., Mason, D. C., and Bates, P. D.: The accuracy of sequential aerial photography and SAR data for observing flood dynamics, a case study of the UK summer 2007 floods, *Remote Sens. Environ.*, 115, 2536–2546, 2011.

Schnebele, E. and Cervone, G.: Improving remote sensing flood assessment using volunteered geographical data, *Nat. Hazards Earth Syst. Sci.*, 13, 669–677, doi:10.5194/nhess-13-669-2013, 2013.

10 SMA RS: Digitalni model višin 5 m × 5 m (DMV 5) (Digital terrain model 5 m × 5 m (DTM 5) – in Slovene), available at: http://www.e-prostor.gov.si/zbirke_prostorskih_podatkov/topografski_in_kartografski_podatki/digitalni_model_visin/digitalni_model_visin_5_x_5_m_dmv_5/, last access: 25 March 2013, Surveying and Mapping Authority of Republic of Slovenia, 2013.

15 Velenje: available at: <http://velenje.com/poplave2012/>, last access: 10 May 2013, 2012.

TerraSAR-X: available at: <http://www.astrium-geo.com/en/228-terrasar-x-technical-documents>, last access: 25 March 2013, 2013.

20 Triglav-Čekada, M., Radovan, D., Gabrovec, M., and Kosmatin Fras, M.: Acquisition of the 3-D boundary of the Triglav glacier from archived non-metric panoramic images, *Photogramm. Rec.*, 26, 111–129, 2011.

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Table 1. The extent of the flooded river sections acquired from the volunteered images: the river length, the area covered by the river prior to the flooding and the total flooded area with the included river area. In the first column the areas are marked as on Fig. 2.

Settlement names (River names)	River length [km]	River area [ha]	Total flooded area [ha]
a Tolmin (Soča)	2.7	72.0	81.8
b Most na Soči (Soča)	2.4	24.0	38.5
c Šoštanj (Paka, Toplica, Klančnica)	4.6	1.8	56.5
d Pameče (Mislinja)	1.8	1.9	16.3
e From Bukovska vas to Dravograd (Mislinja, Meža)	5.9	8.1	111.2
f From Zlatoličje to Ptuj (Drava)	4.6	67.7	234.6
g From Drava lake to Formin (Drava, Formin canal)	26.0	68.6	900.5
Sum	48.0	244.1	1439.4

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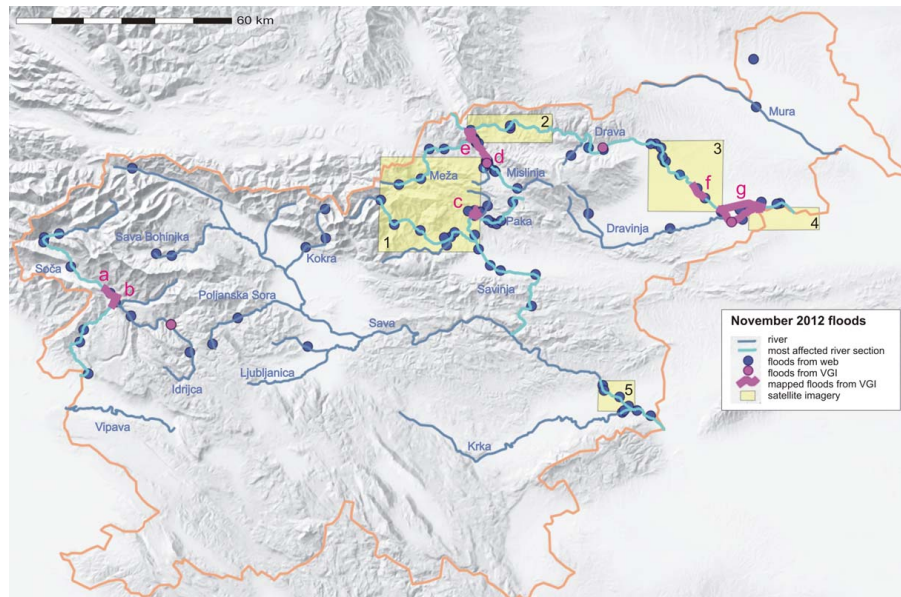


Fig. 1. The extent of the November 2012 floods in Slovenia. The satellite maps are numbered from (1) to (5), the floods mapped from volunteered images from (a) to (g).

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Fig. 2. Digital terrain model (white), roads (white) and border of the flooded area (blue) superimposed on the image of the floods in Most na Soči on 5 November 2012 around 13:00 (marked with (b) on Fig. 1). The author of the underlying image is Miljko Lesjak.

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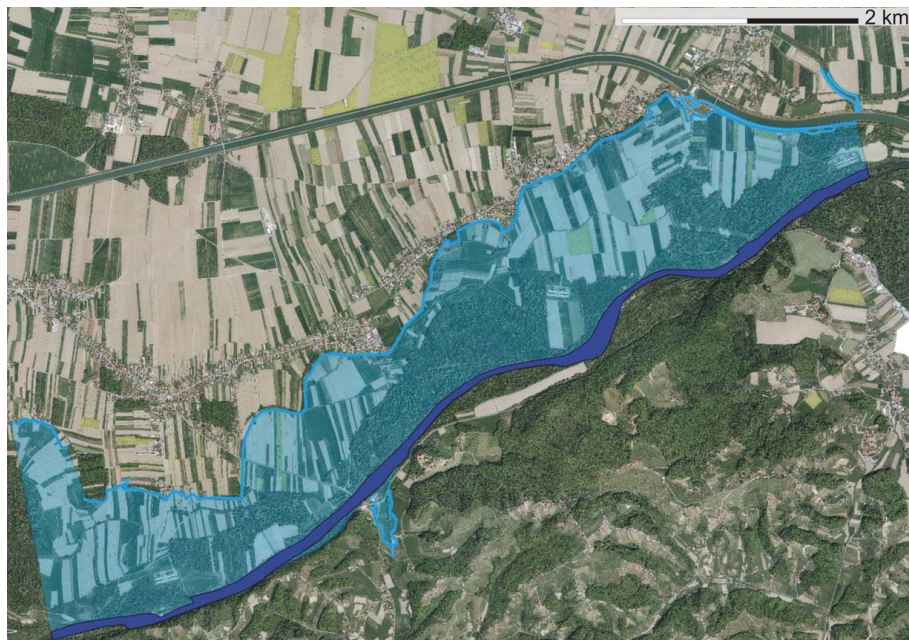
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Fig. 3. Floods of the Drava river on 6 November 2012, between Drava lake and Formin (marked with (g) on Fig. 1) derived from volunteered images and presented on the national orthophoto.

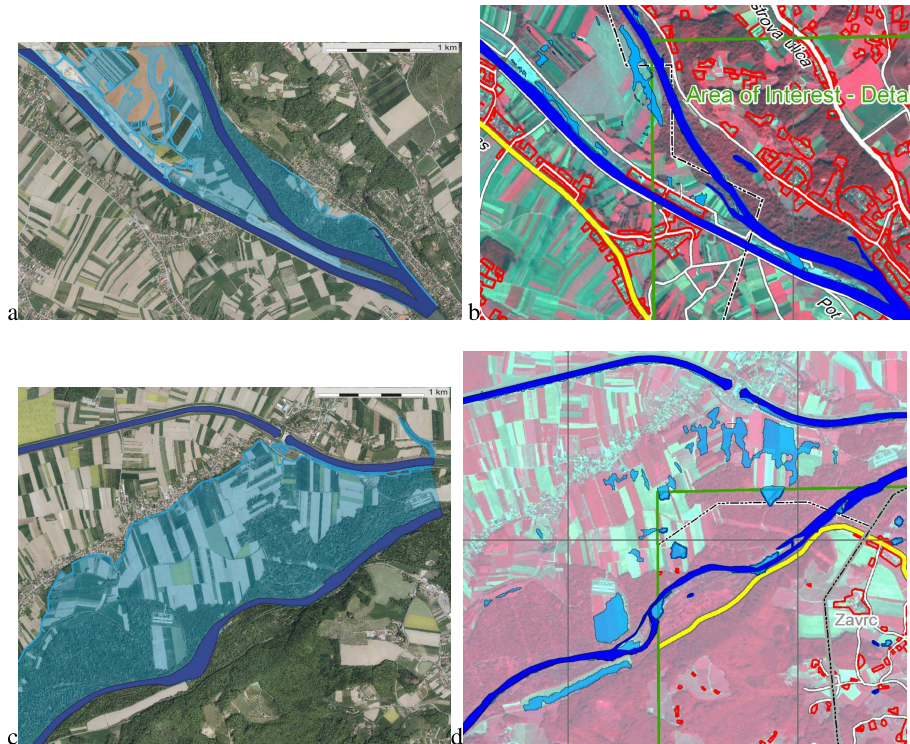


Fig. 4. The flooded areas derived from volunteered images on 6 November (left) and the same detail from the satellite map made for 7 November (right). First row: the area from Zlatoličje to Ptuj (marked with (f) on Fig. 1). Second row: a part of the area from the Ptuj lake to Formin (marked with (g) on Fig. 1). The dark blue areas are the normal river areas and the light-blue are the flooded areas. The flooded area from the volunteered images represents connected water areas to the river bed, while the satellite maps show disconnected water ponds.

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