Activities of IWG-SEM

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JAXA-SAOC

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What is IWG-SEM ?

- ◆IWG-SEM is an abbreviation of “International Working Group on Satellite based Emergency Mapping.
- ◆It was founded to improve cooperation, communication and professional standards among the global network of satellite based emergency mapping providers.
- ◆IWG-SEM is a voluntary group of organizations involved in satellite based emergency mapping.

IWG-SEM Members

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REVIEW

Global trends in satellite-based emergency mapping

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Over the past 15 years, scientists and disaster responders have increasingly used satellite-based Earth observations for global rapid assessment of disaster situations. We review global trends in satellite rapid response and emergency mapping from 2000 to 2014, analyzing more than 1000 incidents in which satellite monitoring was used for assessing major disaster situations. We provide a synthesis of spatial patterns and temporal trends in global satellite emergency mapping efforts and show that satellite-based emergency mapping is most intensively deployed in Asia and Europe and follows well the geographic, physical, and temporal distributions of global natural disasters. We present an outlook on the future use of Earth observation technology for disaster response and mitigation by putting past and current developments into context and perspective.

Disaster responders and the humanitarian community increasingly use Earth Observation (EO) satellite systems to assess the impact of and to plan and coordinate emergency response activities after major natural disasters around the world. EO systems provide response and relief workers with tools to lift the "fog off disaster." EO satellites help overcome operational uncertainties after major disasters that impede emergency response because of limited, incomplete, and often contradictory ground information. Furthermore, EO satellites provide emergency responders with a situational overview otherwise difficult to obtain during an ongoing disaster event. For example, synthetic aperture radar (SAR) sensors can see through storm clouds to remotely assess in near real time the exact extent or severity of flood disasters as they unfold. Local, national, and international agencies also use satellite-based emergency mapping (SEM) as part of larger resilience strategies (1) to help design, implement, and evaluate disaster risk reduction and recovery programs (2-4). The ultimate goal of SEM is to improve disaster relief effectiveness and thus to help reduce suffering and fatalities before, during, and after a disaster event occurs. We focus our Review on the response phase immediately after a disaster, which typically lasts from several days to a few weeks. This phase is technically challenging because of the strict time constraints and demands special skill sets and coordination among disaster responders, the SEM community, satellite operators, and international organizations. The global SEM response capabilities have been developing over the past 15 years and can today be considered to be at the forefront of the use of satellite technology and geoinformation in the broader field of disaster risk management (Box 1) (5).

> **"The availability of … EO satellite systems has increased during the past 15 years."**

Partly in response to growing demand, larger satellite constellations with more advanced sensors are being built, with the potential to provide unprecedented capacity for monitoring the Earth more rapidly and in more detail than ever before. This development has not been limited to the traditional space agencies in Europe, Japan, and the United States. Over the past 15 years, countries throughout Latin America, Africa, and Asia have started their own space programs. Dozens of new satellites have been launched, transforming availability and access to EO technology and data, further expanding the EO constellations and the ease of use of satellite data. The provision of vast quantities of raw satellite data to the disaster response community has no operational value per se. Being time sensitive in its relevance to immediate disaster mitigation, the data need to be rapidly processed, analyzed, and transformed by remote sensing professionals (6) into intuitive and understandable information products such as maps or reports; these can then directly be used in emergency management operations (7, 8).

In reviewing global SEM responses of the past 15 years, five major events stand out, given their influence on the development of the international SEM community: (i) After the Indian Ocean Tsunami in 2004 (7), widespread international SEM cooperation and response coordination were necessary owing to the scale of the event, size of the impacted region, and the number of countries affected. During the disaster, satellite mapping played an important role by providing an overview of the situation on the ground and helping people to understand the magnitude of devastation caused by the tsunami. (ii) The Wenchuan Earthquake in 2008 (9) mobilized an at that time unprecedented number of programmed satellites and acquired satellite imagery for a single disaster event. Analysis and mapping of the data was mainly organized by the National Disaster Reduction Centre of China (NDRCC) and resulted in the generation of numerous satellite products. During this event, it became clear that satellite imagery alone could not suffice to assess more subtle structural earthquake damage to buildings and infrastructure. In response to this, the emergency-mapping community realized the need for airborne sensors and imagery from unmanned airborne vehicles (UAVs) in order to complement satellite-derived products. (iii) The Haiti Earthquake in 2010 (10) marked a turning point in the accessibility of openly licensed post-event satellite imagery to a broader internet and crisis-mapping community. Many satellite-based emergency maps were produced by many different organizations, which led to an overflow of SEM products and some criticism by the international disaster relief community (11). As a result, the International Working Group on Satellite-based Emergency Mapping (IWG-SEM) (12) was established to improve mutual information sharing, harmonization, and cooperation across the international SEM community. (iv) The Pakistan flood in 2010 (13, 14) affected ~5% of the Indus River basin and 20 million people. Many varying SEM products were produced by different initiatives. The emergency response community was again overwhelmed with information, making it challenging to prioritize and ingest all the information into their operational workflows. The main concern was the thematic accuracy of the post-event information because of map products showing different extents of affected areas, such as the extent of flooding. This was another catalyst that led to the creation of the IWG-SEM (19, 20). (v) After The Great East Japan Earthquake in 2011 (Tohoku-Oki) (15), the Japan Aerospace Exploration Agency (JAXA) enlisted the help of international SEM

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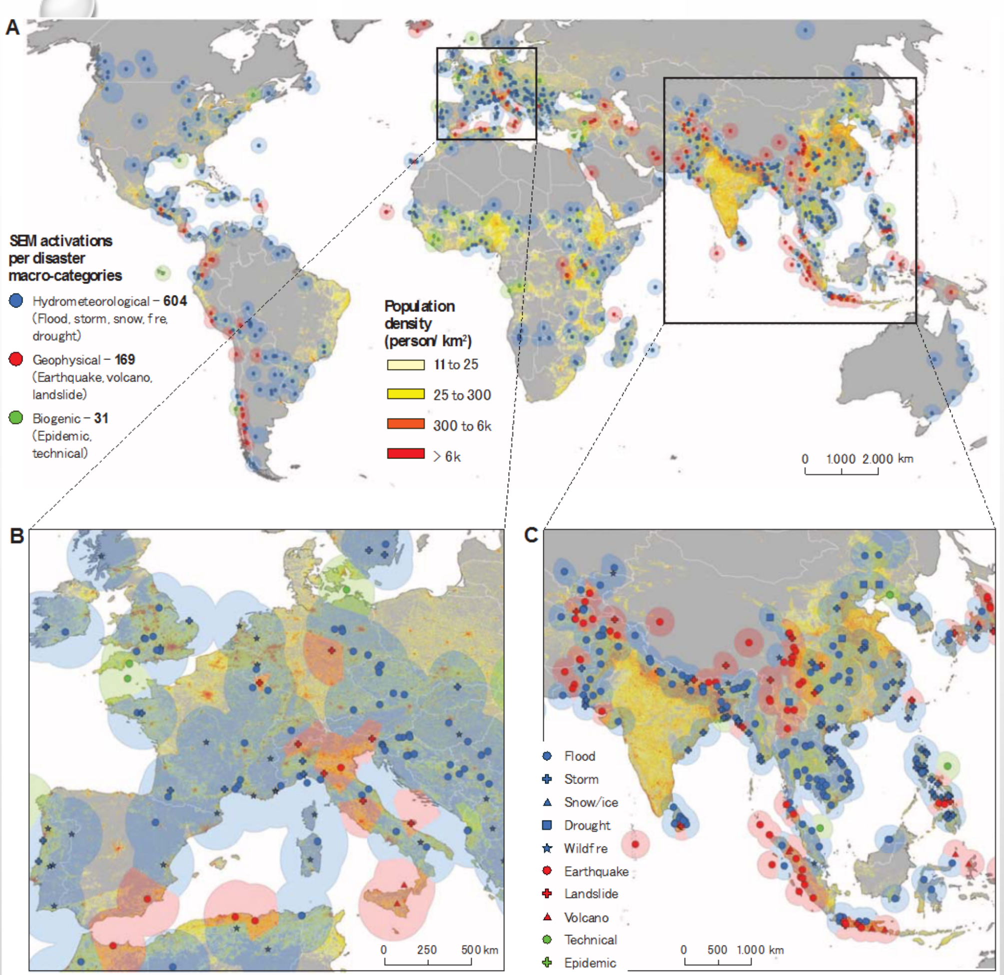

Fig. 2. Spatial distribution of SEM activations by disaster type. (A) At the global level. The distribution of SEM activations are grouped according to three disaster macrocategories: (i) hydrometeorological, blue symbols (including flood, storm, snow, wildfire, and drought events); (ii) geophysical, red symbols (earthquake, volcano, and landslide events); and (iii) biogenic, green symbols (epidemic outbreaks and technical accidents). (B and C) At regional level. (B) Western and southern Europe. (C) Southern, eastern, and southeastern Asia. The detailed disaster types can be read from the individual symbols. Polygons highlight the clustering of activations aggregated at disaster macrocategory level. All three sections show population density in the background (24).

with SEM support. Countries such as China, India, Philippines, Indonesia, Bangladesh, and Japan managed between 10 and 15% of their domestic disasters with SEM. The United States, Afghanistan, Mexico, and Russia range between 5 and 8%. We also found that Asia is the main global focus of international SEM activities, which is in line with the fact that according to EM-DAT, more disasters occur in this region as compared with others. The CHARTER was activated by the United States more than by any other country, and COPERNICUS was activated mainly for disaster situations in southern and southeastern Europe (table S2). In almost all regions of the world, SEM activities have risen in number substantially during the past 5 years. Only for the Americas and the Caribbean has the SEM frequency remained stable or slightly decreased during the past 5 years. Eastern and Western Africa have also remained stable, with a relatively high level of SEM activities over the past 10 years, whereas Australia, Polynesia, and Melanesia are covered by only a few SEM activations during the study period (Fig. 3B).

The reach of individual SEM mechanisms

The CHARTER, because of its global scope and as supported by its recent universal access efforts, is the most widely active and fully international SEM

EMERGENCY MAPPING GUIDELINES

Working Paper

Version 1.0 – as of December **2015**

International Working Group on Satellite-based Emergency Mapping (IWG-SEM)

EMERGENCY MAPPING GUIDELINES

- The aim of the guidelines is to support an effective exchange and harmonization of emergency mapping efforts among Emergency Mapping Organizations.

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(44 pages)

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2.2 FUNDAMENTAL PRINCIPLES

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2.3 INTERACTIONS

2.3.1 Information Exchange

2.3.2 Levels of Interaction

2.3.3 Interaction Tools

2.3.1 Information to be Exchanged

Four distinct phases for information exchange

1. Initial phase
   - AOI, End user input, GeoRSS

2. In-Production phase
   - Metadata of products

3. Delivery/Dissemination phase
   - via Web Portal

4. Post-delivery phase
   - Collecting the feedback from users.

2.3.2 LEVELS OF INTERACTION/ACTIVATION

- Non-crisis situation
  - Level-0 Inactive/unavailable
  - Level-1 Monitoring/On Call
- Crisis situation
  - Level-2 Self-organization(Small to medium scale crisis)
  - Level-3 Cooperation of multiple mapping organizations (medium to large scale crisis)

2.3.3 INTERACTION TOOLS

- GeoRSS
- Email exchanges
- Teleconferences using normal phones and mobile phones
- Videoconferences using specialized teleconferencing equipment (e.g. tele/video- conference rooms, online services such as Webex of GoToMeeting).
- Fax-based communication

2. SATELLITE-BASED EMERGENCY MAPPING

2.4 SHARING OF DATA, ANALYSIS AND RESULTS

2.4.1 Definitions of SEM Sharing

2.4.2 Use and Sharing of Reference Datasets

2.4.3 Sharing of Satellite Imagery Data

2.4.4 Sharing of Analysis

2.4.5 Sharing of Delivered Products

2.4.6 Use/Licensing/Copyright

2.4.2 SHARING OF REFERENCE DATASETS

Use well-known and already validated open data sources such as :

- ✓OSM
- ✓Google Mapmaker data
- ✓WorldPop
- ✓Landscan
- ✓GPW population
- ✓Landsat
- ✓Sentinel1, Sentinel-2
- ✓SRTM v 30m/90m
- ✓GTOPO30.

2.4.4 SHARING OF ANALYSIS

In case there is full or partial overlap of AOIs,

- ✓It is expected to share the analysis among institutions.
- ✓Reference data/information should be shared.

Sharing analysis would allow:

- ✓More aggregated products
- ✓Cross-check of layers among institutions
- ✓Better quality

2. SATELLITE-BASED EMERGENCY MAPPING

2.5 PRODUCT AND INFORMATION CONTENT

2.5.1 Reference/Pre-Event Map

2.5.2 Impact/Delineation/Grading etc.

2.5.3 Situation Update, Event Monitoring Map

2. SATELLITE-BASED EMERGENCY MAPPING

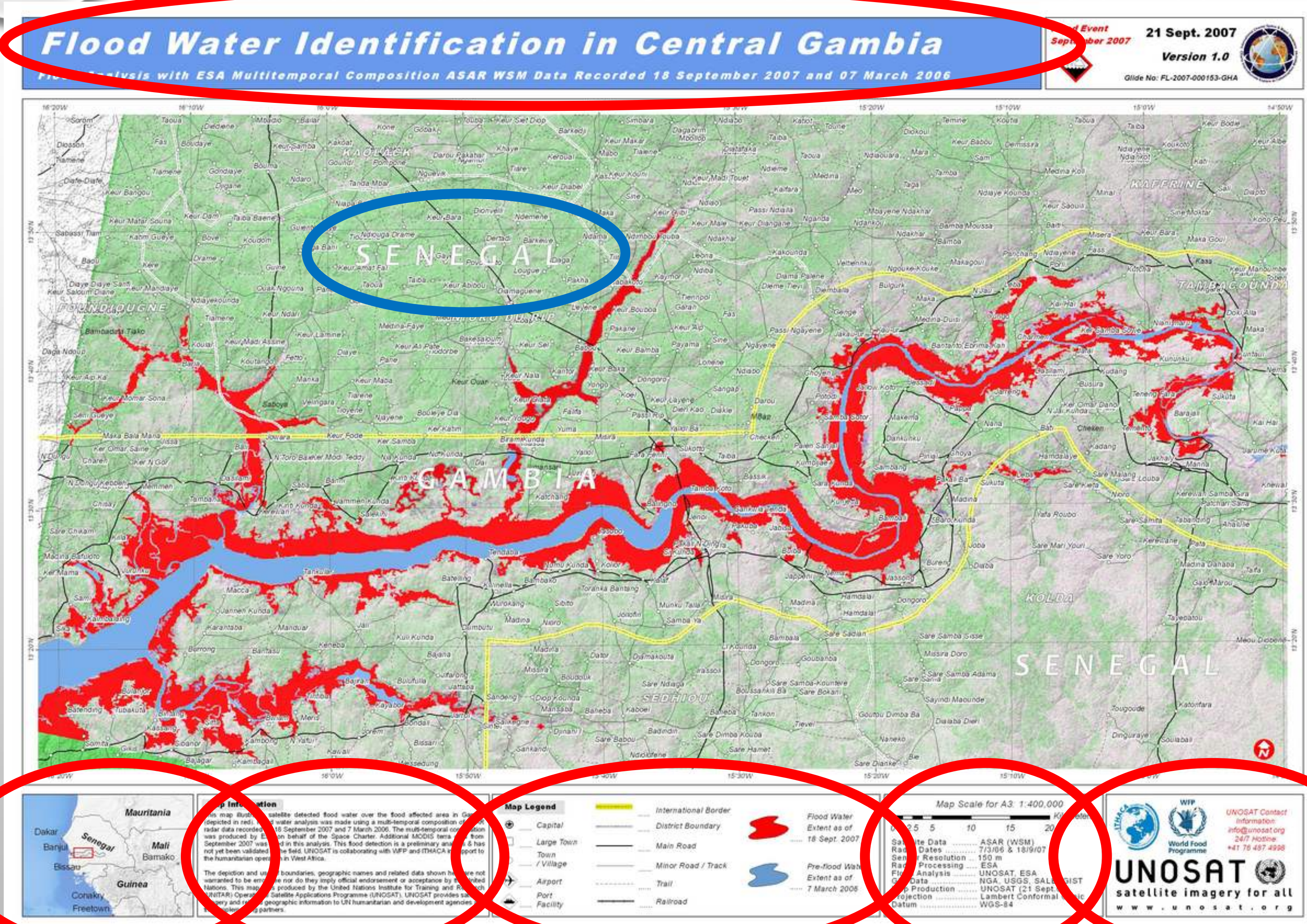
2.6 MAP TEMPLATE

2.6.1 MAP FRAME

2.6.2 MAP MARGINALIA

2.6.3 RECOMMENDATIONS FOR THEMATIC LAYERS

2.6 MAP TEMPLATE



2. SATELLITE-BASED EMERGENCY MAPPING

2.7 DATA DISSEMINATION

2.7.1 NAMING CONVENTIONS

2.7.2 CONTENT OF LAYERS

2.7.3 RASTER DATA

2.7.4 VECTOR DATA

2.7.5 WEB SERVICES

2.7.6 METADATA

2 SATELLITE-BASED EMERGENCY MAPPING

2.8 ASSURANCE OF CAPACITY AND QUALIFICATION

- ✓ Qualification is to assure proper qualification of SEM community members.
- ✓ No formal classification of production capacity/qualification is maintained by the IWG-SEM.
- ✓ A self-assessment check-list on capacity/qualification is provided to allow involved partners to self-assess their internal status and capacity.
- ✓ "IWG-SEM" logo will be used if the mapping is performed following the IWG-SEM guidelines

2.8 ASSURANCE OF CAPACITY AND QUALIFICATION

IWG-SEM Qualification Check List

Quality category	Level	Specification	Check
Availability	light	8 hours / 5 days a week (8/5) or less	
	medium	better than 8/5 but not 24/7	
	strong	24 hours / 7 days a week (24/7)	
Experience with global mechanisms	light	no experience at all	
	medium	up to 5 years	
	strong	more than 5 years	
Capacity	light	provision of single analysis layers	
	medium	1 activation on its own	
	strong	more than 1 activation in parallel	
Product quality	light	no quality control before product	
	medium	internal quality control	
	strong	internal QC following international standards	

Product reliability	light	no validations at all	
	medium	internal validations of analysis results	
	strong	external validations of analysis results	
Product delivery time	light	slower than 16 hours (for 1st crisis	
	medium	8 to 16 hours (for 1st crisis product)	
	strong	faster than 8 hours (for 1st crisis product)	
Robust production chain	light	ad hoc production, manual production; no	
	medium	partly automated processes	
	strong	certified production chain	
Language skills	light	only mother tongue (no English)	
	medium	English (only)	
	strong	English (fluent) and one other language	
Continuous improvement	light	no user feedback gathered and integrated	
	medium	user feedback sometimes	
	strong	user feedback gathered after each	

3. EVENT-SPECIFIC MAPPING GUIDELINES

3.1 FLOOD SPECIFIC GUIDELINES

3.1.1 SCOPE

3.1.2 REFERENCE MAP

3.1.3 FLOOD EXTENT AND IMPACT

3.1.4 MONITORING OF A FLOOD SITUATION

3.1.5 INFORMATION FOR DISASTER RISK REDUCTION

SUBJESTS FOR FLOOD MAP

Theme	Brief Description
Normal water bodies	Indicate the detectable water bodies over a given area derived from the most pertinent data, taking into account seasonal variations when possible
Crisis/disaster event water bodies	A layer highlighting all water bodies in a given area including normal water bodies
Flood extent	All floodwater bodies and traces at a certain (acquisition) date except for the normal water body extents
Impact assessment	Map indicating potentially damaged/flooded buildings, infrastructure, flooding of vegetation/agricultural fields, serious bank erosion/channel displacement...

REQUIREMENTS FOR FLOOD RELATED REFERENCE MAP

Map layer(s)	Reference Map (Floods)
1. Normal water extent/bodies[1]	***
2. Background information layer (e.g. archive/post-event optical satellite imagery, topographic map…)	***
3. Points of Interest (as critical infrastructure[1], important assets… such as airports, railroad stations, bridges, hospitals, embassies …	**
4. Infrastructure information (e.g. city names, road network, railway net…)	**
5. Information on risk (e.g. vulnerability, exposure, modelled risk areas (HQ100, HQ200),…)	*
6. Thematic information layers (e.g. land use/land cover, height information/DEM), population density, potential evacuation areas, soil information…)	*

*** mandatory, ** recommended, * optional

FLOOD REFERENCE MAP

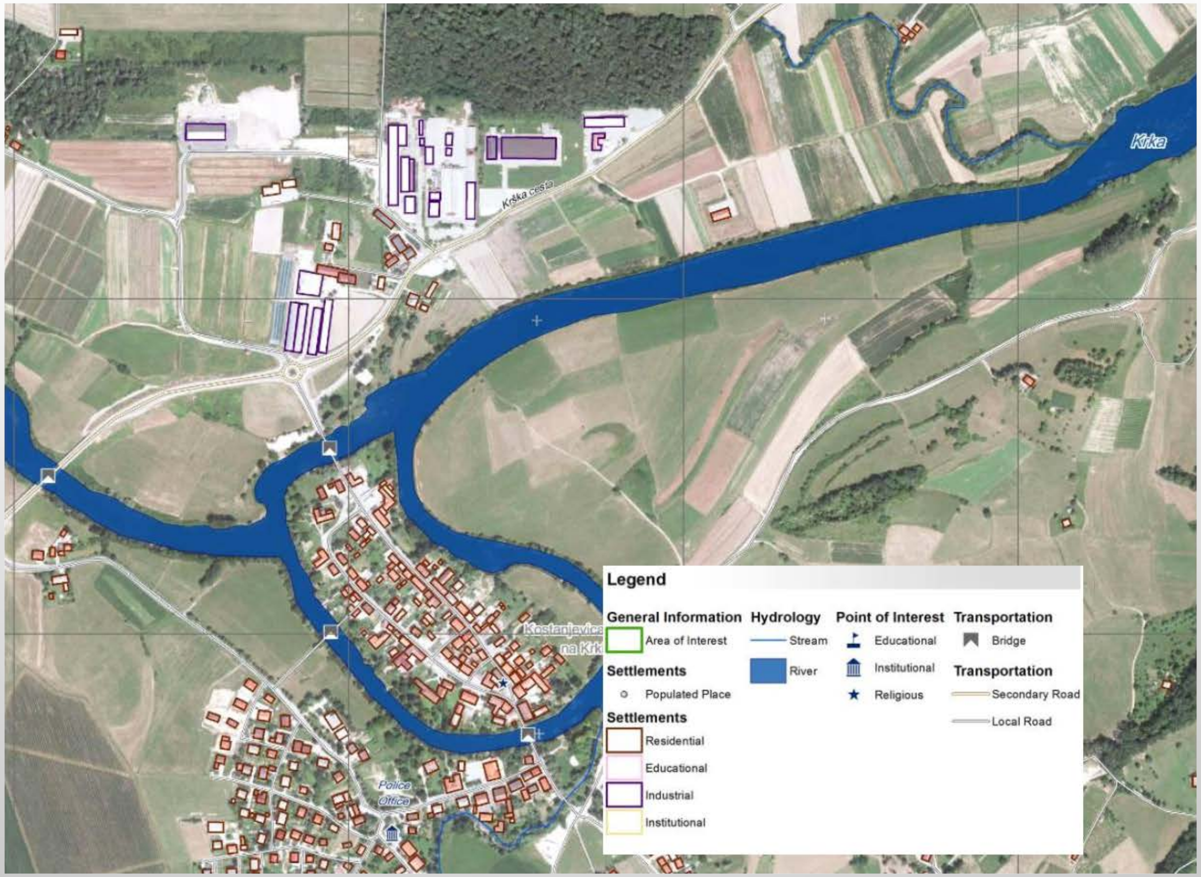


Figure 1: Example for a flood reference map - Source: Copernicus Emergency Management Service - Mapping. http://emergency.copernicus.eu/ (accessed 03/11/15): http://emergency.copernicus.eu/mapping/system/files/components/EMSR102_03KOSTANJEVICA_REFERENCE_DETAIL01_v1_300dpi.jpg)

FLOOD EXTENT VS IMPACT MAP

Map layer(s) \ Crisis map types	Flood Extent Maps	Flood Impact Maps
1. Flood extent	***	***
2. Crisis/disaster event water bodies[2]	***[2]	***[2]
2. Normal water extent/bodies	***	***
3. Information on impact, e.g. affected infrastructure, urban areas, that can appear graphically in maps and as statistics in tables in or associated with maps		***
4. Points of Interest (as critical infrastructure, important assets... such as Embassies, airports, railroad stations, bridges, hospitals...	**	**

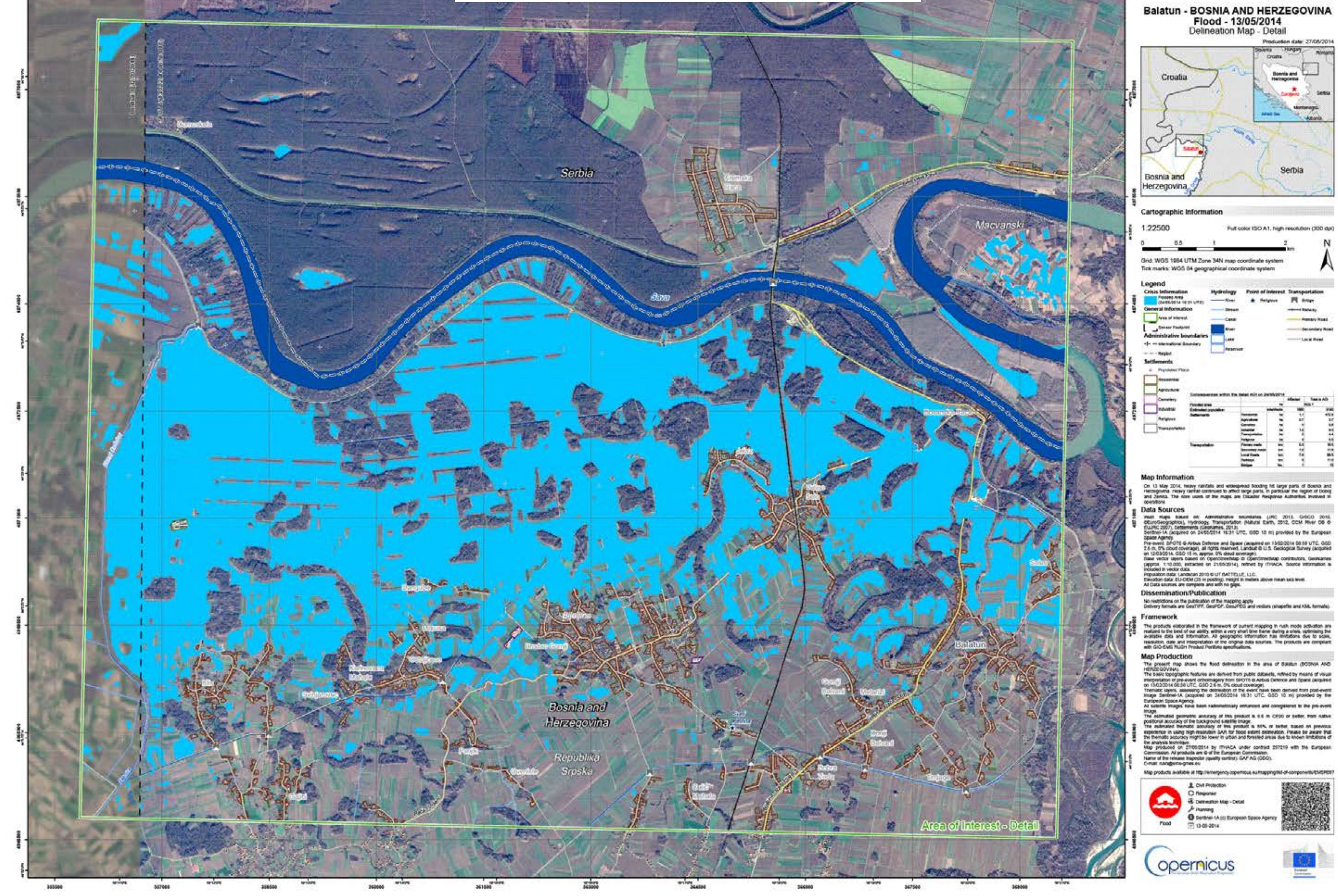
2 Alternative to 1. Flood Extent
*** mondatory
** recommended
* optional

FLOOD EXTENT VS IMPACT MAP

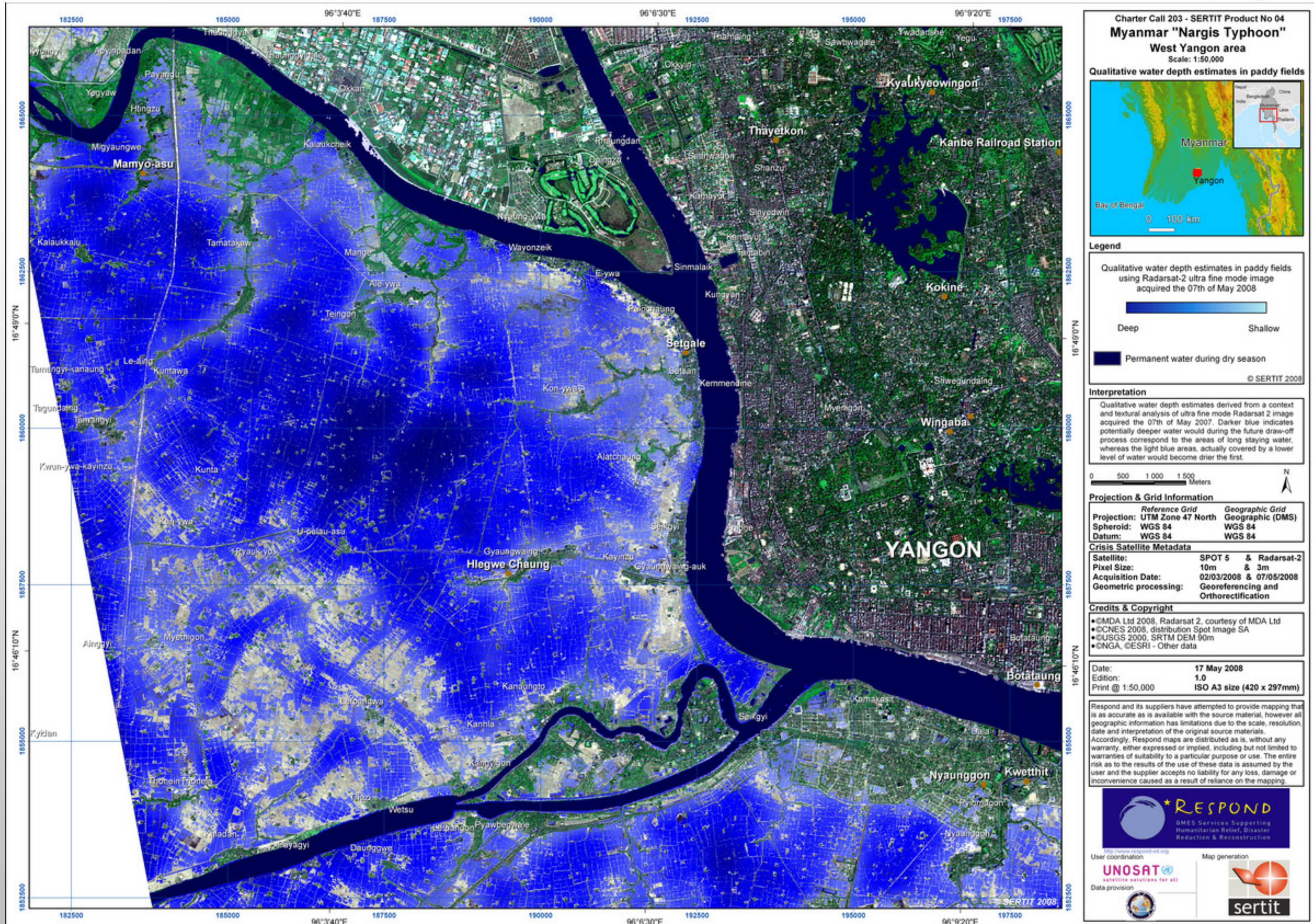
5. Infrastructure information (e.g. city names, road network, railway net…)	**	**
6. Thematic information layers (e.g. land use/land cover, height information/DEM), population density, potential evacuation areas, soil information…)	*	*
7. Background information layer (e.g. archive/post-event optical satellite imagery, topographic map…)	***	***

***** mandatory, ** recommended, * optional**

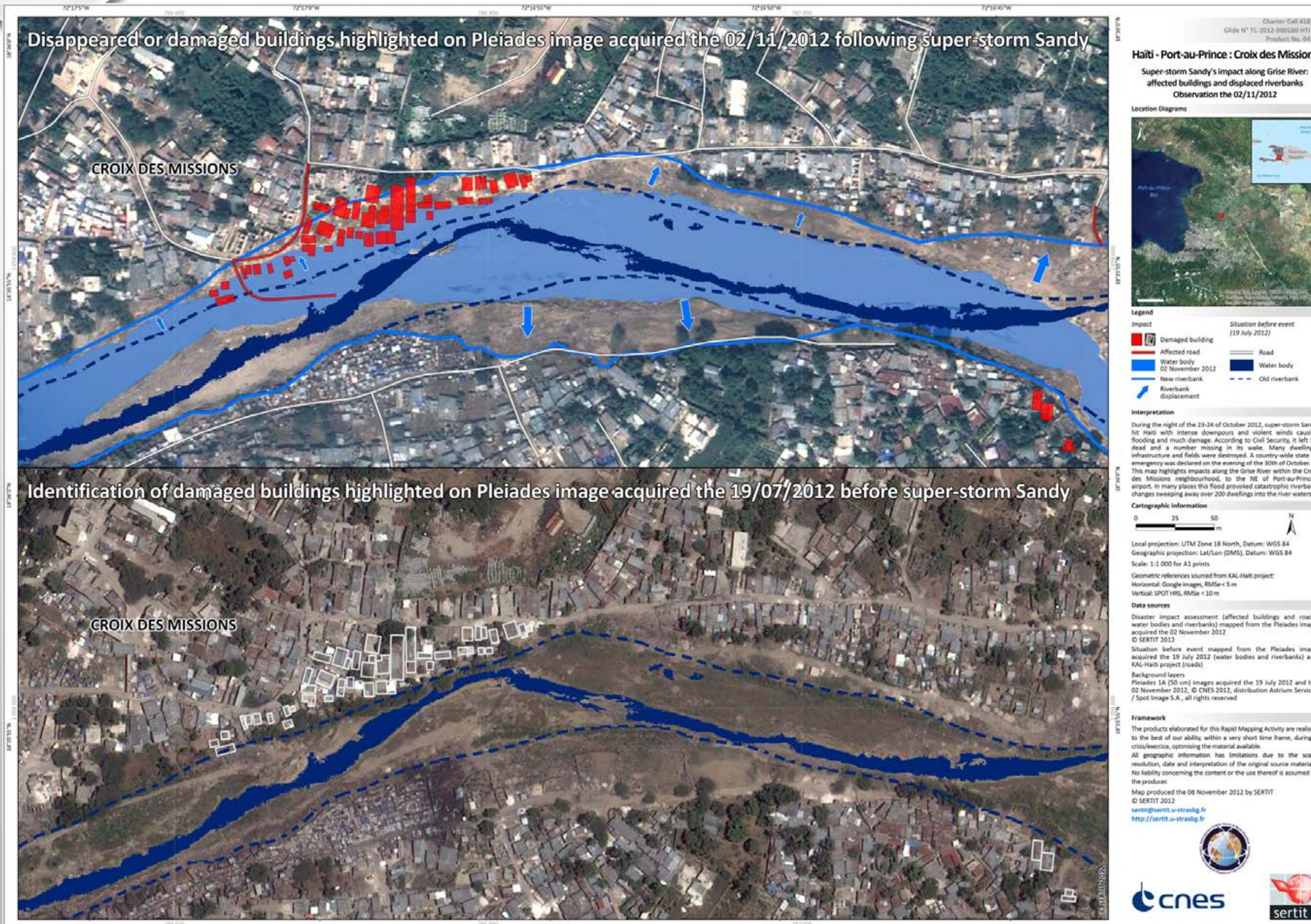
Example of Flood Extent Map



CYCLONE NARGIS, MYANMAR, 2008, ACTIVATION 174
RADARSAT-2 ULTRA FINE IMAGE ACQUIRED MAY 7, 2008
(COMBINED WITH SPOT DATA FOR QUALITATIVE WATER DEPTH ESTIMATES IN PADDY FIELDS)



Example of Impact Map with Reference map



3.1.4 MONITORING OF A FLOOD SITUATION

- EVEN THOUGH FLOODS OFTEN OCCUR AS METEOROLOGICAL SUDDEN-ONSET EVENTS, THEY CAN LAST FOR WEEKS TO EVEN MONTHS, AS CLEARLY DEMONSTRATED BY THE FLOODS IN PAKISTAN IN JULY TO SEPTEMBER 2010.
- MONITORING THE EVOLUTION OF THE FLOOD EVENT IS CRUCIAL FOR ASSESSING THE RATE OF INCREASE AND/OR RETREAT OF FLOOD WATERS, AS WELL AS TO IDENTIFY POTENTIAL NEW DAMAGES.
- IT IS TECHNICALLY POSSIBLE TO CAPTURE A NEARLY DAILY COVERAGE OF THE WHOLE EVENT, ALLOWING THE PEAK-FLOOD LEVEL TO BE CHARTED.

2.5.3 SITUATION UPDATE, EVENT MONITORING MAP

Figure 6: It is suggested to adopt filled polygons without outlines if the flood layers can be derived with a high level of reliablility. For example light blue an show the “older” information while darker blue shows the newer information layer. Trasparency my allow better interpretation due to better readability of the layer context.

3.1.5INFORMATION FOR DISASTER RISK REDUCTION

- Once the emergency phase is over, the recovery phase will start.
- The assessment of significant landscape changes resulting from an event is important for any flood situation.
- The Post Disaster Needs Assessment (PDNA) provides information which is necessary for the government and international community to support the region in large-scale events.

Economic Vulnerability to Food

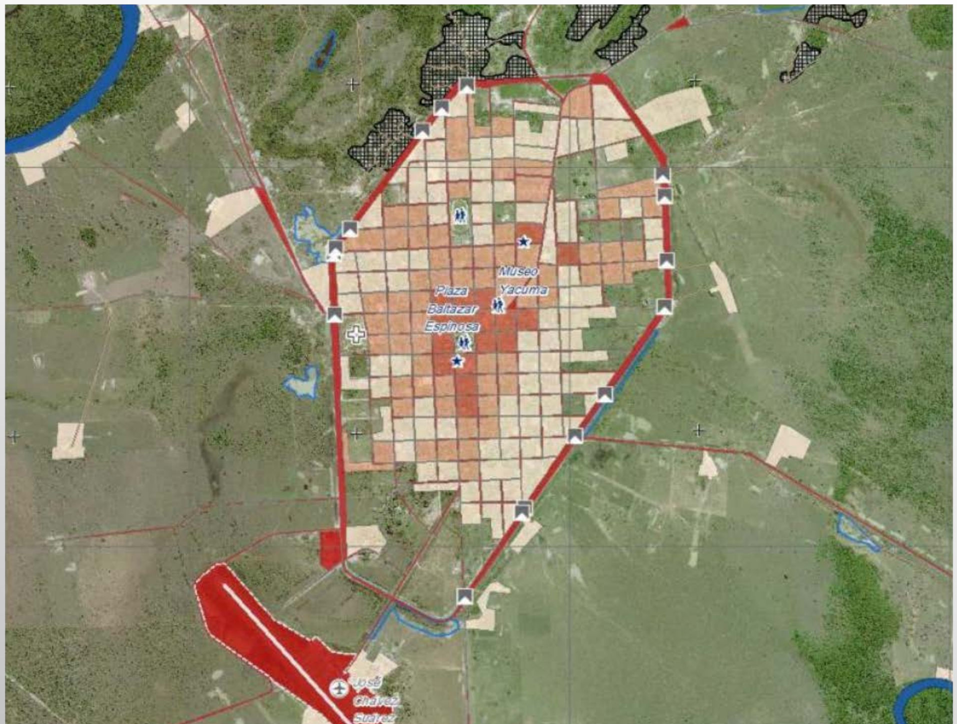


Figure 7: Economic Vulnerability to Floods – Santa Ana del Yacuma, Rio Mamore, Bolivia
The vulnerability index refects exposed assets and estimated building costs (Copernicus EMS, activation EMSN014; http://emergency.copernicus.eu/mapping/list-of-components/EMSN014

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Thank you.

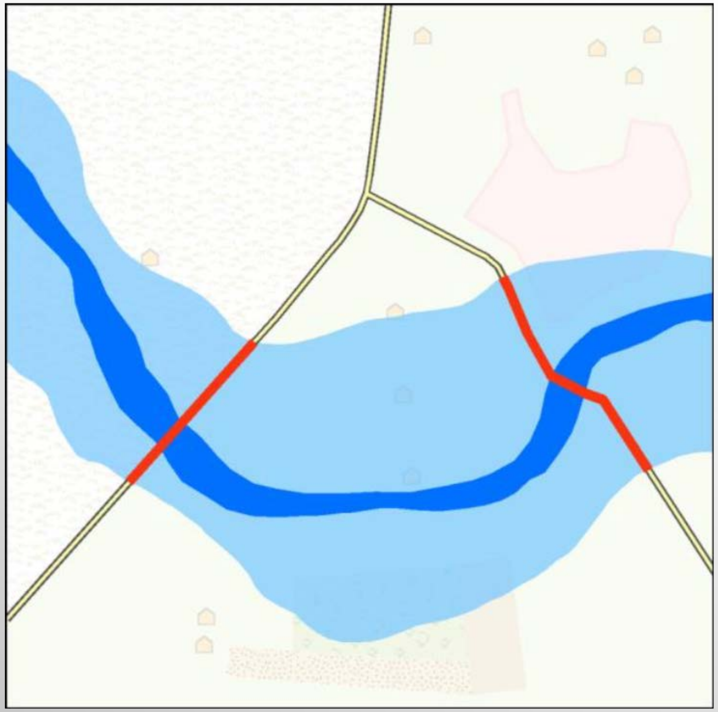

Figure 4: Crossing of highly reliable flood layer with linear infrastructre / road layer

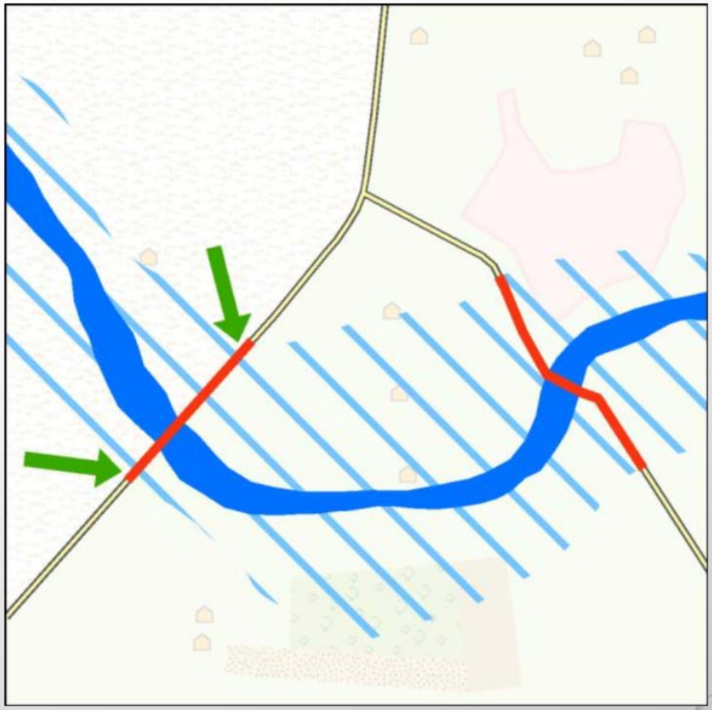

Figure 5: Crossing of poorly reliable flood layer with linear infrastructre / road layer

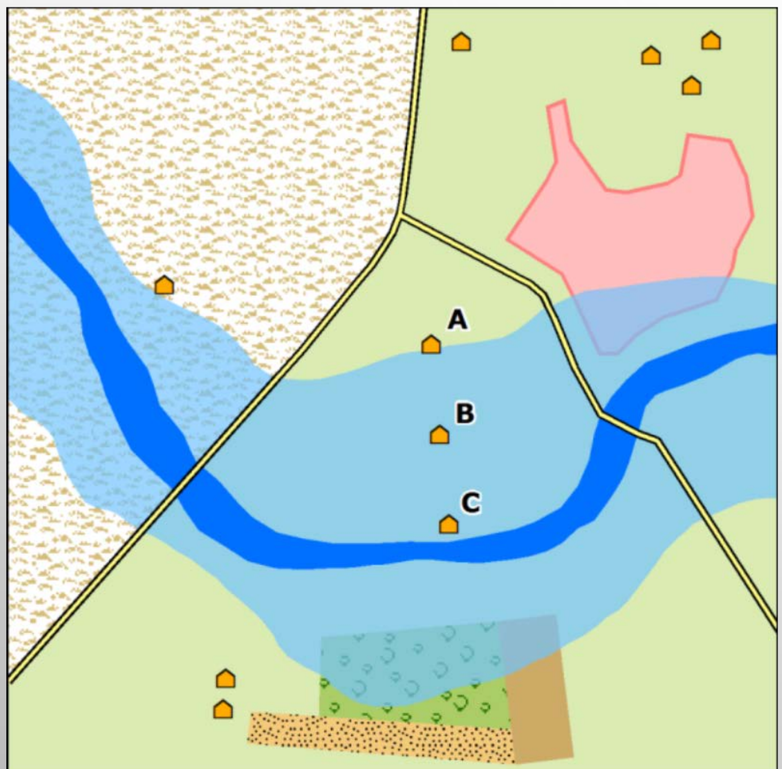

Figure 2: Use a semi-transpartent filled poygon to display reliable flood extent layers

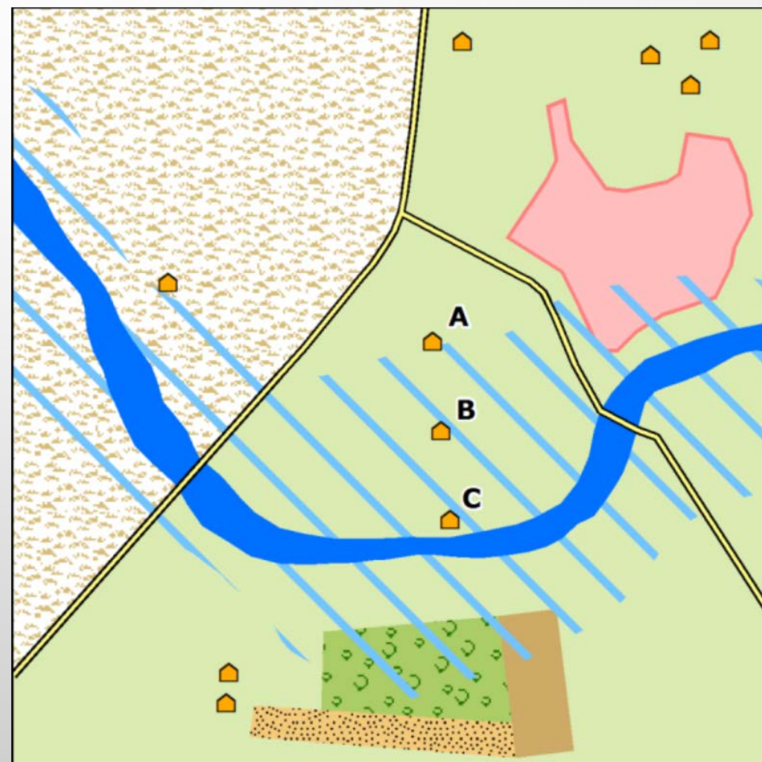

Figure 3 Use open stripes for displaying of low accuracy delineation to visualize a degree of uncertainty