USE OF SPACE APPLICATIONS IN HUMANITARIAN OPERATIONS

Report from the workshop

Warsaw, 17-18 May 2012

During a large scale crisis effective management of the situation requires not only mobilisation of necessary resources, but also appropriate information in order to use them in an optimal manner. In that domain, space applications have a significant potential to offer. Earth observation, navigation and satellite communication may enable an increase of efficiency and effectiveness of civil protection operations and humanitarian assistance.

Use of satellite communications for strategic-level coordination is a relatively standard practice during large-scale operations. Satellite navigation and positioning are regularly used by rescue teams on the ground. Earth observation products often provide strategic overview of situation. Clearly, unavailability of useful technologies is not the main obstacle for optimal utilisation of satellite solutions.

At present, use of space applications during humanitarian crises is largely uncoordinated and, consequently, their capabilities are not fully realized. Furthermore, only a limited number of potential end users is aware of the available possibilities and is prepared to utilise them. No simple solution exists to remedy this situation. However, the challenges are no longer of a technical nature and are mainly related to organizational aspects.

The workshop on "Use of Space Applications in Humanitarian Operations" was devoted to presenting and discussing optimal utilization of space applications in support of humanitarian efforts during large-scale crises.

It was facilitated through a simulation game, with participants playing roles of crisis management actors during a serious flooding in a fictional country – Wonderland. The geospatial environment Alice[1] was employed to demonstrate use of different satellite applications in an integrated manner.

The workshop was co-organised by the Crisis Information Centre of SRC of Poland, the High School of Fire Service of Poland and the Secure World Foundation. It was a part of the Warsaw Space Days 2012, and it was coordinated with the workshop "Earth Observation – Assistance in Crisis Situations" aimed at the Polish crisis management community.

The workshop idea and the concept of the common geospatial environment demonstrated in the simulation were based upon analytical work conducted in Poland during the Polish Presidency of the Council of the European Union in the second half of 2011. The Polish Presidency aimed to, inter alia, raise awareness among the civil protection and humanitarian communities about existing and future technologies, identify potential ways of their effective implementation, and formulate recommendations for use of space applications within existing mechanisms of international cooperation.

A workshop organized by the European Space Policy Institute and the Polish Civil Protection Presidency "Space for Civil Protection", confirmed high interest of users in the topic and provided an overview of the existing situation.

The international civil protection field exercise EU CARPATHEX 2011 has been used to demonstrate utilisation of integrated space applications in a complex crisis, resulting in an increased situational awareness. The Common Operational Picture was established through the use of several technical

[1] "Alice" (Adaptive Layers for Information and Collaboration in Emergency) is the experimental geospatial IT environment for sharing situational information during crisis operations. It has been successfully used in several table-top and field exercises to research needs for and demonstrate added value of optimised flow of geospatial information related to crisis situation and response activities.

solutions, including the Alice geospatial environment similar to the one used during the current workshop.

The results of this effort were reflected in the 8th Space Council Orientations, as the European Ministers responsible for space underlined that: "[...] the effective management of crisis situations [...] requires the integration of different space and ground based applications to support coordination of activities, conducted by multiple actors involved in civil protection and humanitarian operations".

"Alice in the Wonderland" – space in action

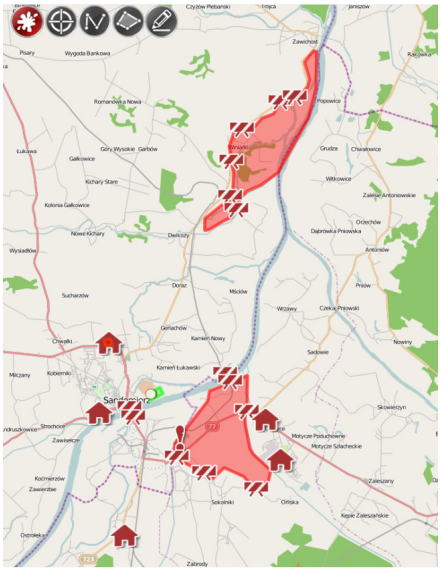
In May 2012 a major flood struck Wonderland – a medium-sized country in Eastern Europe, outside of the European Union. The disaster affected a large part of the country and the scale of destruction forced the Wonderland government to request international humanitarian assistance.

More than 50 participants of the 1-day interactive simulation game were mainly crisis management professionals and experts from related fields. They were divided into 11 groups acting as different actors of the Wonderland crisis. Two regional crisis management centres from neighbouring regions were responsible for management of the local situation. The national rescue coordination centre was responsible for nation-wide coordination of operations and the liaison with OSOCC (On-Site Operations Coordination Centre), which coordinated activities of the international groups. Four international NGOs provided rescue aid and humanitarian assistance. The national crisis management centre was mainly responsible for gathering situational information and developing recommendations for top-level decisions. The separate groups acted as national-level decision-makers and media.

Scenario of the game was fictional, but partially based on a real experience of flooding in Poland in 2010, plus some operational cases from the international civil protection exercise EU Carpathex 2011. For practical reasons, geographic data of south-eastern Poland was used for the Wonderland territory.

The common geospatial environment (Alice) was used to demonstrate the importance of an effective flow of geospatial information. In reality, such efficiency could be achieved by ensuring interoperability of existing systems and by defining standard procedures of sharing geospatial information.

During the simulation, all actors shared the available geospatial information. Each participating group had individual access to the Alice environment and were able to input information about the situation in their area of responsibility and about their own activities. It was assumed that selected field units had satellite access to Alice. Automatic geolocation of some units could also be simulated. Satellite observation products, GNSS information and situation reports from different groups were considered common information and all groups had access to it. Finally, the system was also used to facilitate bilateral communication and coordination of activities between individual groups.



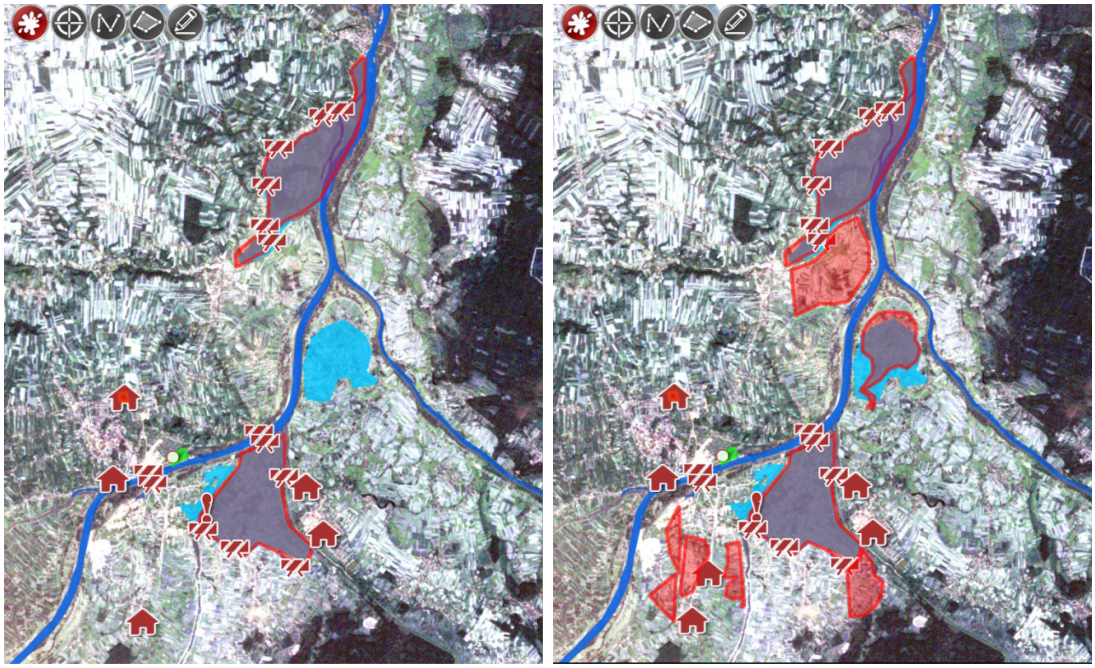
In the early phase the only information was situation reports indicating flooded areas and impassable roads. Information was presented on top of local maps and was available to all participants through the common geospatial environment

The four following cases present different situations when a combination of EO data, local situation reports and location information provided enhanced capabilities.

Case 1 – Understanding the situation

During the early phase of the crisis, when international NGOs were assessing the situation and considering their involvement, they were provided with local maps of affected areas and access to situation reports generated by Wonderland authorities. When satellite observation products became available, they were analysed in the context of local situational information.

After a decision about their involvement was made, the Alice environment was used to facilitate communication with OSOCC and preliminary areas of NGOs responsibility were identified. NGOs had access to local reports – the same information that was exchanged between regional crisis centres (which included reports about flooded areas, extent of damage and impassable roads). As a result, they had a better understanding of the situation during final preparations before deployment.

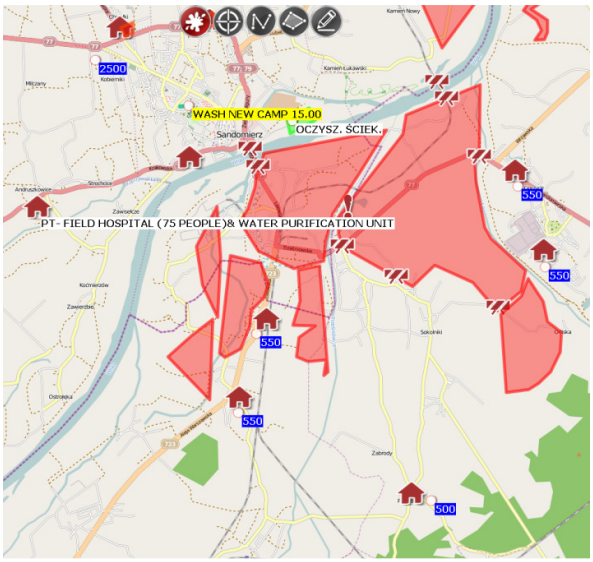


As satellite information indicating flooded areas became available, they were available in the context of local situational reports. The map on the left shows a flooded area that was not indicated in local reports. The map on the right (snapshot taken a few hours later) shows additional local reports (including flooding not visible on satellite image)

Case 2 – Following changes in the situation

Before aerial transport to Wonderland, NGO teams already had certain knowledge of the area. After their arrival, the geospatial environment was used during initial briefings to indicate changes in situation (newly flooded areas) and resulting changes of deployment destinations. As units departed, their GNSS location was shared and it was available in the system. That information was important not only for OSOCC, responsible for supervision of international aid, but also for regional centres that were aware of their presence. When the situation in the region changed (another flooding resulting from dyke failure), all groups became aware of the change as soon as the regional crisis centre reported it. As a result, they were able to modify their plans as soon as the new situation became understood.

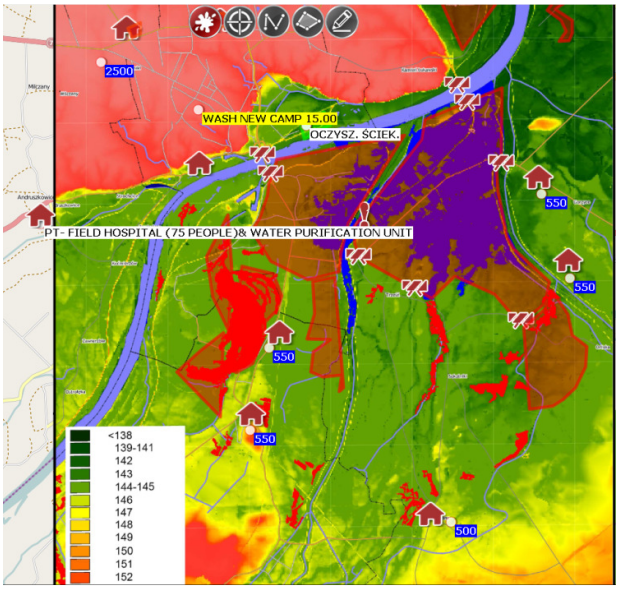
After arriving to destinations, the system was used to provide basic information about status of activities of the NGO teams. One example of shared status information was the availability of free places in temporary housing locations for evacuees.



Location of NGO units and status of their activities were reported on the local maps (text reports).

Case 3 – Increased safety

Common geospatial information was of particular importance when a new dangerous situation emerged. As a technical accident resulted in the release of hazardous chemical substances into the air, the potentially dangerous area was immediately indicated in the Alice environment by the regional crisis centre. One of NGOs was located within that area. Since the team had access to Alice, it became immediately aware of the risk. Knowing the position of the team, the regional crisis centre was also able to react by sending local rescue units to evacuate the NGO camp in the area. Furthermore, OSOCC also became immediately aware of the situation and provided parallel warning to the team. Having the shared information platform proved to be an important and potentially effective mechanism for communicating changes in various situations, in particular those related to safety and security.



Situation reports were combined with analytical maps (flood forecast) to facilitate strategic planning

Case 4 – Strategic planning

The final part of the simulation was a planning session, taking place a few days after the culmination of the flood. As the regional crisis centre received flood predictions derived from satellite observations, it was possible to identify areas that would remain flooded for a longer time and those where water

would flow away naturally. That information was useful for planning pumping operations and for coordination of further activities of international NGOs. During the planning session, forecasts were analysed in the context of situational information available in the geospatial environment.

Evaluation of the simulation

The simulation was evaluated during the workshop on the following day. The evaluation of the game from a functional perspective led to the following findings:

- ★ The common information environment increased situational awareness of all participants of the operation. Everyone had a better understanding of the "wider picture"
- ★ Different units operating in one area had shared situational information, even if they belonged to different chains of command. That was of particular importance in case of rapid situational changes and when potential dangers arose
- ★ All interested parties had access to the most current logistical information. Whenever one party became aware of unavailable roads or other obstacles, this information was made available to all, resulting in more effective transportation
- ★ The common information environment facilitated direct coordination of activities between entities operating in the same area

The workshop was attended by participants representing a wide variety of perspectives, from academia to industry, from data and technology providers to professional users. Results of the open and enriching discussion were used to build the reference model for the flow of geospatial information during humanitarian operation. The resulting model is presented in the last chapter of this report. The discussion led to several findings identified below.

Observations on the systematic approach:

- ★ In terms of providing geospatial information during crisis, there is a clear need to move from map to shared geospatial information
- ★ The geospatial platform should be available through simple visual tools and it should focus on situational information and location of available resources
- ★ Procedures of sharing geospatial information should be very clear and well-established
- ★ Training of users is critical to ensure effective use of any geospatial tools
- ★ Simulations and "serious gaming" are effective means of training and promoting geospatial tools and procedures
- ★ Tools should be extremely easy to use and users must be familiar with them. During crisis there is no possibility to bring new tools
- ★ Integration of any new, universal tools with legacy systems represent a significant difficulty
- ★ Ensuring safety and security of information represent a challenge

Observations regarding implementation:

- ★ As of today, there is no effective and easy-to-use system for using shared geospatial information
- ★ Geospatial information should be available through a limited number of layers (around 5). Each layer would require at least one moderator
- ★ Standardisation of symbols and colours is required
- ★ Availability of pre-existing data (like critical infrastructure) significantly increases usefulness of geospatial tools during crisis
- ★ Crowdsourcing is a valuable source of gathering and organising information
- ★ Key issue is reliability (verification of information) and selection of useful information (avoiding information overload)

Observations from the technical perspective:

- ★ Technology is no longer a real obstacle. Neither cost of equipment nor availability of GIS solutions represent a problem
- ★ Access to broadband communication may often be difficult, particularly if solutions are based on standard www interfaces

- ★ Efficiency of multi-user environment and replication of data in multi-database environment remain difficult

General observations:

- ★ Decisions about development and implementation of geospatial tools to support crisis operations should be based on cost-benefit analysis
- ★ As of today, coordination of crisis activities conducted by NGOs is very limited. This may be partially addressed by sharing information
- ★ Geospatial tools are very useful not only in a response phase of the crisis. Their use for prevention analysis should also be promoted

Space technologies in crisis – the current situation

Findings of the analytical work conducted during the Polish EU Council Presidency confirmed that despite relatively wide use of space applications in crisis, several limitations exist. There is an insufficient number of users fully aware of the possibilities offered by space solutions and prepared to effectively use them. Telecommunication bandwidths available during emergencies may be limited and remain costly. Flow of geospatial information during crisis is not effectively organised, resulting in very limited use of space systems for coordination between different chains of command, particularly in the case of international assistance operations. Consequently, situational awareness is limited and there is no common operational picture. Information exchange between users and services providing satellite imagery could be improved, particularly with regard to operational needs arising during crisis. There is a lack of interoperability between different technical systems that are used by emergency services. Finally, establishment of long-term sustainability of the space-based services to support emergency management poses significant challenges related, in particular, to securing adequate funding for extensive periods of time. More specifically, the infrastructure supporting the services must be fully operational and must evolve according to user needs.

Several non-technical actions can be taken to improve the situation. More intense information campaigns among potential users should be conducted to raise awareness of available capabilities of space applications. In Europe, the reform of the Community Mechanism for Civil Protection[2] and development of new mechanisms for the EU external operations, particularly in the humanitarian field, may offer the opportunity to develop innovative solutions to improve the integration of space systems. Best practices for using space for emergency management should be identified and included in the operational procedures. They should be reflected in the existing training curricula. Technical standards for interoperability of end-user systems should also be sought.

In the coming years the European flagship programmes GMES and Galileo will offer increased capabilities for emergency management. The pre-operational GMES service provided through the SAFER project has already been activated more than 90 times and in 2010 it delivered 440 products. The fully operational GMES Emergency Management Service offers world-wide coverage and rapid 24/7 reactivity, providing products related, among others, to: reference maps; flood risk analysis and mapping; forest fires monitoring; landslides monitoring and forecasting; earthquake damage assessment; and support for assistance efforts during humanitarian crisis. It is expected that the service will expand beyond the emergency response part of the crisis cycle and evolve to cover the entire crisis cycle (crisis prevention, early warning, post-crisis reconstruction and situation assessment). The key current challenge is to ensure sustainability of GMES service provision beyond 2013. Furthermore, data policy applicable to GMES emergency-related products should take into account specific requirements of emergency situations, in particular the need for unrestricted circulation of information.

The use of GMES service is also coordinated with activations of the International Charter: “Space and Major Disasters” – a valuable initiative of ESA, CNES and CSA. Today the Charter has 20 members from all over the world, which have committed appropriate resources to support the provisions of the Charter and thus help to mitigate the effects of disasters on human life and property. The Charter has proved to be an indispensable source of space-based information. Being available for more than a decade, during the last 5 years it has been activated on average almost every week.

The Galileo constellation, in addition to positioning services, will represent a European contribution to the international COSPAS-SARSAT search and rescue system. Galileo satellites will offer new and unique capabilities, enabling near real-time reception of distress messages from anywhere on Earth

[2] The mechanism was established by the European Union to facilitate co-operation in civil protection assistance interventions in case of major emergencies

and providing a channel to send information back to a distress beacon. As a result, the ratio of false alarms will decrease and rescue operations will be launched faster and be better optimised.

The effective utilization of satellite telecommunication for emergency management, and in particular for civil protection operations, requires easy access to satellite connections during the first hours and days of the emergency, when the most critical operational needs emerge. The European Defence Agency has established a centralised Procurement Cell (ESCPC - a three-year pilot project ending in 2013), based on the assumption that coordinating and combining EU Member States' orders for satellite communications services should ensure better access to such services at competitive prices. Establishment of the dedicated organisational framework for that purpose is currently under consideration by ESA. Such arrangement would provide the civil protection community with efficient and simple access to space assets and, through integration of demand, enable it to negotiate better availability and price from satellite operators.

Furthermore, similar arrangement could provide a framework for integrated use of different space applications to support coordination of activities conducted by multiple actors involved in civil protection or humanitarian operations. Standards or common practices of gathering, generating and disseminating geospatial information would result in the creation of a common information environment. Such an environment would facilitate flow of information among different actors of operation, enable exchange of information about location of resources, facilitate access to satellite imagery and improve development of dedicated geospatial analytical products for rapidly responding to emerging needs. As a result, enhanced situational awareness and a common operational picture shared by multiple actors would result in more effective rescue and humanitarian assistance efforts.

The way forward

Building upon the findings of the Polish EU Council Presidency, the evaluation of the international field exercise EU Carpathex 2011 and the evaluation of the workshop's simulation, the following key challenges for use of space for crisis management and humanitarian assistance can be identified:

- ★ Raising the awareness of potential capabilities of integrating space applications in appropriate systems among potential users

- ★ Development of regulatory solutions, leading to interoperability of space-related capabilities and towards a coherent framework of operational procedures to use space-based applications for emergency management

- ★ Considering the establishment of organisational framework, facilitating the utilisation of satellite communication and the effective flow of geospatial information during crisis situations

In the European context, the additional challenge is:

- ★ Ensuring optimal utilisation of space solutions within the framework of existing European coordination mechanism in the field of civil protection and humanitarian assistance

✧ ✧ ✧

The workshop on "Use of Space Applications in Humanitarian Operations" focused on the simulation game. The purpose of such an approach was to demonstrate increased situational awareness resulting from access to information with interoperable systems operating within an established logic for the flow of geospatial information.

The simulation evaluation and the following discussions allowed to further develop a concept of the system integrating use of different space applications and organising the information flow.

The resulting description should be considered as a reference model. It is not intended as a recommendation for implementation, but it is presented with the purpose of stimulating and structuring further discussions.

Reference model of integrated use of geospatial tools for humanitarian operations

The basic logic of the system is to provide a common platform to easily access and to share geospatial information related to a humanitarian crisis. The platform should be offered as a support tool within the framework of the existing coordination mechanisms. It should offer a one-stop-shop for geospatial information for all involved actors, and it should become the first source they check when looking for particular information.

Platform operations should result in increased availability of geospatial information, leading to more informed decisions made by actors of the humanitarian operation. The long term result should be an improvement in coordination of activities conducted by multiple actors involved in operation.

Component 1 – Geospatial platform H-GIS (Humanitarian GIS)

The heart of the system would be the database of geographic information – the platform called Humanitarian GIS (H-GIS).

Currently, multiple actors of humanitarian operations obtain geospatial information individually, starting from maps of the area of operation, through information about available roads, up to detailed assessment of damage. The majority of the information needs of those actors are identical, but they have to collect information individually and that information is often incomplete (or may be assembled in formats that are incompatible). As a result, humanitarian actors often need to operate without sufficient information about the area. In many cases such information is available to some institutions, but they are not shared with all others.

Collecting the most important and generally needed information and enabling easy access to it by all authorised institutions should result in a significant increase in situational awareness and the creation of a common operational picture.

H-GIS could become a geospatial component of the Virtual OSOCC.

A limited set of information could be used for an initial version of H-GIS:

- ★ Reference maps
  - ➢ Maps of the area (including EO-derived maps)
  - ➢ Location of critical infrastructure, including lifelines[3], if available
  - ➢ Location of infrastructure of relevance (airports, heliports, warehouses, etc.), if available
  - ➢ Archive (pre-disaster) satellite images
- ★ General situational information
  - ➢ Danger zones (areas of potential risk for humanitarian actors)
  - ➢ Access information (availability and non-availability of roads, landing sites, etc.)
  - ➢ Disaster extent (areas affected and – when available – assessment of the scale of damage)
- ★ Operational information (defined for particular operation, often specific for some actors only):

[3] Lifelines are systems and facilities that provide critical services vital to the function of a community and important to the emergency response and recovery after a natural disaster

- Actual location of national and international teams
- Location indicated for deployment for arriving teams
- Areas of responsibility
- Available capabilities (i.e.: number of hospital beds, number of places in IDP camps)

The issue of very high importance is credibility of information. It can be assured by limiting sources of information, clear indication of source for each piece of information, and clear indication of time of information.

The main sources of information should be:

- ★ Geospatial information made available by LEMA (regularly updated)
- ★ Geospatial information provided by OSOCC (regularly updated)
- ★ Information derived from EO data, including products resulting from activations of the Charter and the GMES Emergency Management Service
- ★ Information provided by actors participating in the humanitarian operation

Establishment of H-GIS should be supported by definition of recommended standards for interoperability, to facilitate technical exchange of information between GIS systems as well as to facilitate sharing of location (GNSS) data.

In case of information provided by multiple actors participating in the operation, generally recognised procedures should clearly define types of information collected and the styles in which it is depicted(symbols, colours).

Component 2 – Access to H-GIS

Actors participating in the humanitarian operation should be able to use simple technical solutions to access H-GIS.

- ★ Simple geospatial viewer with dedicated interface will provide browsing capability. The browser will keep all information, when used in off-line mode. When access to Internet is available, it will update its content, depending on user needs and available bandwidth.
- ★ The viewer will allow the (authorised) user to enter new information into H-GIS. Examples of information are: road is not passable, hospital has been established and is operational, etc.
- ★ Selected information could be made available for use with GNSS devices. This capability should cover general situational information, in particular information about danger zones and access information. Such capability could be considered for experimental deployment within the framework of the Galileo Commercial Service or EGNOS.

Component 3 – GeoTAST (Geospatial technical assistance and support team)

The most credible and most current sources of situational information are OSOCC and LEMA. However, these entities may not be prepared for effective use of several geospatial products. Furthermore, as of today they are not ready to use geospatial tools to coordinate operations of an international team participating in humanitarian operations.

For that reason they could be supported by a dedicated geospatial team. Such a team could be formed as a dedicated technical assistance and support team (TAST) that could be deployed to the crisis area in the first days of the crisis. GeoTAST would operate at OSOCC and its component could be also established at LEMA, if needed. Its functions would cover:

- ★ Support for use of geospatial products (and in particular satellite images) in OSOCC and (if needed) LEMA. Preparation of additional analysis, according to local needs.
- ★ Collecting and uploading of available geospatial information in H-GIS and regular updating of that information
- ★ Use of geospatial tools to support OSOCC in coordination of activities of international actors involved in operation
- ★ Use of H-GIS to support coordination of activities between OSOCC and LEMA.

Component 4 – EO analysis centre

As EO products become available during the crisis, the amount and complexity of available information grow steeply. In addition, as the humanitarian response is a dynamic effort, there is a need to ensure the most up-to-date information. As the H-GIS should be easy to use, only selected products should be available in H-GIS. The additional reason for that are common bandwidth limitations.

The EO analysis centre should be responsible:

- ★ Maintenance of EO component of H-GIS, in particular, selection and management of available satellite images and downstream products
- ★ Development of additional analytical products, particularly in response to requests from GeoTAST
- ★ Continually updating the information concerning activities in the affected area, either by national or international crews; updated damage and needs assessments, as well as response efforts (in cooperation with GeoTAST)

Levels of participation of humanitarian actors

It should be expected that actors initially participating in the operation will not be willing to be actively involved in sharing information. However they will be very interested in accessing any information that is already available.

As they become used to the system and some trust develops, the willingness to use system to share information and to coordinate their own activities should grow.

For that reason, possible participation in the system should be flexible. It can be defined as several levels, with higher levels requiring more detailed inclusion into operational procedures and additional training.

- ★ Level 1 – access to information (no special procedures necessary)
  - ➢ All authorised actors of the operation (both teams in the field and their headquarters) have access to all information in H-GIS (unless some information has been restricted).
  - ➢ Some information in H-GIS may be available to non-authorised users
  - ➢ Some information in H-GIS may be broadcasted
- ★ Level 2 – provide information
  - ➢ Authorised actors may provide information about situation (e.g.: danger zones, availability of roads) and some operational information (e.g.: status of their units, available capabilities)
  - ➢ If an individual actor uses a tracking system, GNSS information may be shared with OSOCC and/or all authorised users
  - ➢ Individual actors may use H-GIS to provide some of its own information to the general public
- ★ Level 3 – use system to coordinate activities
  - ➢ Individual actors may use H-GIS to facilitate communication with OSOCC
  - ➢ Individual institutions may use H-GIS to facilitate coordination of own activities (H-GIS used by different teams of one organisation). If they chose so, information will not be available to others.
  - ➢ Several institutions may use H-GIS to facilitate coordination of their activities. If they chose so, information will not be available to others.