

INNOVATIVE RUSH MAPPING AT 1:50 000 SCALE

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1. INTRODUCTION

After the Asian Tsunami, several European initiatives were taken in order to reinforce emergency and crisis response capacities, in particular the capacity of analysis, improving coordination and effectiveness of the various instruments available for crisis or emergency situation. In most of the cases, humanitarian assistance is provided outside the territory of European Union for either natural, technological disaster or complex emergencies.

The Emergency Response Core Service (ERSC) is one of these initiatives that have been implemented in the framework of GMES (Global Monitoring for Environment and Security) program, for early warning and crisis management. ERSC implantation group further defines the information products expected from the “first priority” service for managing such crisis or emergency situation:

Reference Maps: which are maps, either derived from pre-existent data or obtained by pre-event simulations, containing cartographic information as well as information about population (location and density), urban and rural habitat, economic assets, main infrastructures (dam, bridges, industrial plants, airports, bus and railway stations, stadiums, refugee camps, etc.) and networks (roads, railways, power and water, etc.), possibly completed with contour lines describing the topography of the area with altitude points, and combined in a proper GIS working environment. In general, suitable scale ranges from global scale (typically 1:100.000) to tactical one (up to 1:25.000).

Assessment Maps: which are maps either directly derived from in-situ data and Earth Observation images acquired during the crisis and comparison between post and pre crisis information. They provide information about the event timing, location, extent, level of hazard and damage. The proper scaling moves from detailed scales (1:10,000 - 1:25,000) to overview scales (1:50,000 - 1:100,000).

With a more detailed level of information, Reference Maps are thus the first ones to be available in case of emergency. Those maps are described as basic “cartographic-type” as it provides valuable information about the intervention field to all actors involved in the rescue operations.

Furthermore, the main request expressed from all emergency stakeholders is the highest level of availability of the Reference Maps wherever the crisis occurs. Maps are also expected to be delivered at very short notice (usually less than one day).

Answering to this very strong need expressed by the experts of crisis management and early warning organisations, Spot Image SA and Infoterra France have combined their expertises to develop a dedicated service called EXPRESSMaps. This web-based service enables users to request a Reference Map, made of reliable geographical data positioned, included into a proper GIS working environment with the highest level of accuracy possible and at very short notice.

2. STATE OF THE ART

Rapid Mapping is well known since more or less the first commercial Earth Observation images are available. Today in Europe, there are several actors involved in rapid mapping such as DLR, SERTIT, EUSC, JRC or UNOSAT. They all provide what is described as Reference Mapping in the meaning of the ERCS Implementation Group and also Rapid Mapping or Situation Mapping which is the mapping description of the event (whatever the disaster: tsunami, wild fire, flood, earthquake or other disaster).

Usually, the Reference Mapping products provided in the frame of the International Disaster Charter are similar to these ones :

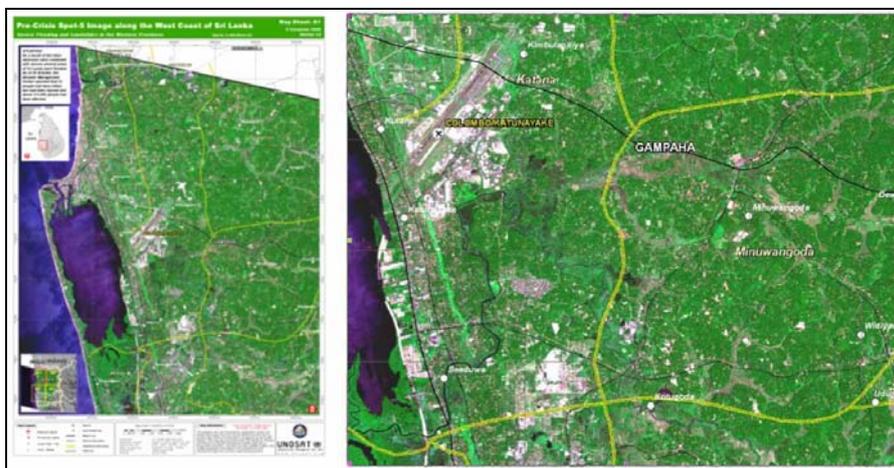


Figure 1 – Reference Map produced by UNOSAT
(<http://unosat.web.cern.ch/unosat/>)

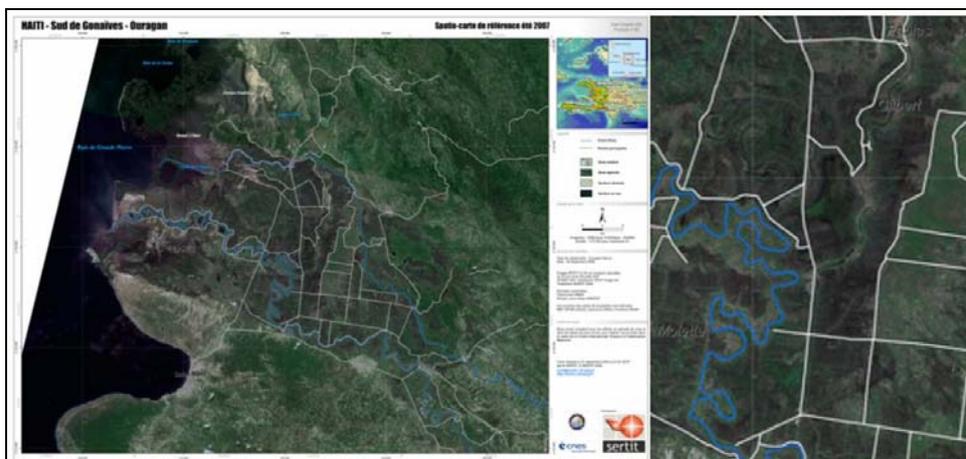


Figure 2 – Reference Map produced by SERTIT
(http://sertit.u-strasbg.fr/SITE_Charte/2008/06_charte_haiti_2008/06_charte_haiti_2008.html)

Rapid Mapping is well known as a part of the International Disaster Charter and of European projects (Respond, Risk-EOS, Preview ...). Within these frames, the Reference Map cannot be delivered within one single day or less after the event, because many players are in charge of the different steps : satellite data archive analysis, pre-processing and geocoding the data, and finally the map production itself.

Further more, from a strict cartographic point of view, these two examples (Fig1& Fig2) could be considered as spacemaps rather than “real“ maps.

Obviously, the safest, quickest and (often) cheapest way to obtain the Reference Map you need is sourcing it from a national mapping institute.

There is no commercial offer of maps at scale 1:50,000 processed over any part of the world, which are not linked to a mapping institute. Resalers of topographic map exist worldwide, offering usually paper maps or scanned maps or databases.

However, the global landmass extent of the Earth is far from being covered by regular 1:50,000 scale maps. In some cases, maps at this scale 1:50,000 are not available because protected or restricted for distribution.

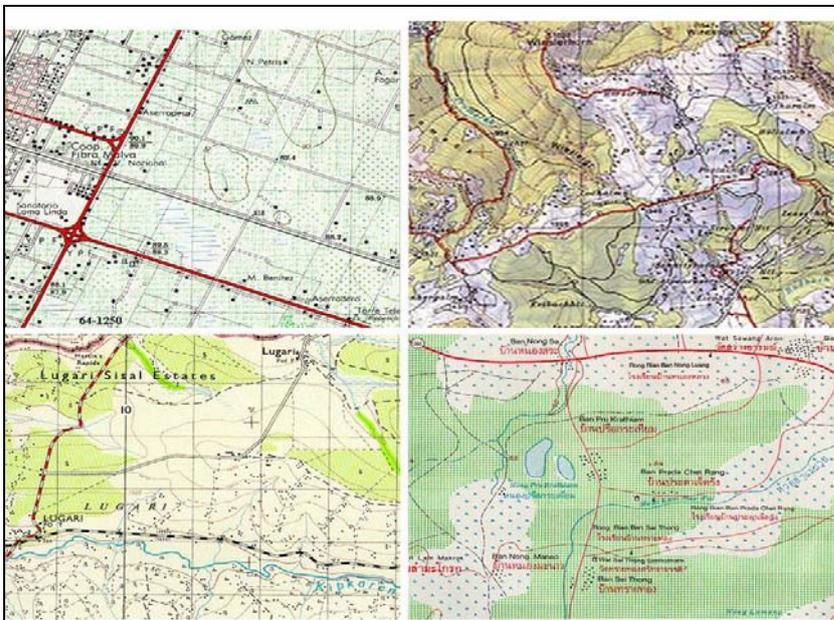


Figure 3 – 4 maps at scale 1:50,000 processed by national mapping institutes (Top-Left : Argentina, Top-right : Austri, Bottom-left : Kenya, Bottom-right : Thailand)

The above examples (Figure 3) show that for a single scale, the content of the maps, and the representation of the information are different. Furthermore, the projection systems are different too. These maps are not always available and when available they can be very old, sometimes older than 30 or 40 years. As an example, the available maps of Kenya have been processed during the 70' and early 80'. Some of the map do not have contour lines.

As most of these maps are paper maps or scanned files from the paper maps, individual layers of information, database and GIS compatible files are generally not existing.

Another possible source for Reference Map is the so-called “Soviet military” corresponding to maps processed by former USSR and available to the market. These maps are accurate, but the user cannot really tell the accuracy figure, which varies from

one country to another. They are very detailed in many cases, but very old and written in Cyrillic alphabet. From the original purpose (military / USSR), these maps use a specific legend / list of objects, and all the topographic information is not represented.

3. DESCRIPTION OF THE NEEDS OF POTENTIAL USERS

Today, there is a strong need of Civil Protection Units, European institutions, United Nations organisations and NGOs for being able to obtain the needed maps within this very short period. No efficient answer exists as there are two important issues to solve for achieving this target :

- ✚ Accessing to a reliable, accurate, documented and as complete as possible source of information
- ✚ Developing a method of production, patented and documented, that provides reliable information in a GIS working environment in a rush timeframe.

Processing maps at the requested scale, within a couple of hours and with the correct accuracy and reliability is not enough to meet user's needs. The provided maps should enable various applications from using it in Headquarters (HQ), in Situation or Coordination Centers or in the theatre in the worst conditions. Furthermore, the maps should enable combination of their own information with in-situ data or external geographical information. These points are some strong expectations from the community.

The users need a service that provides data for **various and immediate operational uses**, from a simplest paper product (1:50,000 map printed on paper), or a "simple" digital file such as the .pmf for display purpose, up to advanced digital products such as the .shp layers to be imported in a GIS or WMS data.

4. DESCRIPTION OF THE SERVICE

To address these needs, Spot Image SA and Infoterra France have decided to launch a web-based service for providing maps at scale 1:50,000 over almost any part of the World, within a very short time after the request (ranging from 6 hours to 24 hours, upon options) , with a very high level of accuracy and an amount of information addressing the needs of pre-registered ERSC or "ERSC-like" users.

The service is dedicated to users who need such map (1:50,000) over a part of the World where topographical maps are either old, or unaccurate, or not accessible or unavailable for any reason. Furthermore, the target of delivering the map within a few hours after the request by any user is indeed oriented to Early Warning, Crisis Management or Disaster Management community of users.

The service can be summarized as "**ONE CLICK, ONE DAY, ONE MAP**" illustrating that the industrial processing chain offers mapping data with a documented and fixed specification, wherever the geographical target , whenever the date and time of order, and whoever might be the customer.

The service is based on the combination of the very large extent of SPOT orthoimages available on-the-shelf and a patented process enabling to create from the orthoimage and open sources, a synthetic map offering all needed information. Hence, the service is available for the areas where Spot Image has built the archive of two main products: SPOTMaps and Reference3D[®] (ie more than 100 millions sq. km as of mid 2009).

The service provides maps at scale of 1:50,000 with a 15' x 15' frame size, answering to the needs as expressed by the ERCS Implementation Group, combining toponyms, elevation information, landcover, ground transportation etc Furthermore, the cutting frame is based on meridians and parallels. For high and low latitudes (limit to be defined) the size of the map will be extended to offer an area (in sq.km) large enough.

4.1. Data source

Since 2002, thanks the performance of SPOT 5 satellite, Spot Image has build a sound off-the-shelf 2D and 3D products which has permitted to implement such ruch mappong service. The standard source data used for EXPRESSMaps is Reference3D[®], which provides the following accuracy to the final map:

- ✚ Absolute horizontal accuracy : 16 m @ 90%
- ✚ Absolute vertical accuracy : 10 m @ 90% for slope < 20°

Where Reference3D[®] is not available, the use of Reference3D Alpha leads to a combination of a SPOT orthoimage (SPOTMaps) with the SRTM DEM. In this case, the final accuracy of the map is :

- ✚ Absolute horizontal accuracy : 16 m @ 90%
- ✚ Absolute vertical accuracy : 16 m @ 90% for slope < 20°

The next figure (figure 4) shows the areas where EXPRESSMaps products can be ordered depending on the available of the source data. This archive is regularly expanding.



Figure 4 – Areas where the service is available (in blue)

The geometric accuracy of the maps is the one of the source data. Both Reference3D and Reference3D Alpha are perfectly compatible with the scale of 1:50,000 and the use of GPS for positioning during field operations.

These sources are described in detail on :

Reference3D[®] : <http://www.spotimage.fr/web/en/812-reference3d.php>

SPOTMaps: <http://www.spotimage.fr/web/en/1285-spotmaps.php>

4.2. Map content and methodology

In the frame of the service design, the map content has been carefully studied in order to answer as much as possible to user's requirement. Map content is the compromise between four independant inputs :

- ✚ What kind of geographical information is needed by the user ?
- ✚ What information can be extracted from the sources, including the satellite image ?
- ✚ Which level of details can be extracted from these sources within a production time measured in hours ?
- ✚ Which reliability level can we achieve on interpreted objects within such a short processing time ?
- ✚ It is the combination of the source data and the extraction process that enables to create what can be qualified as a Reference Map.

Map content is easily interpreted thanks to a legend designed to fit both production constraints and users' needs. The theme and technical specifications are dictated to a large extent by how the map will be used in the field.

The information depicted on each map (figure 5) is guided by the need to provide relevant information to the people and teams on the ground to find their way over unknown environment as easily as possible.

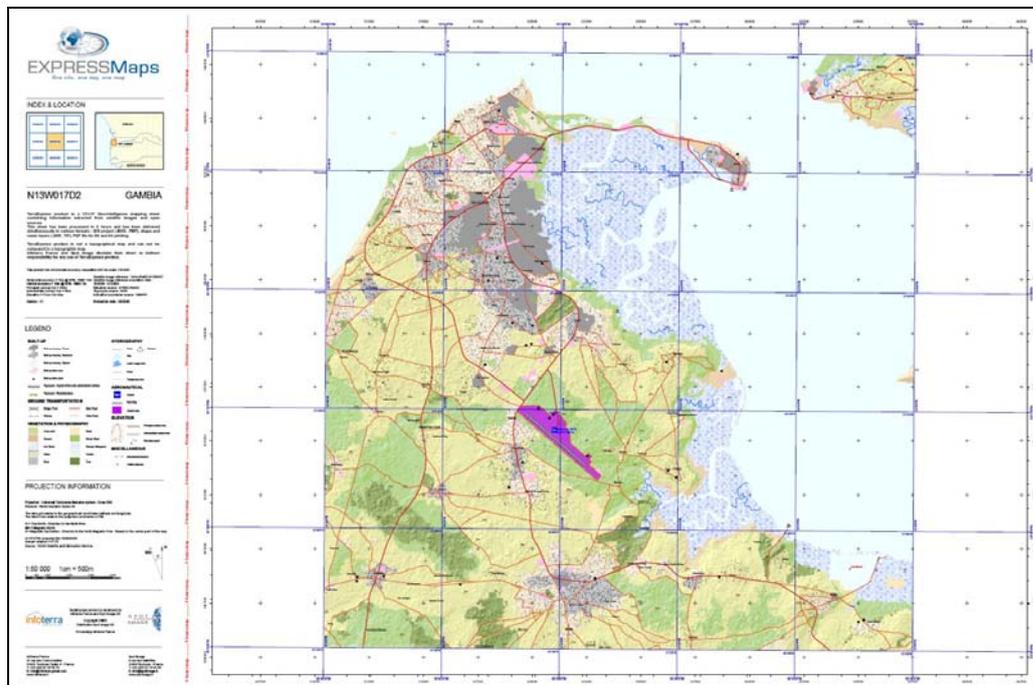


Figure 5 – Example of EXPRESSMaps product (1:50 000 scale map over Gambia)

The methodology developed to acquire the information depicted in the map regarding the time constraint is the following:

<p>Ground transportation</p>	<p>This is one of the map elements that get the most attention during the data extraction process. Two categories of roads or tracks are mapped: main routes and others. The distinction between the two is not based on technical criteria (road surface, number of lanes, etc.) but rather on their relative importance as a line of communication. So, the widest and most-used routes, and those linking the largest villages or towns, are classified as <i>main routes (in red)</i>. All other routes, from</p>
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tracks to secondary roads, are classified as *other routes*.

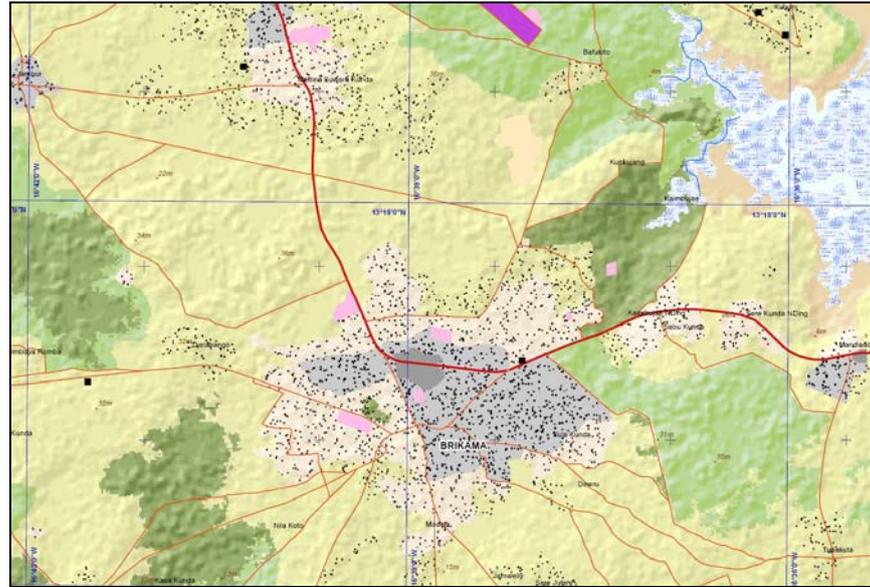


Figure 6 - Example of road network over Gambia

This unusual classification scheme is dictated by the need to extract information very quickly and by the fact that mapped landscapes and road network density may vary enormously. Likewise, this scheme is adapted to the many territories where the main routes are in fact dirt tracks. Such classification is therefore a functional one, highlighting main routes to help teams reach where they need to go as quickly and easily as possible.

Populated areas

Population areas also get special attention. The population layer comprises five classes, three for types of housing. Classes are distinguished according to housing density. Two additional classes cover industrial or trading zones in built-up areas.

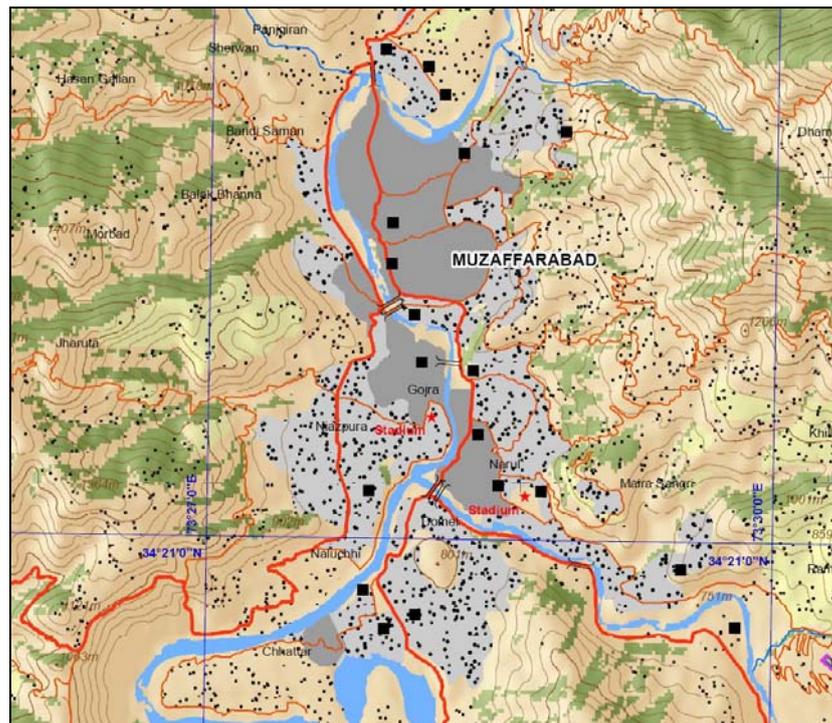


Figure 7 - Example of populated areas over Pakistan

Large areas are represented by polygons, while points enable large buildings like warehouses, factories and so on to be quickly identified. Such landmarks prove very useful for determining where you are on a map.

BUILT-UP

-  Built up housing : Dense
-  Built up housing : Moderate
-  Built up housing : Sparse
-  Built up other area
-  Built up other point

Vegetation

Vegetation and landcover are indicated through ten classes selected to give a pertinent information for the users (mainly dedicated to the ones who will be involved in field operations).

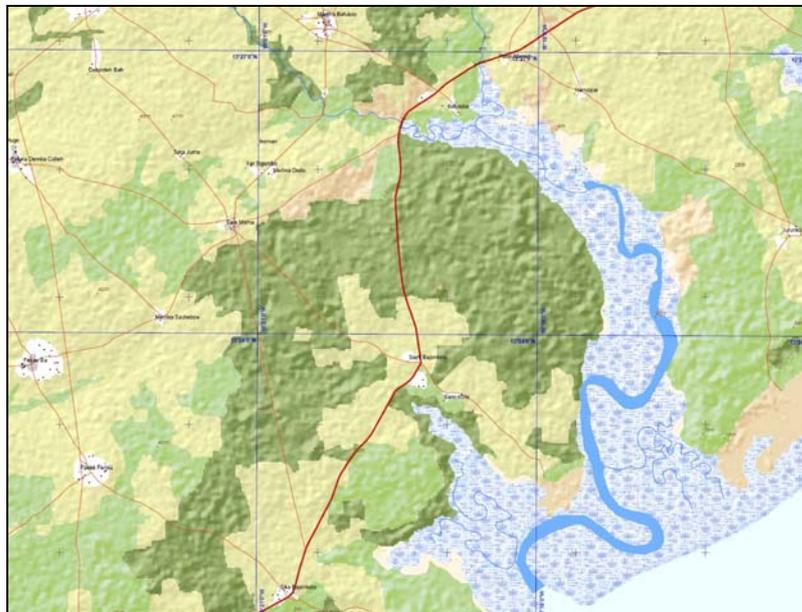


Figure 8 - Example of Vegetation over Gambia

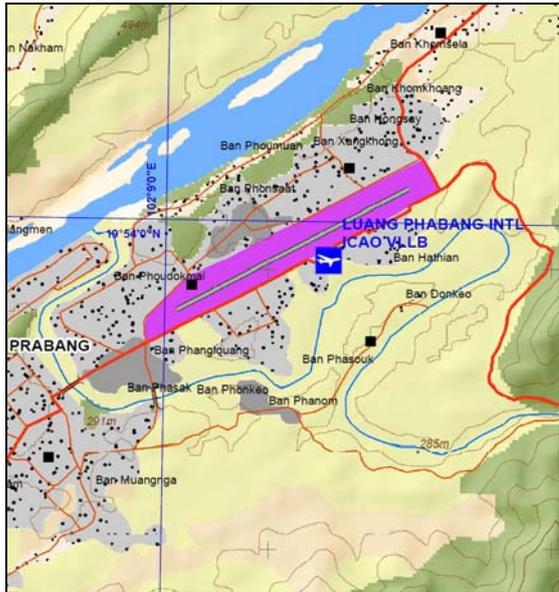
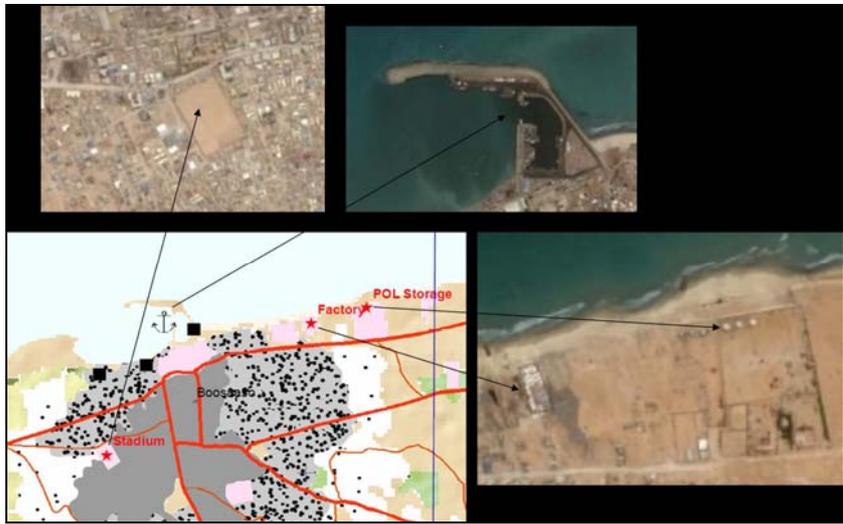
VEGETATION & PHYSIOGRAPHY

	Crop Land		Sand
	Ground		Shrub / Bush
	Ice / Snow		Swamp / Mangrove
	Oasis		Tundra
	Rock		Tree

Other infrastructures

Many point features like bridges, dams, airports and ports are also mapped, to facilitate operational use on the ground.

In addition to these most important points, the maps provided in the frame of this service indicate the location of bridges or fords, of airports and harbours (with a special mention for airports where the International Code (ICAO = International Civil Aviation Organization) is indicated on the map.

	 <p>Figure 9 - Example of infrastructure – Airport over Laos</p>
<p>Hydrographic network</p>	<p>Seas and oceans, dams, as well as lakes and rivers (including temporary ones) are part of the legend for the hydrology part.</p>
<p>Visible features</p>	<p>These “visible features“ correspond to very important details or specific points of interest that are identified on the image with 100% of confidence by experienced operators. Such information can help users (in the field or from HQ) for various operations as helping the positioning of some players, deciding of meeting points, installation of refugee camps, area for evacuation are some examples.</p>  <p>Figure 10 - Extract of visible features and high-resolution image for comparison</p>

Elevation information is represented with three different ways :

- Contour lines extracted at 50m equidistance
- Highest and lowest points of the area with a grid enabling to have a good density of points
- Shades merged with landcover colors for an immediate understanding of the landscape.

Answering to user's requirement, the elevation information is extracted mainly from the DTED2 DEM of Reference3D with a very attractive level of accuracy.

All the toponyms are extracted from Geonames, a database from NGA (National Geospatial-Intelligence Agency, USA).

4.3. Deliverables

In addition to creating a map that can be only printed as a poster and pasted on a wall, the delivery pack offers a wide range of files that enable a combination of utilisation, whatever is the need from the Head Quarter to the theatre of operation, from paper products to GIS digital files:

- ✚ **.shp files** for all the individual layers to be used in any GIS tool of the market
- ✚ **.mxd file** to be used with ArcGIS tool as a "prepared project"
- ✚ **.pmf file** to be used with a freeware viewer
- ✚ **.geotif file** to be used as a raster image with any software
- ✚ **.kml file** to be used with Google Earth
- ✚ **.pdf "ready-to-print A0"** to be printed at scale 1:50,000 with A0 sheet paper
- ✚ **.pdf "ready-to-print A4"** to be printed at scale 1:50,000 (atlas of A4 sheets)
- ✚ **WMS** to enable web base services through a geo-server

Answering the request for multiple operational needs , each "map" is then delivered with such set of files.

5. CONCLUSION

The service provided by Spot Image and Infoterra France answers to the initial requirement of main actors in the field of risk and emergency, crisis management and support to operations, when the time is one of the most important constraints. The challenge is to find the best compromise between the time constraints for delivering the service, the accuracy of the delivered product, the level of completeness of information and the flexibility of enabled applications from the delivered data.

To get more about EXPRESSMaps, visit: <http://express-maps.com/>