Contributing to Land Surveillance using Earth Observation

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BIOGRAPHY

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1. INTRODUCTION

The EU has procured procedures to reinforce citizen's security in view of the disrupting attacks endured since the turn of the Century. Earth Observation (EO) is a remarkable mean to tackle land surveillance for security on account of the vast array of targets that are at stake. The LIMES Land and Infrastructure Surveillance group pioneers security applications for land and infrastructure protection, namely, pipelines, frontiers, power stations and crowd gathering events; these conform just *the tip of the iceberg* of land infrastructures demanding security services, as defined by GMES for the European Union; yet, EO derived security services are in call for hydroelectric power stations, dams and reservoirs, navigation locks, recreation parks, industrial docks, commercial harbours, state public land and administrative facilities, to name but a few requests.

This paper presents the EO derived security service chains designed by the LIMES land and infrastructure surveillance group on critical infrastructures (CI), land border monitoring (LBM), non-proliferation treaties monitoring (NPT) and large event planning (LEP). The services are based on the capacity of Very High Resolution satellites, used in conjunction with high resolution data, aerial imagery, and ancillary data to enable critical spatial analysis with the aim to assess risks, improve security and enhance preparedness.

Critical infrastructures, such as transport networks, often cover large areas; their security relies on a huge set of components that must be controlled, monitored and linked to foreseeable impacts on side infrastructures. Benefiting from EO, satellite imagery provides the foundations for setting up complex information systems able to handle countless security parameters, such as the secure construction of buildings, building materials expansion, status changes, illegal activities, etc.

Land Border Monitoring activities aim to provide added value information to both a local border posts and high level border police authorities. Satellite EO complements in-situ and aerial data collectors of cross border trespassing activities. The wider spatial coverage provided by satellite sensors allows spatial analysis of illegal activities that operate hidden in the remote or less accessible sites.

The NPT Monitoring service develops an integrated platform able to support the verification of NPT. The platform is targeted at the image analyst in the context of Nuclear Safeguards, who has the responsibility of collecting, managing and evaluating satellite imagery (often in conjunction with information from other sources) and extracting NPT relevant information. The analyst generates a report on a country or location of interest and delivers it to the final user, which are high-rank decision makers normally with a high political profile.

Event Planning aims at developing a preoperational system able to provide services, or integrate existing ones, to the very singular needs of single large events filling in gaps that exist in conventional security procedures. Merged data originates from different sources such as airborne, in-situ sensors, local terrain data bases and VHR satellite data which provide additional information to decide security and emergency plans for an event.

2. LEGAL FRAMEWORK

Specific EU policies and legal frames foster the use of EO means for security in the said areas. A brief review of such legal context follows next, purposely short and non-exhaustive since it is not a the primary objective of the paper.

Focussing on CI, the European Programme for Critical Infrastructure Protection (EPCIP) has been consolidated by the Communication from the Commission to the Council and the European Parliament on "Critical Infrastructure Protection in the Fight against Terrorism"[1], the Green Paper on a European Programme for Critical Infrastructure Protection[2], a further Communication from the Commission[3] and a Proposal for a Directive of the Council on the identification and designation of European Critical Infrastructure and the assessment of the need to improve their protection[4].

The legal frame for European sea and land security has been gradually developed through Schengen Rules[5], implementing the complex security paradox of allowing the free movement of people while integrating border security[6]; special budgetary means and the new FRONTEX[7] Agency watch for land surveillance security tasks:

- Coordinate operational cooperation between Member States in the field of management of external borders;
- Assist Member States on training of national border guards, including the establishment of common training standards;
- Carry out risk analyses;
- Follow up on the development of research relevant for the control and surveillance of external borders;
- Assist Member States in circumstances
- Requiring increased technical and operational assistance at external borders;
- Provide Member States with the necessary support in organising joint return operations.

Successful evaluation results of the FRONTEX Agency after three years of operation were reported by the Commission[8] last February 13th 2008. EO surveillance fits within the short term recommendations outlined for risk analysis, technical equipment and training.

The EU legal frame to tackle NPT has had a steady upgrade. The subject conforms one of the founding treaties, the EURATOM, signed at Rome on the 25th of March, 1957; coordination on nuclear energy issues started within the European Political Co-operation Policy (EPC), prior to the Common Foreign and Security Policy (CFSP). This itinerary shows how the EU was already in the process of developing a role in non-proliferation, prior to the adoption of a formal NP strategy in 2003, taken simultaneously with the European Security Strategy (ESS) at the European Council meeting in December 2003[9]. In operative terms, NPT monitoring falls under the Common Foreign and Security Policy (CFSP).

The legal frame European Countries have to follow in matters regarding large event planning is scattered on an array of different norms: those ruling protection against emerging security threats (e.g. terrorism, illegal trafficking, and proliferation of Weapons of Mass Destruction). Precise guidelines for large events were given by a Council Resolution of 29 April 2004 on security at European Council meetings and other comparable events[10]. Another *ad-hoc* disposition is the Council resolution of 17 November 2003 on the use by Member States of bans on access to venues of football matches with an international[11]. In the case of events where only VIPS or Political Authorities attend , it is mandatory to take into account this legal frame, because any possible threat that can eventuate into an actual attack provoking a chain reaction among the community. Crowd gathering events respond to a wide range of calls: political, economic, cultural, religious, sports; it is extremely difficult trying to regulate single security aspects for events that, in themselves have something unique. It is for this uniqueness that local and national rules on public security and health tend to apply. Nonetheless, the EU is aware of its responsibility for security in the case of European calls.

3. EO SERVICES FOR CRITICAL INFRASTRUCTURES

European Critical Infrastructures constitute those designated critical infrastructures which are of the highest importance for the Community and which if disrupted or destroyed would affect two or more Member States, or a single Member State if the critical infrastructure is located in another Member State. This includes transboundary effects resulting from interdependencies between interconnected infrastructures across various sectors[12].

Critical infrastructures engulf a wide variety of man-made structures; civil infrastructures are means to development and stability, crossroads to gather economic exchange and wealth, and therefore represent key targets when aiming at de-stabilisation. One might think that the volume, variety and scope of land and infrastructure surveillance for security are so vast that the objective of co-ordinating common security activities is not worthwhile or even feasible. The rationale should be just the opposite since the weakest security targets are demonstrated those that gather masses inland, preferently within urban or suburban areas. To expand on the scope of security applications for CI let us think on the needs of hydroelectric power stations, dams and reservoirs, navigation locks, recreation parks, industrial docks, commercial harbours, state public land and administrative facilities.

Naturally, EO images to cater for CI security services, should meet end user requirements in terms of spatial, temporal and spectral resolution. Most CI consist of intricate engineering structures, hence, the very high resolution imagery (>1m) provides a number of solutions for detailed elements such fences or status of mains. Nonetheless, EO images with high or medium spatial resolution should not be despised in the case of local spatial analysis or applications. The following sample case might enlighten the use of different EO sources to provide security services to natural gas management infrastructures and to the distribution network. Enlightening work and conclusions were obtained in previous EU funded projects FP5 PRESENSE[13] and FP6 PIPEMON.

The objectives behind the service chains for CI security services are four: (i) three dimensional -3D- modelling of the critical premises, (ii) detection of land use changes adjacent to the CI, (iii) land use risk levelling and (iv) monitoring of slope displacements. The output image products of the said service chains are handled and viewed by the end user, the Spanish gas distributing company in this case, by means of a GIS viewing tool.

3.1. EO processing chain for 3D modelling of a re-gasification plant.

Natural gas regasification plants receive liquated gas vessels on port; the liquated status is turned into gas condition rising the temperature of the product by means of the adjacent sea temperatures. The criticality of the procedure lays in the gas itself, in the resistance of the premises and in the relationship with adjacent criticalities and vulnerabilities. Thus the importance of having a 3D model of the gas plant and dock, together with the model of the side premises, activities, land uses, communication networks, etc.

The EO service chain begins with two VHR stereo-pairs of different dates (SPOT5 PAN); pre-processing entails radiometric calibration, image PAN sharpening, ortho-rectification and image matching comparison. The actual image processing to withdraw the 3D model of the plant and the 3D view of land use changes between dates is attained by means of specific processing algorithms for (i) 3D information extraction and 3D change detection (DLR), (ii) land use-land cover mapping (ZGIS), (iii) change detection (Joanneum) and (iv) a multiple classifier system (University of TN)

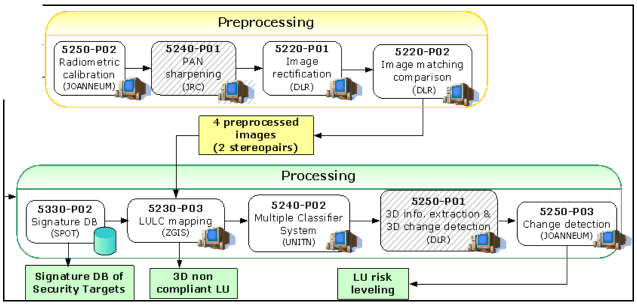

Figure 1: EO for 3D modelling of a regasification plant

3.2. Detection of land use changes adjacent to the CI

This service chain is testes within a densely populated suburban area. Housing state growth, road network expansion, land prices, relocation of industry, commerce and business are but some of the factors that force competitions of land uses in suburban areas. In some cases, the security and the risk of basic services, such as gas mains, comes into open or close conflict with preceding, expanding or intrusive land uses.

The objectives of the second EO service chain are three: to determine non compliant land users along specific width buffers, to ponder a risk levelling criteria for those non compliant land uses and to build up a data base of security targets derived from satellite image pattern recognition. Again, incoming service images are SPOT5 PAN. Image pre-processing is the same as expressed in section 2.1. above. Image processing involves the construction of the security target DB (SPOT), land use-land cover mapping, image classification with a multiple classifier criteria (UNITN), 3D information extraction and change detection.

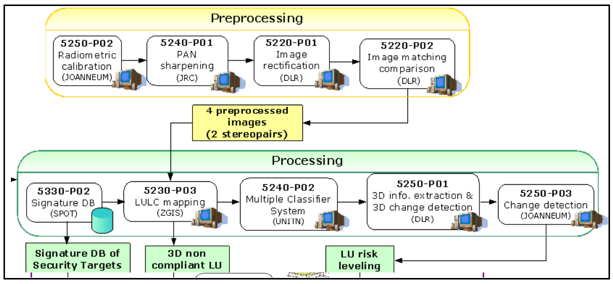

Figure 2: EO for LULC change detection

3.3. Land use risk levelling

The goal of levelling risky buffers adjacent to the natural gas pipes derives quite naturally from the EO service chain just described. Natural gas is a risky element and the spatial impact of an accident or an attack needs preparedness for control. The incidence of destructive incidents of this nature is nearly null in the EU, thanks to the close quality control and tight security measures required in the sector. Nonetheless, asset of this service lays in the updating capacity EO data have to keep up monitoring the very dynamic humanly induced activities in the growing suburban mazes.

Another risk alert service chain is under test using low spatial resolution MODIS images and hot-spots derived products. The service chain warns pipeline control quarters of a hot-spot detected within a prescribed distance buffer; pipeline control headquarters will react depending on the intensity of the hot-spot, distance to the pipeline, continuity of the forest mass, weather conditions and so on. Further components of this service include monitoring of the seasonal shrub growth along pipeline buffers in forest lands, to prevent sudden linear fires or to plan prescribed burns.

3.4. Monitoring of slope displacements

The fourth service chain concentrates in monitoring the risk of the gas infrastructure associated to the common geomorphologic risk of massive land slides in a high mountain location. The process would be just natural if the space was not occupied by a wide gas pipeline. Down-slope movements break pipe stability and integrity. For this service chain, very high resolution radar imagery is processed to determine, below metric dimensions, slope displacements. SAR imagery ingesting the service will be new COSMO.SkyMed,

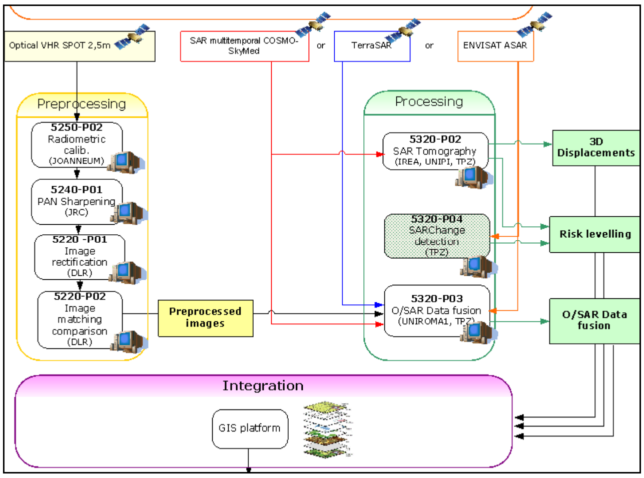

Figure 3: EO for monitoring slope displacements

4. EO SERVICES FOR LAND BORDER MONITORING

Bearing in mind that land border monitoring is a major security issue, the EO derived services focus onto (i) updating and enriching cross border cartographic data using VHR optical satellite data, (ii) generation of interactive cross-border accessibility maps and (iii) inter period automatic change detection and threats classification. The service chains are meant to help out the control activities in the Polish-Ukrainian border. Figure 4 below depicts the logic flow of the EO services for land border monitoring.

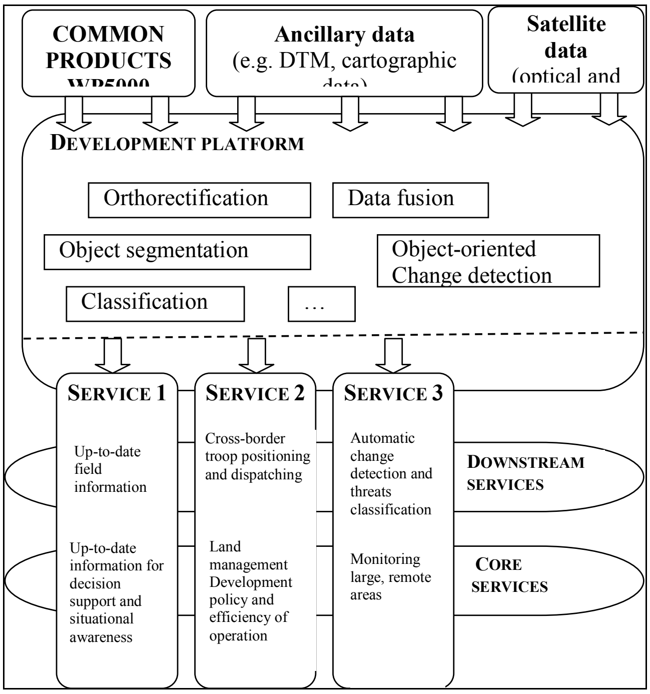

Figure 4: EO services for Land Border Monitoring

4.1. Updating and enriching cross border cartographic data using VHR optical satellite data

Taking VHR optical EO images as input data, the service produces a Raster/Vector layer containing updated information on infrastructures, buildings, camps, railroads, tracks, water bodies, vegetation elements, evident land cover changes adjacent to the border line, as well as specific border objects such as control points or crossing points. The information is up dated for 20km wide buffer, either side of the border line which conforms the responsibility buffer assigned to border guard operations.

Yearly cartographic updating yearly all along the border line is recommended. More frequent updates may be necessary for some border areas where the speed of changes and illegal activities may recommend it. Recommendations are taken from the real field facts reported by assigned guards.

Currently, there, there does not exists a systematic update system assuring actual and accurate terrain information in all border areas. Moreover, many border segments lack harmonized data on both sides of the borderline. The actualization of cartographic databases on both sides of the border based on the same data (EO data source will considerably improve the level of harmonization and, consequently, facilitate a better coordination between neighbouring border guards forces. For certain EU Member States with external borders to the EU, collecting detailed data information from their neighbouring countries is sometimes cumbersome, and therefore satellite information can be the only extensive source of information in such a case.

These kind of data are not only of interest for border surveillance and patrolling activities or border control and intervention activities but also for instances/institutions responsible for cross-border social and economic development and cross-border aid in case of emergencies.

The EO service is integrated at regional/national decision centres at the level of the Border Guard (BG) cartographic department in charged of building and piloting the cartographic reference data. Here, cartographic specialists have access to the most recent cartographic data and are responsible for building the cartographic reference data base. Cartographic data are used by border guards members in different Information Technologies (IT) tools at several levels of the geographical and administrative organisation. The BG cartographic department launches the service for all border zones or to a selected border area where the update has to be called in advance.

The service output consists of a series of raster/vector layers to be viewed together with other cartographic reference maps. A server storing the output of the service should be implemented accordingly at national or regional levels.

If the BG IT system is based on an integrated intranet linking all servers and workstations of all sites, the server storing the output of the service should also be connected to this intranet. Upon decision from the network administrator, the extra layers will be disseminated from this server to all relevant servers and workstations utilizing cartographic data as GIS or map visualization modules at border control sites, local, regional, national and European central data points, according to the IT process defined to update the maps for the entire network.

If the BG IT system is not based on a networked architecture, the extra layers must be transferred in a way to be defined to each site where a server or a workstation uses cartographic maps (GIS or map visualization modules).

4.2. Generation of interactive cross-border accessibility maps

The outcome and objective of this service chain is the production of an interactive raster layer embedded in a GIS system. The raster layer contains information on types of land cover, relief, state of the transport routes for a buffered area of 20 km wide on either side of the border.

The second output consists of an updated table listing thresholds acting on the matrix storing the "weight" of each segment roads. This matrix is used by the " fastest interception route calculation" algorithm to asses the calculation of transport duration between a starting point and ending point as today mobile GPS handhelds . This algorithm is a specific software program of the dispatching module, that is part of the command & control application. The cross-border map will be interactive in the sense that the user will be able to rapidly adapt the assessment of the roads accessibility according to the actual situation.

Importation of the real-time geo-location of the field teams personnel and vehicles on both sides of the border in the GIS system or map visualisation module (automatic vehicle location and automatic pedestrian location services) would largely leverage the benefit of "fastest interception route calculation" application results.

The real-time geo-location of field teams personnel and vehicles and the ability to estimate the fastest interception route thanks to "fastest interception route calculation" application would avoid the redundant dispatch of interception units to one single operation and the dispatch of non efficient units which would arrived to late on the scene . In addition redundant surveillance and protection of certain border hot spots can be avoided and the efficiency of (cross-border) resources use can be increased.

The "fastest interception route" application consists of an software algorithm implemented in the dispatching module of the command and control application software used by BG at different levels, mainly local, sector and regional levels. Such application allows the border management staff in charge of operations at border sites to select and send the closest patrol (in distance and time) to the place of intervention.

The cross-border accessibility maps can be a valuable input for the calculation of the geographic border permeability in JRC's 'Border Permeability Model' (developed in the GMOSS project). The quantitative and spatial nature of the model may allow estimating the effort needed by the different countries to implement an effective border control, to find gaps and to prioritize investments, and to estimate the impact on the overall border permeability due to alternative choices (building a new road, clearing a part of the forest, etc.). Another possible use of the output of the model is to forecast the most probable point of arrival inside the EU territory of illegal immigrants coming from a known departure point by lowest-cost path.

The recommender frequency of service delivery would be a yearly update on all border zones, taking into account singular changes that occur in the wild. More frequent updates are necessary over limited border areas where the change rate is lower. In order to take into account rapid changing circumstances impacting field situations, such as weather modifications, capability to rapidly adapt the route accessibility information to the actual situation would be of great interest for border guards operators. This is for example the case for the "fastest route calculation" process to stick to the real status of the roads and tracks used by BG for their missions.

The innovative contribution of this service lays in the quick, timely synchronised and territorial coverage of up-dated information on land cover, relief and state of the cross border transport routes. Besides, it helps the efficient dispatching of border troops based on travel time, travel distance and position of other cross-border troops. Efficient cross-border troops coordination and mutual aid can also be expected. The service will be integrated into the command and control application tool used by border guards in the surveillance and operations room at border post and sector posts sites. Furthermore, it will also input the Border Permeability Model (BPM) and in the intelligence chain of border guard organisations.

The service is expected to be integrated at regional centres where cartographic specialists are located. Cartographic specialists are building the cartographic reference data base used by border guards members in the different IT tools at several levels in the geographical and administrative organisation. The BG cartographic department should take the responsibility to launch the service for all border zones or to select the border areas where the service has to be called in advance.

A server storing the output of the service should be implemented at each regional level. Additionally the service output consists of a modification of the fastest route calculation reference matrix which is used by the fastest route calculation algorithm.

4.3. Inter-period automatic change detection and threats classification.

In this service, "inter-period" refers to the time lapse between two image dates. Such period could be systematically annual or seasonal or as determined by the authority. It requires SAR imagery, which is weather-independent, thus assuring monitoring activities and short interval monitoring of large and remote areas The main objective of the service is the detection of changes originated from regular movement of vehicles, groups of people, newly built roads or tracks and newly deployed camps in remote and large ‘green border’ areas. Registered changes in the wild border areas will feed the intelligence chain of the BG organisations.

According to the characteristics of the changes and the predefined priorities in terms of sensitive zones and between the different types of illegal activities, etc..., an alarm will be generated to the command and control application at border posts or sector posts sites. This alarm will alert surveillance operators on an unusual activity or abnormal situation which may represent a potential threat within their area of responsibility.

The alarm will contain detailed attributed information on the classification of the threats (vehicles, people, tracks, camps,…), date, location of the detected feature, confidence level of the detection and other possible attributes such as the size of the targets.

The expected output of the service caters for different objectives:
- assist border guards in their surveillance tasks (satellite as a space sensor), providing “targets” of interest.
- assist the border guards in the collection of intelligence, providing near-real time information for local/regional instances on :

- intensity of use of existing routes near the borderline,
- building of new routes near the borderline (as new border crossing roads/tracks)
- changing behaviours of people with the localization and sizes estimates of groups of people near the borderline
- erection or disappearance of camps with their locations and sizes estimates
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Usefulness of the service would require a monthly update of all border zones, not to miss any major impacting changes on the environment, like trends in illegal activities, new routes of smuggling or for illegal migration, etc…. More frequent updates, depending on the satellite’s revisiting frequency, would be desirable over limited border areas, if considered as particularly sensitive or vulnerable on account of higher criminal activities or the need to counteract them quickly.

The service should be integrated preferably at regional centres where “change detection” specialists are located. “Change detection” specialists will be a part of the intelligence process chain of BG organisation participating in the collection of intelligence and issuing alarms to operational levels. The BG “change detection” cell upon request of the intelligence department authorities should take the responsibility to launch the service for all border areas or on selected border zones where there is a need or urgency.

The service output would be an alarm notification coded according alarm frame with attached additional useful information (alarm’s attributes) to the command and control application at border or sector posts levels.
A dedicated server storing the output of the service and generating the alarm should be implemented at each regional level.

If BG IT system is based on an integrated intranet linking all servers and workstations of any sites, this server should be connected to this intranet. This server would deliver the alarm at the end of the service process to all relevant alarm servers and surveillance workstations at border control sites, local, sector.

5. EO SERVICES FOR NON-PROLIFERATION TREATIES MONITORING

The objective of the NPT Monitoring service is to provide an integrated framework and platform supporting the verification of NPT compliance. The platform is targeted at the image analyst in the context of Nuclear Safeguards who has the responsibility of collecting, managing and evaluating satellite imagery, often in conjunction with information from other sources, and extracting NPT relevant information. The analyst generates a report on a country or location of interest and delivers it to the final user, which are high-rank decision makers normally with a high political profile.

Although satellite imagery is already an important tool in nuclear safeguards, current applications rely heavily on visual interpretation with little use of automated processing. Furthermore, current analysis tools usually provide an isolated view on satellite imagery with poor integration of collateral data, such as Open Source information, GIS data, internal databases and reports.

In the near future, new satellite sensors (very high-resolution optical and radar imagery) will further increase the number of possible applications in nuclear safeguards and therefore also the amount of data to be processed. Hence, the NPT Monitoring Service aims at providing a framework supporting the image analyst in the forthcoming challenges. The main benefits are:

- Increased automation of image analysis
- Better integration of multi-source and multi-temporal data (satellite imagery, Open-Source information, reports, GIS data)
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The NPT monitoring service chain features the following items: (i) a semi-automated change analysis using object-oriented methods, (ii) a 3D model of sites for analysis and change detection, (iii) change analysis and anomalies detection using VHR SAR imagery and (iv) a platform integrating multi-source information.

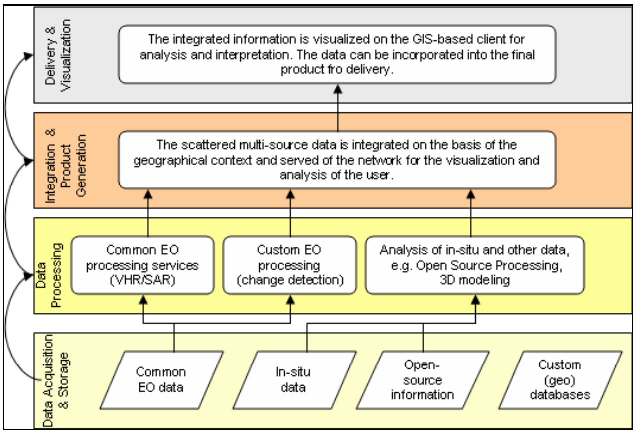

Figure 5: System architecture for the NPT Service

The benefits for the final user (i.e. the high-rank decision maker) are an increased timeliness and accuracy of the reports delivered by the image analyst.

The main outputs of the NPT Monitoring service can be described as follows:

- The platform will be based on a Geographic Information System (GIS) allowing the integration of multi-source and multi-temporal data (satellite imagery, Open-Source information, reports, GIS data). Through an intuitive map-based interface the user can access and analyse all (geographical and non-geographical) information related to a geographic feature (e.g. nuclear site or building).
- Automated change detection using HR (10m-20m) and VHR (1m) optical imagery will facilitate the monitoring of known nuclear locations and support wide-area scanning for the localization of undeclared nuclear activities. Combining pixel-based change analysis and object-based classification allows the detection of changes relevant for NPT monitoring.
- The upcoming VHR SAR (Synthetic Aperture Radar) satellites are of high interest for nuclear safeguards. The NPT Monitoring platform will incorporate new tools that detect NPT-relevant anomalies by analyzing series of interferograms taken at different instants in time. They compares coherence maps calculated from the current data set with the coherence that was predicted from previous measurements
- Open Source information is becoming increasingly important to trigger, guide and support imagery-based analysis. Tools for efficient management, evaluation and correlation of Open Source information are included in the platform.

6. EO SERVICES FOR LARGE EVENT PLANING

Large Events are those public calls which involve crowd gathering, oscillating from hundred to thousands of people, gathered in a confined location during a given time period.

There is a huge variety of events that can be included under the term "Large Event Planning"; the main typologies list out the following ones: sportive events, such as the Olympic Games, cultural events like the Universal Expositions convoked every four years around the world, fairs as technical exhibitions of new technologies, political events and only VIPS gathering events, such as the EU Summits.

Large Event Planning can involve a number of "convention spaces" ranging from small places, as in the case of political events, up to a huge variety of physical locations and constructions of different shapes, as in the case of sportive or cultural events. Depending on the nature of the event, the efforts will concentrate on different security aspects. In political or only VIPS events, the enclosure tends to have reduced dimensions whereas in cultural or sportive events, the enclosure can have remarkable dimensions and in some specific cases can almost include different zones in the same area, separated by urban nuclei.

After all the information explained above, the use of EO data to monitor Large Events depends on the kind of event considered. In case of reduced events where the amount of people is well known, as in political and only VIPS events, the accuracy of the images used is relevant to monitor very confined spaces because of the relationship between number of persons involved and area covered by the enclosure. Any case, for all the events considered, the accuracy is an important deal to consider because of the monitoring required for the security as, for example, video cams location, security staff cabins, vulnerable points.. The more the accuracy is, the more the security can be granted.

The objectives behind the services developed for Large Event Planning are the following ones: (i) Security Zones Planning: Security radii, considering vulnerable points inside and outside the enclosure of an event; Visibilities of main vulnerable buildings, extracted from DEM of the enclosure and surroundings, and taking into account some infrastructures outside and inside an enclosure. (ii) Shadowed and Shinning zones inside the enclosure considered to plan the best location of relevant features. (iii) Natural Damages, in particular case Floods. This application aims to cover different possible natural risks that can affect an enclosure where an event takes place. (iv) Detailed analysis of the enclosure: Ground slopes and Ground's evaluation, is a study to plan best location of emergency exits, and other relevant features for security, as slopes and stairs.

6.1 Security zones planning: Security radii and visibilities.

In order to control security zones through security radii and visibilities application, is necessary to have a pan-sharpened VHR image orthorectified from which is possible to generate a DEM and 3D model of the enclosure and surroundings to calculate main points of vulnerability of the enclosure through the following common product in different steps: (i) Geo-location technique to ortho-rectify main image, (ii) Morphology driven PAN sharpening algorithm, (iii) eCognition Soft & DB of security targets, (iv) Information extraction, pixel based classification, (v) 3D Information extraction and

3D change detection for 3D coarse urban model of the city, (vi) In case of visibility, 3D Information extraction and 3D change detection for DEM of the city.

6.2 Shadowed and shinning zones inside the enclosure.

This service aims to cover vulnerabilities inside the enclosure considered, that means, zones that have to be considered in terms of sunlight and security, and to plan the best location of relevant features as security staff cabins, advertising screens and others.

The different steps that have to be followed to develop this service are: (i) Geo-location technique to ortho-rectify main image, (ii) eCognition Soft & DB of security targets, (iii) 3D Information extraction and 3D change detection for 3D coarse urban model of the city, (iv) In case of visibility, 3D Information extraction and 3D change detection for DEM of the city, (v)Reclassification maps of images.

6.3 Natural Damages: Floods.

This service aims to cover vulnerabilities around an enclosure produced by different natural hazards, as floods, fires, tides, that means, zones that have to be considered in terms of security that can be affected by those natural phenomena.

The different steps that have to be followed to develop this service are: (i) Geo-location technique to ortho-rectify main image, (ii) eCognition Soft & DB of security targets, (iii) 3D Information extraction and 3D change detection for 3D coarse urban model of the city, (iv)Reclassification maps of images.

6.4 Detailed analysis of the enclosure: ground slopes and ground's study.

This detailed study of the ground aims to provide a general vision of the land where the enclosure is placed, in terms of security. It can help to identify some vulnerabilities of items as emergency exits, inappropriate location of evacuation stairs and slopes, general slopes of the enclosure and the composition and location of different materials.

The convenient steps to be followed are (i) Geo-location technique to ortho-rectify main image, (ii) Morphology driven PAN sharpening algorithm, (iii) eCognition Soft & DB of security targets, (iv) 3D Information extraction and 3D change detection for 3D coarse urban model of the city, (v) 3D Information extraction and 3D change detection for DEM of the city. (vi)Reclassification maps of images.

7. CONCLUSIONS

The land and infrastructure surveillance EO service chains are under development: results are expected by the second half of 2008; hence, the conclusions deserved in this paper fall in the accuracy of the service's architecture, design, early development, interaction with the end users and integration within the current security systems for further improvement.

The rationale supporting the EO service chains leans on:

- The EU explicit interest (legal frames) and guidance towards Land and Infrastructure security, expressed in the specific security objectives of GMES, in the European Policy on Critical Infrastructure Protection, or in other sectoral security measures for the areas of technology, transport, civil protection, Earth observation, chemical and nuclear sectors, etc.
- The group of L&I stakeholders already involved and interested in testing EO derived services for security. The group of stakeholders involves both public and private representatives, as indicated by the CI protection Directive

Land and Infrastructure security and protection amalgamates a vast array of areas of application, as seen in the definitions of European CI agreed upon in EC documents. The range runs from energy control to civil protection, public order in crowd gatherings, integrity of premises or trans-boundary effects; Users needs have been very well defined and yet there is a difficulty in trying to amalgamate EO derived security products and services, on account of those specificities. It is for this reason that the amount of services is quiet large and directed to the application and to the end user.

Exploitation and managements of EO service chains falls both under Public and private responsibility. Each sector, either Public or private, leans on very different technical and managerial backgrounds, at the time of introducing EO derived security products. Hence, specificities on communication, technology transfer, acceptance and dissemination of results must be catered for.

In a word, the scope of applications for VHR EO imagery opens wide in the field of land and infrastructure security monitoring.

8. REFERENCES

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