G-SEXTANT Publishable summary report

Executive summary

Previous pre-operational Copernicus Security-related projects, such as G-MOSAIC, developed technologically non-mature geospatial services and identified related gaps. Further research and development were needed to transform them into operational products and services.

Building on the outcomes of and lessons learned from precursor projects, the EU-funded G-SEXTANT project (*Service provision of geospatial intelligence in EU External Actions support*) addressed technological and governance-related gaps in order to develop a standardised portfolio of Earth Observation (EO) products and services.

Overall, the aim was to support the geospatial information needs of EU External Action users and stakeholders, such as the European External Action Service (EEAS). This included mapping and EO products ready to contribute the improvement of crisis prevention, preparedness and response capacities.

To achieve this, project partners performed products and services in six lines of research and innovation:

- Humanitarian crisis (situation analysis and monitoring of refugee/internally displaced person (IDP) camps, monitoring repatriation processes of displaced population and informal settlement characterization);
- Land conflict (land degradation around refugee/IDP camps; land use changes as conflict indicators and monitoring large-scale land investments);
- Natural resources (situation analysis of mining sites and oil fields);
- Illicit crops (situation awareness of illicit crops cultivation areas and illicit crops warning service);
- Monitoring border trafficability and
- Tools for monitoring nuclear sites and activities.

All project results considered feedback from users to improve the final operational EO products and services.

During the first reporting period, security user scenarios were defined. From mid-2013 until end of 2014 the project started developing pre-operational services and receiving requests from users. The development of technological products and tools for each line of research and innovation had been successfully finished and presented in a dedicated workshop addressed to representatives from institutions and organizations involved in security related activities: EU institutions, Member States and National Administrations. Selected G-SEXTANT products have be proposed for Copernicus operational phase and onwards, plus additional research for non-mature products.

The security user community can greatly benefit from these products, resulting in the better protection of European citizens.

Summary description of project context and main objectives

The Copernicus service for Security applications aims to support the relevant European Union policies in the following priority areas[1]:

- Support to EU External Action;
- Border Surveillance and
- Maritime Surveillance.

G-SEXTANT aimed to improve and enhance the Copernicus services for Security applications in Support to EU External Action by researching and developing techniques and products, as identified in the context of precursor projects (such as G-MOSAIC[2]).

Between 2009 and 2012, the G-MOSAIC project developed a wide portfolio of Copernicus services for Security applications. Some of these services were considered more advanced by users and providers and therefore in need of an additional (but limited) research and development phase before becoming operational. Other services were deemed to be less developed,

and therefore in need of much further technological development over a longer period of time. G-SEXTANT was therefore focusing on the less technologically mature products developed within G-MOSAIC. The heritage of G-MOSAIC was continued in the following products/tools: Situation analysis and monitoring of refugee/IDP camps; Monitoring repatriation processes of displaced population; Environmental impact around refugee/IDP camps; Situation analysis of mining sites and oil fields; Situation awareness of illicit crops cultivation areas; Illicit crops warning service; Monitoring border trafficability and Tools for monitoring nuclear sites and activities. Additionally, new products were developed in G-SEXTANT, such as Informal settlements characterization, Land use changes as conflict indicators and Monitoring of large-scale land investments.

On this basis, the European Commission and its Research Executive Agency (REA) decided to fund, under the FP7 Programme, two different projects: G-NEXT[3] (focusing on the current pre-operational services) and G-SEXTANT (focusing on the non-mature services and development of new services). The ultimate aim of G-SEXTANT has been to incorporate into the Copernicus Security portfolio those services considered suitable to enter into the operational phase.

The **main goals of the G-SEXTANT** (*Service provision of geospatial intelligence in EU External Actions support)* project are:

- The **definition of Support to External Action geospatial services**;
- The **preparation and delivery of pre-operational services**, developed in the context of Copernicus service for Security applications; and
- **Enhancement of existing capabilities through R&D focusing on specific gaps previously identified.**
- **The analysis of synergies, policies, benefits and service evolution**.

[1] Regulation (EU) No 377/2014 of the European Parliament and of the Council of 3 April 2014 establishing the Copernicus Programme and repealing Regulation (EU) No 911/2010.
[2] GMES services for Management of Operations, Situation Awareness and Intelligence for regional Crisis.
[3] GMES pre-operational Security services for supporting EU External Action.

Main S & T results

Main results of G-SEXTANT project are focused on: improvement of current geospatial technologies and methodologies from user requirements, development of services to an operational status to Support External Action Service, the analysis of synergies with other related initiatives and the identification of further research in this domain.

Definition of services and products to support to External Action

G-SEXTANT project has been enhanced existing Security services on the basis of a detailed analysis of user requirements and through continued research and development. The former European Commission's Directorate General for Enterprise and Industry has formed a dedicated working group (SEA-Working Group) to address the Security dimension of Copernicus and is gathering the requirements related to the European External Action Service (EEAS) through consultation. In addition, the project relied on the direct participation and feedback of other European and international users, such as:

- **DG DEVCO** (Directorate General for Development and Cooperation) EuropeAid, interested in land conflict situation awareness to get information on potential land use changes in agricultural areas.
- **UN HABITAT** (United Nations Human Settlements Programme), interested in Humanitarian crisis products, specifically in the development of new approaches for the detection and the monitoring of slum areas or informal settlements.
- **UNCS** (United Nations Cartographic Section), actively involved in border monitoring with the aim to analyze different aspects of the borders, including trafficability issue.
- **UNODC** (United Nations Office on Drugs and Crime), actively involved in the area of Illicit crops (products for situation awareness of illicit crops cultivation areas and Illicit crops warning service). Main requirements were to improve efficiency and accuracy of illicit crop monitoring, as well as lowering the cost of the methods currently in use.
- **IAEA** (International Atomic Energy Agency), involved in monitoring of nuclear sites and activities in the context of the Nuclear Non-Proliferation Treaty (NPT). IAEA provided user requirements and feedback on tools development.
- **BICC** (Bonn International Center for Conversion), acted as a user and partner in the domain of natural resources exploitation and land conflict situation awareness. Tasks as a partner comprised the integration of additional data sources (e.g. socio-political, social-economic data, in-situ data, background information) to guide the image interpretation, to manifest and complement the derived satellite-based information. As a user, utilized G-SEXTANT products as additional information source and complementing tool within their work.
- **EU SatCen**, interested in monitoring of nuclear sites and activities to obtain advanced tools for improvement of the detection of valuable information inside the satellite imagery (with focus put on SAR imagery).
- **SANSA** (South African National Space Agency), Cooperating closely with UN-HABITAT on their common tasks, mainly regarding monitoring of informal urban settlements. SANSA selected the South African test site in Rustenburg and provided reference information and provided feedback during the product development.

Gathering user requirements has played an essential role in the design and development of the final services and products. In this way, the project combines the knowledge and experience of different users with the expertise of the members of the project consortium. The **identification of user needs** were drawn from the SEA-Working Group Portfolio, requirements of users actively involved in the project and several meetings with European security domain users and stakeholders.

In order to support the needs of the EEAS, the following portfolio of products and services (as crucial objective) were defined in the context of the G-SEXTANT project and related services and products developed during the project:

- The **Humanitarian crisis service** serves the purpose of demonstrating that the technological improvements made in G-SEXTANT are able to assist the European External Action Service in managing timely and efficient humanitarian relief operations, by offering information on temporary (e.g. refugee/Internal Displaced Persons- IDP- camps) and informal settlements (slums). Users highlighted the need to access more efficient and low-cost services.

- The excessive exploitation of natural resources often precipitates the outbreak of conflicts. The **G-SEXTANT Natural resources service** provides information on mining activities related to different types of minerals. The information extracted is linked to situations in surrounding settlements and their subsequent evolution, to changes in land use, and to reports on past, ongoing or potential violent/armed conflicts. This service can also be used to analyse areas surrounding oil extraction plants in order to identify any major grievances emerging in areas where such activities are taking place.

- The **Land conflict service** provides geospatial information on land use changes in relation to conflict-prone situations such as the transition of a political or societal system, the impact of refugee/IDP camps on the environment or large-scale land investments. The rationale is to effectively link empirically observable changes in the natural habitat and social systems, so as to allow for predictions about changes occurring in one of them based on developments in the other.

- G-SEXTANT also aimed to refine the tools related to the **Monitoring of nuclear sites and activities** by enhancing Synthetic Aperture Radar (SAR) visualisation and SAR/optical change detection capabilities, which can be then be assimilated with an integrated platform for non-proliferation experts.

- The **G-SEXTANT Illicit crops service** can support users by providing enhanced information on illicit crop cultivations. Users need reliable data on the locations and the distribution of illicit crop areas, as well as on areas that could potentially be used for such purposes, changes occurring in these areas (variations in land cover from forest to agricultural plantations, new settlements, etc.). This information is needed to enable users to assess the impact of the relevant policies being implemented, in order to prevent such illegal activities.

- A specific user involved in the project required detailed mapping and knowledge of borders of areas of interest for EU missions and/or operations. The **G-SEXTANT Border trafficability service** provides valuable information on border conflicts

outside European boundaries through products such as maps showing border trafficability, background information including land cover, critical infrastructure and analyses of border crossing points.

Technological enhancements

One key-element of the G-SEXTANT project was the further development and improvement of methodologies developed in precursor projects within the following seven processing chains: Reference mapping, Thematic mapping, Synthetic Aperture Radar (SAR) and optical change detection, Feature extraction, extraction of Digital Elevation Models (DEM) and 3D modelling and the Survey on adaption of new sensors. Altogether, 58 methodologies within these seven categories have been developed and/or applied.

Technological enhancement was achieved during the project lifecycle and the SEA operational service**:**

- Refinement of the processing chain of **reference mapping**, permitting time and cost reduction in the production by using a "cartographic update" approach based on standardization of basic cartographic information from open sources and low cost data and improvement of classification and object extraction methods of relevant features (rivers, buildings, border settlements, roads and cart tracks, etc.).

- **Thematic mapping**:
    - Object-based image analysis focusing on the **identification of informal settlement candidates** and statistical analysis of the urban classes aiming to create clear decision criteria per urban class.
    - **An object-based toolbox to support manual classification** refinements of automated results to improve post processing time and accuracy. The manual interaction is supported by automated processes (domain specific delineation of homogenous areas / region growing algorithms supporting digitizing routines; systematical step-by-step analysis of relevant parts of the thematic map; automated clearing up routines etc.)[4,5].
    - **Fully automated (parameter free) land cover pre-classification method.** Land cover pre-classifications in fully automatic mode based on a physical model-based expert system[6,].

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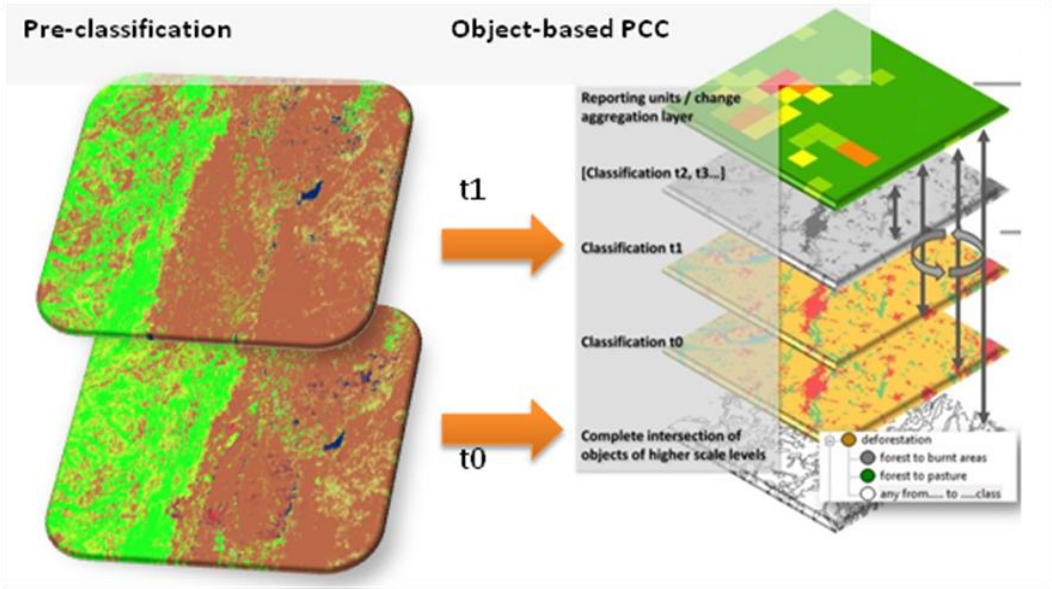
[4] Tiede, D., Füreder, P., Lang, S., Hölbling, D., Zeil, P., (2013). Automated Analysis of Satellite Imagery to provide Information Products for Humanitarian Relief Operations in Refugee Camps - from Scientific Development towards Operational Services. PFG Photogrammetrie, Fernerkundung, Geoinformation, 3/2013, 185-195.

5 Füreder, P., Lang, S., Rogenhofer, E., Tiede, D., Papp, A. (2015)."Monitoring displaced people in crisis situations using multi-temporal VHR satellite data during humanitarian operations in South Sudan". GI_Forum '15. Proceedings of the Geoinformatics Forum, Salzburg. Heidelberg, Wichmann. Pages pending

[6] Tiede, D., Lüthje, F., Baraldi, A., (2014). Automatic post-classification land cover change detection in Landsat images: Analysis of changes in agricultural areas during the Syrian crisis, in: 34. Jahrestagung in Hamburg 2014. Publikationen der Deutschen Gesellschaft für Photogrammetrie, Fernerkundung und Geoinformation (DGPF) e.V., Potsdam.

- **Multitemporal change detection analysis of land cover/land use (LC/LU) in high (HR) or very high (VHR) resolution imagery of different sensors**. Fully automated change detection method based on land-cover pre-classifications method and automatic OBIA post-classification change detection technique[7]. The change results are aggregated as information layers in regular or arbitrary units (e.g. grids, hexagons or administrative units).



Multitemporal changes detection method concept

- **Development of a risk map for illicit crops (poppy)**. The risk assessment combined socio-economic factors with environmental factors known to be related to opium poppy cultivation in order to assess the location-specific (independent of administrative boundaries) risk of opium poppy cultivation[8,9].

- **Improvement of methodology from Global Human Settlement Layer** (GHSL) to provide built-up-area scale (10 m) and building scale (2.5 m) products[10].

- **Settlement information extraction using roads and textural measurements**: road candidates at different spatial resolution; road density at the block level (200/300 m) and settlement irregularity measure using HR and VHR data.

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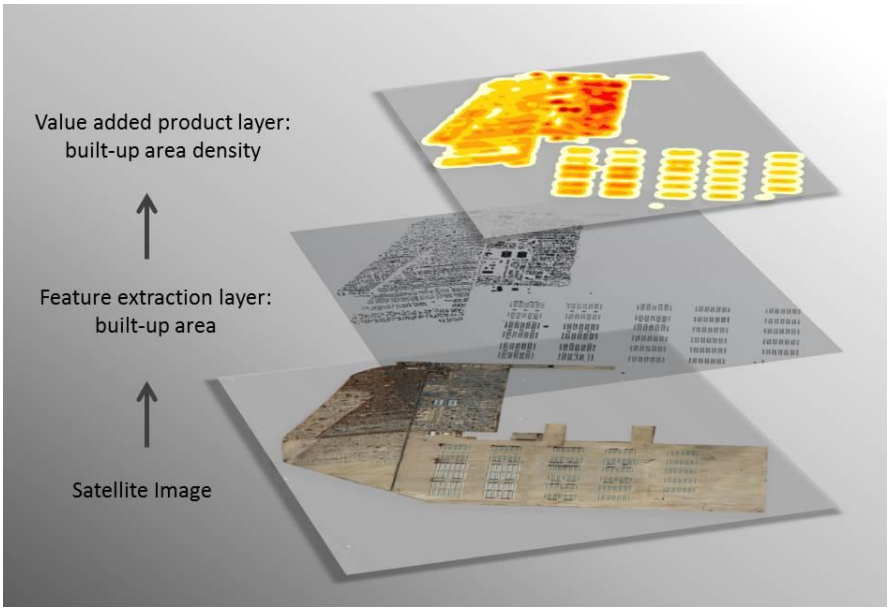
[7] Tiede, D., (2014). A new geospatial overlay method for the analysis and visualization of spatial change patterns using object-oriented data modeling concepts. Cartography and Geographic Information Science 41, 227–234.

[8] Afghanistan Opium Survey Report (2014) – socio-economic analysis", UNODC (United Nations Office on Drugs and Crime). Published on March 2015.

[9] Lang, S., Kienberger, S., Tiede, D., Hagenlocher, M., and Pernkopf, L., (2014): "Geons – domain-specific regionalization of space". Cartography and Geographic Information Science, 41 (3): 214-226

[10] Johannes Heinzel and Thomas Kemper (2015). "Automated metric characterization of urban structure using building decomposition from very high resolution imagery". International Journal of Applied Earth Observation and Geoinformation, Volume 35, Part B, March 2015, Pages 151-160, ISSN 0303-2434.

- **Optical change detection:**
  - **Change detection based on mutual information mining**: geometrical feature extraction in both images using several techniques.
  - Development of robust and **transferable rule-sets based on object-based classification change detection**.
- **Feature extraction:**
  - Fully automated **oil well pad extraction** by SAR polarimetry and OBIA[11][12].
  - **Built-up area extraction** technique based on robust and transferable rule-sets and machine learning approach[13].



Built-up area extraction technique concept

  - **Development of object-based dwelling extraction algorithms**: (1) transferable master rule-sets using adapted segmentation, relative spectral differences, form parameters and relations to neighbouring objects[14]; (2) two

[11] Plank, S., Mager, A., Schoepfer, E. (2014): Monitoring of Oil Exploitation Infrastructure by Combining Unsupervised Pixel-Based Classification of Polarimetric SAR and Object-Based Image Analysis. Remote Sensing, 6, 11977-12004

[12] Plank, S., Mager, A. & Schoepfer, E. (2015). "Automated feature extraction by combining polarimetric SAR and object-based image analysis for monitoring of natural resource exploitation". 7th International Workshop on Science and Applications of SAR Polarimetry and Polarimetric Interferometry, POLinSAR 2015, 26th-30th January 2015, Frascati, Italy.

[13] Plank, S., Aravena Pelizari, P., Spröhnle, K., Bernhard, E.M., Mager, A., Nitsche, R., Martinis, S., Schoepfer, E. (2014): „Multi-sensor OBIA methods for conflict research and humanitarian relief applications".South-Eastern European Journal of Earth Observation and Geomatics, 3 (2S), 259-262.

[14] Tiede, D., Füreder, P., Lang, S., Hölbling, D., Zeil, P., 2013. Automated Analysis of Satellite Imagery to provide Information Products for Humanitarian Relief Operations in Refugee Camps - from Scientific

stage analysis workflow from fast algorithm focusing on easy-to-extract dwellings to a second stage distinguishing several classes[15]**;** (3) dwelling indication algorithm detecting large edges structures considered as human-induced and (4) template matching and OBIA algorithm based on the calculation of a probability layer which is integrated into OBIA classification rule-sets.

- **Automated dwelling extraction based on WorldView 2 coastal band:** adaption and improvement of automatic dwelling count algorithm to camp situations with more or less consistent bright dwelling objects[16].

- **Extraction of indicators for agricultural activities** based on analysis of field fragmentation indicating abandonment/expansion of agricultural activity[17].

- **Change analysis/monitoring of indicators for agricultural activity** based on the extraction of linear agricultural features applied to monitoring large-scale land investments.

- **Tools for monitoring of nuclear sites and activities[18]** [19]

  - **Pseudo-automatic changes map** based on Multi-temporal (MT) RedGreenBlue (RGB) image.

  - **Activity map** based on analysis of target of interest backscattering response and interferometric phase coherence time behaviour; usage of high temporal sampling interferometric series including short term pairs (e.g. 1 day) and semi-automatic change detection procedure for very long-term monitoring.

  - **Optical change detection tools** for monitoring nuclear sites: bi-temporal segmentation; objects correspondence; statistical change detection and change classification[20].

- **Digital Terrain Models (DTM) and 3D modelling**

Development towards Operational Services. PFG Photogrammetrie, Fernerkundung, Geoinformation, 3/2013, 185-195.

[15] Füreder, P., Tiede, D., Lüthje, F., Lang, S. (2014). “Object-based dwelling extraction in refugee/IDP camps-challenges in an operational mode”. South-Eastern European Journal of Earth Observation and Geomatics, 3 (2S), 539-544.

[16] Johannes Heinzel, T. Kemper (2014). “Use of new coastal spectral band for precise dwelling extraction in the Hagadera refugee camp”. Proceedings of ESA-EUSC-JRC 9th Conference on Image Information Mining, 5th – 7th March, 2014, Bucharest, Romania.

[17] Tiede, D. (2014). “A new geospatial overlay method for the analysis and visualization of spatial change patterns using object-oriented data modeling concepts”. Cartography and Geographic Information Science, 41(3), 227-234.

[18] Niemeyer, I., Listner, C., Canty, M.J., Wolfart, E., Lagrange, J.-M. (2014). Integrated Analysis of Satellite Imagery for Nuclear Monitoring - Results from G-SEXTANT. In: Proc. INMM 55th Annual Meeting, Atlanta, 21-24 July 2014

[19] Niemeyer, I., Canty, M.J., Lagrange, J-M., Listner, C., Schwartz, D., Uruñuela Hernández, S.. Wolfart, E. (2015): Integrated Analysis of Satellite Imagery for Nuclear Monitoring - G-SEXTANT Findings, Proceedings 37th ESARDA Symposium on Safeguards and Nuclear Non-Proliferation, Manchester, UK, 19-21 May 2015

[20] Niemeyer, I., Nussbaum, S., Tueshaus, J., Listner C. (2013). Advances in Detecting Changes at Nuclear Facilities Using Very High-resolution Optical Satellite Imagery. In: Proc. INMM 54th Annual Meeting, Palm Desert, 14-18 July 2013.

- **Terrain extraction from surface models** based on the development of object-based filtering model using object specific properties (form/shape parameters) and relationships between objects and identification of built-up objects and higher vegetation as a prerequisite to extract DTMs from DSMs (Digital Surface Models)[21].

As conclusion several state-of-the-art algorithms and completely new approaches were implemented including:

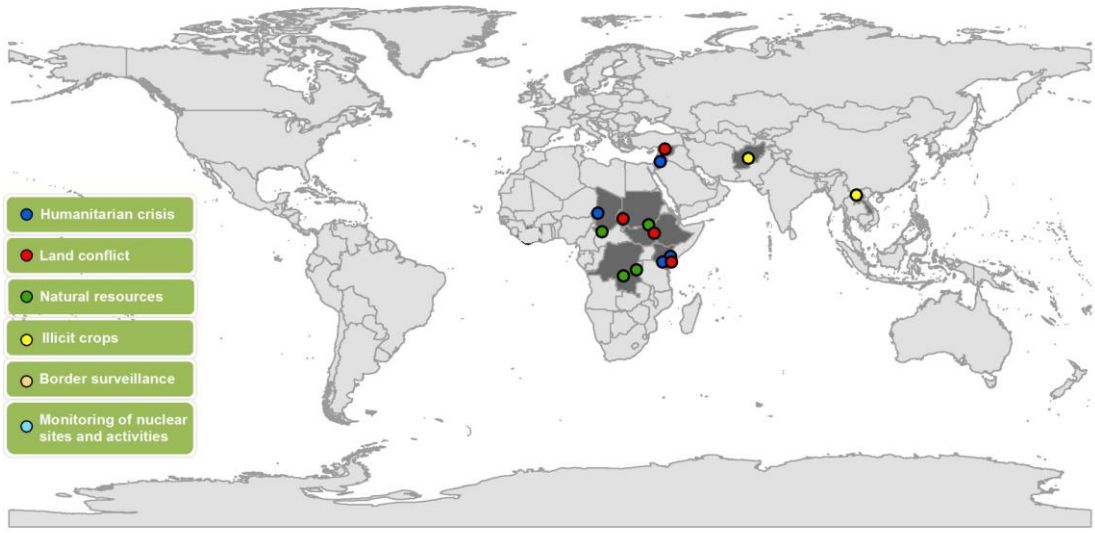
- Object-Based Image Analysis (OBIA);
- Machine Learning;
- Template matching;
- Morphology techniques and
- SAR interferometry (coherence) and polarimetry.

Methodologies within Thematic Mapping, Optical Change Detection and Feature Extraction seem to be the most advances one.

It should be underlined that scientific relevant publications were derived from G-SEXTANT, published in international workshops, conferences, journals, etc.

A list of publications is available at the project website: http://externalaction.security-copernicus.eu/publications/articles-and-papers/g-sextant-list-publications-1.

Enhanced products and new tools were tested in two production cycles. In the 1st Production Cycle preliminary products were developed which have been further enhanced and optimized in the 2nd Production Cycle according to the user feedback and the findings derived in the validation and verification activities. 16 study sites were analyzed in the 1st Production Cycle and 53 products elaborated. During the 2nd Production Cycle, 22 sites were under study and 58 products resulted.

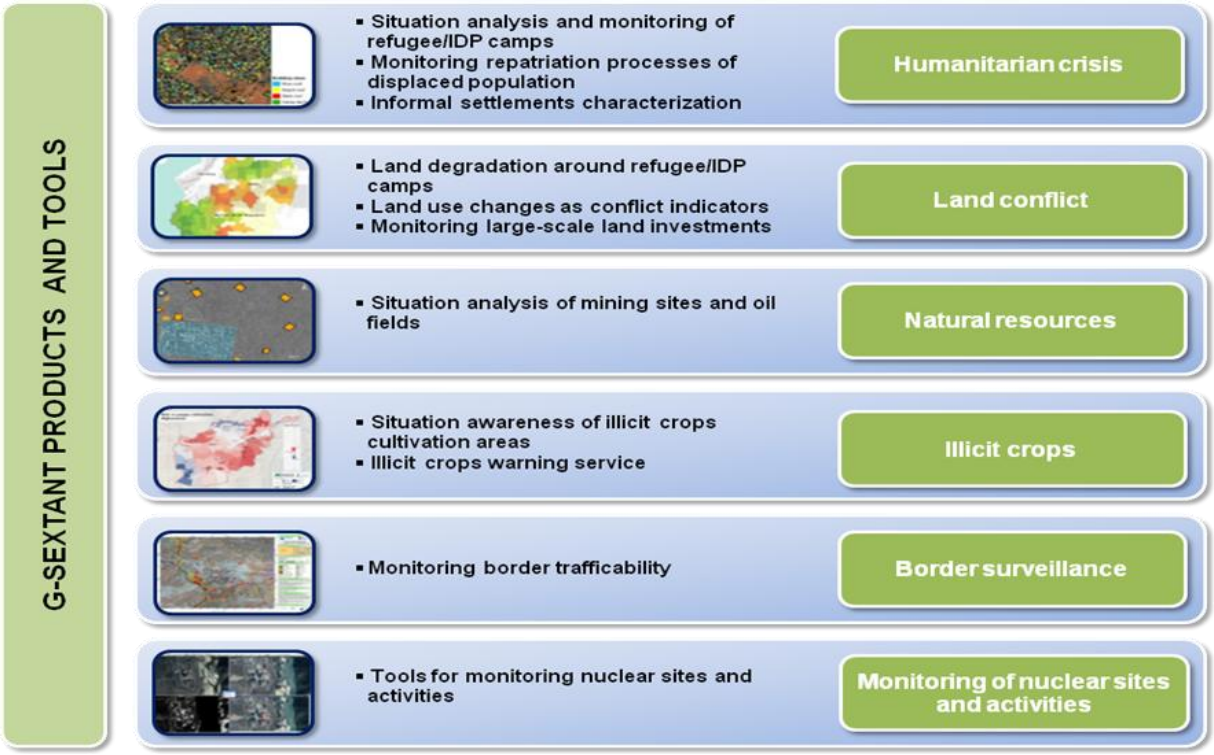


G-SEXTANT study sites of the 2nd Production Cycle

[21] Lüthje, F., Tiede, D., Eisank, C. (2014). "Object-based DTM generation from VHR stereo imagery derived DSM data sets". South-Eastern European Journal of Earth Observation and Geomatics, 3 (2S), 109-114.

Development of mature Security services

The final G-SEXTANT portfolio includes six different service elements and correspondent products for each one, as it is shown in the figure below.



G-SEXTANT portfolio

The product specifications were based on technical feasibility analysis of users' requests. Detailed specifications of products (cartographic extraction rules, nomenclatures and extraction guidelines, databases and cartographic specifications, etc.) were according to this feasibility analysis. In addition, templates were elaborated in the project to have standardized products, including map formats and product nomenclature.

Some products and tools elaborated in G-SEXTANT are available to be incorporated to the service in Support to EU External Action; others still need a pre-operational environment and therefore more development. A short summary of G-SEXTANT products/tools & services achievements as follows:

- The product **Situation awareness of illicit crops cultivation was already used in operations by the user (UNODC)**. This is a clear success case of development of a new product within G-SEXTANT. Even more the product is included in a user publication "Afghanistan Opium Survey Report 2014", UNODC[22]. The concept of risk implemented in the Afghanistan test case developed during the project, which combines the socio-economic and environmental indicators, has several advantages: the assessment clearly shows that substantial differences within

[22] https://www.unodc.org/documents/crop-monitoring/Afghanistan/Afghanistan_Opium_Survey_Socio-economic_analysis_2014_web.pdf

Afghanistan exist, both in terms of the values and the nature of vulnerability to opium poppy cultivation and the environmental suitability of the land. Furthermore, each single region can be decomposed into its components, allowing the identification of the contributions of the single indicators to the overall risk in a spatially explicit way independent from administrative units. In this way, the risk assessment can support the development of context and location specific interventions that aim at reducing vulnerabilities. By considering the results of the vulnerability assessment, the drivers of vulnerability can be better explored and can assist with addressing opium poppy cultivation in a localised manner. The vulnerability component can potentially be implemented as a monitoring tool to evaluate changes in time and the impact of various interventions.

- Regarding Land conflict products, geo-spatial techniques were improved (basically related to OBIA methodologies) and the application of **Land use changes as conflict indicators** in external action operations is considered as demonstrated (this service was tested in and operational environment), internally verified/validated and supported by scientific publications. Even more, the Land use/cover and changes product is already included in SEA pre-operational service. Now, the challenge is to introduce these improvements in operational mode and high demanding operational chains.
- The overall objective of the **Humanitarian crisis service** was the analysis of temporary settlements (refugee/IDP camps) and informal settlements (slums) in fast growing cities of developing countries. The products developed within this service aimed to provide information on refugee camp infrastructure, the number of people in need and their spatial distribution (crucial for successful relief and recovery operations) and information on potential informal settlement areas separated from total urban built-up structure. **Situation analysis in refugee/IDP camps product** gave an overview on the camp situation and thus can support humanitarian aid especially with regard to camp planning and management purposes. Different semi--automatic approaches were applied which delivered good to moderate results (depending on the accuracy measure used for verification) with a clear tendency to underestimations, both, for the spatially explicit verification of dwelling areas and dwelling numbers. **Monitoring of refugee/IDP camps product** illustrates the spatio-temporal developments in the built-up area coverage within a camp. By means of the change maps detailed spatial changes of the built-up area within the camp-extent were easy to assess. Such information can support humanitarian aid especially with regard to camp planning and management purposes. The high potential of remote sensing, to retrospectively reveal and document settlement developments in refugee camps within crisis situations based on VHR-satellite imagery from different sensors could be demonstrated. **Monitoring repatriation processes of displaced population product** showed the potential of retrospective and up-to-date monitoring possibilities in regard of camp evolution as well as environmental factors to support information on repatriation processes of refugees or a stabilization of the camp situation vice versa. A high degree of automation and transferability of the classification and feature extraction rule-sets between the different images could be reached, indicating a good status of maturity to be applied to camps of similar conditions. **Informal settlements characterization** product provides a set of robust information layers that can be used to extract potential informal settlement areas from total urban built-up structure. Under the hypothesis that there are structural differences in the formal and informal settlements that are

visible and/or measureable in the images (e.g. building size and density, road network) the information layers contain features, which are suitable to distinguish poverty areas from other built-up areas in the city. The methodology for identification of informal settlements was developed in the context of Rustenburg, South Africa. In the second production phase this approach was applied to the imagery of Nairobi and proofed to deliver quality results. It is expected that the approach is applicable in other contexts as well and hence is suitable for an operational service.

Service related to Humanitarian crisis is considered ready to operations and supported by scientific findings and/or verification/validation internal procedures. G-SEXTANT partners have been involved in developments at the highest international level in these topics and clear analysis of technical service capacity was provided.

- The product ***Land degradation around refugee/IDP camps*** **product** included in Land conflict service is also considered ready to operations. The methods to identify dwellings were well consolidated by G-SEXTANT partners and many peer-review papers were published in this thematic domain. *Single trees analysis within a camp area*[23] (as a new concept developed during G-SEXTANT) product fits the needs of the user and provides enough accurate results. Accordingly, in an operational environment is needed to evaluate the cost/benefit assessment related to visual interpretation methodologies and the proposed G-SEXTANT semi-automatic techniques.

- The general concept of ***Monitoring border trafficability*** **product** is easily transferable but the processing chain needs to be readapted to each area of interest based on its characteristics and the geospatial and imagery available. The product has potentiality to be developed in the mid-long term.

- Specific ***Tools for monitoring nuclear sites and activities*** were developed to help users to identify relevant changes between two or more acquisition times and to integrate of multi-type information. These tools assist the user to verify the correctness and completeness of the member states' declarations, and to prepare for on-site inspections and other technical visits.

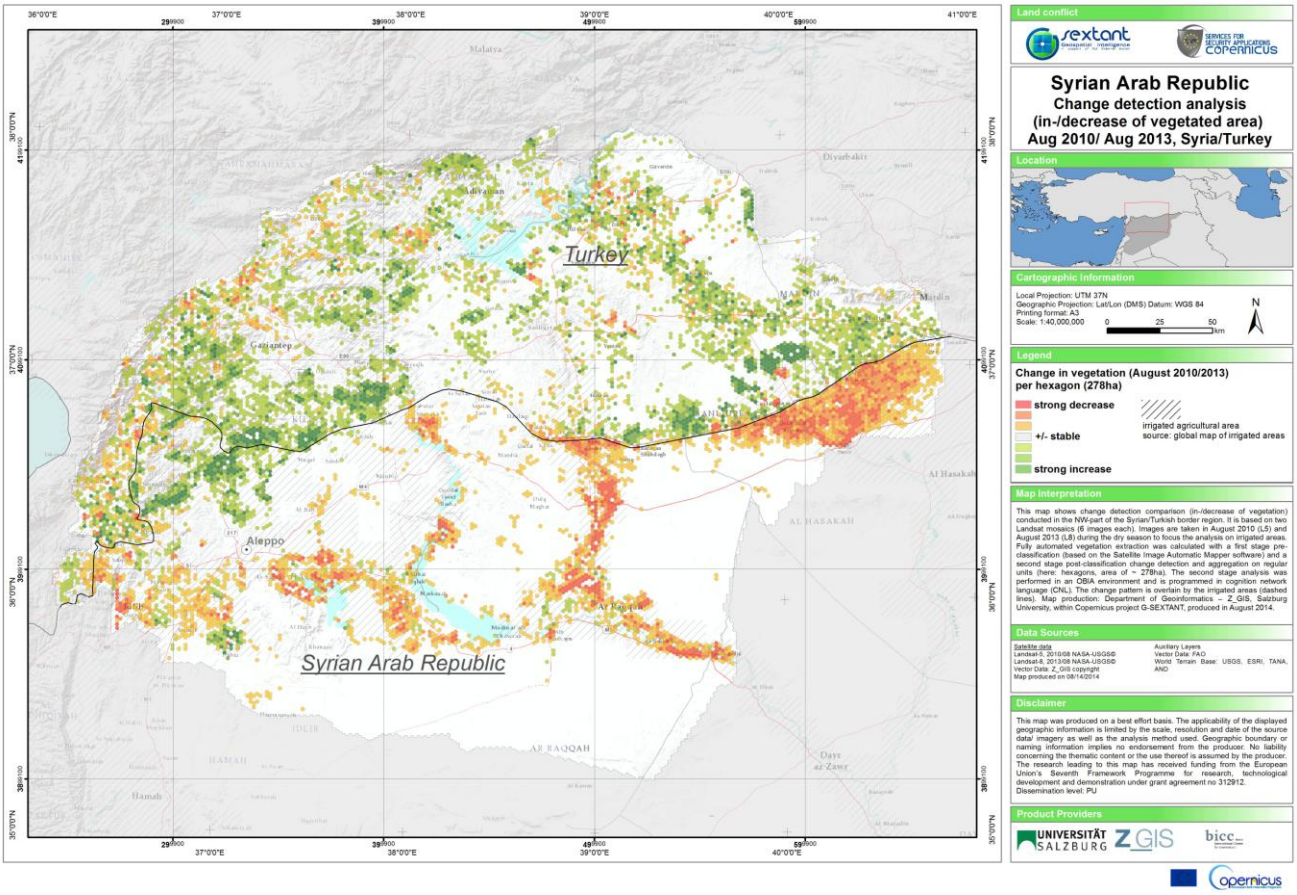
- ***Situation analysis of mining sites and oil fields*** **product** provided methodologies to detect mining sites and the assessment of their impact, and to identify major grievances around oil extraction. The main finding of this service is the implementation of tools for a better understanding of interlinkages between resource extraction and conflicts. The user extensively used the product in its research but pre-operational environment is needed.

- A new product ***Monitoring large-scale land investments*** was developed in G-SEXTANT being a clear promising product to be developed and demonstrated in (pre-)operational environment in the future. In that sense, the highest potential of this product is perhaps to monitor the crucial follow-up processes of land acquisitions by verifying if and how much of a sold or leased area is actually

[23] Luethje, F., Tiede, D., Füreder, P. (accepted). “Don’t see the dwellings for the trees: Quantifying the effect of tree growth on multi-temporal dwelling extraction in a refugee camp”. GI_Forum 2015. Proceedings of the Geoinformatics Forum, Salzburg. Heidelberg, Wichmann.

developed. Also it is needed to identify potential further needs and uses regarding the product.

- The use of EO technology in **illicit crops assessment and monitoring** was proved in pre-operational conditions (e.g. Lao PDR test case). A clear statement of capabilities related to Illicit crops warning *service* was identified (opium cultivation). For the detection of opium cultivation is important to have field data in order to assure that these fields correspond to poppy. The illicit crop warning service evolved during the two production cycles especially in the direction of automation and scope: the focus shifted therefore from a detailed analysis (e.g. single field scale) to a broader identification of indicators for illicit crop cultivations. This is also based on the interaction with the user UNODC and their needs, since fine scale analysis needs to be done anyhow in the field (aerial campaigns, field campaigns) but to limit these campaigns to certain reasons (stratified) would help considerably. Within this service is possible to extract clear-cuts, agricultural areas, settlements, arable land (since poppy fields are strongly spatial correlated with other existing agricultural areas), etc.



An example of a product developed within G-SEXTANT: 'Automatic post-classification land cover change detection in Landsat images: Analysis of changes in agricultural areas during the Syrian crisis' which focuses on the changes of vegetation mainly in irrigated agricultural areas.
Credits: PLUS for the G-SEXTANT Project; Source: Tiede, D., Lüthje, F., Baraldi, A., 2014. Automatic post-classification land cover change detection in Landsat images: Analysis of changes in agricultural areas during the Syrian crisis, in: Seyfert, E., Gülch, E., Heipke, C., Schiewe, J., Sester, M. (Eds.), Band 23: Geoinformationen Öffnen Das Tor Zur Welt, 34. Jahrestagung in Hamburg 2014. Publikationen der Deutschen Gesellschaft für Photogrammetrie, Fernerkundung und Geoinformation (DGPF) e.V., Potsdam.

Analysis of synergies with other related initiatives

Synergies between both pre-operational Copernicus Security External Action project (**G-NEXT** and G-SEXTANT) have been extensively exploited so far, including user involvement and user coordination; SEA portfolio drafting; dissemination activities and ethical issues.

Synergies between Emergency Management Service (EMS) and SEA service have been explored and analysed jointly by G-NEXT and G-SEXTANT projects.

Further technological research identification

Further technological research and new lines of interest for a next future has been identified as evolution of G-SEXTANT project. The proposed evolution rationale of G-SEXTANT is based on the integration of new sensors; technological evolution of current and new layers and their standardization; data integration approach; development of products and crisis indicators at different level scales (multi-scale approach); dissemination of products taking into account confidentialities issues (multi-layer approach) and exploration of new tools and mechanism to disseminate products.

New or future sensors and space systems need to be taken into account in further research, such as the Sentinels and satellite video systems. Civil thermal, nocturnal or hyperspectral satellites have limited capabilities and in many cases are not useful in services such as illicit crops or border monitoring, as it has been highlighted in G-SEXTANT. Other promising systems need to be assessed and their operational capabilities validated in the security domain as follows:

- Civil systems providing images of 30 cm resolution or better could be increased, for example, current performance of counting of dwelling but introducing needed adaptation of current methods;
- HD Video and Full Motion Video, both aerial or spatial (as recent systems deployed on the International Spatial Station or other satellites systems);
- Planned satellite constellations, offering more frequent revisits; and
- Potentially small satellites dedicated to a particular purpose.

Obviously Sentinel data need to be incorporated into current development, especially in land conflict/natural services and surveillance of large borders. While selecting the most adequate imagery for a specific AOI and time window, it would be ideal to skip rainy and/or cloudy seasons. The provision of freely EO data, such as Sentinel-1 and Sentinel-2, will facilitate to skip this restriction factor in the near future.

The research evolution needs the integration of other sources of information (such as open sources, socio-economic data, etc.) according to user requirements. A good example of this integration is the *Conflict report* developed in the G-SEXTANT *Situation analysis of mining sites and oil fields* product which combined EO information with other variables and local data, or the product *Situation awareness of illicit crops cultivation areas*. The integration of other data sources will allow efficient use of the powerful

synergies possible, when integrating state-of-the-art information extraction and techniques from the different disciplines, e.g. technological on one hand side and socio-economic on the other, but it needs to be further investigated and more deeply developed; as well as friendly tools (as the change detection methods used in the illicit crops service) or new ways to present products to final users (investigated in G-SEXTANT in the *Land degradation around refugee/IDP camps*).

Apart from thematic layer improvement, new research is also needed in the **development of crisis indicators**, which will substantially support the early warning, risk reduction and analysis of crisis situations, if generated at appropriate scale and appropriate repetition and response manner. The development of crisis indicators could be complemented with a **multi-scale approach** from global to local scale. This means that the crisis indicators could be provided from global data (e.g. continental food crisis indicators), country level (e.g. environmental indicators of fragile states) or local/micro-local scale (e.g. type of roof of dwellings).

And finally, **the concept of multi-layer** has been required by EEAS in order to guarantee data security issues. As result of the application of this concept, the final product should be composed by several thematic layers that can be disseminatedfollowing the applicable security regulations.

New lines of research are proposed attending to European policies and global security risks:

- Environmental and natural services, especially water access and availability as source of conflicts and illegal logging, no included in the G-SEXTANT portfolio;
- Urban resilience, addressing humanitarian aid and disaster risk reduction and source of social instability and conflicts, not included in G-SEXTANT portfolio;
- Risk related to climate change are clearly considered as one of the main future risk for national and global security;
- Conflicts related to energy demand are expected, depending on the situation of the country and the type of resource, e.g. destabilization due unexpected or dramatic changes in electricity provision in the developing world or disruptions in the delivery of natural gas. But probably fuelwood will remain the predominant energy source in the developing world due cost of other energetic sources. The G-SEXTANT product *Land degradation around refugee/IDP camps* could be the base of an extended product to allow assessing the pressure on land and related conflicts;
- There is also a growing interest in failed and fragile states, including effects on governance, economics, security and crime, human development, demography and environment.

Description of the potential impact use and the main dissemination activities and the exploitation of results

G-SEXTANT impact is focused on several European policies, especially Development, Humanitarian Aid, Border Control outside EU, Environment and natural resources, Non-proliferation and Common Security and Defence Policy (CSDP) operations.

G-SEXTANT products could support development initiatives providing geospatial information on illicit crops as well as the EU is active in supporting 'alternative development' models for developing countries which are particularly vulnerable to the negative effects of illicit crops plantation. The EU needs reliable information on the location and distribution of illicit crops areas, or on areas potentially suitable for this purpose (G-SEXTANT *Situation awareness of illicit crops cultivation areas* product); and on changes occurring in monitored areas over time, for instance variations in land cover from forest to agricultural plantation, in order to assess the impact of its policies (G-SEXTANT *Illicit crops warning*).

Humanitarian aid is one of the relevant services of G-SEXTANT and one of the main pillars of EU External Action. Technological improvements related to refugee/IDP camps and informal settlements (location and structure of camps, dwelling extraction and estimation of refugee population using advanced methodologies, assessment of camp development and camp structure, indicators for supporting and monitoring repatriation processes, impacts on the environment of refugee/IDP camps and informal settlements characterization) has been achieved during the project.

The EU is engaged in border control activities not only along the external frontier of the Union, but also in other areas of the world where border issues may endanger European citizens' safety. The current general concept of G-SEXTANT ***Monitoring border trafficability*** product is easily transferable but the processing chain needs to be readapted to each area of interest based on its characteristics and the geospatial and imagery available.

Environmental problems and their impact on the political and security stability of third countries are of particular concern for both DG ENV and the EEAS. Several related services have been enhanced in G-SEXTANT, such as ***Land use changes as conflict indicators*** (used in operations in Syria crisis) and ***Situation analysis of mining sites and oil fields***.

The EU is especially concerned with **monitoring nuclear sites and activities** at international level. Specific tools have been enhanced in G-SEXTAT to support user requirements in this domain.

Common Security and Defence Policy (CSDP) missions are usually deployed in conflict-ridden contexts affected by similar natural, political, economic, social, logistical and operational problems which may require the EU to have valuable information. G-SEXTANT products, tools and services could be taken into account in this context.

Regarding **dissemination and visibility**, several activities have been developed. These have been used to disseminate information about the project and have been designed to be closely aligned with the G-NEXT project.

Following the request from the Research Executive Agency (REA) of the European Commission to ensure the close coordination of the two projects, the common look and feel of communication tools and the visual identity of the two projects were developed, leading to a single web entry and an aligned Communication Strategy and Action Plan. These communication tools were designed to target relevant stakeholders and provided information about the G-SEXTANT and G-NEXT projects.

The website has attracted higher numbers of visitors during the G-SEXTANT project's second reporting period, including relatively high numbers of visits from countries further than Europe. This demonstrated that the impact of the website reached further than European Countries as well as the importance of the website in the stakeholder communities.

The G-SEXTANT project has been represented at several events during the second reporting period. A major highlight was the organisation of the "Copernicus Support to EU External Action Workshop", which was attended by 72 high-level participants from the user community as well as high-level officials from the European Commission. Media coverage includes an article on the event, which has been published on the common website.

Example of communication tools

Project partners

G-SEXTANT was performed by 14 partners from 7 different EU Member States, plus an Independent Ethics Expert (Prof. Dr. Herbert Wulf) required for the ethical issues of the project.

PARTNER		COUNTRY
Research centre and academia		
German Aerospace Center (DLR)		Germany
Paris-Lodron University Salzburg (PLUS)		Austria
Forschungszentrum Juelich		Germany
Space Research Centre of the Polish Academy of Sciences (SRC)		Poland
University of Pavia (UP)		Italy
French Atomic Energy Commission (CEA)		France
Industry		
Indra Sistemas S.A. (IDR)		Spain
e-GEOS (eG)		Italy
SpaceTec (STP)		Belgium
Eurosense Belfotop (EUR)		Belgium
EU Council Agency and EU Commission		
European Union Satellite Centre (EU SatCen)		Spain
Joint Research Centre (JRC)		Italy
Non-profit organization		
Istituto Affari Internazionali (IAI)		Italy
Bonn International Center for Conversion (BICC)		Germany

Address of the public website

http://externalaction.security-copernicus.eu/

Contact details

Marino Palacios
G-SEXTANT Coordinator
Indra
mpalacios@indra.es

Use and dissemination of foreground

A plan for use and dissemination of foreground (including socio-economic impact and target groups for the results of the research) shall be established at the end of the project. It should, where appropriate, be an update of the initial plan in Annex I for use and dissemination of foreground and be consistent with the report on societal implications on the use and dissemination of foreground (section 4.3 – H).

The plan should consist of:

- Section A

  This section should describe the dissemination measures, including any scientific publications relating to foreground. **Its content will be made available in the public domain** thus demonstrating the added-value and positive impact of the project on the European Union.

- Section B

  This section should specify the exploitable foreground and provide the plans for exploitation. All these data can be public or confidential; the report must clearly mark non-publishable (confidential) parts that will be treated as such by the Commission. Information under Section B that is not marked as confidential **will be made available in the public domain** thus demonstrating the added-value and positive impact of the project on the European Union.

Section A (public)

This section includes two templates

- Template A1: List of all scientific (peer reviewed) publications relating to the foreground of the project.
- Template A2: List of all dissemination activities (publications, conferences, workshops, web sites/applications, press releases, flyers, articles published in the popular press, videos, media briefings, presentations, exhibitions, thesis, interviews, films, TV clips, posters).

These tables are cumulative, which means that they should always show all publications and activities from the beginning until after the end of the project. Updates are possible at any time.

TEMPLATE A1: LIST OF SCIENTIFIC (PEER REVIEWED) PUBLICATIONS, STARTING WITH THE MOST IMPORTANT ONES										
NO.	Title	Main author	Title of the periodical or the series	Number, date or frequency	Publisher	Place of publication	Year of publication	Relevant pages	Permanent identifiers[24] (if available)	Is/Will open access[25] provided to this publication?
1	*Monitoring of Oil Exploitation Infrastructure by Combining Unsupervised Pixel-Based Classification of Polarimetric SAR and Object-Based Image Analysis*	*Plank, Simon*	*Remote Sensing*	*Volume 6, December 2014*	*MDPI*	*Basel*	*2014*	*11977-12004*	*doi:10.3390/rs61211977*	*yes*
2	*Automated metric characterization of urban structure using building decomposition from very high*	*Heinzel, Johannes*	*International Journal of Applied Earth Observation and*	*Volume 35, Part B, March xxx*			*2015*	*151-160*		

[24] A permanent identifier should be a persistent link to the published version full text if open access or abstract if article is pay per view) or to the final manuscript accepted for publication (link to article in repository).

[25] Open Access is defined as free of charge access for anyone via Internet. Please answer "yes" if the open access to the publication is already established and also if the embargo period for open access is not yet over but you intend to establish open access afterwards.

	resolution imagery		*Geoinformation*							
3	*A new geospatial overlay method for the analysis and visualization of spatial change patterns using object-oriented data modeling concepts*	*Tiede, Dirk*	*Cartography and Geographic Information Science*	*41(3)*	*Taylor & Francis*	*xxx*	*2014*	*227-234*	*http://dx.doi.org/10.1080/15230406.2014.901900*	*Taylor & Francis*
4	*Object-based dwelling extraction in refugee/IDP camps-challenges in an operational mode*	*Füreder, P., Tiede, D., Lüthje, F., Lang, S.*	*South-Eastern European Journal of Earth Observation and Geomatics*	*3 (2S)*			*2014*	*539-544*		
5	*Object-based DTM generation from VHR stereo imagery derived DSM data sets*	*Lüthje, F., Tiede, D., Eisank, C.*	*South-Eastern European Journal of Earth Observation and Geomatics*	*3 (2S)*			*2014*	*109-114*		
6	*Automatic post-classification land cover change detection in Landsat images: Analysis of changes in agricultural areas during the Syrian crisis*	*Tiede, D., Lüthje, F., Baraldi A.*	*Band 23: Geoinformationen öffnen das Tor zur Welt, 34. Jahrestagung in Hamburg 2014*				*2014*	*7 pages*		*yes*
7	*Object-based Image Analysis Using VHR Satellite Imagery for Monitoring the Dismantling of a Refugee Camp after a Crisis : The Case of Lukole , Tanzania*	*Stängel, M., Tiede, D., Lüthje, F., Füreder, P., Lang, S.*	*GI_Forum 2014 - Geospatial Innovation for Society*		*Austrian Academy of Sciences Press*	*Vienna, Austria*	*2014*	*45-48*	*http://epub.oeaw.ac.at/?arp=7652-7_inhalt/1_07_CGI_Staengel.pdf*	
8	*Don ' t See the Dwellings for the Trees: Quantifying the Effect of Tree Growth on Multi-temporal Dwelling Extraction in a Refugee Camp*	*Lüthje, F., Tiede, D., Füreder, P.*	*GI_Forum 2015 – Geospatial Minds for Society.*		*Austrian Academy of Sciences Press*	*Vienna, Austria*	*2015*	*406–415*	*10.1553/giscience2015s406.Quantifying*	
9	*Monitoring Displaced People in Crisis Situations Using Multi-temporal VHR Satellite Data During Humanitarian Operations in South Sudan*	*Füreder, P., Lang, S., Rogenhofer, E., Tiede, D., Papp, A.*	*GI_Forum 2015 – Geospatial Minds for Society.*		*Austrian Academy of Sciences Press*	*Vienna, Austria*	*2015*	*391–401*	*10.1553/giscience2015s391.392*	
10	*Long-term Monitoring of the Environmental Impact of a Refugee Camp Based on*	*Langer, S., Tiede, D., Lüthje, F.*	*GI_Forum 2015 – Geospatial Minds for Society.*		*Austrian Academy of Sciences*	*Vienna, Austria*	*2015*	*434-437*	*10.1553/giscience2015s434.Long-term*	

	Landsat Time Series : The Example of Deforestation and Reforestation During the whole Lifespan of the Camp Lukole , Tanzania				*Press*					
11	*Humanitarian Emergencies: Causes, Traits, and Impacts as Observed by Remote Sensing*	*Lang, S. Füreder, P., Kranz, O., Card, B., Roberts, S., Papp, A.*	*In book: Remote Sensing of Water Resources, Disasters, and Urban Studies, Edition: 1, Chapter: Humanitarian Emergencies: Causes, Traits, and Impacts as Observed by Remote Sensing, Editors: Prasad S. Thenkabail,*		*CRC Press, Taylor & Francis Group*		*2015*	*32 pages*		

TEMPLATE A2: LIST OF DISSEMINATION ACTIVITIES								
NO.	Type of activities[26]	Main leader	Title	Date/Period	Place	Type of audience[27]	Size of audience	Countries addressed
1	*Web site*	*Space Tec Partners*				*Scientific Community, Industry, Policy makers, Civil Society*	*4,334 visits. 2,913 unique visitors*	*Italy, Spain, Belgium, Germany, Austria, France, India, United States, United Kingdom, Slovakia*
2	*Multimedia presentation*	*Space Tec Partners*				*Scientific Community, Industry, Policy makers, Civil Society*		*Pan-European*
3	*Leaflet*	*Space Tec Partners*				*Scientific Community, Industry, Policy makers, Civil Society*		*Pan-European*
4	*Conference*		*ESA Living Planet Symposium 2013*	*9-13 September 2013*	*Edinburgh, United Kingdom*	*Scientific Community, Industry, Policy makers*	*More than 500*	*Pan-European*
5	*Conference*	*Ventura, Gemma*	*International Space Research Conference 2014*	*15-17 September 2104*	*Rome, Italy*	*Policy makers, Scientific Community, Industry*	*More than 200*	*Pan-European*
6	*Conference*	*Voigt, Stefan*	*Global Humanitarian*	*10.-13. Okt. 2014*	*San Jose, CA, USA*	*Scientific Community,*	*More than 500*	*International*

[26] A drop down list allows choosing the dissemination activity: publications, conferences, workshops, web, press releases, flyers, articles published in the popular press, videos, media briefings, presentations, exhibitions, thesis, interviews, films, TV clips, posters, Other.

[27] A drop down list allows choosing the type of public: Scientific Community (higher education, Research), Industry, Civil Society, Policy makers, Medias, Other ('multiple choices' is possible).

			Technology Conference (GHTC), 2014			Industry, Policy makers		
7	Conference	Space Tec Partners	Copernicus Sentinels Serving the Environment and Society	12-13 May 2014	Athens, Greece	Policy makers, Scientific Community, Industry	More than 500	Pan-European
8	Conference	Tiede, D.,	IGARSS'14,	July 13-18 2014	Quebec City, Canada			
9	Conference	Füreder, P	5th GEOBIA 2014	21-24.5.2014	Thessaloniki, Greece			
10	Conference	Lüthje, F.	5th GEOBIA 2014	21-24.5.2014	Thessaloniki, Greece	Scientific Community, Industry	More than 100	international
11	Conference	Tiede, D.	5th GEOBIA 2014	21-24.5.2014	Thessaloniki, Greece	Scientific Community, Industry	More than 100	international
12	Conference	Plank, S	POLinSAR 2015	26-30 January 2015	Frascati, Italy	Scientific Community	More than 200	International
13	Conference	Irmgard Niemeyer	ISPRS Conference on Serving Society with Geoinformatics	Nov. 11-15, 2013	Antalya/Turkey	Scientific Community, Industry, Policy makers	More than 500	International
14	Conference	Irmgard Niemeyer	INMM (Institute of Nuclear Materials Management) 55th Annual Meeting, Atlanta, 21-24 July 2014	July 21-14, 2014	Atlanta, USA	Scientific Community, Industry, Policy makers	More than 700	International
15	Conference	Irmgard Niemeyer	Symposium on International Safeguards: Linking Strategy, Implementation and People, Vienna, Austria	Oct. 20-24, 2014	Vienna, Austria	Scientific Community, Industry, Policy makers	More than 600	International
16	Conference	Irmgard Niemeyer	37th ESARDA (European Safeguards Research and Development Association)	May 19-21, 2015	Manchester, UK	Scientific Community, Industry, Policy makers	More than 200	Pan-European, International

			Symposium on Safeguards and Nuclear Non-Proliferation					
17	*Conference*	*Johannes Heinzel*	*ESA-EUSC-JRC 9th Conference on Image Information Mining*	*March 5-7, 2014*	*Bucharest, Romania*			
18	*Conference*	*Langer, S*	*GI_Forum '15*	*July 7-10, 2015*	*Salzburg, Austria*	*Scientific Community, Civil Society, Stakeholders*	*more than 100*	*international*
19	*Conference*	*Füreder, P.*	*GI_Forum '15*	*July 7-10, 2015*	*Salzburg, Austria*	*Scientific Community, Civil Society, Stakeholders*	*More than 100*	*international*
20	*Conference*	*Lüthje, F.*	*GI_Forum '15*	*July 7-10, 2015*	*Salzburg, Austria*	*Scientific Community, Civil Society, Stakeholders*	*More than 100*	*international*
21	*Conference*	*Stängel, M.*	*GI_Forum '14*	*July 1-4, 2014*	*Salzburg, Austria*	*Scientific Community, Civil Society, Stakeholders*	*More than 100*	*international*
22	*Workshop*	*SatCen*	*Copernicus Support to EU External Action Workshop*	*March 5, 2015*	*Brussels, Belgium*	*Policy makers, Industry, Scientific Community*	*More than 100*	*Pan-European*
23	*Workshop*	*Füreder, P*	*GIS for the United Nations and International Community Conference*	*07-08.04.2014*	*Geneva, Switzerland*	*NGOs, Policy makers, Industry, Scientific Community*	*more than 100*	*international*
24	*Conference*	*SatCen*	*Copernicus Sentinels Serving Society and the Environment*	*11-13.05.2014*	*Athens*	*Policy makers, Scientific Community, Industry*	*More than 500*	*Pan-European*
25	*Committee*	*SatCen*	*1st Copernicus Committee Meeting*	*20-21.05.2014*	*Brussels*	*Copernicus Stakeholders*	*Approx 50*	*Pan-European*
26	*Committee*	*SatCen*	*2nd Copernicus*	*25-26.06.2014*	*Brussels*	*Copernicus*	*Approx 50*	*Pan-European*

			Committee Meeting			*Stakeholders*		
27	*User Forum*	*SatCen*	*1st Copernicus User Forum*	*9-10.07.2014*	*Brussels*	*Copernicus Users*	*Approx 50*	*Pan-European*
28	*Conference*	*SatCen*	*7th Annual Conference on EU Space Policy*	*26-29.01.2015*	*Brussels*	*Policy makers, Scientific Community, Industry*		
29	*Committee*	*SatCen*	*5th Copernicus Committee*	*26-27.03.2015*	*Brussels*	*Copernicus Stakeholders*	*Approx 50*	

Section B (Confidential[28] or public: confidential information to be marked clearly)
Part B1

The applications for patents, trademarks, registered designs, etc. shall be listed according to the template B1 provided hereafter.

The list should, specify at least one unique identifier e.g. European Patent application reference. For patent applications, only if applicable, contributions to standards should be specified. This table is cumulative, which means that it should always show all applications from the beginning until after the end of the project.

TEMPLATE B1: LIST OF APPLICATIONS FOR PATENTS, TRADEMARKS, REGISTERED DESIGNS, ETC.					
Type of IP Rights[29]:	Confidential Click on YES/NO	Foreseen embargo date dd/mm/yyyy	Application reference(s) (e.g. EP123456)	Subject or title of application	Applicant (s) (as on the application)
x	x	x	x	x	x

[28] Note to be confused with the "EU CONFIDENTIAL" classification for some security research projects.

[29] A drop down list allows choosing the type of IP rights: Patents, Trademarks, Registered designs, Utility models, Others.

Part B2
Please complete the table hereafter:

Type of Exploitable Foreground[30]	Description of exploitable foreground	Confidential Click on YES/NO	Foreseen embargo date dd/mm/yyyy	Exploitable product(s) or measure(s)	Sector(s) of application[31]	Timetable, commercial or any other use	Patents or other IPR exploitation (licences)	Owner & Other Beneficiary(s) involved
	Ex: New supercond uctive Nb-Ti alloy			*MRI equipment*	*1. Medical* *2. Industrial inspection*	*2008* *2010*	*A materials patent is planned for 2006*	*Beneficiary X (owner) Beneficiary Y, Beneficiary Z, Poss. licensing to equipment manuf. ABC*
x	x	x	x	x	x	x	x	x

In addition to the table, please provide a text to explain the exploitable foreground, in particular:

- Its purpose
- How the foreground might be exploited, when and by whom
- IPR exploitable measures taken or intended
- Further research necessary, if any
- Potential/expected impact (quantify where possible)

[19] A drop down list allows choosing the type of foreground: General advancement of knowledge, Commercial exploitation of R&D results, Exploitation of R&D results via standards, exploitation of results through EU policies, exploitation of results through (social) innovation.
[31] A drop down list allows choosing the type sector (NACE nomenclature) : http://ec.europa.eu/competition/mergers/cases/index/nace_all.html

Report on societal implications

Replies to the following questions will assist the Commission to obtain statistics and indicators on societal and socio-economic issues addressed by projects. The questions are arranged in a number of key themes. As well as producing certain statistics, the replies will also help identify those projects that have shown a real engagement with wider societal issues, and thereby identify interesting approaches to these issues and best practices. The replies for individual projects will not be made public.

C Workforce Statistics		
3. Workforce statistics for the project: Please indicate in the table below the number of people who worked on the project (on a headcount basis).		
Type of Position	**Number of Women**	**Number of Men**
Scientific Coordinator	1	5
Work package leaders	7	9
Experienced researchers (i.e. PhD holders)	14	36
PhD Students	3	2
Other	15	8

4. How many additional researchers (in companies and universities) were recruited specifically for this project?	**2**
Of which, indicate the number of men:	2

D Gender Aspects

5. Did you carry out specific Gender Equality Actions under the project? ⦿○ Yes No

6. Which of the following actions did you carry out and how effective were they?

	Not at all effective				Very effective
☒ Design and implement an equal opportunity policy	○	○	○	⦿	○
❑ Set targets to achieve a gender balance in the workforce	○	○	○	○	○
❑ Organise conferences and workshops on gender	○	○	○	○	○
❑ Actions to improve work-life balance	○	○	○	○	⦿

○ Other:

7. Was there a gender dimension associated with the research content – i.e. wherever people were the focus of the research as, for example, consumers, users, patients or in trials, was the issue of gender considered and addressed?

○ Yes- please specify

⦿ No

1. Please indicate the number of woman and men working in the project and their role
   In the project have been involved a total of 40 women and 60 men, most of them with partial dedication with the reole distribution according to table C (workforce statistics)

2. Number of medium weekly working hours for women and men on the project.

   On average, its equally 40 hours for women and men.

3. Please specify specifics equal opportunities policies developed within your company/organization.
   The norm is equal job opportunities for men and women for all partners

4. Specific recruitment/internal promotion related to the project/gender implemented within your organization

Recruitment procedure is promoting exclusively competence and qualifications of the candidates

E Synergies with Science Education

8. Did your project involve working with students and/or school pupils (e.g. open days, participation in science festivals and events, prizes/competitions or joint projects)?

x Yes- please specify: GIS day activities with school pupils, supervision of master thesis, internships for students (University of Salzburg)
SatCen: Involvement during the participation of the Space Expo (Madrid, Warsaw)

○ No

9. Did the project generate any science education material (e.g. kits, websites, explanatory booklets, DVDs)?

⦿ Yes- please specify Explanatory material kits for Space Expo (booklets,DVDs)

○ No

○ Yes – as a **secondary** objective (please indicate areas below - multiple answer possible)

○ No

13c If Yes, at which level?

- ○ Local / regional levels
- ○ National level
- ○ European level
- ○ International level

H Use and dissemination

16. Indicate how many of the following Intellectual Property Rights were applied for (give number in each box).	Trademark	
	Registered design	
	Other	

17. How many spin-off companies were created / are planned as a direct result of the project?	
Indicate the approximate number of additional jobs in these companies:	

18. Please indicate whether your project has a potential impact on employment, in comparison with the situation before your project:

- ☒ Increase in employment, or
- ☒ Safeguard employment, or
- ❑ Decrease in employment,
- ❑ Difficult to estimate / not possible to quantify

- ☒ In small & medium-sized enterprises
- ☒ In large companies
- ❑ None of the above / not relevant to the project

19. For your project partnership please estimate the employment effect resulting directly from your participation in Full Time Equivalent (*FTE = one person working fulltime for a year*) jobs:	*Indicate figure:*
Difficult to estimate / not possible to quantify	☒