CHAPTER 4

A Study on the Exploitation of Satellite-Based Information in the Maltese Islands

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Introduction

The subject of Space is often perceived as abstract. Yet, our communications infrastructure, navigation on land, sea and air, surveillance, border control and security, agriculture, meteorological observation, monitoring of natural disasters and early warning systems all rely on Space. Furthermore, the understanding of our planet, the solar system and beyond through space science, all rely on investment in the space sector. Space is not a luxury, but it is indeed essential for our daily lives.

Malta and the Current Cooperation with ESA

The European Space Agency (ESA) is Europe's flagship entity for the space sector and often seen as Europe's gateway to space. Key European Programmes in Space, such as Copernicus and Galileo are implemented by ESA, providing Europe with Earth Observation and global navigation infrastructures respectively. ESA's primary objective is to develop and boost European space capability and to ensure continued investment in space such that societal challenges can be overcome through the help of space applications. The Cooperation Agreement which Malta signed with the ESA in February 2012 (ESA, 2012), granted Malta an Observer status enabling it to follow discussions within an ESA context on ESA–EU matters and to learn first-hand about the processes involved in ESA decision-making. Additionally, the cooperation agreement resulted in new training and research opportunities for Maltese students and researchers, access to state-of-the-art equipment and facilities, as well as the possibility of networking with ESA researchers.

Raising Awareness and Jump Starting the Sector

Malta's cooperation agreement with ESA led to the setting up of the directorate for Space Technologies within the MCST. The directorate focuses on building relationships with foreign space agencies, the Maltese government, industry and educational sector and aims to explore the use of space-applications for businesses and the educational sector amongst others. Being the National Contact Organisation for Space-related matters, MCST maintained an active attendance to ESA Council meetings and other related fora,

such as the Copernicus Committee, Copernicus User Forum and the Space Surveillance and Tracking Committee. Considering their remits involving the use of Space applications, a number of space-related fora are also attended by other governmental entities, namely: the Malta Communications Authority (MCA), the Armed Forces of Malta (AFM), the Planning Authority (PA) and the Environment and Resources Authority (ERA). MCST meets these entities in quarterly space governance meetings that help ensure proper communication between the Maltese entities having an interest or responsibilities within the local space sector. This aids establishing a common front in tackling joint issues and helps avoid duplication of effort.

MCST also represents national interests through Malta's Observer status with ESA. Through its motivation to pursue relevant opportunities with ESA, in October 2015, MCST organised a technical visit in Malta during which an esteemed number of Maltese SMEs and academic institutions where interviewed by ESA experts. The objectives of the visit where twofold: to facilitate the identification of areas that a national space strategy should specifically address and to help map the existing local capabilities or potential in contributing to such areas.

As identified through the Satellite data user uptake study (European Commission, 2016b), performed by the European Commission to help formulate a user engagement strategy for its Earth Observation programme, the Maltese user community has an overall low awareness of the potential of satellite based observation services, such as those emanating from Europe's Copernicus Programme (European Commission, 2016a). Consequently, MCST has embarked on a number of initiatives to help raise awareness and bridge the gap between society and satellite technologies. One important step in this direction was taken when MCST became a member of Eurisy, an association of space agencies that raises awareness of emerging satellite applications (Eurisy, 2016). The first tangible result of such a membership came along in November 2015, when the Council together with Eurisy co-organised the 'Satellite Solutions for Smarter Island' international conference in Malta (Eurisy, 2015).

With the participation of high profile entities, such as ESA, the European GNSS Agency and the Space Policy Directorate of the European Commission, the one-day conference discussed how island economies can leverage Europe's investments in satellite services to boost their economy and live up to current challenges. Case studies from private and public sectors exhibited the potential of satellite applications in various sectors such as tourism, transport and maritime. The conference was very well attended with over 100 participants converging from some ten countries. During the conference, the Council

in collaboration with the Malta Information and Technology Agency (MITA) and the Malta Environment and Planning Authority (MEPA), today known as the PA and the ERA, launched the 'Satellite Solutions for Smarter Islands App Challenge'. The application challenge invited competitors to propose creative ideas for apps that could help solve environmental and socio-economic challenges in Malta.

As a follow-up to the conference, this initiative was aimed at raising awareness about the potential of exploiting open data, including European satellite datasets over Malta, for the benefit of Maltese citizens. Within the framework of this App Challenge, in February 2016 MCST organised an Earth Observation training day delivered by experts from ESA and Airbus Defence and Space. The training was primarily composed of a hands-on session using a free ESA toolbox and guided participants to download free satellite datasets over Malta and extract information related to a multitude of themes, amongst which agriculture, environment, land-use and maritime. The event was oversubscribed with around 35 participants turning up on the day. Another similar hands-on workshop organised in Malta was an ESA-sponsored course on Synthetic Aperture Radar (SAR). Lecturers from ESA and foreign universities provided an intensive week-long course covering SAR theory, polarimetry/interferometry, vegetation applications, land cover mapping, GIS/GPS integration, marine applications and archaeology applications.

The course was open to the public and was well attended by various public sector entities, academia and private researchers and SME's. Apart from raising awareness through conferences and workshops, MCST issued a number of calls for Maltese nationals to follow one-year placements at ESA establishments. Through the International Research Fellowship scheme and the National Traineeship scheme, Maltese students and researchers had the opportunity of training in state of the art establishments such as those in European Space Research and Technology Centre (ESTEC), otherwise known as ESA' s technical heart (ESA, 2016).

Such capacity building measures where made possible through Malta's current 5-year cooperation agreement with ESA, which is due to expire in February 2017. Considering results of the ESA technical visit and its willingness to further jump-start the local space sector, MCST is currently looking into possibilities of closer cooperation between Malta and ESA. This could be done through concrete research and education projects which will aid local capacity-building in line with Malta's current and immediate priorities.

Satellite Data Use in Malta

While the immediate general perception is perhaps that EO-satellite based services are underutilized in Malta, Maltese authorities directly benefit through satellite-based EU services within numerous applications and domains. The following sections intend to 'bring space down to Earth' by providing an overview of how satellite technologies are utilized in the day-to-day function of Maltese public authorities. This helps create a mind-map of satellite data use in Malta, particularly the utilization of imagery derived through satellite-based Earth Observation (EO), which is made possible through imaging satellites usually orbiting between 500km and 800km.

The main objectives of the following study are as follows:

1. Creating a review of satellite data use in Maltese public authorities with a primary focus on EO. This work not only captures entities which have the capacity of actual satellite-data preprocessing, but also reviews the utilization of services emerging further downstream the satellite data-flow process; and
2. The study feeds into processes that help identify gaps in satellite-data usage and hence support targeted capacity building measures. This is in line with efforts that help ensure Maltese public entities are maximizing Europe's investment in satellite technologies, particularly those related to EO.

While somewhat comprehensive, the following review is not an exhaustive list of Maltese entities utilising satellite technologies. The study focuses on public entities making use of satellite based EO services within their mainstream activities and does not delve into public bodies that utilize satellite information on an ad-hoc or ancillary basis. Additionally, it does not discuss services delivered by privately owned entities. Apart from EO, numerous other authorities and businesses rely on the other two satellite-based technologies, namely Satellite-based communication (SATCOM) and Satellite Based-navigation (SATNAV). As an example, Malta's Air Navigation Service Provider (ANSP) and the Maltese telecommunication service providers, rely on such technologies on a day-to-day basis. Such technologies are however outside of the scope of this study.

Satellite EO and Land Applications

Agricultural Control with Remote Sensing

As part of the infrastructure supporting Europe's Common Agricultural Policy (CAP) which, amongst other programmes, implements a system of agricultural subsidies, national authorities are required to operate an Integrated Administration and Control System (IACS). The system uniquely identifies each farmer together with the agricultural parcels

of land and helps ensure that payments are made correctly, irregularities are prevented or identified, followed up and amounts unduly paid are recovered. Locally, operation of the IACS falls under the remit of the Agriculture and Rural Payments Agency (ARPA). Within the 'Ministry for Sustainable Development, the Environment and Climate Change', the agency is responsible for regulatory compliance of land parcels versus EU aid requested, together with any associated inspections. As a matter of fact, at the heart of the IACS is the Land Parcel Identification System (LPIS), a supporting tool for the generation and upkeep of a spatial register. This system, which is operated by a dedicated unit within ARPA, allows for the registration of agricultural "parcels" by farmers, intending to apply for EU aid. Farmers are entitled to receiving such aid subject to the fulfilment of criteria that is assessed through checks carried out on-the-spot. When combined with traditional checks physically carried out at the particular land parcel, the use of remote sensing helps making the control process more cost-effective and efficient.

In Malta approximately 15,000 agricultural land parcels are controlled annually through satellite remote sensing very-high resolution satellite imagery (VHR) to check farmers' declarations, and verify the compliance of their farming practices with CAP rules (Agriculture and Rural Payments Agency, 2016). Such satellite imagery is provided by the European Commission's Joint Research Centre as part of its Control with Remote Sensing Programme (CwRS) which makes available two VHR 400km2 datasets per year to be used in supporting the local implementation of CAP. The sub-metre resolution imagery through satellite sensors such as GeoEye-1 (0.46m) and WorldView-2 (0.46m), provides for the definition and identification of land types, features and relationships between these through the digitisation of polygons. Here, the use of satellite data through remote sensing is not only resource-efficient when compared to on-site inspection visits, but also cost-effective when compared to aerial photography of the land parcels. This provides a significant advantage for that part of inspection pertaining to land eligibility and cross compliance checks.

Land-Use Planning

The Mapping Unit within the PA is the National Mapping Agency of Malta, being responsible for large and small scale topographic mapping of the Maltese Islands. The unit maintains an archive of high quality aerial photography and is responsible to producing the national orthophoto map every two years. The centimetre resolution digital orthophotos taken through a specifically equipped surveying aircraft, form the basis of all planning undertaken by the authority. While RGB orthoimages are sufficient for the delineation of polygon mosaics associated with planning processes, the use of multispectral satellite imagery is crucial in ensuring a holistic spatial planning analysis.

The additional number of optical channels within the satellite dataset, help add value on a multitude of different themes, particularly when substantiated by other datasets such as elevation information collected through LIDAR imaging. An example of satellite imagery preprocessing done by the PA in this domain is the watershed analysis shown in Figure 1. Such an analysis, undertaken using RapidEye (5m) imagery, enables an understanding of soil and road erosion potential together with mapping of floodplains and stream pour points into the sea: all of which are useful parameters to consider in the processing of the planning applications. The PA also coordinates with the ERA in producing land cover maps for the CORINE Land Cover (CLC) inventory, which is coordinated by the European Environmental Agency (EEA). Updates have been produced in 2000, 2006, and 2012 (Copernicus, 2012) and involved the preprocessing of EO satellite imagery obtained through the EEA in conjunction with other ancillary datasets such as topographic maps, habitats, agricultural datasets, and development planning parcels. (Planning Authority, 2016).

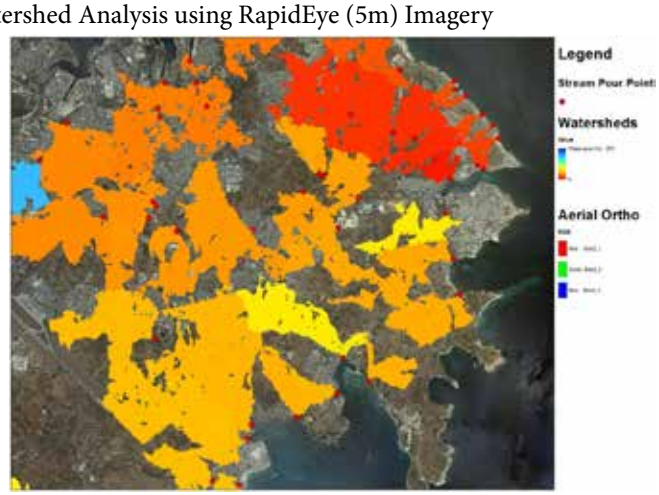
A snapshot of the CLC 2012 dataset, produced through preprocessing IRS P6 and RapidEye datasets (Copernicus, 2012) is shown in Figure 2. Through its proficiency working with Geospatial and Remote Sensing software packages such as ESRI ArcGIS (ESRI, 2016) and the ERDAS Imagine toolset (Hexagonal Geospatial, 2016), the PA has on various occasions, been commissioned by other entities or departments to orthorectify and preprocess EO optical imagery.

Apart from preprocessing satellite imagery to fulfil part of its remit, the PA has been also heading a number of processes to maximize the availability and usability of spatial information systems emanating from both aerial and remotely-sensed data. Through the PA, Malta undertook to integrate the requirements of the international activities and prepare a physical structure for data collection, input, storage, analysis and dissemination. Such was created through the acquisition of ERDF Funds through a project entitled "Developing National Environmental Monitoring Infrastructure and Capacity" (MEPA, 2013), which complied with dataflow requirements stipulated by the EEA. This process ensured the free dissemination of data to the public inclusive of spatial, environmental and physical data.

The initiative was based on the concept that the thematic disciplines will have available a comprehensive infrastructure that will enable NGOs, academia and the general public to upload thematic data and carry out cross-thematic analysis without the need to create their own systems. Such efforts are continuing through a follow-up project entitled SIntegraM: Spatial Integration for the Maltese Islands – Developing Integrated National

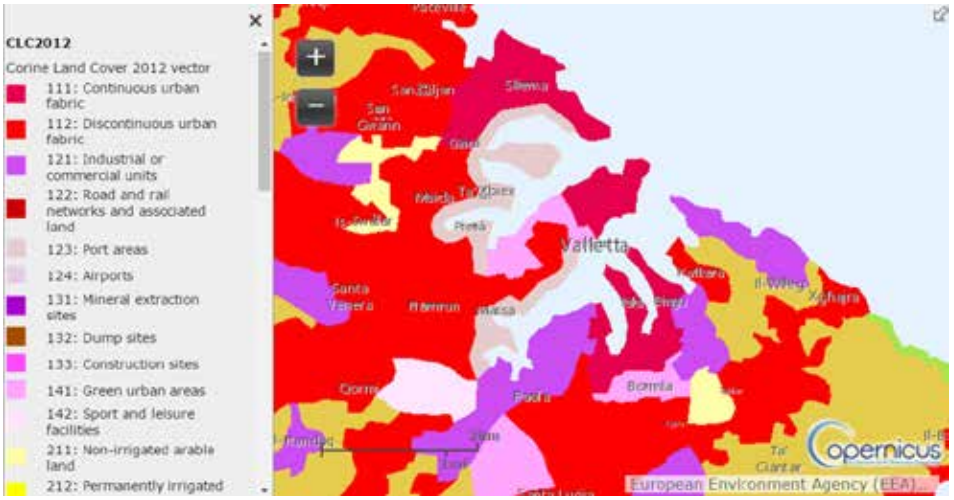
Spatial Information Capacity (refer to Formosa, Chapter 1), which involves building the necessary infrastructure, enhancing the human capacity and ensuring a legislative and mentality shift towards the free exchange of data. Furthermore, considering its interest in satellite-based EO, the PA represents Malta in a number of related fora and committees, amongst which are the Copernicus User Forum and the Copernicus Committee.

Figure 1: Watershed Analysis using RapidEye (5m) Imagery



Source: PA

Figure 2: Snapshot of Malta Dataset as part of CLC2012



Source: (Copernicus, 2012)

Environmental Monitoring

Previous academic research on the use of satellite imagery over the Maltese Islands, such as (Drago, Sorgente, & Olita, 2010), (Deidun, Drago, Gauci, Galea, Azzopardi, & Mélin, 2011) and (Azzopardi, Deidun, Gianni, Gauci, Pan, & Cioffi, 2013) has demonstrated the usefulness in using EO to study and monitor the local coastal and marine environment. The availability of satellite-derived data with snapshots (in some cases available several times daily), offers great potential in monitoring the temporal evolution of sea surface parameters such as surface currents, temperature variability and chlorophyll concentrations, amongst others. Since publication of the above-mentioned research, the availability and accessibility of satellite derived information over the Mediterranean sea has been significantly improved through Europe's EO programme, Copernicus.

Figure 3: Example of Copernicus Sentinel-2A imagery, 13th April 2016

Source: (ESA, 2016)

Apart from offering an elaborate satellite-derived information portfolio covering various ocean parameters (Copernicus Marine, 2016), the programme also exposes the lower level Sentinel-series satellite datasets through its Sentinels Scientific Data Hub (Copernicus , 2016). Such freely available datasets, which are accessible through fast registration, enables researchers and scientists to preprocess and derive additional parameters. As an example, the Sentinel-2A imagery in Figure 3 has been downloaded through the Sentinels Scientific Data Hub (ESA, 2016a) and processed using the SNAP toolbox (ESA, 2016b), which is also freely available from the ESA portal in support of the Copernicus Programme (ESA, 2016). The 10m resolution RGB image, dated 13th April 2016, shows clearly shows sediments, possibly combined with phytoplankton growth, flowing off the Sicilian coast towards Malta.

Considering the potential such imagery has to offer, ERA considers the use of satellite-derived information, substantiated by in-situ measurements for coastal and maritime environment monitoring as required by the Marine Strategy Framework Directive (ERA, 2016). Additionally, ERA also considers utilising EO for assessing ecosystem land cover in fulfilling actions related to the National Biodiversity Strategy and Action Plan (ERA, 2016a) and the EU Biodiversity Strategy to 2020.

Maritime Applications

Data from Earth observation satellites offer a systematic and unique perspective of our oceans, seas and coastlines. Apart from the multitude of satellite derived datasets, which when combined with in-situ samples provide invaluable information on marine ecosystems, satellite based solutions also contribute to maritime safety. In fact, the European Maritime Safety Agency (EMSA), an EU agency providing support to Member States in the development and implementation of legislation on maritime safety and security, provides services supported by satellite systems at their core. The European Commission has delegated EMSA with the implementation of satellite services dedicated to maritime surveillance as part of the Copernicus programme (European Commission, 2016). The following subsections provide an overview of three such services together with an outline of Maltese authorities that contribute and stand to benefit from such programmes.

Maritime Vessel Tracking

Vessels of a certain class or tonnage are mandated by international maritime law to be equipped with an Automated Identification System (AIS). The system continuously transmits messages containing, amongst other information, the ship identity and positioning information acquired from the shipborne Global Navigation Satellite System

(GPS) receiver. The radio frequency signals are instrumental as a collision-avoidance aid when picked by other nearby vessels and help enhance maritime situational awareness when picked up by land-based receiving stations when close to the coast. As a matter of fact, in line with European and International legislation Members States have developed national Vessel Traffic Monitoring Systems (VTMS) to track vessels along their coastlines.

Locally, the entity responsible for the implementation and operation of the Maltese VTMIS is Transport Malta. The system, which is linked to eight coastal radar sites in addition to AIS receiving stations (Transport Malta) significantly enhances the surveillance and monitoring capabilities available to the maritime departments within Transport Malta, the Armed Forces of Malta (AFM) and the Fisheries and Aquaculture Department. Apart from enhancing day-to-day vessel monitoring activities, the VTMIS has been instrumental in a number of operations which have led to the interception of craft carrying illegal migrants or engaged in the smuggling of controlled substances and contraband items.

In addition, as with the larger majority of EU countries, the Maltese VTMIS interfaces to the European Maritime Safety Agency's Safe Sea Net (SSN) Index Server, which harbours a complete network of AIS receiving stations monitoring vessels and their cargoes. The SSN National Competent Authority in Malta, which has the role of administrator at a national level is the Port and Yachting Directorate within Transport Malta (EMSA, Procedures for Requesting EMSA Data, 2014).

Overall, SSN monitors over 12,000 ships per day in EU waters and offers an interface for approved users to provide and request current and historical datasets (EMSA, How SafeSeaNet Works). Hence the Maltese Authorities may easily request information on a vessel that originated elsewhere in European Waters. Additionally vessels outside the range of coastal AIS receiving stations relay information to the SafeSeaNet network through Low Earth Orbit (LEO) Satellites equipped with AIS receivers (ESA, SAT-AIS factsheet). Research in satellite-based AIS systems, commonly referred to as SAT-AIS, is currently ongoing as part of a partnership between ESA and EMSA and while be instrumental as a back-up to the terrestrial SafeSeaNet information while extending its range to become a worldwide system (ESA, SAT-AIS Overview).

Apart from SSN, within the maritime surveillance domain, EMSA also manages the European Union Long Range Identification and Tracking Data Centre (EU LRIT DC). The LRIT system, devised by the International Maritime Organization (IMO), provides for the global identification and tracking of ships through an international data

exchange with a data distribution plan that converges on the participation of contracted governments (International Maritime Organization). In contrast with the broadcast protocol used for AIS, LRIT information is only sent to specific recipients for confidential treatment. LRIT shipborne equipment, which is mandatory for certain vessels classes, utilises Telecommunication satellites such as the INMARSAT and IRIDIUM constellations (EMSA, 2014), to transmit identification and positioning information to data centres. As a participating state, contributing to the EU LRIT DC, the Maltese authorities may request real-time information on the location on Maltese-registered vessels around the world, vessels that are within 1000 nautical miles of the Maltese coast or vessels that are destined to a Maltese port. Additionally, in its role in the surveillance of Maltese waters, providing search and rescue operations and aiding other governmental entities, AFM's accesses to LRIT information aids a timely and effective operation.

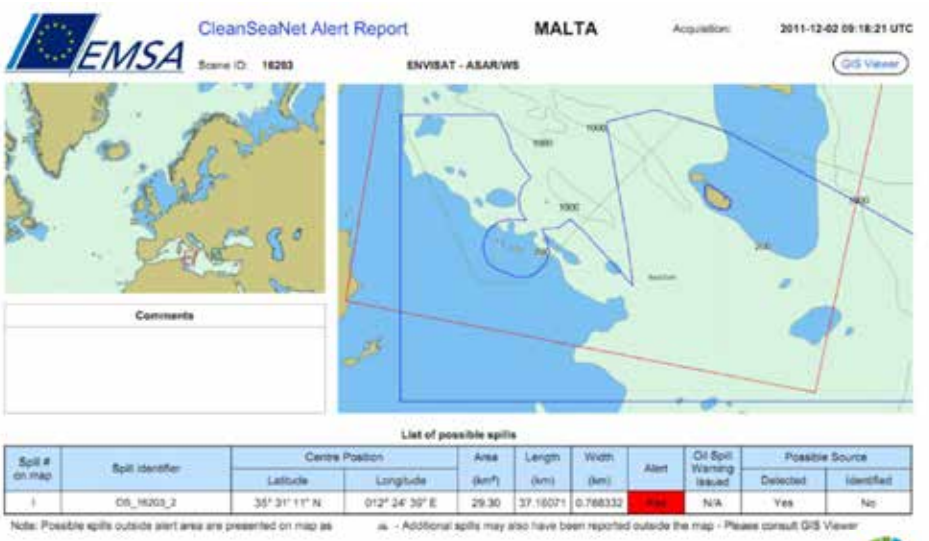
Oil Spill Detection

The Pollution and Incidence Response Unit (PIRU), falling within Transport Malta remit, is responsible for on-site assessment of small-scale maritime-related incidents. Following incident assessment, they often liaise with other authorities including the Civil Protection Department (CPD), the AFM, the ERA, and others. As with the tracking of maritime vessels presented in the previous section, such activities are well-substantiated by aids from satellite applications. In fact, PIRU is the national contact authority on CleanSeaNet, a near-real time satellite-based oil-spill detection service provided by EMSA (EMSA, 2010). This is possible through imagery taken through a number radar satellites orbiting in LEO (usually between 500km and 800km) and providing coverage of EU waters several times per day. Radar satellites, as opposed to optical satellites, have the inherent advantage of not being impaired by cloud formations and can operate during day and night. Oil slicks are distinctly visible in SAR imagery as characteristically dark features (Sentinel 1 Team, ESA, 2013).

Following a satellite pass, the imagery is downloaded through a network of ground stations and passed for rapid processing. Should expert analysis detect a possible oil spill, a CleanSeaNet report is sent to the locally relevant authorities, namely PIRU, AFM and the University of Malta Physical Oceanography Research Group, which has developed oil spill models for the Maltese Islands (Figure 4). A standard report usually includes the satellite images, the oil spill detection analysis result and, if visible, the identity of the likely polluter. (EMSA, 2010). Timing is of course critical in ensuring an appropriate operational response to accidental or deliberate shipborne oil spills. As a matter of fact, time from data acquisition by the satellite to the receipt of processed information by the local authorities is usually kept under 30 minutes (EMSA). To verify the reports received, as part of the

Emergency Response Control team, AFM utilises its own sea or air assets or contacts vessels navigating in the incident area.

Figure 4: Example of a CleanSeaNet Alert Report received by the Maltese Authorities



Source: (EMSA, 2012)

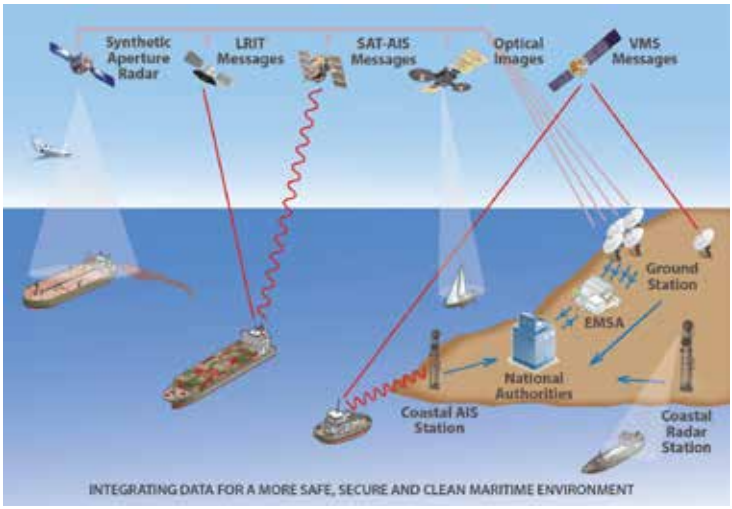
A 2014 performance audit to help measure Malta's level of preparedness to deal with an oil spill at sea concluded that oil spill detection mechanisms are primarily based on satellite imagery provide by the CleanSeaNet service (National Audit Office, 2014). Additionally, the report mentions a number of limitations in this regard, namely: the frequency and coverage of available satellite imagery, and the incidence of false alarms. Considering the European Commission investments in the Europe's flagship Earth observation programme, Copernicus, the frequency of imagery availability has improved significantly since publication of the audit report. As part of the Copernicus programme, radar satellites Sentinel-1A and Sentinel-1B, launched in 2014 and 2016 respectively, help ensure a revisit frequency of approximately 2 days over Malta (Sentinel 1 Team, ESA, 2013). Additionally, apart from the Sentinel series of radar satellites, EMSA's CleanSeaNet programme is supported by other radar satellites, such as the Canadian Space Agency's RADARSAT-2 (EMSA).

This helps improving revisit frequencies even further. Considering the incidence of false oil spill detections, this is also improving particularly as a result of the ESA's open

data policy on Copernicus Sentinel datasets (ESA). This means that researchers from around the work have free access to Sentinel datasets, improving research prospects in all Earth Observation domains, including the science of oil spill detection through radar satellites. While the CleanSeaNet service identifies oil spills, it is usually complemented by the previously mentioned vessel tracking services, which are also substantiated by satellite technologies. Considering the fact that most oil slicks are caused by ships illegally emptying their bilge before entering port, slick detections through CleanSeaNet can be correlated with AIS information gather through SafeSeaNet to determine the source and gather evidence to prosecute the offenders (Sentinel 1 Team, ESA, 2013). As with most satellite EO based applications, the potential of such systems can be only fully exploitable through its integration with other sources of information.

Such satellite data-driven initiatives truly provide a timely and remote visualisation of the potential incident to enable initial assessment before deploying resources for on-site monitoring. The advantages here are not only optimisation of resources by more focused action, but also the latent advantages of a cross-border cooperation platforms and the speed at which incidents may be dealt with through the use of satellite data. Both SafeSeaNet and CleanSeaNet are put to good use by Transport Malta and AFM since such satellite-based solutions are instrumental in supporting the relatively small local resource in monitoring the considerably large Maltese Search and Rescue area (Figure 5). Hence, the need for more intelligent-sources for early detection and resource optimisation is clear.

Figure 5: Integrated Maritime Services using Satellite Technologies



Source: (EMSA, 2013)

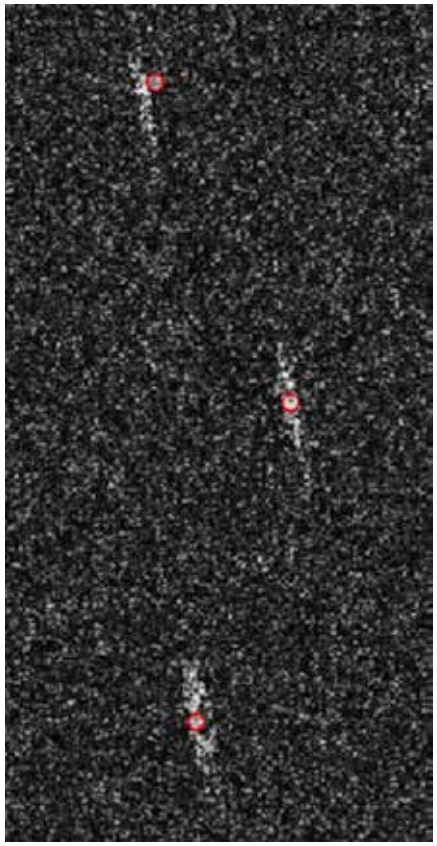
Security Applications

In December 2015, FRONTEX, the European Union Agency managing the cooperation between national border guards signed a delegation agreement with the European Commission to implement satellite services dedicated to border surveillance as part of the Copernicus programme (Frontex, 2015). As a result of this agreement, Frontex has access to Copernicus Sentinel imagery in addition to other VHR Copernicus contributing missions. Additionally, through its association with the EU Satellite Centre (SatCen), the agency utilizes sub-meter VHR radar and optical imagery through satellite sensors such as SAR-Lupe, COSMO Sky-Med, Pléiades and Spot6 /7.

In fact, Frontex is able to support authorities from EU countries in rapid response capability, assisting Member States with an enhanced situational awareness and providing an information sharing environment including satellite-based information gathering services. The collection of these services, called Eurosur Fusion Services, some of which are delivered in cooperation with the European Maritime Safety Agency (EMSA, 2014a) and the EU Satellite Centre (SatCen), include automated maritime vessel tracking and detection capabilities and software functionalities allowing complex calculations for detecting anomalies and predicting vessel positions. Previously mentioned EMSA services, such as SafeSeaNet, feed into Frontex coordinated services to help realise an EU-wide recognised maritime picture. While SafeSeaNet was primarily established to enhance maritime safety and efficiency, Eurosur services are more aligned to improving the reaction capability in combating cross-border crime, tackling irregular migration and preventing loss of migrant lives at sea.

Consequently, maritime-related Fusion Services use optical and radar satellite technology to locate vessels requiring search and rescue operations or those that are suspected of being engaged in criminal activities, such as illegal trafficking of migrants, drug or weapon smuggling (Frontex, 2016). While vessels involved in illegal activities would most likely be invisible to traditional vessel monitoring services such as AIS and SafeSeaNet due to a switched off or absent shipborne VMS, they may still be detected through Earth observation satellite scans. The Synthetic Aperture Radar (SAR) imagery from October 2015 shown in Figure 6, shows three rubber boats off the Libyan coast, identified as part of an operation involving experts from Frontex, EMSA, EUNAVFORMED and the Italian authorities. The identified vessels where migrant boats in distress and the timeliness identification led to the rescue of 370 migrants.

Figure 6: Radar image with the rubber boats spotted near Libyan coast, October 2015



Source: (Frontex, 2015)

Through its mandate to reinforce and streamline cooperation between national border authorities, Frontex provides Maltese border authorities with access to information regarding emerging risks and the current state of affairs, particularly in Maltese and neighbouring waters (Frontex, 2016a). The designated Maltese border authorities, namely the Malta Police Force, the AFM and Malta Customs (Frontex, 2016b) contribute to EU-wide information sharing infrastructure while benefitting from services such as Eurosur, particularly considering the fact that Malta is notably located within transit route of irregular migration.

Emergency Applications

As mentioned in previous sections, apart from making openly available large amounts of Earth Observation datasets, Copernicus delivers a number of services addressing various thematic areas. One such service is the Copernicus Emergency Management service (Copernicus EMS, 2016c) which, provides all actors involved in the management of natural disasters, emergency situations, and humanitarian crises with timely and accurate geo-spatial information derived from satellite remote sensing substantiated with other data sources (European Commission, 2016). Imagery is provided through the Copernicus Sentinel satellites or through any of the Copernicus contributing missions, which include VHR optical and radar satellites. The service, which is available to authorised users, consists of two components:

- •Rapid Mapping involves the fast provision of on-demand geospatial information intended to support authorities immediately following an emergency event. Timeliness of the information is critical and is made available within hours or at maximum a few days. When placing a service request, the authorised user specifies the required parameters. The service delivery consists of three standard products: Reference Maps, Delineation Maps that provide an assessment of the event extent, and Grading Maps (Figure 7) that include an assessment of the damage grade and its spatial distribution (European Commission, 2016).

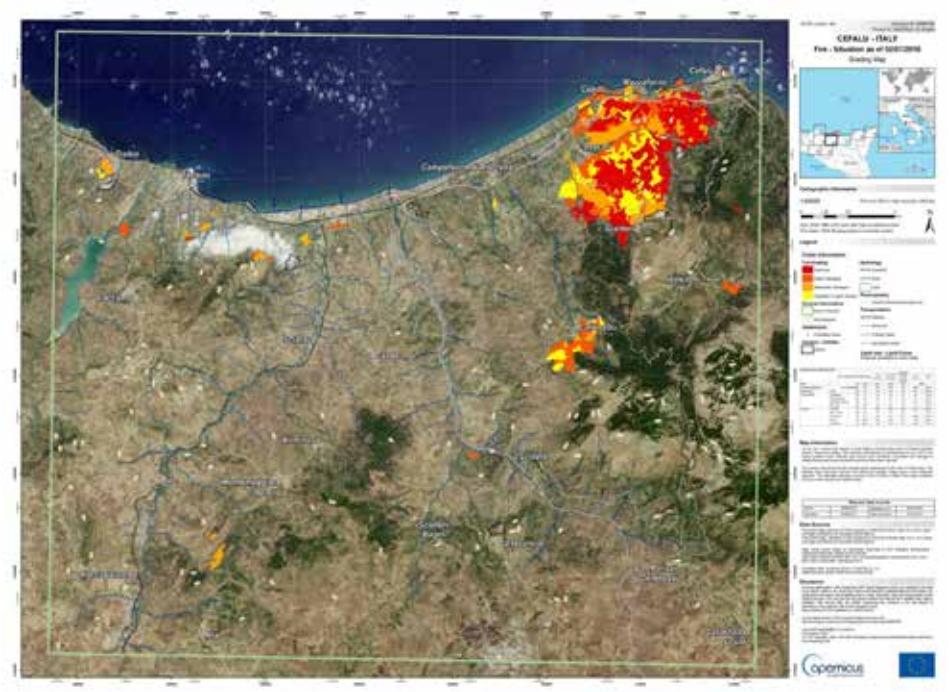
- Risk and Recovery Mapping consists of the on-demand provision of geospatial information in support of activities not requiring immediate response. This applies in particular to activities dealing with prevention, preparedness, disaster risk reduction and recovery. Within this component, the three standard product categories are: Reference Maps, Pre-disaster Situation Maps and Post-disaster Situation Maps (European Commission, 2016).

The service may be triggered by Authorised Users by sending a service request form directly to the European Response Coordination Centre (ERCC). In Malta, the authorised user is the CPD which falls under the Ministry for Home Affairs and National Security (MHAS). Other associated users, such as the AFM amongst others, coordinate with the CPD in order to trigger the service. While such a satellite-based service might be considered as only marginally useful to small states such as Malta, a few application scenarios immediately come to mind.

Examples of emergencies related to naturally occurring disasters include incidents involving land subsidence or extensive flooding; tracking of volcanic ash plumes affecting

airline traffic, phytosanitary emergencies affecting agricultural goods or algae blooms affecting the local coastal and marine environment. Examples of man-made emergency situations relevant locally might include amongst others, maritime incidents resulting in oil spillage or other forms of sea pollution, which would link to services delivered through EMSA.

Figure 7: EMS Grading Map covering the June 2016 Forest Fires in Sicily



Source: (Copernicus EMS, European Commission, 2016)

Conclusion

Satellite technologies and particularly the services rendered through remote sensing, have reached fruition through the entire data cycle, from gathering to analysis to output, enabling the mitigation of physical and social parameters towards social wellbeing as well as safety and security. When integrated within governmental polices and services, such technologies help deliver smarter and more effective solutions, ultimately benefitting the economic, academic, social and public domains.

While certain satellite application areas in Malta are well established and regulated, it is recognised that the remote sensing sector harbours additional potential which is currently not appropriately exploited. The identification of utilization gaps is a necessary prerequisite to embarking on appropriate capacity building measures, which help enable a resourceful approach to tackling societal challenges. Additionally, tailored awareness raising campaigns are instrumental in enabling a mentality shift; a shift in the conceptualisation and implementation of the technologies, data and information within a knowledge and action scenario. The review provided in this chapter is a step in this direction.

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