IPSENTINEL

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Abstract

The Portuguese Directorate-General for Territory (DGT) and the Portuguese Institute of the Sea and Atmosphere (IPMA) carried out the assembly of a national platform designated as Portuguese Infrastructure for Sentinel data – IPSentinel. This project had the financial support of the European Economic Area Financial Mechanism (EEA Grants), operated by the Directorate-General for Marine Policy (DGPM), and the Portuguese Government.

IPSentinel corresponds to an integrated action of Portugal's active participation in the European Earth Observation Program - Copernicus. IPSentinel provides a simple, fast, free and systematic way of accessing the Sentinel satellite data for the Portuguese territory and for the search and rescue area in the Atlantic, under the responsibility of Portugal. It also provides a privileged access to Sentinel 1 data through the Santa Maria Collaborative Ground Station, located in the Autonomous Region of Azores.

IPsentinel has been operational since April 2017 and already has about 300 registered users. This fairly large number of users for the portuguese reality in such a short period of time is an indicator that the portuguese users find this platform very useful. The information provided by this infrastructure presents an enormous potential with regard to the creation of products and services for the portuguese territory.

Resumen

La Dirección General de Territorio (DGT) y el Instituto Portugués del Mar y la Atmósfera (IPMA) llevaron a cabo el montaje de una plataforma nacional designada como Infraestructura Portuguesa para los datos de Sentinel - IPSentinel. Este proyecto contó con el apoyo financiero del Mecanismo Financiero del Área Económica Europea (EEA Grants), operado por la Dirección General de Política Marina (DGPM), y el Gobierno portugués.

IPSentinel corresponde a una acción integrada de la participación activa de Portugal en el Programa Europeo de Observación de la Tierra - Copérnico. IPSentinel proporciona una forma simple, rápida, gratuita y sistemática de acceder a los datos satelitales Sentinel para el territorio portugués y para el área de búsqueda y rescate en el Atlántico, bajo la responsabilidad de Portugal. También proporciona un acceso privilegiado a los datos de Sentinel 1 a través de la Estación de Colaboración Santa María, ubicada en la Región Autónoma de Azores.

IPsentinel ha estado en funcionamiento desde abril de 2017 y ya cuenta con unos 300 usuarios registrados. Este número bastante grande de usuarios de la realidad portuguesa en tan poco tiempo es un indicador de que los usuarios portugueses encuentran esta plataforma muy útil. La información proporcionada por esta infraestructura presenta un enorme potencial en lo que respecta a la creación de productos y servicios para el territorio portugués.

Palabras clave: Sentinel, Portugal, Copernicus, earth observation, satellite images.

Keywords: Sentinel, Portugal, Copérnico, Observación de la Tierra, imágenes satelitales.

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1. INTRODUCTION

We can easily find good examples of the use of geographic information (GI) and how it enables more efficient and effective responses to the institutional decision-making process. However GI is not limited to provide support to decision makers, it also contributes decisively, directly and indirectly, to the growth of the economy. Today, GI technologies and systems evolve at a considerable pace, in particular in the area of the Earth Observation (EO) where satellites play an increasingly important role, as sources of quality and accurate information, allowing a growing range of applications. In line with this dynamic, the European Union (EU) has created the Copernicus Program (Regulation (EU) No377 / 2014 of the European Parliament and of the Council of 3 April 2014). This program, implemented by the EU together with the European Space Agency (ESA) and its Member States (MS), aims to observe and monitor the Earth in several areas (e.g. ocean, terrestrial and atmospheric environments, climate change, security and natural disasters) and aspires to ensure the availability of geographic information, with quality, accuracy and high level of updating, responding to ordinary and / or regular needs but also in emergency situations.

The Copernicus program organization is based on three distinct components: Space, InSitu and Services. Each one of these components plays a key role in the success of the program and involves significant investments. At this stage the Space Component is perhaps the most visible, by the development and launching of dedicated satellites which are carrying a variety of technologies, such as radar and multispectral sensors for monitoring earth, ocean and atmosphere - Sentinel missions (Caetano et al., 2014). The space component is being implemented by ESA and the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT). With the objective of promoting and disseminating the results of these missions, Sentinel has formed the Collaborative Ground Segment (CollGS), which includes several agents with particular emphasis on the various MS.

Figure 1. Area of information available at IPSentinel

The IPSentinel project and its outcome correspond to the implementation of the CollGS policies regarding the creation of national platforms that allow the storage and dissemination of data from the dedicated missions - National Mirrors. The platform IPSentinel results from the partnership between the Directorate-General for the Territory (DGT) and the Portuguese Institute for the Sea and the Atmosphere (IPMA). This project was funded by the EEA Grants program, operated by the Directorate-General for Marine Policy (DGPM), and by the National Government.

The data and information available at IPSentinel correspond to an area (Figure 1) that includes Portugal mainland, the Autonomous Regions, the Exclusive Economic Zone (EEZ) and the sea area defined as the search and rescue area in which Portugal has operational responsibilities. IPSentinel has privileged access to Sentinel 1 data since it has a direct connection to the Santa Maria Collaborative Ground Station, which is the first recipient of these data.

IPSentinel intends to make a responsible and decisive contribution to the dissemination and exploitation of Sentinel mission data, as well as to promote the use of derived products in the most varied areas of the EO, offering public and private entities the opportunity to take advantage of the technological innovations resulting from such missions.

2. FRAMEWORK

Copernicus is an European program for the Earth observation and monitoring, which follows the Global Monitoring for Environment and Security (GMES) program and it's based on a partnership established between the European Union (EU), ESA and the various Member States. Its main purpose is the acquisition, treatment and timely availability of accurate and reliable geospatial information. All this information supports a wide range of applications including environmental protection, urban management, regional and local planning, agriculture, forestry, fisheries, health, transport, climate change, sustainable development, civil protection and tourism, among others. It is intended to be an essential contribution to policy-makers and public authorities who will be able to support their strategic decisions in up-to-date and reference information (EU, Terms and Conditions for the Use and Distribution of Sentinel Data).

The Copernicus program integrates in its structure three essential components: Space, In Situ and Services. The Space Component has the purpose of collecting, pre-processing and distributing data obtained from remote sensors installed

Table 1. Sentinel constellations – Main features

Mission	Sensor	Applications
Sentinel-1	C-SAR sensor	Monitoring land and ocean
Sentinel-2	High Resolution Multispectral sensor	Monitoring land
Sentinel-3	Several sensors: • OLCI - Ocean and Land Colour Instrument • SLSTR - Sea and Land Surface Temperature Radiometer • SRAL - SAR Altimeter • MWR - Microwave Radiometer	Monitoring land and ocean
Sentinel-4	Ultra-violet Visible Near-infrared spectrometer – UVN (It will be placed aboard EUMETSAT satellites)	Atmospheric monitoring
Sentinel-5 e 5P	Troposphere Monitoring Instrument – TROPOMI (includes Ultraviolet Visible Near-infrared Shortwave Spectrometer – UVNS)	Atmospheric monitoring from polar orbit satellites
Sentinel-6/ Jason-CS	Several instruments: • Radar altimeter; • Microwave radiometer (AMR-C); • GNSS receiver; • DORIS receptor; • Laser Reflector Array; • Radio-Occultation Instrument	Monitoring ocean (mainly high precision topographic observations of the ocean surface)

in satellites. This component covers two types of missions: Dedicated Missions - satellites built and operated under Copernicus (Table 1); and Contributing Missions - satellites operated by National, European or International organizations who acquire relevant data for Copernicus Services.

The Space Component is complemented by the Collaborative Ground Segment (CollGS) that controls flight operations and data acquisition, archiving, processing and distribution. In this segment the MS have assumed an important role with the implementation of technological infrastructures, being IPSentinel one of these examples.

The *In Situ* Component has the purpose of collecting, pre-processing and distributing data obtained from *In Situ* infrastructures, the kind of information that can only be obtained nearer or at the exact place where the phenomena under analysis occur. The existing network includes data from: the European Network of Meteorological Services (EUMETNET); the European Association for the Global Observation System (EuroGOOS); the European Association of Cartographic Agencies and Cadastral Agencies (EuroGeographics); the European Association of Geological Surveys (EuroGeoSurveys) and the European Marine Observation and Data Network (EMODNET). This component also includes geographical reference information.

The services component will be the most visible component of the Copernicus program, fulfilling one of its main objectives: to provide services and information built upon EO and In Situ data in a timely and user-friendly manner for citizens and entities with responsibilities in the areas of resource management, security and civil protection.

All the Copernicus services and data are freely available for users.

3. OBJECTIVES

As mentioned before IPSentinel is the outcome of a joint venture of two portuguese national agencies, with responsibilities in defining strategic management policies for land and marine territory. The starting point of this project is based on the idea that the European investments on Earth Observation have to be potentiated and offered for all users.

The main purpose of the infrastructure is to provide a simple, fast, free and stable mode to access Sentinel images. As is, the ESA Scientific Data Hub is not providing the expected and necessary download performance to users. After the implementation of IPSentinel, the platform has been tested to evaluate its performance vs. the ESA Scientific Data Hub. In Figure 2 below, the graphics show the performance of the download of three different randomly chosen products between March and April 2017, the average download velocity for IPSentinel was 12,4 MB/s and 4,8 MB/s for the ESA Data Hub. Moreover, the steadiness of the streaming is also quite remarkable, which means that IPSentinel is providing a reliable service. This is also

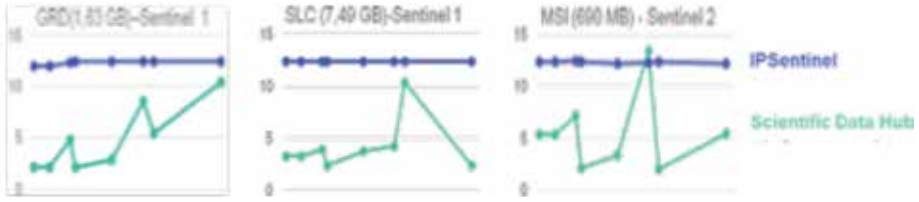

Figure 2. Testing performance IPSentinel vs. ESA Scientific Data Hub

the result of using the GÉANT network, since this infrastructure contributes decisively to the development of research and education.

Another huge advantage of IPSentinel is the direct connection to Santa Maria Collaborative Ground Station in Azores. Because of its geographical position this Ground Station has the possibility to access Sentinel 1 data in near real-time. That was also one of the main purposes of this project, to take benefit of this advantage which can be decisive in emergency scenarios.

4. ARCHITECTURE AND FUNCTIONALITIES

It's important to mention that this project was developed while the European Commission and ESA were still defining the strategy for the Ground Segment and in particular for the setting of national mirrors like IPSentinel. After contacting the ESA specialists and studying which would be the ideal software to operate this infrastructure, DGT and IPMA decided to adapt the software Data Hub Software (DHuS). DHuS is an open source software developed by the Serco-Gael consortium to support ESA Copernicus Data Access. It provides a simple web interface to allow interactive data search and download. This software also allows access to data through programs and scripts, therefore, automating the download within the users' workflow.

The adaption of the DHuS software and the IPSentinel platform design was made by the Portuguese company EDISOFT - Defence and Aerospace Technologies.

4.2. DHuS Software

- DHuS (Data Hub Software) is an open source software that provides users with access to an ESA Rolling Archive (RA) containing data from Sentinel Satellites, thus providing the dissemination of Earth Observation (EO) products.
- DHuS offers users, through a browser, access to a graphical interface (GUI) allowing navigation and exploitation of the available data. The software also allows the download of data not only through the GUI, but also through scripts, using for thiat purpose the access protocol OData[1] (Open Data Protocol).
- The software can run on a scalable framework. It can be installed either on a personal computer or on a server infrastructure. As a user, you will only need access to a browser.
- One of the most important features of DHuS is its ability to handle different formats for navigation of EO data contents. Given the heterogeneity of EO products, DHuS achieves a transparent management using an open-source application which allows you to read, write and process heterogeneous data - Data Request Broker (DRB).

More information in: https://sentineldatahub.github.io/DataHubSystem/

The DHuS host is on a 64-bit Linux machine in a multi-threaded environment and the virtualization environment used is the Red Hat Enterprise Virtualization (RHEV). The Hardware characteristics are:

- Number of CPUs: 16
- RAM: 16Gb
- Local Storage: 1Tb
- Storage Archive : 36 TB (estimated for 3 month storing)
- External Connectivity : 2 Gbps
- Internal bandwidth through storage : 4 Gbps

DHuS is a stand-alone product that is prepared to deploy middleware software packages. This is only dependent on the most current version of Java JDK certified. The Linux distribution installed is the CentOS version 7.

4.3. IPSentinel Architecture

- The conceived architecture takes into account the integration of DHuS software provided by ESA
- DHuS software is integrated in the section called IPSentinel Front-End Server
- The package provided by ESA consists on the DHuS application and a database.

4.4. Architecture Details

- **IPSentinel.pt:** Website with EO information, program: Copernicus in Portugal, Sentinel satellites, Sentinel products; case studies in the areas of EO, documentation,

[1]The Open Data Protocol (OData) allows the creation of REST-based services, which allows web clients, based on HTTP messages, to publish and consume resources identified on the basis of Uniform Resource Identifiers (URIs) and defined in a data model. The OData protocol allows easy access to the Data Hub and can be used to build URIs to perform search queries and product downloads, giving users the ability to remotely run scripts in batch mode. (Rosa, Joana, Manual de Utilizador, 2017)

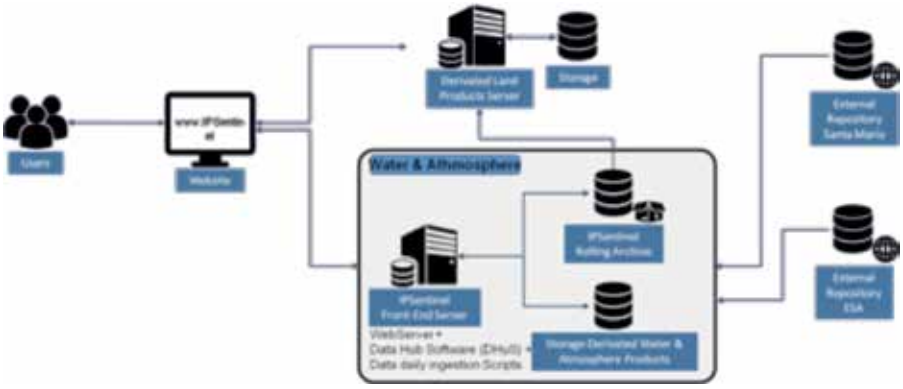

Figure 3. IPSentinel Architecture

information, etc. and working platform for the GIOT;

- **Front-End IPSentinel Front-End Server:** With the Web-Server function installed, the DHuS (Sentinel image storage / dissemination management software) application is responsible for the ingestion, in the IPSentinel Rolling Archive, of data from the ESA repository and the Santa Maria Station repository Sentinel satellites – so far it has only received information from Sentinel 1);
- **IPSentinel Rolling Archive:** Repository of images from the ESA and Santa Maria Station repositories; The stored products will be updated regularly (2 to 3 months);
- **Storage:** Repositories of derived products (sea, atmosphere and land)

4.5. Users Profile

The IPSentinel platform targets two user profiles:

- Specialist User:
  - Target Group: Research centers, universities, etc.
  - Data: Use of raw data, i.e. images without any processing.
- Normal User:
  - Target Group: End users, e.g. civil protection, firefighters, public institutions, etc.
  - Data: Use of products already processed.

4.6. Relational platform model

4.6.1. IPSentinel Users- Functions

Technical specifications

Figure 4. IPSentinel Architecture – Technical specifications

_ Platform User

- Search and Download - Registered user requesting download permissions from the administrator:
  - After registering on the portal the user will have access to search functions.
  - A user can download all pro ducts freely.
  - Functionalities
  - Register and Login
  - Product Research and Inspection
  - Basic and advanced search (e.g. search by date, by AOI, by satellite, etc.)
  - Product Inspection:
  - Product Quicklooks
  - Product information (satellite, date, etc.)
  - Save search
  - Product downloads
  - **_Administrator**
- All user and administration functions:
  - Has access to all the functionalities of the platform for routine and administration operations:
  - **Management of user and data access rights:** create, validate, modify, delete and allow access to products.
  - **Catalog management:** create, modify and delete catalogs, insert or remove products.
  - **File management:** manage file, disk space, set data storage margin (data ingestion <= 2 months).
  - **System Monitoring:** monitoring machines (CPUs, memory, etc); IPSentinel usage statistics.
  - **Database management:** start / stop, database maintenance (backups, restore, etc)
  - **Network management:** remotely manage IPSentinel framework connections

4.7. Network and Security

- A new network structure was developed, based on the OSI model, and mechanisms have been adopted which guarantee the security of the client-server connection and the data transmission.
- The installation and configuration of the firewall guarantees the security of the databases and the connections between the different machines.
- As far as communication protocols are concerned, they ensure authentication, privacy and integrity in exchanging information

(e.g. HTTPS).
- Data transfer protocols meet the above criteria (privacy and integrity) and ensure an average SFTP transfer rate for a 100MB 6 / 9MB connection and a 1GB 40MB connection.
- The maximum number of simultaneous downloads per user is 2 products.

4.8. Backup and System Integrity Policy

- Periodic copies of the database (database dump)
- IPSentinel Server has a backup system of the most important files on the machine, thus ensuring that the system can be rolled back to a state before the occurrence of a problem.
- A High Availability system is implemented that ensures uninterrupted portal availability.

5. SDI INTERACTION

Since the beginning of the project it became very clear that it is fundamental to provide access not only to the Sentinel images but also to derivate products and services somehow related to these images. In Portugal there are several Spatial Data Infrastructures (SDI), the National Spatial Data infrastructure – Sistema Nacional de Informação Geográfica (SNIG) and some thematic Spatial Data Infrastructures like SNIMar, specific for the maritime information, or SNIAmb for environmental data.

IPSentinel has already integrated SNIG, SNIAmb and, in a near future, SNIMar catalogue will be also integrated. The catalogues of these infrastructures, which are based in Open Geospatial Consortium (OGC) Catalogue Service for the Web (CSW), are adapted into the format expected by the DHuS component by the interface ETL (Extract, Transform, Load). This interface was integrated in the DHuS software and converts the OGC CSW search results into OData results. Therefore, the external interface is the same as OData. This is a straightforward approach that allows users to perform their search in the IPSentinel environment and get the results from the IPSentinel catalogue, from external catalogues or both.

6. STATISTICAL DATA

IPSentinel is fully operational since April 2017. In the present the storage provides 35 TB which means that is possible to keep about 1 month and 15 days of products available for download. In that period the most space consuming images are Sentinel 1, corresponding to about 67 % the storage capacity and the lower consumer is Sentinel 2 with 5 %. The number of products available is mostly from Sentinel 3 with 52 % while Sentinel 2 only provides about 14 %. These numbers are detailed in Figure 5.

When registering in IPSentinel some information are requested like the domain area of interest and the area of usage of the images, this information intends to permit a better understanding of the user profile. Since April to November 2017 the number of users has been increasing. The next tables and charts demonstrate the user profiles and the use of data of IPSentinel.

These data show that most of the users come from the

Satellite	Data volume		Products	
	TB	%	Units	%
S1	19,3	67,01%	7325	33,28%
S2	1,4	4,86%	3166	14,39%
S3	8,1	28,13%	11517	52,33%
All	28,8	100,00%	22008	100,00%

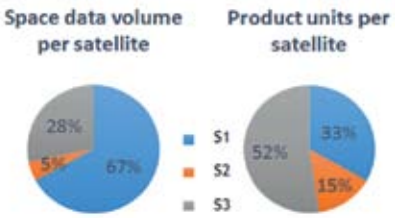

Figure 5. Data volume and number of products available

Domain area	Registered users	
	Number	%
Atmosphere	18	6,08%
Climate	10	3,38%
Emergency	20	6,76%
Land	168	56,76%
Marine	26	8,78%
Other	43	14,53%
Security	11	3,71%
Total	296	100,00%

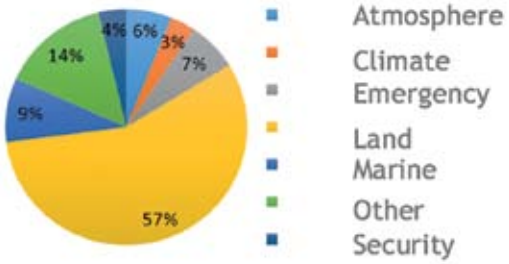

Figure 6. Users by domain area

Products usage	Registered users	
	Number	%
Commercial	15	5,07%
Education	42	14,19%
Other	58	19,59%
Research	181	61,15%
Total	296	100,00%

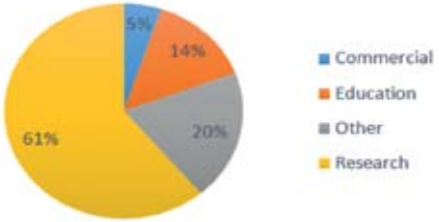

Figure 7. Users by product usage

Product usage	Data volume		Downloads	
	GB	%	Units	%
Research	319,64	58,67%	316	55,05%
Commercial	41,43	7,60%	41	7,14%
Education	50,40	9,25%	67	11,67%
Other	133,34	24,48%	150	26,14%
Total usage	**544,81**	**100,00%**	**574**	**100,00%**

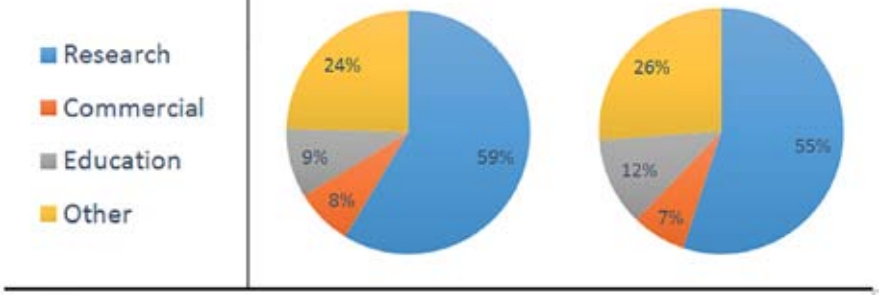

Figure 8. Amount and volume of downloads by user area

research area and the thematic area is mostly from Land products users.

In the last six months the downloaded data also points out research area users as the most active and with greater amount of downloaded data.

Also interesting to see is the download by satellite. In this item Sentinel 2 is way ahead with 69 % of the total downloads while Sentinel 3 only represents 3 %.

These figures show that the infrastructure is being largely used by the community and the feedback from the users has been also very positive. This is an encouragement to keep up with the service and explore its potential in the future.

7. CONCLUSIONS

The use of satellite images in Portugal still doesn't occur systematically and they are mainly used by some specialists in their areas of expertise. The potential of satellite imagery, although recognized by many, is not yet conveniently explored and needs to be expanded and diversified.

The IPSentinel infrastructure will allow a simple access to the Sentinel satellite images for the Portuguese users. This infrastructure will act also as a platform to promote the use of Sentinel satellite images in Portugal by creating conditions for the Portuguese users to explore the enormous possibilities provided by these images. Considering that Sentinel satellites provide images every 5 -6 days, it is expected that in the future web services will emerge and it will be possible to take advantage of this vast potential. Sentinel satellites will allow all the users to be aware, almost in real time, of all the changes that occur in the territory.

The IPSentinel infrastructure is also a good example of institutional collaboration in the Portuguese public administration. The successful cooperation established between the Directorate-General for the Territory and the Portuguese Institute for Sea and Atmosphere in this project hopefully can be extended to other projects in the future.

The challenges of IPSentinel for the near future are its maintenance and performance, the products of the new Sentinels to be launched (4, 5 and 6), the archive dimension, the products to keep and the expected evolution to a scenery where this infrastructure will allow processing through pre-referenced or custom made algorithms. IPSentinel's growth depends on a positive response to these challenges.

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Table 2. Data volume and downloads by domain area

Product domain	Data volume		Downloads	
	GB	%	Units	%
Atmosphere	37,80	6,94 %	23	4,01 %
Emergency	20,72	3,80 %	26	4,53 %
Marine	22,85	4,19 %	39	6,79 %
Land	302,95	55,61 %	318	55,40 %
Security	32,59	5,98 %	33	5,75 %
Climate	2,67	0,49 %	7	1,22 %
Other	125,23	22,99 %	128	22,00 %
Total domain	**544,81**	**100,00 %**	**574**	**100,00 %**

	GB	GB%	Units	%
S1A + S1B	266,52	48,92%	162	28,19%
S2A	270,44	49,64%	397	69,15%
S3A	7,85	1,44%	15	2,66%
Total	**544,81**	**100,00%**	**574**	**100,00%**

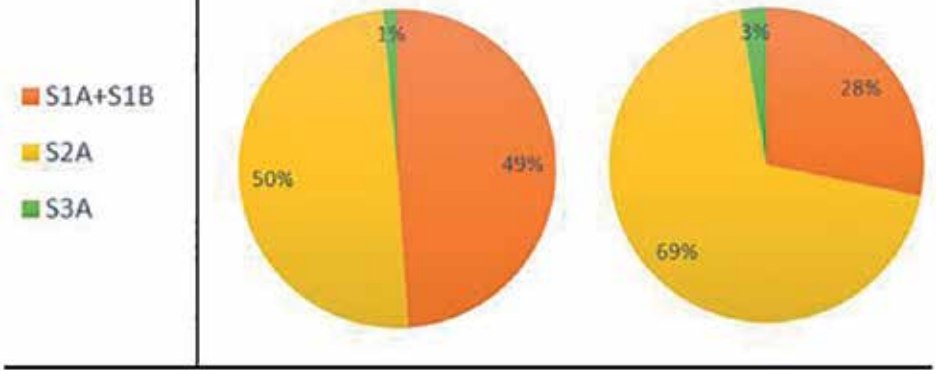

Figure 9. Data volume and downloads by satellite

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He spent two years working has a Programmer/Analyst on the private sector doing essentially analysis and development of systems in the area of banking and insurance. After that, from 2002 to 2010, he worked has an inspector for the Inspeção-Geral de Finanças (IGF). Thereafter, from 2010 to 2012, he worked has the Coordinator of the Informatics, Communications and Equipment Division (DICE) in the Meteorological Institute doing, essentially, Information Systems Management and being responsible for: IM for the European Centre for Medium - Range Weather Forecasts (ECMWF); IM interlocutor for the Information and Communication Technologies Project Group (GPTIC); Local IM Power Management.
Currently, he occupies the position of Head of Division of Information Systems, Communications and Technological Development (DivSI) in IPMA (Portuguese Institute of the Sea and Atmosphere) where his responsibilities are: IPMA Computing Representative for the European Centre for Medium - Range

Weather Forecasts (ECMWF); IPMA representative in WMO working groups; IPMA Interlocutor for the Group of Project for Information and Communication Technologies (GPTIC).

Marco Silva

He is graduated in Computer Science w/ Business Management by European University, Marco Silva worked from 1991 to 1996, in several different businesses, on the private sector. In 1996 Marco Silva started working in the public health sector has an IT Technician. The work consisted mainly in supporting UNIX/LINUX, WIN NT/Server and systems and programming in health management applications.

Since 2001 he has been working for IPMA (Portuguese Institute of the Sea and Atmosphere) at the National Meteorological Service, in the first four years has an IT Technician and after that has an IT Specialist. During the first four years he supported UNIX/LINUX, WIN NT/Server and VAX/VMS Systems in 24/7 Schedule. Thereafter, and currently, his work consists in: Implement and supporting critical computing environments with Virtualization, Storage; Backups; Network and other IT technologies in Windows, Linux and Unix environments; Orientation of research scholarships in projects; IT Support and training monitor; IT Contracting (Human Resources and Technology); Support for ISO certification.

Cristina Pimentel

She is graduated in Applied Mathematics (2000) by Évora University with master's degree in Mathematics and Applications - Numerical analyses (2006) acquired in Instituto Superior Técnico of Lisbon University.

From 2002 to 2012 she worked for Higher School of Technology and Management in Beja and for Portugal Higher education institutions of Engineering, Science and Technology teaching mathematics subjects and doing the preparation of disciplinary programs. Later she was granted a Science and Technology Management Grant (BGCT), within the framework of the project "Creating a Portuguese infrastructure for storing and disseminating Sentinel data (IP Sentinel) ". Project Management, Storage and Databases - Big Data in which she worked from June 2016 to April 2017.

Currently Cristina Pimentel is working for IPMA (Portuguese Institute of the Sea and Atmosphere) doing consulting and development of ITIL (Information Technology Infrastructure Library) and respective integration with the Institute systems.

Pedro Benevides

He completed his degree in Geographic Engineering from the University of Lisbon in 2009. He completed his Ph.D in Geophysics and Geoinformation in the same institute in 2016. He has been a research fellow in several projects, also associated with different institutions: Técnico IST, Laboratório Nacional de Engenharia Civil (LNEC), Agronomia ISA, Direção-Geral do Território (DGT) and Instituto Dom Luiz (IDL). Some domains of his work include topics like remote sensing of land deformation with radar data (interferometry), remote sensing of terrain data combined with land use maps and geo-statistical analysis, hydrodymanics modeling data, large scale land use inventory mapping and reclassification, tropospheric water vapor studies and rainfall applications by means of GNSS data, 3D tomography modeling of the troposphere with auxiliary meteorological and remote sensing datasets, Sentinel-2 semi-automatic mosaicking and other GIS and computer programming applications.

Inês Girão

He is graduated in Geography (2013) with a master's degree in Geographic Information Systems (2015) acquired in Institute of Geography and Territorial Planning of Lisbon University.

The master's thesis, in Remote Sensing, was developed under a scientific research grant (PERMANTAR-3) between 2014 and 2015. In addition to developing the thesis under this grant, she also participated in an Antarctic campaign and in several field trips.

Later she worked as GIS Analyst at the Center for Geographical Studies in the NoVOID project where she consolidated her skills in image interpretation, data processing and spatial modeling.

Currently she is working has a research fellow at the Directorate-General for Territory (DGT) in the IPSentinel project.

Mário Caetano

He is a principal investigator of Directorate-General of Territorial Development (DGT) and since October 2014 he is the Deputy Director-General of DGT with responsibilities on geographic information, remote sensing and the national spatial data infrastructure. Since 2000 he is an Associate Professor at Information Management School from the New University of Lisboa (NOVA IMS).

Mário Caetano has a degree in Forest Engineering from the Lisboa University of Technology (1989), a MSc in Geography from the University of California, Santa Barbara (1995), a Ph.D. in Forestry (2000) from the Lisboa University of Technology, and a Habilitation in Information Management from ISEGI-NOVA (2013). Research interests include information systems and management, spatial analysis and the use of remote sensing data for land cover land use (LCLU) characterisation and environment monitoring. He is the author of more than 150 publications in books, journals and conference proceedings.