A Taxonomy for the EO Services Market:
enhancing the perception and performance of the EO service industry

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TABLES

1 INTRODUCTION

Recent work has shown the need to establish a new taxonomy for the EO services market. A clear and common description of EO products and services will help suppliers and customers arrive at a common understanding of what can be offered. By proposing a common language, the taxonomy should also provide a translation between the world of EO services and the world(s) of their customers.

Originally used as a term to mean a classification of biological species, a taxonomy is now taken to be a classification of any group of objects. In this paper we are seeking to define a structure with which to understand better and to assess the market for EO geo-information services. The aim is to present and explain the rationale for the EO taxonomy that is proposed and to address the common products and services from two perspectives:

- A market segmentation will provide a tool to help classify and understand the markets for EO services as well as to define the type of customer.

- A thematic segmentation provides a tool to help describe and classify the products that are offered by the service providers.

Two specific projects being carried out by EARSC require a taxonomy:

- Eopages which is a brokerage site for customers to find suitable EO services
- A survey of the EO services industry in which we shall seek to understand the markets in which EO companies are doing business.

In both cases, where we are dealing with many companies all offering EO services, it will be important to address each one with the same name for a service in order that we have a basis for comparison or, for eopages, clients are not bewildered by a variety of names for services offering essentially the same products. Since both projects should be completed in 2012, we need as a first step to define the common language – the EO market taxonomy.

It is also important to note that this is not a final product and should continuously evolve – in the detail. Whilst we hope that the structure will prove sufficiently robust to accommodate all future market segments and thematic topics, the segments and topics will change and should be added; as indeed will the specific examples given in each category. In addition, many of the category assignments are subjective and in compiling this document, various reviewers have pointed to cases where their view has differed. We can cite as an example the market super-category “managed living resources” which at first we called managed resources only for reviewers to question why this does not include the oil and gas sector.

Another factor in proposing a taxonomy is the use of language. We are working in English and the very words used may be recognised differently to non-native English speakers. Perhaps the easiest and most well-known example here could be “security” which means safety as well as security in French and many other languages. Similarly cultural differences can alter the understanding. For example the question of electricity generation and transmission could be recognised as an industry or as a service (we choose industry because we include it with other utilities – but this is also a term open to interpretation!).

So we can only apologise to those who find that they disagree with our views. We are quite ready to listen to alternative proposals and to keep this document live; but at the same time its strength will be in its robustness and hence ability to accommodate new terms, market sectors, EO services etc without fundamental change.

We shall review this periodically and invite comment and suggestions as to improvements.

2 APPROACH

A quick review shows that there are many, different taxonomies in use and no standard exists today. Here we shall take a look at the different options available, at the needs for a new taxonomy and propose a solution that we shall use for the two projects in 2012.

Of the various taxonomies that exist some are organised around customers and markets and some products and services. Each is useful and our goal is to provide a single unified structure with a mapping across to switch between the two. Since earlier studies have been conducted using one or more of these taxonomies, it is also important that we can track or measure the changes between them. This is to allow comparisons to be made in the evolution of the market.

The European programme for GMES is also an important element that will influence the future market for EO services. A number (6) services have already been defined each of which offers a number of products. Therefore, an EO market taxonomy must be able to accommodate the structure within GMES. Nevertheless, GMES is dealing primarily with public sector information needs and hence a workable taxonomy must go beyond GMES since many other elements of the market are not addressed. Therefore we propose to start from the wide view and back-check to see that the result is consistent with GMES.

Since our main goal is to classify and structure the market for EO services, our first constraint will be to provide as much continuity from previous surveys. This should allow the best comparison between surveys at different dates and hence to understand the change in the market. Our second constraint will be to provide a classification within which GMES and other key programmes can fit. We do not expect to find a perfect solution but will try to find the best possible (in our opinion).

We wish to look at the EO services from both the markets they serve and the thematic areas they represent. We would also like to be able to match the two since both use different terminologies. In generating the taxonomy we have tried to recognise the difference between a client facing description of the service and a supplier facing description. As we progress, the terms have become closer and closer and in the end we may find that a single description of the service will serve both sides (client and supplier). This would be preferable but in the tables given, both columns still exist. Hence.

- The market view will structure the market for EO services from a customer perspective. It should there be based on a customer segmentation including industry public organisations etc. Along with the segments, we shall identify the types of organisation that fit into each one. This will help guide users in deciding which segment applies to them. Examples of a market view are; Oil & Gas, Utilities, Local and Regional Planners.

- The thematic view will seek to gather the services into groups that represent different thematic areas. This is more difficult than the market view as there are in fact many more possibilities. Examples of a thematic view are; disasters and conflicts, environmental impact assessments, meteorology.

- The two views are linked with the products and services on offer. Even here though there is a difference in terminology between a market facing and a thematic facing organisation. This we represent with a different name for the need or the service. Whilst it would be possible to have one need met with more than one product/service, we have chosen to attempt to maintain a one to one relationship between them.

We realise that even here some standardisation will help. Therefore we have introduced a standard set of verbs to describe the need of the user (and eventually the service on offer. Five verbs have been chosen; assess, detect, forecast, map, monitor. Other possibilities, i.e. evaluate, predict, track etc are considered synonymous or very closely so with the 5 verbs chosen. The table below shows our arguments.

Taxonomy Verb	Alternatives / Equivalents / Synonyms
Monitor	Track, observe, record, follow, understand
Map	Locate, identify, classify, trace, record
Forecast	Predict, plan, model, estimate, project
Assess	Evaluate, measure, understand, review, quantify
Detect	Locate, warn, identify, highlight, spot

Tabla 1: Standard set of verbs and equivalents proposed.

Services will apply to more than one market segment. In the thematic view, each service has a unique name and is specific to the thematic área. If the same service is then used in two different market segments, the same name is used to avoid confusión.

As far as we are aware, this is a unique approach. Many existing structures have been studied and elements introduced where appropriate. We have already explained how we wish to be traceable between previous surveys and hence the CEOS structure and the Vega structure are the most used. For completeness, the table below shows the various previous examples of taxonomies of which we are aware.

Source	Reference	Description
Booz & Co	http://ec.europa.eu/enterprise/policies/space/files/gmes/studies/ec_gmes_cba_final_en.pdf	Used in the Report on Cost-Benefit Analysis for GMES, Booz&Co
CEOS	www.ceos.org	Nomenclature used by the Committee on Earth Observation Satellites
CEOS-ESA	ceos.esrin.esa.int	CEOS Dossier
ESA/DUP	due.esrin.esa.int	Terminology used at the ESA data user element programme
GEOSS	www.earthobservations.org	Nomenclature used by the Group of Earth Observations and Global Earth Observation System of Systems (GEOSS)
GMES	www.gmes.info	Terminology used at the Official GMES website
GMES ontology	http://gmesdata.esa.int/OTE/navigateInfoDomain	GMES space component data access
UN-Spider	www.un-spider.org	Terminology used at "United Nations Platform for Space-based Information for Disaster Management and Emergency Response"
Vega at ESA.EOMD	www.eomd.esa.int	Used in the reference market surveys of 2004 and 2008. Includes both Market and Thematic taxonomies.
Wikipedia	http://en.wikipedia.org/wiki/Environmental_impact_assessment	Environmental Impact Assessment

Tabla 2: Taxonomies identified. More extends links are provided at bibliography.

3 MARKET TAXONOMY

A full list of previous surveys and indeed of taxonomies is given in the annex (Bibliography). The most prominent and the most quoted is that from Vega / Booz in 2004, repeated in 2008 and also picked up by Ecorys in 2011. The second reference that is widely used is the classification made by CEOS. These are the two strongest influences on our proposal.

Both a market view and a thematic view are used extensively in the Vega survey and are then reused in subsequent studies ie Ecorys (2011). We should like to be able to compare new survey results with those taken previously which means a minimum change or at least an understandable mapping from the old taxonomy to the new one.

The two are compared in Annex 2. Note a key difference is the structuring by CEOS into what we have called super-categories. We like this approach that could be helpful when drawing up comparisons of markets, since the numbers become limited and more manageable ie 6 super-categories and 22 market categories. However, we do make some changes.

Comments and comparisons of the two taxonomies leading to the EARSC proposal:

- The CEOS approach has a few more sub-topics (27 including "other" against 23) but is structured to a higher level of aggregation (ie the super-categories) than the Vega structure. This helps when performing a market survey.
- The CEOS market category "other" should not exist and all customers should be able to find their place in the final structure.
- CEOS includes market categories for local and regional, public national, public operational under the super-category. We prefer to focus here on functions rather than different market levels which we feel are an artificial distinction. Therefore we have included the emergency services, the defence and security function as well as maintaining education and research.
- Under the international section, CEOS includes the European Commission, which we do not consider as a market. The EC does use or promote the use of EO services but these come under different policy areas and we prefer to recognise these separately ie agriculture since there is no real difference between national and European activities.

As a result, the super-categories we have used are:

1. **Managed living resources** rather than "agriculture, forest and fisheries", to indicate where mankind is exploiting natural organic resources ie farming in the very general sense. However, farming would be too open to misinterpretation and we need a description to distinguish from "energy and mineral resources" which concerns extractive industries.
2. **Energy and natural resources** which applies to the extractive industries. We do not use the latter term as we include alternative energy in this super-category.
3. **Industrial** which is applied to all manufacturing and physical supply including the utilities. Whilst electricity can be considered as energy and water could be taken as a natural resource, the activity of enerprises is largely an industrial one and allows us to more easily include waste. The market category "communications" is included under industry since the applications coming from EO services are mainly tied to the infrastructure side and not the services part of communications. The supply of content (using telecoms) is included under "news and media" in the services super-category.
4. **Services** is a broad area of activity that touches on many other market sectors. The categories we have included are quite readily identifiable as a service and not part of the physical supply of goods. Compared to CEOS we have taken out the market category of software since we find this too broad and confusing. Any games or other entertainment software where EO service may be used can be included under media. We include supply logistics under retail. Strictly, this will not cover all logistics activities e.g. supply chain management but in the absence of evidence that this is a significant market sector in its own

right (for EO services) we believe it does not merit a separate category. This may be open to review in the future.

5. **Public authorities** is a term that is widely recognised and we feel is sufficiently important to the EO services industry that it should be retained. However, we choose to recognise that many of the functions may be outsourced and hence commercial activities associated with (say) town planning and architecture are included in this market category. Security is a new(ish) topic that is missing and will added to give "defence and security".
6. **International bodies** is a super-category that covers activities that are associated largely with international treaties and hence there is strong international collaboration. We distinguish from regional co-operation as might be the case in the European Union where in fact most actions are national in nature – hence come under public authorities. This means that environment and climate come under this super-category as well as humanitarian and development actions. We recognise that many of the activities covered under this category are also of interest to private organisations. We believe that these should be included elsewhere through the detailed level of the services offered. Hence in our terminology, international bodies is a market area where sales are to the international bodies directly e.g. UN or the network of supporting organisations e.g. NGO's or climate consultancy.

GMES (Global Monitoring for Environment and Security)

As mentioned before, GMES is a key programme in Europe and we should ensure that the GMES Services can be found a place within the taxonomy. Following literature **GMES** will provide three main categories of services:

- **Mapping,** including topography or road maps, land-use and harvest, forestry monitoring, mineral and water resources, contributing to short and long-term management of territories and natural resources. This service generally requires exhaustive coverage of the Earth surface, archiving and periodic updating of data.

- **Forecasting,** covering marine zones, air quality or crop yields. This service systematically provides data on extended areas permitting the prediction of short, medium or long-term events, including their modelling and evolution.

- **Support:** Emergency GMES management also is involved in supporting services, which are concentrated on the provision of data before implementing further services.

The first two types of service are fully recognised in the taxonomy and in the verbs we use to describe the EO services. However, "support" is a very general term that could be applied to almost any topic and we prefer not to use this term.

A full list of the GMES Services is given below. Taken from the GMES web-site each service is described in the following way:

- The GMES **Land Monitoring** service provides accurate and cross-border harmonised geo-information at global to local scales…. geographical information on land cover including its seasonal and annual changes and monitors variables such as the vegetation state or the water cycle. It has a wide range of applications for use in land use / land cover change, soil sealing, water quality and availability, spatial planning, forest monitoring and global food security.
- The GMES **Marine Environment Monitoring** service provides regular and systematic reference information on the state of the oceans and regional seas. It addresses four main domains; Marine safety (e.g. marine operations, oil spill combat, ship routing, defense, search & rescue, ...), Marine resources (e.g. fish stock management, ...), Marine and coastal environment (e.g. water quality, pollution, coastal activities, ...), Climate and seasonal forecasting (e.g. climate monitoring, ice survey, seasonal forecasting, ...).

- The GMES **Atmosphere Monitoring** service provides data records on atmospheric composition for recent years, current data for monitoring present conditions and forecasting the distribution of key constituents for a few days ahead. The service addresses the following; Greenhouse gases, Reactive gases, which influence the air we breathe, Ozone layer and solar UV radiation, Aerosols, which affect temperature, air quality and the transmission of solar radiation.
- The GMES **Emergency Management** service addresses, with a worldwide coverage, a wide range of emergency situations resulting from natural or man-made disasters. It covers in particular; Floods, Forest fires, Landslides, Earthquakes and volcanic eruptions, Humanitarian crises.
- The GMES **Climate Change** service closely monitors each of the Earth's different subsystems and help to better monitor and understand climate change; The GMES Atmosphere Monitoring Service monitors, forecasts and provides data – and historical data for comparison - about greenhouse gases and aerosol concentrations, The GMES Marine Environment Monitoring Service continually observes and monitors the physical state of oceans - and how they store carbon and transport heat from one region of the world to another, The GMES Land Monitoring Service helps to quantify terrestrial sinks and sources of carbon by providing data on the vegetation state and carbon fluxes.
- The GMES services for **Security Applications** aim at supporting the related European Union policies in the following priority areas; Border surveillance, Maritime surveillance, Support to EU External Action.

From this we can see that the Climate Change service is essentially drawn from a combination of other services and the security service is also quite dependent on others. In our thematic taxonomy, we have chosen to place the climate change thematic with the atmosphere thematic but to maintain “security” as a separate thematic. In this way the mapping of the GMES thematic services maps quite well into the thematic taxonomy selected by EARSC.

4 THEMATIC TAXONOMY

It seems that a thematic taxonomy is even more complicated than one which is market focused! Whilst it was not the first goal of this work, we find it is useful to complete, since it will allow us to group the products being offered by suppliers and to get a better understanding of where their focus lies.

One approach would be to be technology oriented. This would split products up into categories such as maps, models, analyses, change detection, interferometry and so on. Whilst this may be meaningful to experts within the industry, we do not find it useful to explain to those outside and especially to policy makers what it is that we do.

We could also categorise by type of activity for which the observations are being made ie, risk assessment, forecasting, responding, monitoring, detecting etc. This again would not be very familiar to non-experts although it would be more comprehensible to policy makers. It could also serve a distinction between the timeliness of observations but in the end we prefer not to use this categorisation.

Our preferred approach is to focus on thematic areas where we are more concerned with the underlying physical measurement than the techniques that are used to extract information or to represent it. As a result we come to represent the products the industry provides by their major application area, and we end up with 6 super-thematics as shown in the table and explained below.

- Land. This covers all applications that are focused on natural land areas even if it involves human intervention.
- Built environment and human factors. The built environment includes all urban and infrastructure related applications. It also includes political boundaries such as borders. We have added human factors to cover applications that are otherwise difficult to place such as those for population migration and humanitarian oriented.
- Marine and Ocean. This includes all maritime focused applications whether natural or human oriented. The question always arises as to where to place ports and harbours. The distinction however is made through the thematic since if it is watery then it is in this category whilst if it is on land then it comes under infrastructure.
- Atmosphere and climate change. As stated above we have chosen to combine these but accept the possibility to separate if necessary. Many of the land based observations will also fall under the land category.
- Geohazards / Disasters. This category is distinct from others in that it relates to observations linked to natural risks.
- Security. This deserves a category in its own right since the nature of observations is quite different from many others. They are distinctive in terms of being fine scale (high resolution) and often with high sensitivity.

It turns out that these 6 thematic areas are not so far from the GMES services and this gives some reassurance that the result is reasonable to use. The main differences are the combination of atmosphere and climate change and the split of land into natural areas and the built environment. We find the latter more useful whilst atmosphere may be separated from climate change if it is felt necessary. From our (industry) perspective we feel it is not.

We introduce the thematic area linked to the built environment as the thematic needs are quite different to those for land applications in general.

In order to allow some traceability from previous classifications, and particularly for the industry survey, we have made a cross check between the previous Vega/Booz/Ecorys structure and that proposed. This cross mapping will allow some comparison between new and previous results.

5 CONCLUSIONS

A new or rather updated EO service taxonomy is presented. This covers both the market and the thematic perspectives as well as making links between them by definitions of types of services. The results are not complete in that more services can and will be added. Nevertheless, the structure should be sufficiently robust that any new service can find its place within the taxonomy.

We explained in the introduction some of the factors that make a taxonomy difficult to define and always open to criticism (not meant to be negative) and interpretation e.g. language, culture etc. This will always be true and no one "true" result can or ever will exist. Nevertheless, the structure and words defined here will be used by EARSC for our future activities and we hope that others will find it useful also.

A final word about other possible dimensions to a breakdown of markets and services. EO services may be classified by their scale of operation; local, regional, global, by their timeliness of the need; real-time etc, or by the regularity of observations; daily, monthly, annually etc. We believe that these could be further developed and described but are indeed mainly a parameter associated with each service with many values being attributable to each variable (for example crop monitoring could be daily, monthly, annually depending on the user and his precise need). These parameters provide alternative degrees by which the services may be organised and categorised and we leave it to others to tackle this work if there is interest to so organise the EO services being offered.

ANNEX 1: DEFINITIONS

A **taxonomy** describes a classification structure for content or other information according to a pre-determined system. Taxonomies are frequently hierarchical in structure in order to permit us to understand the relationships among entities and between entities and proprieties which are responsible for their character in the real word. However taxonomy may also refer to relationship schemes other than hierarchies, such as network structures.
The taxonomy requires a method to be used to categorize operations and collection of operations.

Ontologies indicate the hierarchies and relationships that exist between different resources within a specific domain. We have decided to represent our earth observation services with ontologies. An ontology is a schema that formally defines the hierarchies and relationships between different resources while taxonomy will be a system of classification.

Services: The special nature of EO services is their compose ability. This characteristic allows the composition of service chains that tackle the necessity of solving complex business procedures supported by technological platforms.

The service trading involves two roles:
- the service requester who is the interested user in receiving the candidate services' profiles and the product of the selected service;
- and the service provider, which is the direct responsible of executing the offered and selected service.

VERBS	
Analyse	to study or examine something in detail, in order to discover more about it
Assess	to judge or decide the amount, value, quality or importance of something
Design	plan
Detect	to notice something that is partly hidden or not clear, or to discover something, especially using a special method
Evaluate	to judge or calculate the quality, importance, amount or value of something. To characterize and appraise using criteria
Forecast	to provide statements covering a range of different outcomes, to say what you expect to happen in the future
Locate	to situate
Map	to represent an area of land in the form of a map
Measure	to discover the exact size or amount of something, or to be of a particular size
Monitor	to watch and check a situation carefully for a period of time in order to discover something about it
Plan	to think about and decide what you are going to do or how you are going to do something to intend to do something or that an event or result should happen
Predict	to say that an event or action will happen in the future, especially as a result of knowledge or experience, it provides statements that some outcome is expected
Track	to move/follow, to record the progress or development of something over a period
Observe	to watch carefully the way something happens or the way someone does something, especially in order to learn more about it

Tabla 3: Verbs definitions following Cambridge online .

ANNEX 2: COMPARISON OF CEOS AND VEGA MARKET TAXONOMIES

CEOS	Vega (markets)
Agriculture, Fisheries & Forests	Defence & Law Enforcement
Agriculture	Oil, gas & mining
Fishing	Environmental protection & pollution
Forestry	Science & technology
Energy & natural Resources	Agriculture
Oil and gas	Forestry
Alternative Energy	Regional Planning & Urban management
Minerals / Mining	Water Resources
Water	Emergency & Civil security
Infrastructure, Transport, Communications	Telecomms
Construction	Fisheries
Transportation	Marine Eng. & Offshore operations
Shipping	Utilities & Infrastructure
Navigation	Construction & Civil engineering
Telecomms	Meteorology & Climate
Services	Transport
Insurance	News, media & Education
Real-estate	Geomarkeing & retail
news/media	Travel, leisure, tourism
software	Public Health
travel. Tourism, leisure, retail	Insurance & Finance
Public / government	Real Estate
local & regional	Legal & Forensic
Public national	
Public operational (emergency services)	
Education, training, research	
Defence	
International and Intergovernmental	
European Commission	
Intergovernmental bodies	
NGO's	
Meteorological	
Other	

Tabla 4: Comparison CEOS and VEGA taxonomies.

ANNEX 3: EARSC MARKET TAXONOMY

Group	Sector	Composition (Industry Examples)
Managed Living Resources		
	Agriculture	Agricultural commodities/Trading, agricultural production / Horticulture, Agricultural services, Agriculture machinery, Agriculture and Rural Development Policy, Agro chemicals / Plants & Fertilizers, Animal production / Livestock, Agriculture and rural Policy makers.
	Forestry	Forest management, Forest Services, Commodities, Logging industry, Wood, paper and pulp industry, Forest policy, Forest machinery, Forest Policy makers.
	Fisheries	Fish stock management, Fishing fleets, Fishery distribution logistics, Aquaculture / fish farms, Coastal management agencies, Fisheries authorities / policy makers.
Energy and Natural Resources		
	Oil and Gas	Offshore exploration and production, on-shore exploration and production, drilling and support services, oil and gas commodities trading, Energy planners.
	Alternative Energy	Solar energy providers, Wind energy providers, Tidal energy providers, Energy and Carbon traders, Local and regional planners, National policy makers.
	Minerals and Mining	Mining and quarrying companies, Exploration and survey specialists, Commodities traders, Exploration and extraction equipment suppliers, Drilling, excavation and support services, Regional planners / policy makers.
Industry		
	Utilities (water, electricity, waste)	Power station operators, Water plants operators, Survey companies, Hydroelectric suppliers, Regulatory Bodies, Distribution companies, Landfill and waste, Regional planners / policy makers.
	Construction	Construction companies, Civil engineering consultancies, Architect and design companies, Planning authorities, National land agencies.
	Transportation	Road transport operators, haulage, Road infrastructure operators, tolls etc, Airport operators, Rail operators, Airlines and airline services, Transport engineers.
	Maritime	Ports & harbours administration, bulk cargo carriers, Cruise liners operators, Ferry operators, Naval operations, Rescue and safety at sea
	Communications	Mobile telecommunications providers, Fixed Telecommunication Providers.
Services		
	Insurance & Finance	Primary insurance companies, Re-insurance sector, Insurance brokers, Insurance service suppliers, Commercial banks, major projects, International financial institution.
	Real-Estate Management	Real-estate brokers, Estate agents, Estate management offices.
	Retail & Geo-Marketing	Navigation and LBS, Retail centres, Advertising and Marketing

		agencies, Shopping chains, logicatics.
	News and Media	Television companies, Broadcasting providers, News and Information agencies, Web service providers, Entertainment software providers.
	Travel, Tourism, Leisure	Tour operators, Leisure service providers, hotels, parks etc, Offices of tourism, Travel agencies, Ski and coastal resorts, Surfers & sailors.
Public Authorities		
	Local & Regional Planners	Town / city authorities, Regional governments, Architects and Planners.
	Emergency Services	Coast guards, Ambulance services, Fire services, Police services, Civil protection organisations, Rescue Services.
	Education, Training and Research	Schools and Education Authorities, Universities, Research Organisations, Professional Training Organisations.
	Security, Defence and Military.	Border control organisations, Police and rescue forces, Military services, Intelligence Services.
International Bodies		
	Environment, Pollution & Climate.	European Commission, United Nations, International meteorological bodies, European and International Agencies, National environment authorities, Environment consultants, NGO´s.
	Humanitarian Operations and Health	Humanitarian aid organisations, Health organisations, Humanitarian support organisations.

Tabla 5: Proposed EARSC Market taxonomy.

ANNEX 4: DETAILED EARSC MARKET TAXONOMY

For each Market Segment, there are a list of existing services which can be provided. The following tables give the list for each super-category and market segment.

Tabla 6: Proposed Detail EARSC Market taxonomy.

Managed Living Resources	Description of Service	
	Client View	Supplier View
1 Agriculture		
	Assess environmental impact of farming	agri-environment monitoring
	Assessing crop damage due to storms	bad weather impact on crops
	Monitor crop disease and stress	crop health monitoring
	Assess crop acreage and yield. Harvest	crop inventories / statistics
	Monitor specific crops	crop types monitoring (extent, growth, health)
	Forecast crop yields	crop Yield forecasts
	Monitor water use on crops and horticulture	irrigation / water stress
	Detect illegal or undesired crops	illegal crops
	Measure land use statistics	landuse studies
2 Forestry		
	Assess Deforestation / Degradation	Deforestation / Degradation maps
	Assess environmental impact of forestry	agri-environment monitoring
	Assessing forest damage due to storms or insects	Storm or insect damage impact maps
	Assess changes in the carbon balance	carbon monitoring
	Detect and monitor wildfires	fire (risk, information, damage)
	Assess forest types	forest classification (cover, types, extent, biomass)
	Monitor forest resources	forest monitoring (health, biomass)
	Detect illegal forest activities	illicit logging
3 Fisheries		
	Map water depth	charting /bathymetry
	Forecast and map large waves	extreme waves / tsunami
	Map fish shoals	fish-shoal location
	Detect and monitor illegal fishing	illegal fishing
	Forecast and monitor ocean movement and drift	tides and ocean currents
	Detect and monitor oil slicks/pollution	Oil slicks

Energy & Natural Resources	Description of Service	
	Client View	Supplier View
4 Oil and Gas		
	Map water depth	charting /bathymetry
	Forecast and map large waves	extreme waves / tsunami
	Monitor oil rig flares	gas flares and oil rigs
	Map geological features	geological mapping
	Detect land movement, subsidence, heave	land movement
	Detect natural oil seepage	oil seepage
	Detect and monitor oil slicks	oil slicks
	Detect and monitor ice risk at sea	sea-ice and icebergs
	Assess dredging operation impacts	sediments and plumes
	Map seismic survey operations	seismic survey
	Forecast and monitor ocean movement and drift	tides and ocean currents
	Forecast and monitor ocean winds and waves	metocean; winds (speed, direction, stress) and waves
5 Alternative Energy		
	Assess changes in the carbon balance	carbon monitoring
	Map and monitor solar energy (solar farms)	solar energy (design and operation)
	Forecast and monitor ocean movement and drift	tides and ocean currents
	Map and monitor of wind energy (wind farms)	wind energy (design and operation)
	Forecast and monitor ocean winds and waves	metocean; winds (speed, direction, stress) and waves
	Map hydroelectric and wind farms	terrain mapping
6 Minerals and Mining		
	Assess environmental impact of human activities	environmental assessment
	Map geological features	geological mapping
	Detect land movement, subsidence, heave	land movement
	Measure land use statistics	landuse studies
	Monitor of land pollution	pollution monitoring
	Monitor Mineral extraction	mineral workings / ground surface

Industrial		Description of Services	
		Client View	Supplier View
7	Utilities (water, electricity, waste)		
		Monitor pollution in rivers and lakes	algal blooms (rivers & inland waters)
		Assess changes in the carbon balance	carbon monitoring
		Assess environmental impact of human activities	environmental assessment
		Monitor of land pollution	pollution monitoring
		Assess changes to urban and rural areas	spatial planning
		Assess and monitor water quality	water quality
		Assess ground water and run-off	water run-off
8	Construction		
		Monitor building development	building footprint
		Assess environmental impact of human activities	environmental assessment
		Map and assess Flooding	flood (risk, damage, information)
		Detect land movement, subsidence, heave	land movement
		Measure land use statistics	landuse studies
9	Transport		
		Assess environmental impact of human activities	environmental assessment
		Map and assess Flooding	flood (risk, damage, information)
		Detect land movement, subsidence, heave	land movement
		Assess changes to urban and rural areas	spatial planning
		Assess and monitor volcanic activity	volcanic eruptions
10	Maritime		
		Monitor quality / producivity	algal bloom (phytoplankton)
		Monitor pollution at sea	turbidity & pollutants
		Forecast and map large waves	extreme waves / tsunami
		Detect and monitor oil slicks	oil slicks
		Detect and monitor ice risk at sea	sea-ice and icebergs
		Monitor ice-free passages for shipping	ship routing
		Forecast and monitor ocean movement and drift	tides and ocean currents
		Forecast and monitor ocean winds and waves	metocean; winds (speed, direction, stress) and waves
		Map water depth	charting /bathymetry
		Monitor ship movements	Ship Monitoring
11	Communications		
		Monitor building development	building footprint
		Assess changes to urban and rural areas	spatial planning
		Map line of sight visibility (height, land cover)	terrain Mapping

Services		Description of Services	
		Client View	Supplier View
12	**Insurance and Finance**		
		Assessing crop damage due to storms	bad weather impact on crops
		Monitor building development	building footprint
		Asses damage from earthquakes	earthquakes (risk, information, damage)
		Forecast and map large waves	extreme waves / tsunami
		Detect and monitor wildfires	fire (risk, information, damage)
		Map and assess Flooding	flood (risk, damage, information)
		Detect land movement, subsidence, heave	land movement
		Forecast and assess landslides	landslides (risk, monitoring, damage) slope inestability and subsidence detection
13	**Real-estate management**		
		Assess environmental impact of farming	agri-environment monitoring
		Monitor building development	building footprint
		Assess environmental impact of human activities	environmental assessment
		Assess land value, ownership, type, use etc	land accounting (use, parcels)
		Detect land movement, subsidence, heave	land movement
		Monitor of land pollution	pollution monitoring
14	**Retail and Geo-marketing**		
		Assess land value, ownership, type, use etc	land accounting (use, parcels)
		Monitor high risk areas	precision mapping
		Map urban areas	urban atlas
15	**News and Media**		
		Asses damage from earthquakes	earthquakes (risk, information, damage)
		Forecast and map large waves	extreme waves / tsunami
		Detect and monitor wildfires	fire (risk, information, damage)
		Detect sensitive security risks	geospatial intelligence
		Forecast and assess landslides	landslides (risk, monitoring, damage) slope inestability and subsidence detection
		Monitor high risk areas	precision mapping
		Assess and monitor volcanic activity	volcanic eruptions
16	**Travel, Tourism and Leisure**		
		Monitor pollution in rivers and lakes	algal blooms (rivers & inland waters)
		Assess changes in land use and quality	land degradation
		Map and assess Flooding	flood (risk, damage, information)
		Forecast and monitor ocean winds and waves	metocean; winds (speed, direction, stress) and waves

Public Authorities	Description of Services	
	Client View	Supplier View
17 Local and regional planners		
	Monitor air quality	air quality
	Monitor pollution in rivers and lakes	algal blooms (rivers & inland waters)
	Monitor building development	building footprint
	Assess land value, ownership, type, use etc	land accounting (use, parcels)
	Assess changes in land use and quality	land degradation
	Detect land movement, subsidence, heave	land movement
	Measure land use statistics	landuse studies
	Monitor high risk areas	precision mapping
	Assess pressures on populations, migration	population pressures / migration
	Assess changes to urban and rural areas	spatial planning
	Map urban areas	urban atlas
	Monitor urban development	urban monitoring
18 Emergency Services		
	Detect and monitor arid areas	drought monitoring
	Detect and monitor wildfires	fire (risk, information, damage)
	Map and assess Flooding	flood (risk, damage, information)
	Forecast and assess landslides	landslides (risk, monitoring, damage) slope instability and subsidence detection
	Assess and monitor volcanic activity	volcanic eruptions
	Forecast and map large waves	extreme waves / tsunami
	Assess damage from earthquakes	earthquakes (risk, information, damage)
	Monitor Snow Cover	Snow cover
	Detect and monitor hurricanes, typhoons	ocean surface topography
19 Education, training and research		
	Assess changes in the carbon balance	carbon monitoring
	Assess climate change risk	climate change
	Map geological features	geological mapping
	Monitor high risk areas	precision mapping
	Assess changes to urban and rural areas	spatial planning
20 Security, Defence and military		
	Monitor land border incursions	border area monitoring (land)
	Detect sensitive security risks	geospatial intelligence
	Monitor high risk areas	precision mapping
	Assess pressures on populations, migration	population pressures / migration
	Detect ships in critical areas	shipping monitoring

International Bodies	Description of Services	
	Client View	Supplier View
21 **Environment, Pollution and Climate**		
	Assess environmental impact of farming	agri-environment monitoring
	Monitor air quality	air quality
	Assess changes in the carbon balance	carbon monitoring
	Assess climate change risk	climate change
	Assess crop acreage and yield. Harvest	crop inventories / statistics
	Forecast crop yields	crop Yield forecasts
	Assess environmental impact of human activities	environmental assessment
	Detect changes in glaciers	glacier monitoring
	Monitor water use on crops and horticulture	irrigation / water stress
	Assess land value, ownership, type, use etc	land accounting (use, parcels)
	Assess changes in land use and quality	land degradation
	Measure land use statistics	landuse studies
	Detect and monitor oil slicks	oil slicks
	Monitor of land pollution	pollution monitoring
	Assess dredging operation impacts	sediments and plumes
	Detect and monitor ice risk at sea	sea-ice and icebergs
	Forecast and monitor ocean movement and drift	tides and ocean currents
22 **Humanitarian Operations and Health**		
	Detect and monitor arid areas	drought monitoring
	Detect sensitive security risks	geospatial intelligence
	Map disaster areas	humanitarian aid maps
	Monitor water use on crops and horticulture	irrigation / water stress
	Monit humanitarian movement and camps	monitoring of settlements
	Assess pressures on populations, migration	population pressures / migration
	forecasting air quality parameters	air quality index (ozone, NO2, …)
	Forecasting epidemics and diseases	epidemics
	Forecasting exposure	Radiation (UV, cloud coverage,ozone)

ANNEX 5: EARSC THEMATIC TAXONOMY

Tabla 7: Proposed Detail EARSC Thematic taxonomy.

Land	List/ Description of Services	
	Client view	Supplier view
Agriculture		
	Assess environmental impact of farming	agri-environment monitoring
	Assessing crop damage due to storms	bad weather impact on crops
	Monitor crop disease and stress	crop health monitoring
	Assess crop acreage and yield. Harvest	crop inventories / statistics
	Monitor specific crops	crop types monitoring (extent, growth, health)
	Forecast crop yields	crop Yield forecasts
	Detect illegal or undesired crops	illegal crops
	Monitor water use on crops and horticulture	irrigation / water stress
Forests		
	Assess forest types	forest classification (cover, types, extent, biomass)
	Monitor forest resources	forest monitoring (health, biomass)
	Detect illegal forest activities	illicit logging
Inland Water		
	Monitor pollution in rivers and lakes	algal blooms (rivers & inland waters)
	Assess and monitor water quality	water quality
	Assess ground water and run-off	water run-off
Snow & Ice		
	Detect changes in glaciers	glacier monitoring
	Monitor Snow Cover	Snow cover
Land Ecosystems		
	Detect and monitor arid areas	drought monitoring
	Assess environmental impact of human activities	environmental assessment
	Monitor of land pollution	pollution monitoring
Land use / cover & change		
	Detect illegal mining activities	illicit mining
	Assess land value, ownership, type, use etc	land accounting (use, parcels)
	Assess changes in land use and quality	land degradation
	Measure land use statistics	landuse studies
	Monit humanitarian movement and camps	monitoring of settlements
	Assess pressures on populations, migration	population pressures / migration
Land Motion / Ground Movement		
	Detect land movement, subsidence, heave	land movement
	Map and monitor Pipelines Routes	Sand dunes
Geology		
	Map geological features	geological mapping
	Map seismic survey operations	seismic survey
	Monitor Mineral extraction	mineral workings / ground surface

Built Environment & Human Factors	Description of Services	
	Client View	Supplier View
Urban Areas		
	Monitor urban development	urban monitoring
	Map urban areas	urban atlas
	Assess changes to urban and rural areas	spatial planning
Infrastructure		
	Monitor building development	building footprint
	Map and monitor solar energy (solar farms)	solar energy (design and operation)
	Map and monitor of wind energy (wind farms)	wind energy (design and operation)
	Map line of sight visibility (height, land cover)	terrain Mapping
Borders		
	Monitor land border incursions	border area monitoring (land)

Ocean / Marine	Description of Services	
	Client View	Supplier View
marine ecosystem pollution		
	Monitor quality / productivity	algal bloom (phytoplankton)
	Monitor pollution at sea	turbidity & pollutants
	Detect natural oil seepage	oil seepage
	Detect and monitor oil slicks	oil slicks
	Monitor oil rig flares	gas flares and oil rigs
	Assess dredging operation impacts	sediments and plumes
coastal		
	Map water depth	charting /bathymetry
	Monitor ocean level and surface	Operational Oceanology
metocean		
	Forecast and monitor ocean movement and drift	tides and ocean currents
	Forecast and monitor ocean winds and waves	metocean; winds (speed, direction, stress) and waves
	Forecast and map large waves	extreme waves / tsunami
Fisheries		
	Map fish shoals	fish-shoal location
	Detct and monitor illegal fishing	illegal fishing
ships		
	Monitor ice-free passages for shipping	ship routing
	Detect ships in critical areas	shipping monitoring
	Monitor ship movements	Ship Monitoring
sea-ice and icebergs		
	Detect and monitor ice risk at sea	sea-ice and icebergs

Atmosphere & Climate Change	Description of Services	
	Client View	Supplier View
air quality	Monitor air quality	air quality
climate	Assess changes in the carbon balance	carbon monitoring
	Assess climate change risk	climate change
weather		

Disasters / Geohazards	Description of Services	
	Client View	Supplier View
floods	Map and assess Flooding	flood (risk, damage, information)
fires	Detect and monitor wildfires	fire (risk, information, damage)
earthquakes	Asses damage from earthquakes	earthquakes (risk, information, damage)
landslides	Forecast and assess landslides	landslides (risk, monitoring, damage) slope instability and subsidence detection
volcanos	Assess and monitor volcanic activity	volcanic eruptions

Security	Description of Services	
	Client View	Supplier View
	Detect sensitive security risks	geospatial intelligence
	Map disaster areas	humanitarian aid maps
	Monitor high risk areas	precision mapping

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