

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

This document is the second issue of the EARSC Taxonomy for EO Services. It provides a structured view of the market for EO services bringing together the products and services which are offered by service providers and maps those to the market sectors to which those products apply.

To complete the picture, it also starts to compile a structured list of the specific needs of market sectors starting in this issue with the Oil & Gas sector.

Version	Date	Change
Issue 1	February 2012	First Issue
Issue 2	August 2015	Revised document

EARSC, the European Association of Remote Sensing Companies represents the Earth Observation geo-information services sector in Europe. Today EARSC has 75 members (66 full members and 9 observers), coming from 22 countries covering the full EO services value chain including commercial operators of EO satellites, resellers of data, value-adding companies, geospatial information suppliers, consultancies and EO system/software providers.

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1 INTRODUCTION

1.1 BACKGROUND AND CHANGES

Recognising a need to structure products and services, EARSC prepared and issued the first version of the EARSC Taxonomy for the EO Services Market in February 2012. It is intended to be a living document and a new version is being issued now in August 2015 for 3 reasons:

- Lessons were learned from discussions after the first issue and from the implementation into the EO wiki which should be incorporated.
- A major project was undertaken looking at the use of EO products in the oil and gas industry. EO4OG has been translated into a comprehensive set of products for the O&G sector each of which should find its place in a comprehensive taxonomy.
- Various other projects will influence the taxonomy and we need to reflect the current status and thinking into the document now.

We intend that this shall remain a living document and anticipate that version 3 of the taxonomy may follow rather more quickly than did version 2.

Note that this is not a simple update and that some of the material comparing earlier taxonomies which was included in version 1 has been dropped from this version. Accordingly, for a full history, readers will also need to refer to issue 1 which shall be maintained available through the EARSC web-site.

1.2 RATIONALE FOR A TAXONOMY

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 service suppliers 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.

Three specific projects have been carried out by EARSC which 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.
- An EOWiki which presents EO services and products in a structured way. This has become maybe the main tool for testing the taxonomy. The production of a structured site for EO4OG and the need to link with a core database of EO services and products has elaborated a lot of thinking behind the update to the taxonomy.

The latter is becoming more and more relevant and the driver for the taxonomy in that it provides a live version of the taxonomy. It is a clear test of whether the structure works in that all EO products should find their place in the EOWiki as well as in the taxonomy. Our approach here is to seek to set up a database of all the EO products and services as reflected in the thematic view and then identify which of those are relevant for each market sector. The EO4OG provides the first test of this approach and we are also addressing the market needs of International Financial Institutions (IFI's).

It is also important to note that it should evolve continuously – in the detail. Whilst we hope that the structure will prove sufficiently robust to accommodate all future products and customer needs, the segments will hopefully not change.

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 CHANGES INTRODUCED

In the 2nd issue of the taxonomy some significant changes have been made based on the lessons learned from the first issue. In addition, the comprehensive EO4OG project allows us to test the taxonomy against an exhaustive study of the needs coming from a single sector.

The main changes are:

- The taxonomy now includes; a thematic view, a market view, and a sector view. The latter expresses the client needs of a particular sector in a structured way.
- Within the EO4OG project, the needs of the clients (the Oil & Gas industry) have been expressed as “challenges”. Then a set of products have been identified to meet those challenges. The challenges for each market sector are different. In this document, we present the structure of the challenges for the Oil & Gas sector; this is the sector view. We shall expand on this for other sectors in the future.
- The products have been structured according to the EARSC taxonomy. Where some do not fit, then the taxonomy has been adapted. A litmus test for the taxonomy presented here is that each product meeting a challenge for the O&G sector can be placed within the taxonomy.
- Nevertheless, this does not mean that each EO4OG product is also an EO Service. Many of the products are very similar in nature and hence we have introduced the list of key-words which replaces the “client view” which we had previously defined within the thematic taxonomy. In a future issue we could consider to expand the key words to become a list of products making up the service.
- In issue 1, the difference between the client view and the supplier view was not sufficiently distinguished. We found that the terms were becoming almost the same and hence we have dropped the client view from the thematic taxonomy (replacing it with the key-words).
- Hence we now have a hierarchy defining the thematic products which goes from Thematic Segments eg Land, Marine, to Thematic sectors eg agriculture, forestry etc to EO service eg. Environmental impact of farming, to key-words which in effect define the products which make up a service.
- We have merged a number of EO services which were very similar in nature. For example, under agriculture we had 4 different services all linked to crop yields. We have merged these into one service and added key-words which distinguish further products.
- The market view has not changed significantly except to expand the list of EO services relevant to the Oil and gas sector deriving from the EO4OG projects.

The results of these changes and some further considerations relative to issue 1 are described in section 3.

3 APPROACH

3.1 DESCRIPTION

The taxonomy rests on two tables; one providing a market view and one providing a thematic view; these can be taken as synonymous with a client view and a supplier view.

The thematic or supplier view provides a structured list of EO products and services each of which is unique. The thematic taxonomy is broken down into 6 major sectors and 25 segments; each thematic segment contains a number of EO services. For each EO service we define a list of key-words which will help identify products which could be included with the service.

The market or client view is also broken down into 6 major segments and 22 sectors. EO services which meet the needs of each of these are identified. Any one service may contribute to meeting the needs of clients in several sectors or segments. All the EO services identified come from the thematic view but can be used in several market sectors.

As far as we are aware, this approach is unique.

3.2 VERBS

Where we wish to standardise around a list of common EO services and products, a limited set of verbs will help keep the products clear. Therefore we introduced a standard set of verbs to describe the need of the user (and eventually the service on offer. Five verbs were 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

Table 1 : Standard set of verbs and equivalents proposed.

A full set of definitions of all of these verbs is given in annex 1.

3.3 OTHER RELEVANT TAXONOMIES AND PROJECTS

In the first issue of the document, we made a quick review of some of the different taxonomies in use today; a full list is given in Table 2. More information is given in issue 1 of this document.

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.

The European programme for Copernicus is also an important element that will influence the future market for EO services. A number (6) of 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 Copernicus. But a workable taxonomy must go beyond Copernicus since many other elements of the market are not addressed.

For completeness, Table 2 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

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

4 THEMATIC TAXONOMY

The core of the EARSC taxonomy is that focussed on the thematic segments. This is because it is a structure in which each service and product is uniquely placed. The Thematic taxonomy starts with the major thematic areas of which there are 6. Each of these is broken down into a number of thematic segments giving 25 in total. For each segment, a number of EO services are identified for which key-words are given which help define the products which can be part of an EO service. The full taxonomy is shown below.

Table 3 : EARSC Thematic Taxonomy of EO Products

Land Services

Thematic Sector	EO Services	Key words
Agriculture	<u>Assess Environmental impact of farming</u>	agri-environment
	<u>Assess crop damage due to storms</u>	bad weather, impact on crops
	<u>Monitor crops</u>	crop health (<u>disease and stress</u>), <u>crop acreage and yield harvest</u> (inventories / statistics), <u>crop types</u> (extent, growth, health, stress), <u>crop yields</u>
	<u>Detect illegal or undesired crops</u>	illegal crops
	<u>Monitor water use on crops and horticulture</u>	soil water index, surface soil moisture, run-off
Forests	<u>Assess Deforestation / Forest Degradation</u>	deforestation, degradation maps
	<u>Assess forest damage due to storms or insects</u>	storm, insect damage impact maps
	<u>Monitor forest resources</u>	forest biomass (diversity, health, extent), <u>forest type</u> , <u>forest classification (cover density)</u> , tree cover density (canopy coverage)
	<u>Detect illegal forest activities</u>	illicit logging
	<u>Assess environmental impact of forestry</u>	forest location, extent and tree cover density

	<u>Monitor forest carbon content</u>	emissions from Deforestation and Forest Degradation (REDD)
Inland Water	<u>Assess and monitor water bodies</u>	<u>water quality</u> , <u>pollution</u> , turbidity, suspended sediment concentrations (quantitative, qualitative), waterbody (temperature, extent, volume, quantity), algal blooms
	<u>Assess ground water and run-off</u>	water run-off (water quantity), hydrological network and catchment areas (water catchment)
	<u>Monitor ice on rivers and lakes</u>	inland ice
Snow & Ice	<u>Detect changes in glaciers</u>	glacier
	<u>Monitor snow cover</u>	snow cover
Land Ecosystems	<u>Monitor land ecosystems and biodiversity</u>	critical habitat maps, wildlife corridors, linear features (hedges and boundaries, vegetation index (FAPAR; NDVI, LAI), vegetation stress, stem volume, soil moisture
	<u>Assess environmental impact of human activities</u>	environmental assessment
	<u>Monitor land pollution</u>	pollution
	<u>Monitor land cover and detect change</u>	<u>arid areas</u> , wet areas, erosion potential, CORINE (characterization & classification), soil sealing
Land use	<u>Detect illegal mining activities</u>	illicit mining
	<u>Assess land value, ownership, type, use</u>	land accounting (use, parcels), cadastral, <u>land use</u>
	<u>Measure land use statistics</u>	land administration, land use studies
	<u>Monitor humanitarian movement and camps</u>	monitoring of settlements
	<u>Assess pressures on populations and migration</u>	population pressures / migration
	<u>Monitor vegetation encroachment</u>	mapping of terrain, infrastructure and operations, pipeline corridor status, encroachment
Topography	<u>Baseline mapping</u>	Digital Elevation Models (DEMs), Digital Surface Model (DSM), Digital Terrain Model (DTM), terrain roughness measure, slope stability (curvature, aspect), surface deformation maps and profiles

	<u>Measure detect land surface change</u>	surface movement: sand dunes, <u>pipeline routes</u> (corridor status), soil erosion
	<u>Detect and monitor ground movement</u>	reservoir compartmentalization & optimization, permafrost zone stability, ground displacement: fault identification, reactivation & discontinuities, <u>uplift</u> , <u>subsidence</u> , <u>heave</u> .
Geology	<u>Map geological features</u>	near surface features, lithology features, linear disturbance features: faults & discontinuities
	<u>Map seismic survey operations</u>	seismic (survey, coupling, logistics)
	<u>Monitor mineral extraction</u>	mineral workings / ground surface, <u>illegal activities</u>
	Identify hydrocarbon seeps in soil	hydrocarbon seepage (oil seeps) detection (near surface geology: faults, fractures, unconformities or carrier beds)

Built Environment & Human Factors

Thematic Sector	EO Service	Key words
Urban Areas	<u>Monitor urban areas</u>	<u>urban areas</u> , urban atlas, urban settlement maps, <u>urban development</u> , smart cities, individual houses inventory
	<u>Monitor urban surroundings</u>	<u>rural areas and surroundings</u> , waste management, water supply, positioning energy, leisure
Infrastructure	<u>Monitor construction and buildings</u>	building inventory & footprint, strategic infrastructure development, structural interpretation
	<u>Map and monitor solar energy (solar farms)</u>	solar energy and radiation (design and operation)
	<u>Map and monitor wind energy (wind farms)</u>	wind energy (design and operation), wind roses
	<u>Map line of sight visibility (land surface)</u>	<u>land surface</u> , spatial planning, landscape visibility analysis, terrain mapping (DTMs), map transmission and land routes
	<u>Map and monitor hydroelectric energy</u>	hydroelectric plants (design and operation)
	<u>Map and monitor transport networks</u>	<u>infrastructure</u> , soft ground, identification of road or track for logistics planning, transport network
	Assess damage from industrial accidents	disaster risk reduction (emergency response, recovery, rehabilitation and reconstruction)

	<u>Asset infrastructure monitoring</u>	land cover, infrastructure
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Ocean & Marine

Thematic Sector	EO Service	Key words
Marine ecosystem	<u>Monitor ocean quality and productivity</u>	algal bloom (phytoplankton), ocean colour composite (chl-a, swath, qualitative, quantitative), sea surface temperature (SST)
	<u>Monitor pollution at sea</u>	turbidity & pollutants
	<u>Detect and monitor oil slicks</u>	oil spill threats (early warning), <u>natural oil seepage</u> ,
	<u>Monitor oil rigs and flares</u>	gas flares and oil rigs
	<u>Monitor marine habitats</u>	algal blooms, marine mammals, sea surface temperature, sediments, plumes, <u>dredging operation</u>
Coastal	<u>Map water depth or charting</u>	charting / shallow water bathymetry
	<u>Monitor coastal ecosystem</u>	waterbody nutrients / productivity (chlorophyll-a concentration), coastal, littoral and subtidal habitat (mangroves, coral reefs, seagrass canopy density)
	<u>Monitor ocean level and surface</u>	sea rise
	<u>Assess and monitor coastal water quality</u>	sediment (qualitative, quantitative), turbidity (quality, quantitative), visibility, chlorophyll-a concentration
	<u>Monitor the coast line</u>	coastal land cover, shoreline change and coastal morphology (coastal terrain models)
Metoccean	<u>Forecast and monitor ocean currents and drift</u>	<u>ocean dynamics</u> and circulation: tides and ocean currents (surface current models for tides), sea surface salinity (internal waves, eddies and frontal areas), upwelling
	<u>Forecast and monitor ocean winds and waves</u>	derived winds (speed, direction, stress) and waves (current veins, swell-maps: sea surface height), wave exposure (fetch, averaged directional wind speed and bathymetry), sea surface roughness (rain cells)
	<u>Forecast and map large waves</u>	extreme waves / tsunamis
	<u>Detect and monitor</u>	atmospheric front, local weather phenomena, cloud structure,

	<u>hurricanes and typhoons</u>	winds and waves, sea-surface temperature and sea-surface height
Fisheries	<u>Map fish shoals</u>	fish-shoal location
	<u>Detect and monitor illegal fishing</u>	illegal fishing
Ships	<u>Detect ships in critical areas</u>	shipping and navigation
	<u>Monitor ship movements</u>	ship
Sea-ice and icebergs	<u>Detect and monitor ice-risk at sea</u>	sea-ice and icebergs, ship routing, ice cover, oil rigs

Atmosphere & Climate

Thematic Sector	EO Service	Key words
Atmosphere	<u>Monitor air quality & emissions</u>	air quality forecasting, emissions of carbon monoxide, nitrogen oxides. ie: CH ₄ , tropospheric NO ₂ and SO ₂ , particulate matters or aerosols
	<u>Monitor atmosphere composition</u>	aerosol and carbon monoxide, greenhouse gases: CO ₂ , Methane, NO _x , SO _x
	<u>Forecasting sunlight exposure</u>	UV & solar radiation measures
Climate	<u>Assess changes in the carbon balance</u>	carbon monitoring
	<u>Assess climate change risk</u>	climate change, record of stratospheric ozone
	<u>Assess climate forcing</u>	infrared radiation, scattering of solar radiation
Meteorology	<u>Forecast weather</u>	weather monitoring and prediction (hurricane tracks, cyclone, storm tracks), visibility

Disasters & Geohazards

Thematic Sector	EO Services	Key words
Floods	<u>Map and assess flooding</u>	surface soil moisture, floodplain, flood extend mapping, flood risk assessment, flood frequency, rainfall, monitoring

		flash floods, flood frequency and modelling
Fires	<u>Detect and monitor wildfires</u>	forest fire risk (extent, burnt scars), damage
Earthquakes	<u>Assess damage from earthquakes</u>	earthquake (risk, information, damage), seismic, inter-seismic deformations, slip rates & active faults, stress transfer on faults
Landslides	<u>Forecast and assess landslides</u>	landslides (risk, monitoring, damage), slope instability and subsidence detection, fault and discontinuity maps (vector or raster)
Volcanos	<u>Assess and Monitor Volcanic Activity</u>	volcanic eruptions (pre-eruptive, sin-eruptive, atmospheric ash, dispersion)

Security

Thematic Sector	EO Service	Key words
Security	<u>Monitor sensitive risk areas</u>	geospatial intelligence, <u>sensitive risk areas</u> (mines, unexploded objects (UXO), de-mining), <u>high risk areas</u> , precision mapping
	<u>Map disaster areas</u>	humanitarian aid maps
	<u>Monitor land border incursions</u>	border area monitoring
	<u>Monitor movement of people</u>	migration and cleansing
	<u>Monitor economic activity</u>	legal and illegal activities
	<u>Monitor transport routes</u>	transportation of legal and illegal goods, trafficking
	<u>Forecasting epidemics and diseases</u>	daily disease risk maps, NDVI, land cover, soil type

5 MARKET TAXONOMY

In the first issue of the EARSC taxonomy of EO services we looked at a number of previously constructed taxonomies, compared them and used the result as the basis for our document.

The market view includes definitions of the likely organisations included in each sector and the list of EO services which are considered relevant. The market is broken down into 6 major segments: managed living resources, energy and natural resources, industrial, services, public authorities and international bodies.

Table 4 : EARSC Market taxonomy.

Table 4a: Managed Living Resources

Market Sector	Composition	EO Services
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.	Assess environmental impact of farming Assess crop damage due to storms Monitor crop disease and stress Assess crop acreage and yield harvest Monitor specific crop types Forecast crop yields Monitor water use on crops and horticulture Detect illegal or undesired crops Measure land use statistics
Forestry	Forest management, Forest Services, Commodities, Logging industry, Wood, paper and pulp industry, Forest policy, Forest machinery, Forest Policy makers.	Assess deforestation / forest degradation Assess environmental impact of forestry Assess forest damage due to storms or insects Assess changes in the carbon balance Detect and monitor wildfires Assess forest types Monitor forest resources Detect illegal forest activities
Fisheries	Fish stock management, Fishing fleets, Fishery distribution logistics, Aquaculture / fish farms, Coastal management	Map water depth / charting Forecast and map large waves Map fish shoals Detect and monitor illegal fishing Forecast and monitor current movement and drift

	agencies, Fisheries authorities / policy makers.	Detect and monitor oil slicks Detect and monitor oil slicks Monitor pollution at sea
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Table 4b: Energy and Natural Resources

Market Sector	Composition	EO Services
Oil and Gas	Offshore exploration and production, on-shore exploration and production, drilling and support services, oil and gas commodities trading, Energy planners.	Assess environmental impact of human activities Asset infrastructure monitoring Map water depth / charting Monitor construction and buildings Monitor ocean quality and productivity Monitor the coast line Monitor atmosphere composition Monitor land ecosystems and biodiversity Forecast and monitor current movement and drift Baseline mapping Monitor vegetation encroachment Map geological features Measure detect land surface change Map and assess flooding Monitor forest resources Detect and monitor wildfires Detect and monitor hurricanes and typhoons Identify hydrocarbon seeps in soil Assess ground water and run-off Detect and monitor ice risk at sea Monitor land cover and detect change Forecast and monitor ocean winds and waves Detect and monitor oil slicks Monitor coastal ecosystem Monitor air quality & emissions Monitor marine habitats Forecast and map large waves Monitor ice on rivers and lakes Monitor oil rigs and flares Forecasting sunlight exposure Forecast weather Monitor pollution at sea Monitor urban areas Monitor sensitive risk areas Assess and monitor water bodies Detect and monitor ground movement

		Assess dredging operation impacts Map seismic survey operations Map of transport networks
Alternative Energy	Solar energy providers, Wind energy providers, Tidal energy providers, Energy and Carbon traders, Local and regional planners, National policy makers.	Assess changes in the carbon balance Map and monitor solar energy (solar farms) Forecast and monitor current movement and drift Map and monitor wind energy (wind farms) Forecast and monitor ocean winds and waves Map hydroelectric sources
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.	Assess environmental impact of human activities Map geological features Detect and monitor ground movement Measure land use statistics Monitor land pollution Monitor mineral extraction

Table 4c: Industrial

Market Sector	Composition	EO Services
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.	Monitor pollution in rivers and lakes Assess changes in the carbon balance Assess environmental impact of human activities Monitor land pollution Assess changes to urban and rural areas Assess and monitor water quality Assess ground water and run-off
Construction	Construction companies, Civil engineering consultancies, Architect and design companies, Planning authorities, National land agencies.	Monitor building development Assess environmental impact of human activities Map and assess flooding Detect land movement, subsidence, heave. Monitor land-use statistics
Transportation	Road transport operators, haulage,	Assess environmental impact of human activities Map and assess flooding

	Road infrastructure operators, tolls Airport operators, Rail operators, Airlines and airline services, Transport engineers.	Detect land movement, subsidence, heave. Assess changes to urban and rural areas Assess and monitor volcanic activity Monitor ice on rivers and lakes monitor ice free passages for ships
Maritime	Ports & harbors administration, bulk cargo carriers, Cruise liners operators, Ferry operators, Naval operations, Rescue and safety at sea	Monitor water quality and productivity Monitor pollution at sea Forecast and map large waves Detect and monitor oil slicks Detect and monitor ice-risk at sea Monitor ice free passages for ships Forecast and monitor ocean movement and drift Forecast and monitor ocean winds and waves Map water depth / charting Monitor ship movements
Communications	Mobile telecommunications providers, Fixed Telecommunication Providers.	Monitor building development Assess changes to urban and rural areas Map line of sight visibility (terrain height, land cover)

Table 4d : Services

Market Sector	Composition	EO Services
Insurance & Finance	Primary insurance companies, Re-insurance sector, Insurance brokers, Insurance service suppliers, Commercial banks, major projects, International financial institution.	Assess crop damage due to storms Monitor building development Assess damage from earthquakes Forecast and map large waves Detect and monitor wildfires Map and assess flooding Detect land movement, subsidence, heave Forecast and assess landslides
Real-estate management	Real-estate brokers, Estate agents, Estate management offices.	Assess environmental impact of farming Monitor building development Assess environmental impact of human activities Assess land value, ownership, type use etc. Detect land movement; subsidence, heave Monitor land pollution
Retail and Geo-	Navigation and LBS, Retail centres,	Assess land value, ownership, type, use Monitor high risk areas

marketing	Advertising and Marketing agencies, Shopping chains, logistics.	Map urban areas
News and Media	Television companies, Broadcasting providers, News and Information agencies, Web service providers, Entertainment software providers	Assess damage from earthquakes Forecast and map large waves Detect and monitor wildfires Detect sensitive risk areas Forecast and assess landslides Monitor high risk areas Assess and monitor volcanic activity
Travel, Tourism and Leisure	Tour operators, Leisure service providers, hotels, parks etc, Offices of tourism, Travel agencies, Ski and coastal resorts, Surfers & sailors.	Monitor pollution in rivers and lakes Assess changes in land use and quality Map and assess flooding Forecast and monitor ocean winds and waves

Table 4e : Public Authorities

Market Sector	Composition	EO Services
Local and regional planners	Town / city authorities, Regional governments, Architects and Planners.	Monitor air quality Monitor pollution in rivers and lakes Monitor building development Assess land value, ownership, type, use Assess changes in land use and quality Detect land movement; subsidence, heave Measure land-use statistics Monitor high risk areas Assess pressures on populations and migration Assess changes to urban and rural areas Map urban areas Monitor urban development
Emergency Services	Coast guards, Ambulance services, Fire services, Police services, Civil protection organisations, Rescue Services.	Detect and monitor arid areas Detect and monitor wildfires Map and assess flooding Forecast and assess landslides Assess and monitor volcanic activity Forecast and map large waves Assess damage from earthquakes

		Monitor snow cover Detect and monitor hurricanes and typhoons
Education, training and research	Schools and Education Authorities, Universities, Research Organisations, Professional Training Organisations.	Assess changes in the carbon balance Assess climate change risk Map geological features Monitor high risk areas Assess changes to urban and rural areas
Security, Defence and military	Border control organisations, Police and rescue forces, Military services, Intelligence Services.	Monitor land border incursions Detect sensitive risk areas Monitor high risk areas Assess pressures on populations and migrations Detect ships in critical areas.

Table 4f : International Bodies

Market Sector	Composition	EO Services
Environmental, Pollution & Climate	European Commission, United Nations, International meteorological bodies, European and International Agencies, National environment authorities, Environment consultants, NGO's.	Assess environmental impact of farming Monitor air quality Assess changes in the carbon balance Assess climate change risk Assess crop acreage and yield harvest Forecast crop yields Assess environmental impact of human activities Detect changes in glaciers Monitor water use on crops and horticulture Assess land value, ownership, type use etc Assess changes in land use and quality Measure land-use statistics Detect and monitor oil slicks Monitor land pollution Assess dredging operations impacts Detect and monitor ice-risk at sea Forecast and monitor ocean movement and drift

Humanitarian Operations and Health	Humanitarian aid organisations, Health organisations, Humanitarian support organisations.	Detect and monitor arid areas Detect sensitive risk areas Map disaster areas (Situation Awareness) Monitor water use on crops and horticulture Monitor humanitarian movement and camps Assess pressures on populations and migration Monitor air quality Forecasting epidemics and diseases Forecasting sunlight exposure
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6 MARKET SECTOR NEEDS

As a result of the work on EO4OG we have a first comprehensive view of the challenges faced by a market sector for which EO technology can be a solution. We hope to expand on this in the future but for the moment we only have this breakdown for the Oil and Gas market sector.

The EO4OG challenges reflect the requirements of the O&G industry. They have been organised into 7 groups; 2 for off-shore and 5 for on-shore challenges. Each challenge maps to one or more EO products which are able to meet or partially meet it. The full list of those EO products can be found under the O&G sector of the market taxonomy.

This is too complex to show graphically and below you can find the structured list of challenges for the O&G industry. A full mapping of the challenges to products can be found in the EOWiki (<https://earsc-portal.eu/display/EOSTAN/EO+Wiki>) and in the EO4OG portal (<https://earsc-portal.eu/display/EO4/EO4OG+Home>) where this taxonomy is implemented.

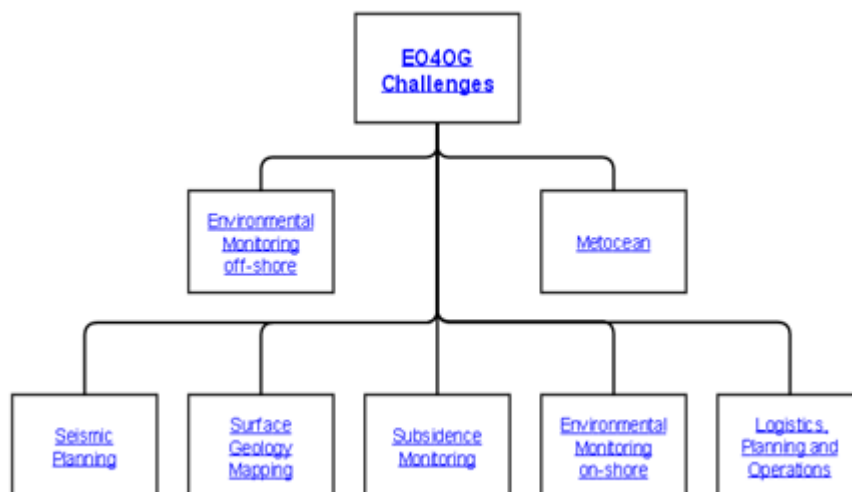


Figure 6-1 : Overview of the O&G Industry Challenges (Needs)

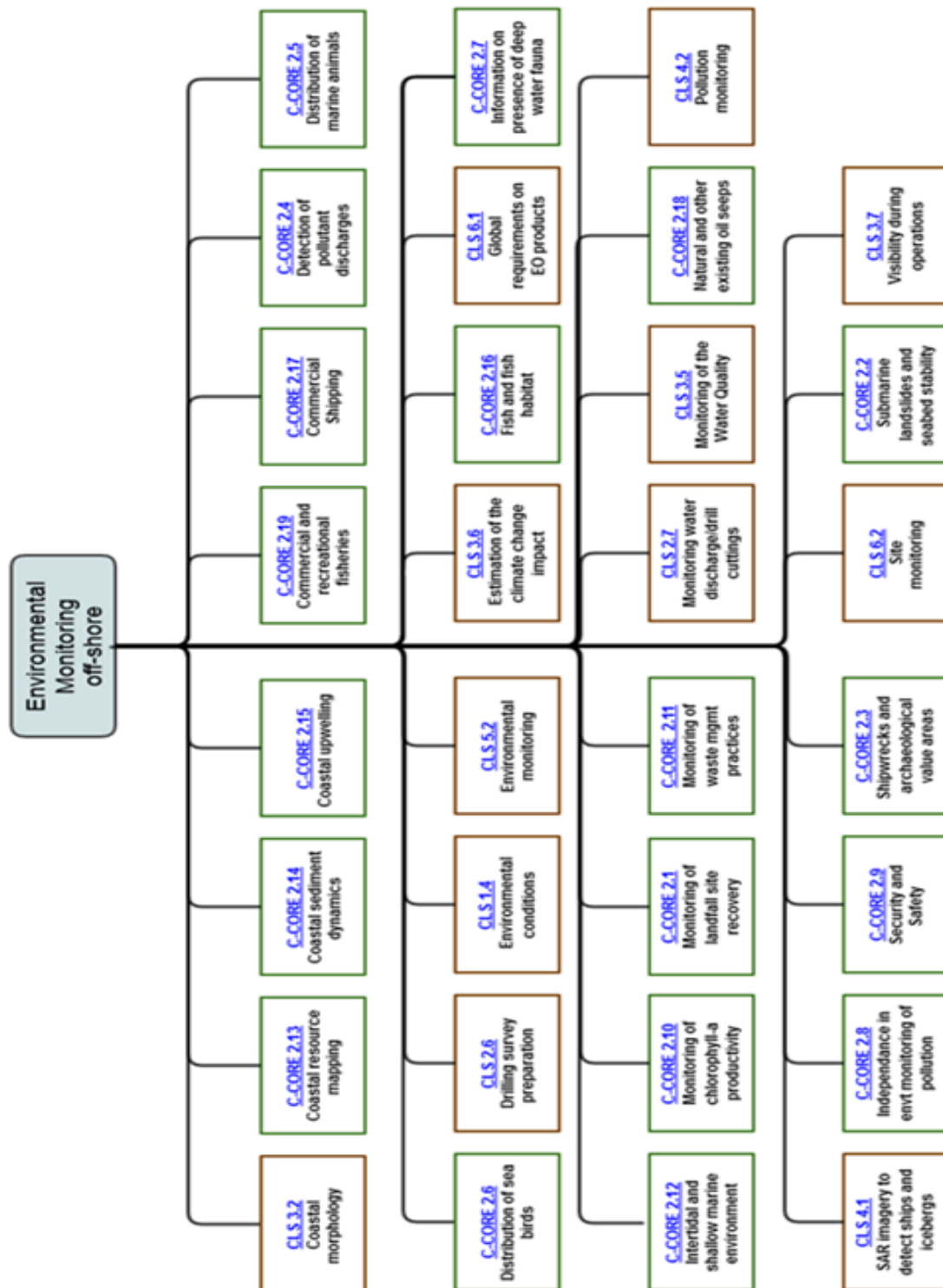


Figure 6-2 : O&G industry challenges - off-shore environmental monitoring

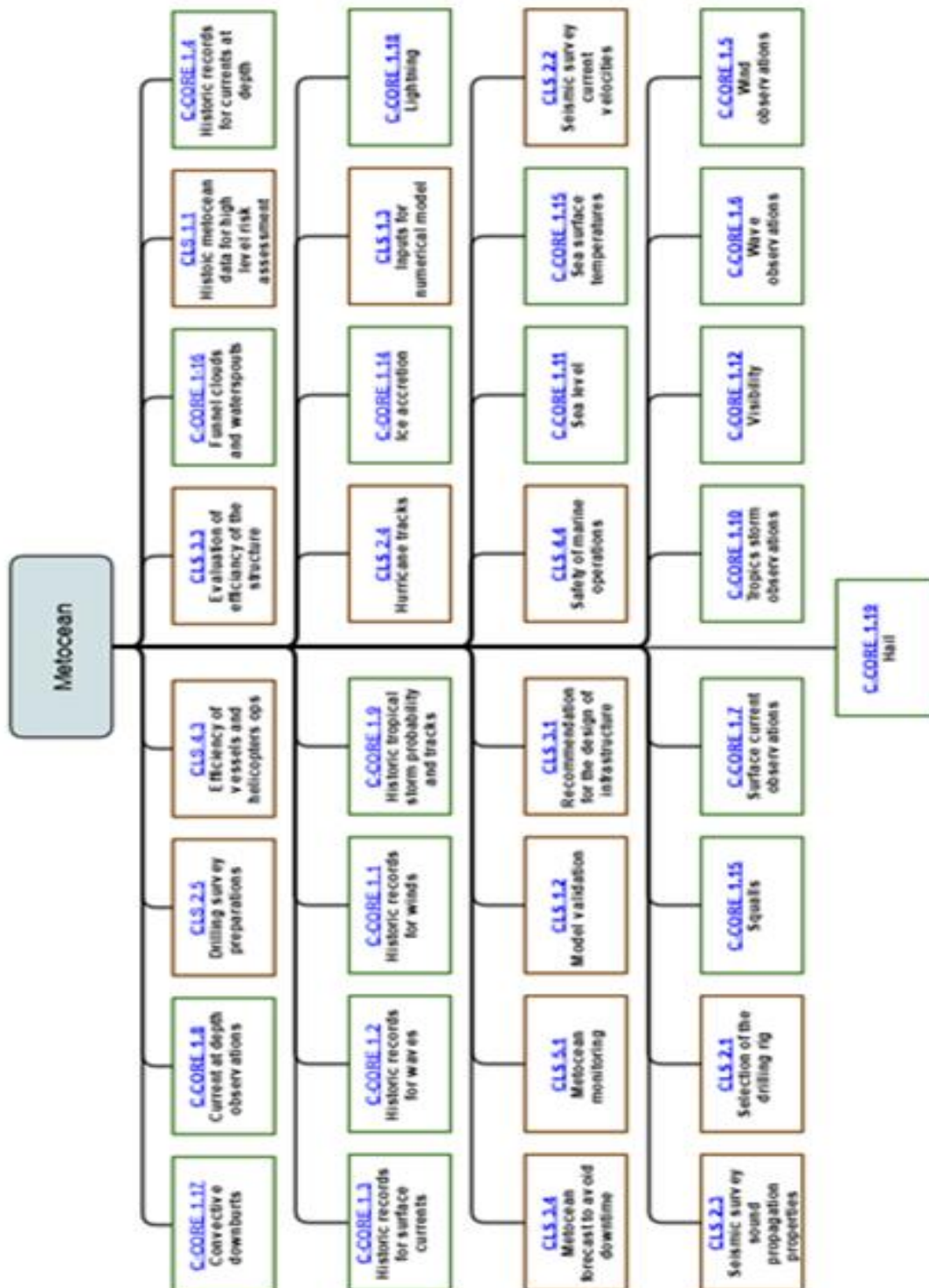


Figure 6-3 : O&G industry challenges - Metoccean

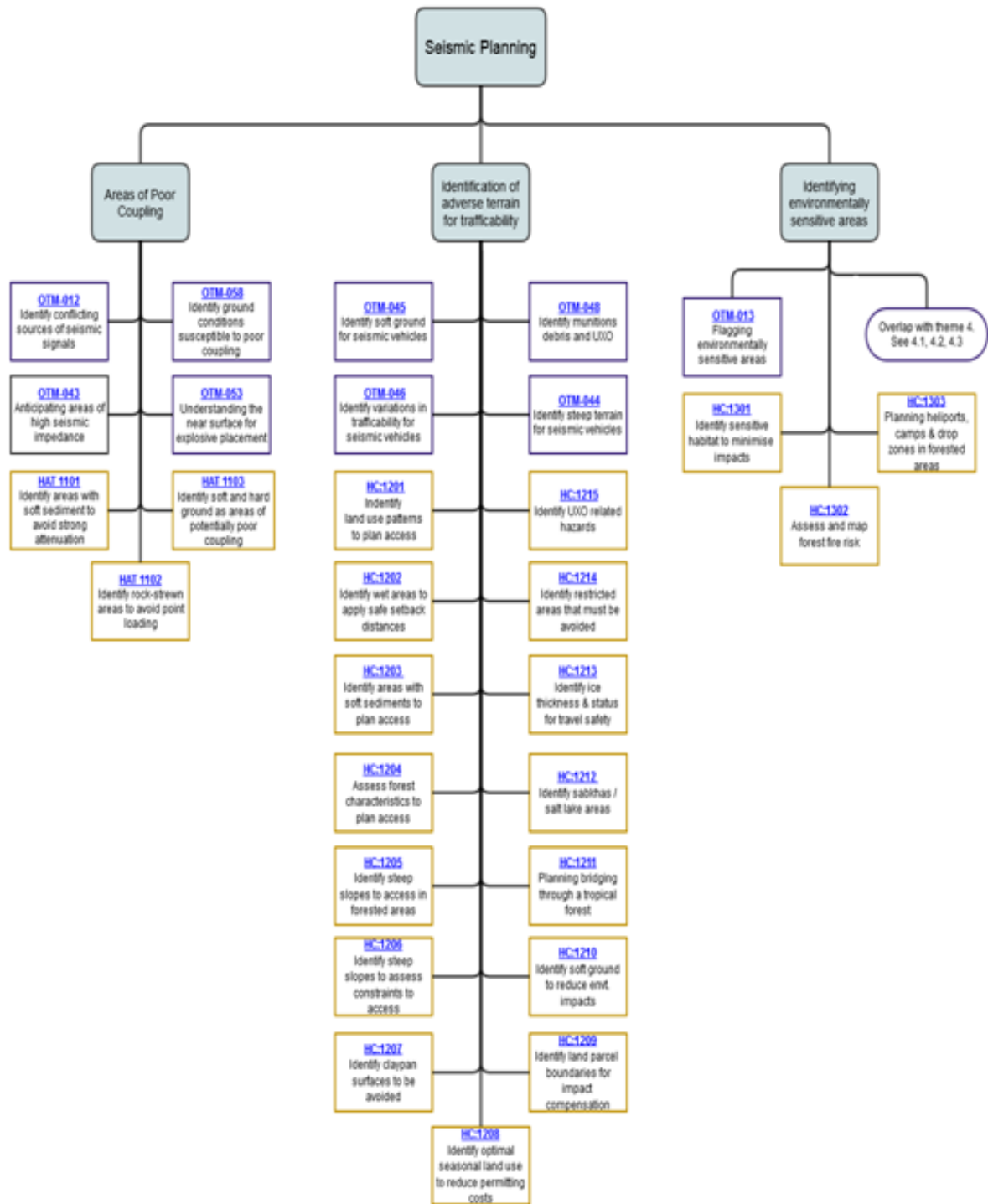


Figure 6-4 : O&G Industry challenges – Seismic Planning

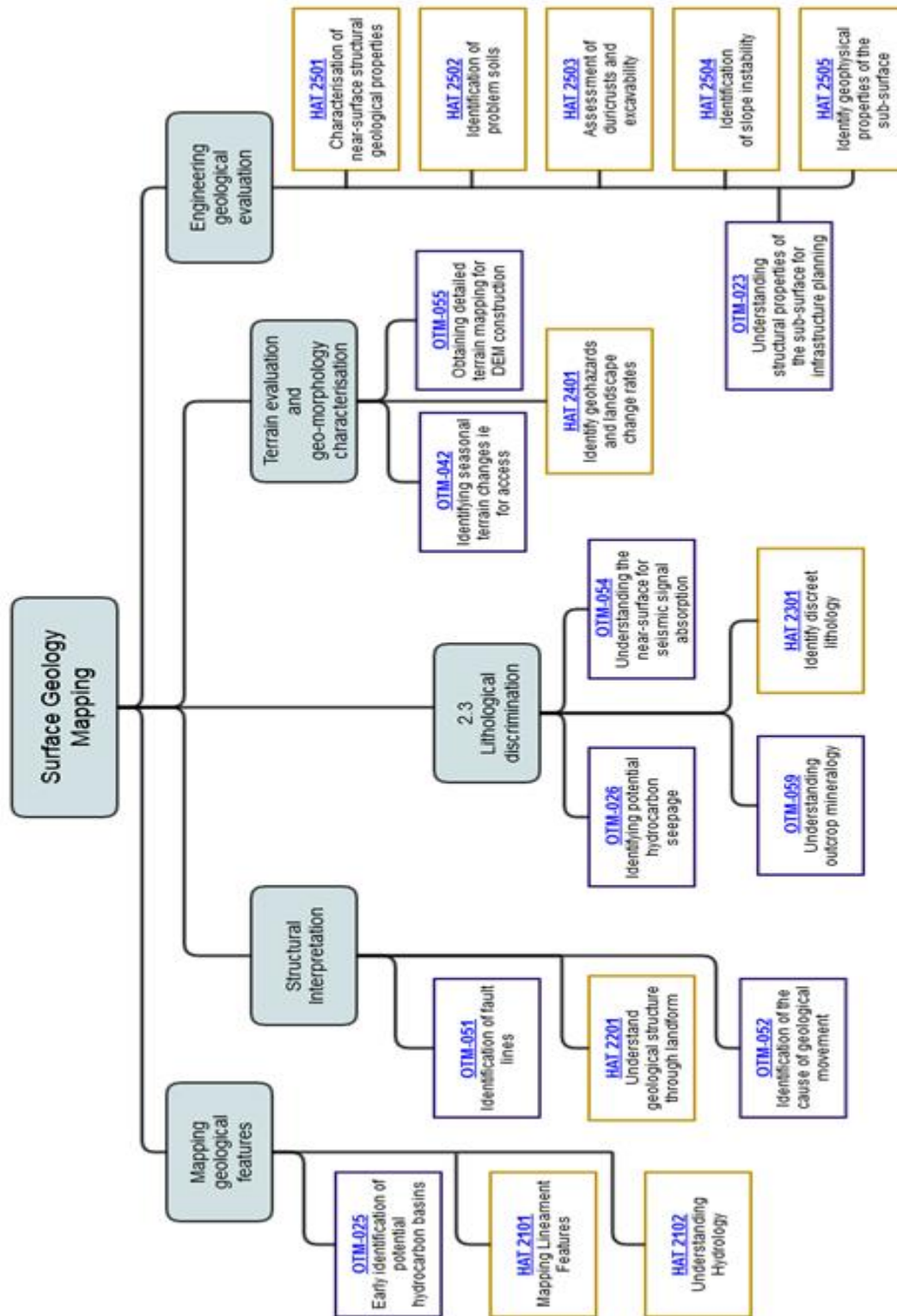


Figure 6-5 : O&G Industry challenges – surface geology mapping

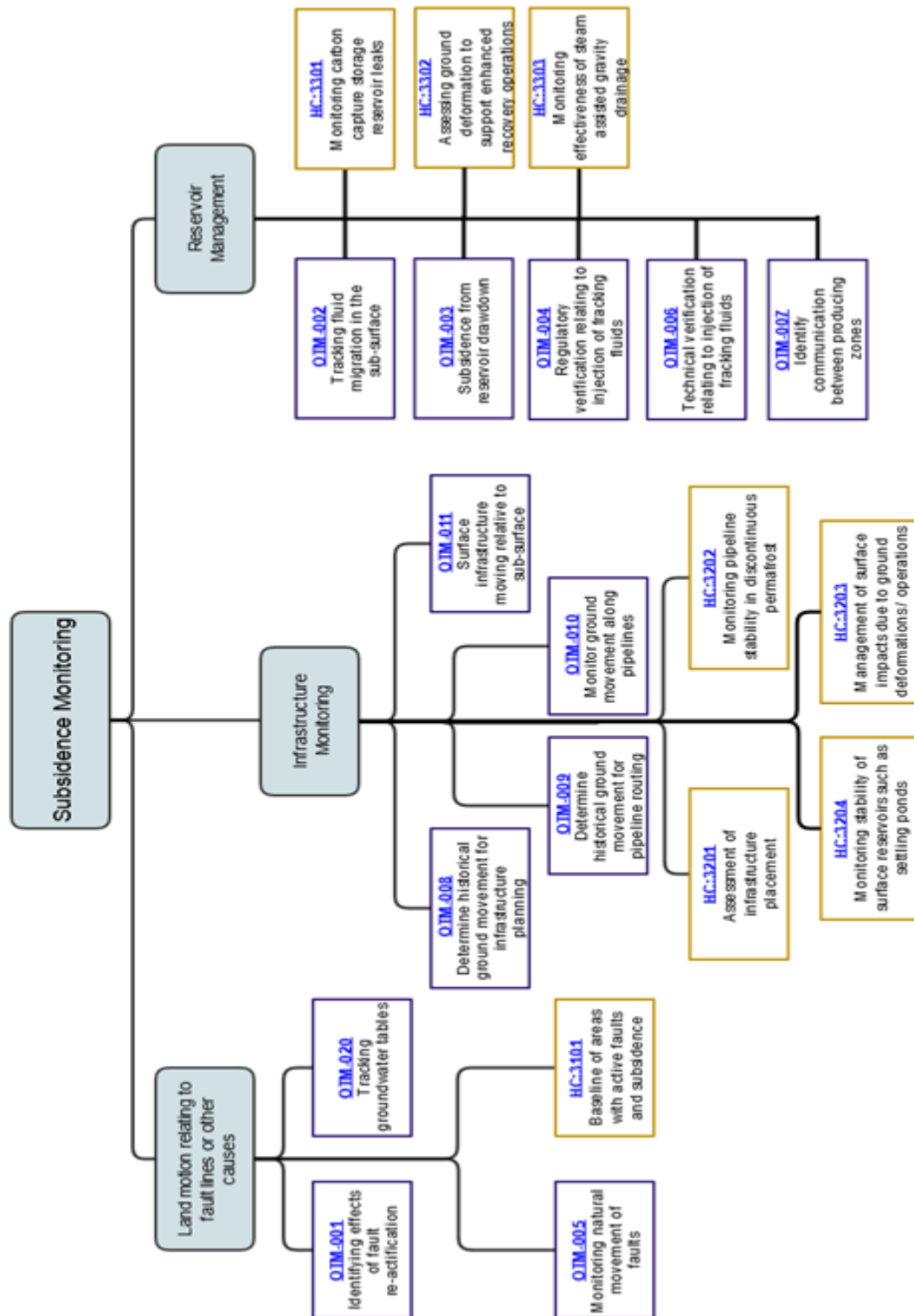


Figure 6-6 : O&G Industry challenges - Subsidence monitoring

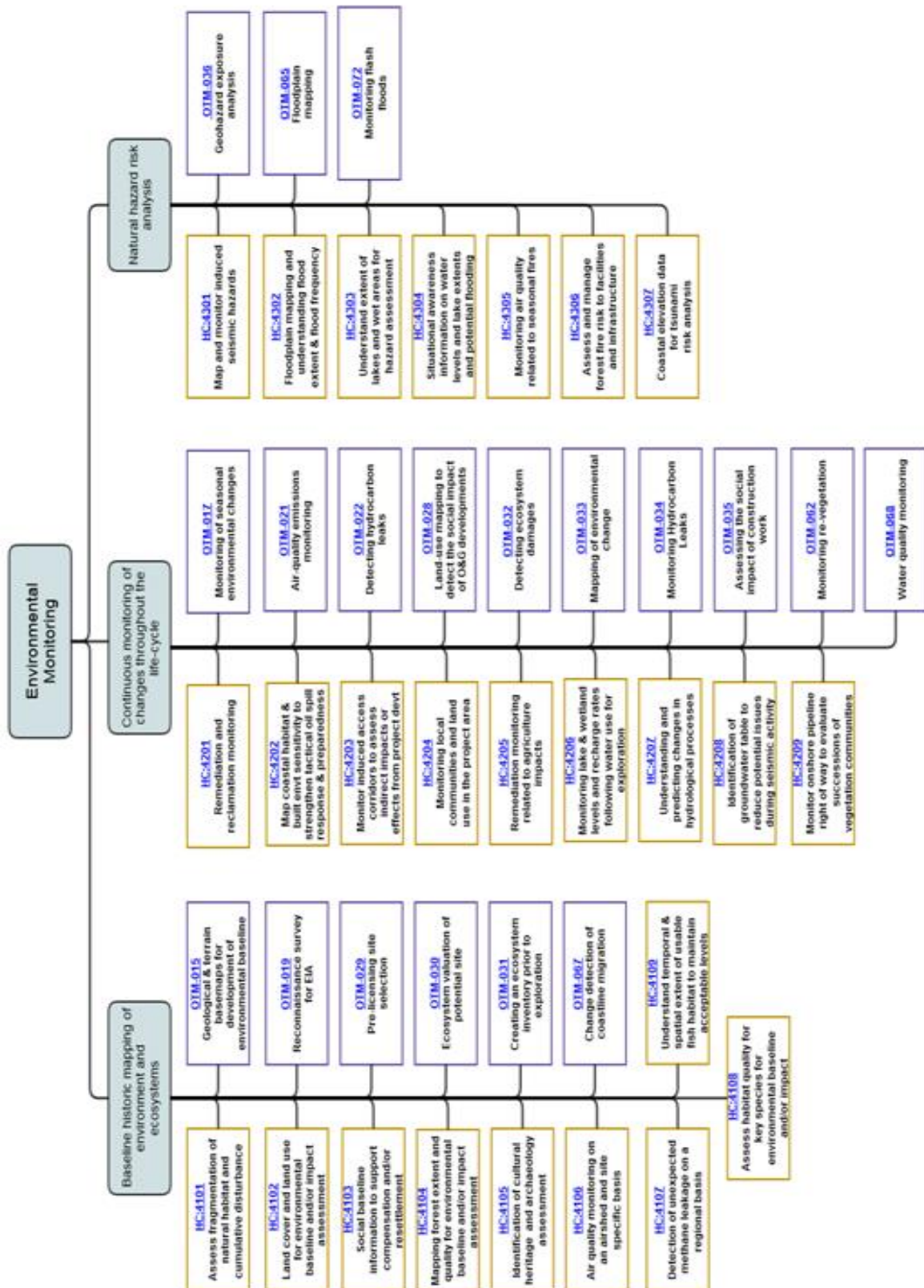


Figure 6-7 : O&G Industry challenges - Environmental monitoring on-shore

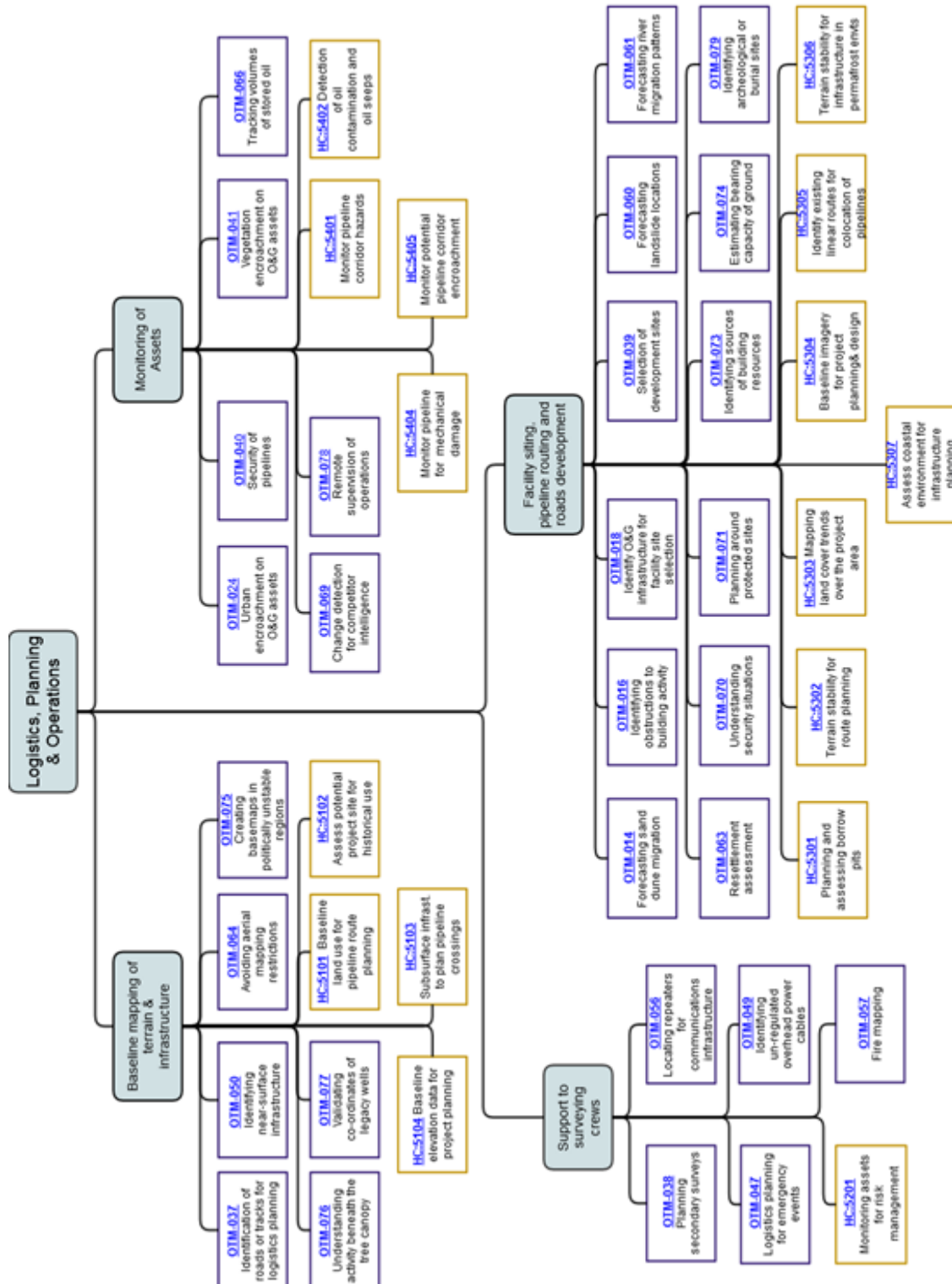


Figure 6-8 : O&G Industry challenges - Logistics, planning & operations

7 CONCLUSIONS

A new or rather updated EO service taxonomy is presented. This covers both market and 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 world. 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

Table 5 : Verbs definitions following Cambridge online.

ANNEX 2: EARSC COMPOSITION OF MARKETS

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, logistics.
	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.

Table 6 : Composition of Sectors under EARSC Market taxonomy.

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