

Earth Observation Responses to Geo-information Market Drivers

marine



agriculture



property



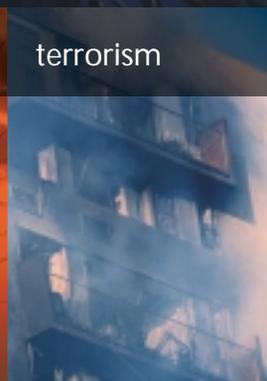
forestry



energy



terrorism



Insurance Sector | Summary Report

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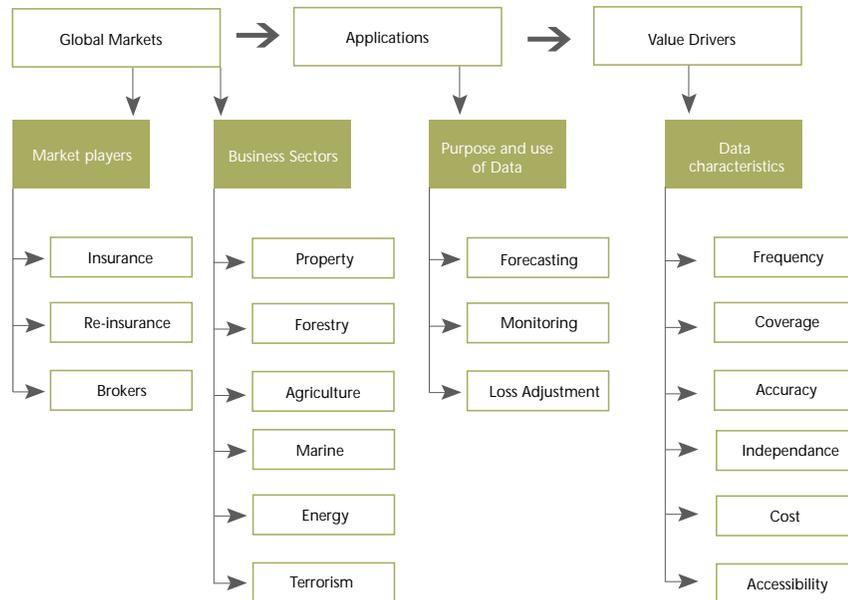
Introduction

This interim summary report has been produced by Aon Limited and ESYS plc under contract ESRIN/Contract No. 17814/03/I-LG: Earth Observation Responses to Geo-information Market Drivers – Insurance Segment. It summarises three deliverables on the use of geo-information in the insurance industry.

Deliverable 1.1 aims to provide an overview of the insurance industry and the main drivers from the insurance perspective. It then identifies and focuses on those aspects of the insurance industry which have a demand for geo-information and could potentially use Earth Observation (EO) data. Deliverable 1.2 looks in more depth at current geospatial information utilisation in the insurance industry, while Deliverable 1.3 identifies blockages to wider use of geo-information and Earth Observation based information services¹. All three deliverables are written from the insurance perspective.

Understanding insurance in general, and the use of geo-spatial information in particular, and appreciating the limitations of geo-information from the insurance perspective provides a valuable input to a realistic analysis of opportunities for EO information and services.

This summary report is intended to help the EO industry understand the insurance market and prepare responses to specific market opportunities.



Our analysis of the listed insurance sectors aims to identify where the EO industry can develop value propositions to meet insurance market needs using the above criteria. This will feed into subsequent work, carried out by ESYS to match market opportunities and EO technology developments and options.

¹ Copies of the full reports are available from ESYS plc and Aon Ltd. Contact details are provided on the back page of this summary report.

² All reference to 'insurance' in this survey and the main reports excludes personal lines and are in respect of commercial general insurance.

What is insurance?

Insurance is the business of transferring risk. Risk may be defined as the possibility of meeting danger or suffering loss. Many definitions of insurance risk exist but all include the criteria of uncertainty and the effect of an adverse or harmful event. Organisations and individuals learn to mitigate risk and provide for risk in different ways. One way to mitigate the financial implications of a future event is to transfer the liability of potential losses arising from the event to another party, through insurance.

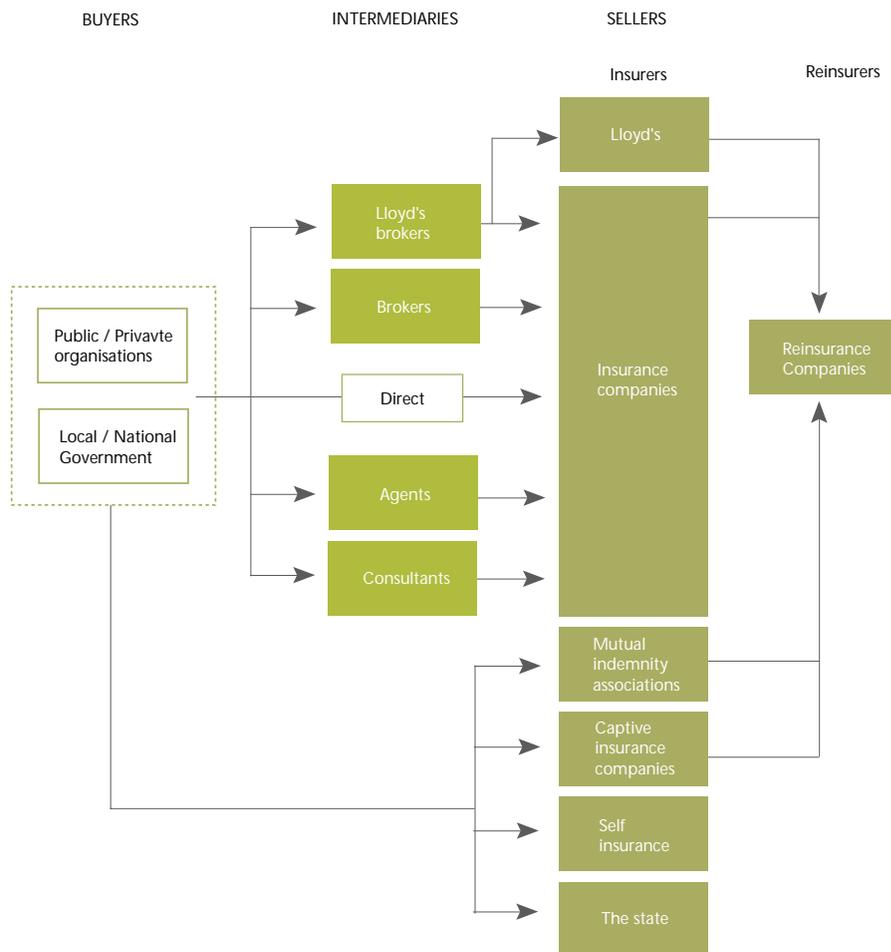
General characteristics of insurable risks are shown in the diagram below. An important consideration is that insurance is generally not available for totally predictable events.



Not all insurable risks are insured. At one extreme, for low severity, high frequency risks, buyers may choose to retain and mitigate risk on their balance sheets. At the other extreme, for high severity, low frequency risks, governments may step in to provide financial protection.

Who is involved?

There are up to five parties (buyer, intermediary, primary insurer, reinsurance broker and reinsurer) and two principal transactions (insurance and reinsurance) involved in the risk transfer process.



Buyers: Governments, public entities (municipalities), corporations or voluntary associations as well as private individuals are all buyers of insurance products. In essence, any individual or group who have a risk that meets the criteria given above can transfer that risk to a special financial vehicle and/or to the insurance industry.

Intermediaries: The traditional, and still the most common, way for a buyer to take out an insurance policy is to use the services of an intermediary or broker, who is experienced in the transaction of risk and insurance products. However, with the advent of primary insurers, who sell exclusively by telephone or via the internet, many insurances (such as motor, home, travel) no longer require the services of an intermediary.

Primary Insurers: The different types of insurer are summarised below:

- Insurance companies can either take the form of composites, offering numerous types of insurance (e.g. Allianz, Royal & Sun Alliance, AIG), or specialists, which write only one or two lines of business (e.g. Westminster, Catlin). Insurers may undertake a range of activities, including risk surveying, underwriting, claims handling and investment management.
- Mutual indemnity associations are owned by their policyholders, who usually have some common exposure, with profits being returned to members (policy holders) through reduced future premiums and / or increased policy benefits (e.g. OIL Insurance Ltd. Bermuda, EMANI, NFU and many other agricultural mutual insurance societies).
- Captive insurers are "in-house" insurance companies, set up and owned by large corporations to underwrite certain of their risks. In addition to achieving certain tax efficiencies, captives retain premiums within the organisation, avoiding the loss of finance to the insurance market.
- The state / government, in addition to being a buyer of insurance, can also act as an insurer (or reinsurer), particularly in areas where the insurance market is unable to offer cover and there is a need for protection.

Reinsurers: Reinsurers are similar to insurers, except that they provide insurance coverage to the primary insurers. That is, they insure the insurer. Unlike primary insurers, reinsurers buy portfolios or books of business from the primary insurer. To this end, reinsurers are interested in the aggregation of risk not only from the book of business being transferred but also the aggregation across books.

To summarise, liabilities attached to any risk transferred to the insurance market will become the interest of a number of different parties. The insured retains a level of exposure and one or more insurers will cover a proportion of the transferred risk. These insurers will probably reinsure part of the liability – perhaps a catastrophe layer into the reinsurance market. Insurers and reinsurers thereby share these liabilities and also the attached premiums.

The main data interests of the parties are summarised below.

Buyers

- Understand size of their risk and risk appetite
- Determine amount and cost benefit of risk transfer
- Determine balance sheet impact of retained risk.

Insurers

- Determine pure premium risk in transaction
- Support new product design
- Monitor liabilities
- Claims management
- Monitor risk aggregation within and across lines
- Manage compliance on solvency requirements.

Reinsurers

- Determine pure premium in pricing reinsurance
- Modelling and pricing catastrophe risk reinsurance
- Monitor risk aggregation within and across lines
- Manage compliance on solvency requirements.

Key issues facing insurance today

Regulatory requirements

The insurance industry is facing increased control and financial regulation, principally to ensure it maintains adequate levels of financial reserves to meet potential future liabilities. There is significant emphasis on identifying, gathering and aggregating data, including balance sheet position and market exposure data, internal loss history, relevant risk indicator data, subjective assessments of exposure and consideration of long tail liabilities (long time lag for liability emergence or claims settlement). There are also regulations where governments may require insurers to take on risk compulsorily, such as environmental risk, terrorism etc.

Increased complexity and globalisation

Insurance and risk transfer products are constantly reacting to greater complexity in business activities (e.g. outsourcing and “just in time” supply management change the risks associated with business interruption). Globalisation means companies are expanding into new political and operational environments (for example, the drilling of oil and gas in politically/socially unstable countries). Credit derivatives, political risk insurance and terrorism insurance demonstrate the insurance market’s ability to allocate capital to new risks, which corporations wish to transfer off their balance sheets.

Volatility in cost and market cycles

The insurance market is cyclical. “Soft” market conditions, when premium rates decrease (usually due to over capacity) are followed by generally shorter and sharper periods of “hard” market conditions. In recent years, increasing frequency and size of loss events, coupled with falls in investment income within the insurance industry, meant a return to “hard” conditions (with the reduction / withdrawal of cover and an increase in premiums). Over time, buyers also have different appetites for risk retention. Insurers generally see the market softening in 2004/2005.

Balancing buyer and investor needs

As in any service related business, insurance must be responsive to its buyers’ needs. Capital is used to underwrite specific lines of risk against which investors are prepared to commit capital. The insurance market’s ability to underwrite specific risks is based on the industry’s ability to balance risk transfer against return on capital. In turn, capital allocation and availability will vary from year to year, depending on market performance in previous years and fresh inflows/outflows of capital from corporate and institutional investors.

Credit rating

For any buyer of insurance, the rating of the insurer (e.g. Standard and Poors, Moodys or Fitch) is the key indicator of the insurer’s ability to underwrite the risk and pay any claims. The same is true for reinsurers. Thus, a high rating (AAA+) indicates strong financial security, and a low rating (BB) indicates marginal financial security which could lead to difficulties in meeting future financial commitments. Since the beginning of 2002, there have been 47 downgrades and only three upgrades among the largest 150 reinsurers. In this environment, insurers and reinsurers are placing greater value on improved risk information to provide a better understanding of the risk being written and to model and monitor risk accumulation and exposure across their portfolios.

In parallel, these demands coincide with requirements from regulatory authorities and investment institutions for greater transparency and openness on the risks and liabilities insurers face.

Premium estimation

In principle, insurance premiums look to cover expected claims (for the corresponding policies), operating and administrative costs and a return on investment for the capital providers: this is known as the fair premium*. In strong equity markets, any underwriting losses are usually covered by strong investment income making up the shortfall. In addition, providing losses are not catastrophic, the annual cycle of premium renewal means that the effects of one year's loss could be reduced the following year by increasing premiums.

The old model of recovering losses in future years was severely tested between 2000 –2003, when low premium income coincided with severe falls in global investment markets. Generally, this has created pressure on insurers to develop more sustainable risk transfer pricing models.

Cost of claims

Having underwritten a risk, an important way for an insurer to maintain or improve profitability, is to reduce administration costs and claims paid. Loss adjustment service quality is benchmarked by clients on the following criteria:

- Speed of response post event
- Time to completion of the claims process.

Extended delay in settling claims has cash flow implications for the insured and complicates reserving and compliance for insurers. Regulations are expected to increase, adding pressure for insurers to improve claims settlement times.

Geographic penetration

The United States, Switzerland, Japan, United Kingdom, Italy, France and Germany and Bermuda represent the countries where the major insurers and reinsurers are based. They also represent the main insurance markets – but also the most saturated. International insurers and reinsurers are looking for opportunities to expand their traditional products into new markets – it reduces portfolio risk and increases market opportunities.

Markets in Eastern Europe, South East Asia and South America represent the greatest potential – but also markets with the least underwriting information.

*Definition: In this summary and main reports, Fair premium reflects expected claims (for the corresponding policies), operating and administrative costs and a return on investment for the capital providers. Pure premium is the part of the premium which covers costs associated with expected losses, that is, the losses themselves and loss adjustment cost.

New products – Alternative Risk Transfer

The insurance sector, along with other elements in the financial services sector, are developing products that either reduce financial volatility for their customers (e.g. weather covers or weather derivatives) or reduce exposure to low frequency - high impact risks (e.g. catastrophe bonds). These products often relate to risks associated with weather or natural events and rely on measuring the key natural phenomena accurately and consistently, using an agreed methodology. Payments are made according to an agreed formula or conditions based on index points beyond a particular threshold – the strike level or ‘trigger’.

Climate change

Climate change is becoming a serious issue for the insurance industry. Given that climate change is most probably already altering the weather, and catastrophe risks may be rising by as much as 4% per year, ¹then the inaccuracies associated with using loss data from the past 5 or 10 years to project future losses could be quite considerable. The insurance industry is responding to climate change issues by altering underwriting policies and developing new risk analysis tools.

Summary

Analysis of the issues above suggests that the greatest potential benefits of using geospatial information within the insurance sector (and EO data specifically) are likely to be:

- Reduced insurer losses through improved forecasting of scale, frequency and intensity of natural events and hence better pricing.
- Reduced administration and operational costs by providing better measurement and monitoring of exposures.
- Reduced frictional costs of risk transfer and improved profitability of insurers by reducing fraudulent claims ex post event.
- Increased geographic penetration of insurance in developing countries.
- Expansion of the range of insurance products available.
- Reducing the cyclical nature of the insurance market.

¹Source: Dr Andrew Dlugolecki ‘A changing Climate for Insurance’: A Summary Report for Chief Executives and Policymakers June 2004



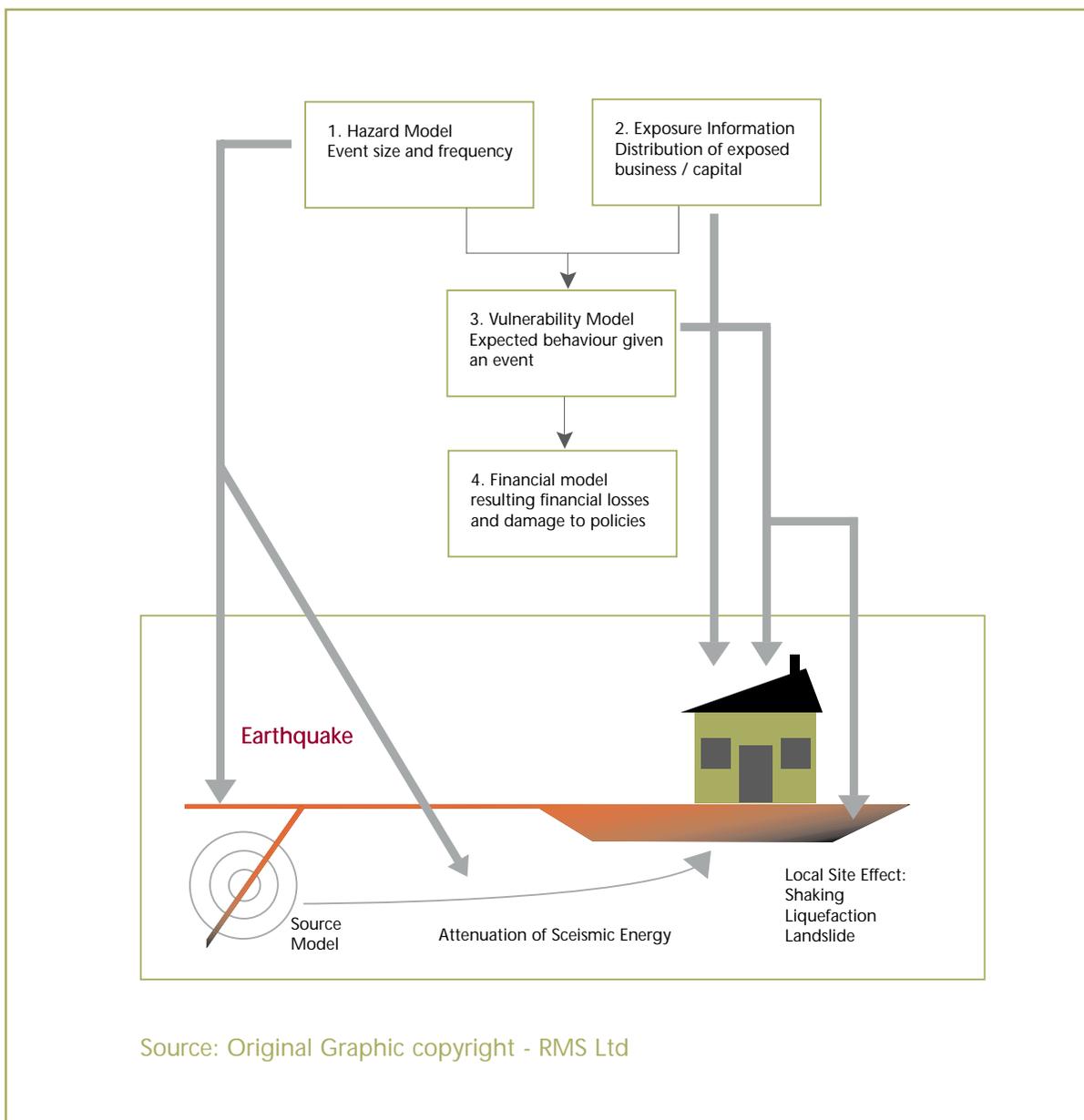
Market sectors with an interest in EO

Property

With respect to property insurance, this study focused on losses from natural perils. In the insurance / reinsurance industry, these losses are generally covered under the fire and property class of business and relate to physical damage and business interruption. Events are generally categorised as catastrophic (high severity / low frequency – e.g. hurricanes, earthquakes) and non-catastrophic risks (low severity / high frequency – e.g. subsidence, local flooding, fire), although definitions are starting to blur with climatic changes. The pricing of risk due to natural perils, and catastrophe risk in particular, has become more technically based over the last decade

Non-catastrophe risk rating – Insurance underwriters require information to assist in the assessment of individual risks. Traditionally, historic loss data was used. To some extent, this data is now being combined with or substituted by geospatial information to determine location more accurately and therefore improve the relationship between historic losses and future liabilities associated with an insurance programme.

Catastrophe modelling - The key element of this process is the determination of the probable maximum loss (PML) that could arise from a natural catastrophe. The insured, the insurer and the reinsurer use tools to determine accurately their accumulated PML combining hazard, exposure, vulnerability and financial models. Today, models of varying sophistication are available to estimate PMLs.



These include:

- Deterministic PML – a ‘what if’ loss estimate designed to analyse what loss an insured or insurer could incur should a specific historic event occur again today.
- Probabilistic PML - an estimation of the accumulated losses from events that potentially may occur. This often takes the form of a loss associated with a certain exceedance probability (or return period).

The usage of catastrophe models is now an integral part of the reinsurance transaction. It is also becoming a standard practice for insurers to present their PMLs from one of these models (usually through an intermediary), in order to negotiate terms for the cover they seek. In addition, they are also used by underwriters for exposure tracking, portfolio management and pricing of risks.



Energy

Traditional insurance products cover property damage for installations. Energy sector drivers are resulting in increased investment in sustainable and renewable energy sources. This is triggering development of a range of weather products to limit revenue volatility, catastrophe bonds and products specially designed to accommodate risks associated with these new technologies and renewables.

Market and trading risks: Conventional power generators are continually developing new strategies to manage their diverse demand side risks, as electricity cannot be stored once produced. One major cause of variability in demand is weather. Few sectors are more vulnerable to, or influenced by, the variability and unpredictability of weather than power generation utilities. Energy companies will also have new risks associated with increases to their renewable energy capacity. The EU has established a target of 20% renewable energy by 2020. This is likely to be from wind, biomass and solar sources, but tidal and wave technologies are also included. The greater a generator's overall reliance on renewables, the greater the likely aggregation of earnings volatility, as, in general, both supply of fuel and demand will be directly linked to weather.

Operational risks: These include asset performance and system risks. Loss of availability due to mechanical failure and physical damage is the most important insurable risk. The loss applies both to the repair or replacement of the damaged generation sets, but more importantly, to the contingent business interruption exposure in deregulated markets. Sudden and unexpected outages create potentially massive market exposure as generators have to use the spot market to meet supply obligations to the system. Therefore, extreme events such as windstorms create both risks of property damage as well as business interruption. Power generation, transmission and distribution companies are becoming increasingly aware of the overall risks to capital posed by short term extreme changes in weather conditions and patterns, and over the longer term, changing climate.

Security of supply: Another long term risk the industry faces is that of 'security of supply' of fossil fuels. By 2012 the European Union is faced with the prospect of energy imports rising by more than 150% to meet an increase in consumption of 50%. Much of this supply will be sourced from and delivered through politically unstable regions, leaving the EU exposed to interruption risks. This creates very significant political risks associated with interruption of supply.



Forestry

To all intents and purposes, traditional 'forestry insurance' has meant insurance of property, that is the plant and equipment associated with timber processing. However, the recent forestry 'crop' insurance business has been problematic and never developed global portfolios due largely to inadequate data about remote forests, tree crops and their natural environment.

In addition, knowledge within the insurance sector regarding the risks associated with the growing of the trees themselves (e.g. forest fire or wind damage, or rainfall effects on tree crop yields) is scarce, and this contributes to the lack of forestry insurance globally. It is estimated that only about 0.5% of commercially usable forestry (including plantations) is insured. Additional factors include the high cost of selling insurance to rural-based forest businesses, the lack of an institutional infrastructure and appropriate risk assessment and insurance skills at the national and local level. Between 2001-2003, where forestry insurance was available, there were high levels of losses within insurers' forestry portfolios. It is not surprising, therefore, that there is so little insurance capacity available to the forestry sector globally.

However, there are a number of changes now occurring within the forestry industry which are increasing the requirement for insurance. The most important of these is the increasing trend (and legal obligation) to move away from cutting native forests to plantation based production. This brings a need for forestry companies to protect their investments which could be five times greater per hectare under a plantation system. Furthermore, environmental and legislative pressures have reduced timber companies' ability to buffer variations in annual plantation cut by harvesting standing native timber. Finally, there is strong evidence of a very marked increase in fire risk over the last twenty years due to land use changes and climate change.



Agriculture

Agribusiness uses a mixture of insurance and government subsidies to mitigate risk. The main insurance markets are in the EU, Australia and USA – each market has its own structure depending on the agricultural sector structure, crops, natural hazards and the level of government intervention. For example, in the EU the Common Agricultural Policy (CAP) has set the rules, regulations and support mechanisms across all member states (MS) for agricultural production, and assures farmers a base price for all production. This system of agricultural support has generally discouraged the use of private insurance solutions, and has been a disincentive for farmers to implement risk management structures. This system, which protects farmers against fluctuations in global commodity prices, is now being progressively dismantled, which will expose European farmers to world commodity prices and volatility, technology changes and a reduction in inputs. As a result, agricultural insurance is likely to have an increasing role as a risk management tool in arable and livestock farming.

In Australia the farming sector is extremely susceptible to drought. Over the next 10 years, irrigation water allocation and availability will be the biggest single determinant in what is grown, where, and with what success. There is likely to be increasing government intervention in the form of new policy measures, which will result in major land use changes and may result in a national water use policy.

In the USA, consolidation and vertical integration by large food companies into agro industrial consortia is leading to the entry of a much more sophisticated buyer of insurance, with greater volume of risk and ability to take significant first loss either on the balance sheet or via captives.

Taking into account global variations, two common forms of insurance for the agricultural sector are:

- **Crop Hail Insurance.** This can be broadly divided into two major groups – broadacre field crops such as cereals, potatoes and oilseed rape and high value, principally horticultural crops, such as fruit, vines and vegetables. In the case of broadacre crops, the loss is based on a damage rating, whereas with high value crops it is based on a damage level and loss of quality assessment.

The uptake of this type of insurance is extremely stable across Europe, and forms the backbone of the agricultural insurance sector's activities and offerings. With the exception of Italy, Portugal, Poland and Hungary this form of insurance is not subsidised within the EU.

- **Multi Peril Crop Insurance (MPCI)**. This is a yield-based product, triggered at the point of harvest where the indemnity is based on the financial loss (based on measures of both yield and quality at a farm level) below an average return per hectare of a reference period. Cover is usually only available where farmers include all individual crop acreages within specified districts within an MPCI programme. There are no excluded natural perils. Farmers normally have a deductible – usually between 30% and 50% of average yield. The need to establish and verify historical crop performance creates significant moral hazard for farmers and potential problems for insurers. Claims on MPCI are not differentiated by cause of loss – multiple perils are covered unless loss can be proved to be the result of poor management. However, the need to establish that the cause is insured and not excluded, creates potential problems and costs for insurers.



Marine

Marine insurance is arguably the oldest class of insurance and is categorised as follows:

- Marine hull (including collision liability) is concerned with insuring the vessel against perils such as weather, fire, explosion, piracy, collision liability and salvage charges.
- Offshore covers structures such as oil and gas exploration and drilling.
- Marine cargo / specie (high value cargoes such as precious metals, diamonds and cash) covers cargo (both on land and sea) against perils which could lead to their damage or loss. These are treated as separate forms of insurance with separate policies being written for each category.
- Liability is of more recent concern to the marine industry. Oil spills, which fall under the category of liability risk, can be significant (for example, Exxon Valdez and Prestige) and is a critical issue for the industry. Environmental awareness and a shift towards a litigious culture have escalated the potential liabilities.

In recent years marine insurance has been characterised by sharp reductions in premiums as well as significant reductions in claims. In many cases, underwriters are not charging a fair premium for the risks they are assuming, being influenced more by corporate strategies, which seem to be holding rates artificially low. The implication is that in assessing pricing, marketing strategy overrides technical risk evaluation. However, it is doubtful that the market can sustain such underwriting losses for much longer.

Of the perils covered under marine hull insurance, the majority will have weather related causes (stranding, sinking, collision, heavy weather). Storm tracks are already monitored and insurance underwriters are well aware of the importance of limiting cover in areas with high probabilities of impact of specific storms.



Terrorism

Terrorism risk creates a challenge to the insurance market. It is neither homogenous nor predictable or particular to an individual country or state. Terrorism borders on what many would deem to be a risk which is faced by society as a whole. This would suggest that, as a risk class, terrorism does not lend itself to being insurable.

The terrorist attacks in the United States and Spain have dramatically changed the perceived risk levels faced by organisations as the threat from terrorism went from being 'localised', affecting certain regions or countries, to being a global issue. After such events the insurance market hardened considerably with huge premium increases not uncommon in many geographical regions. Indeed, in city centre locations many insurers even refused to write risk. This has meant that government have had to intervene, particularly where reinsurance is a condition of license (e.g airlines) As location is the overriding consideration in pricing terrorism insurance, principally to understand risk aggregation limits, this is the critical data insurers need to establish premium rates, along with level of liability. Underwriters also demand to know the risk mitigation procedures and security systems put in place by the buyer.

Why is EO rarely used?

This section (Report D1.3) summarises a number of key issues that currently create, or could create, blockages for the wider utilisation of EO data and is necessarily negative, focusing on the barriers to entry for EO data, but this should not be misinterpreted as a lack of opportunities. Very few in the insurance industry have any direct experience of EO data – even amongst the specialist insurance sectors, such as catastrophe modelling groups. On a more positive note, since the majority of risks transferred to the insurer / reinsurer have a geographical location, most insurers are already using geospatial information in one form or another.

Insurance is a very conservative industry

Brokers, insurers and reinsurers are inclined to stick to incumbent systems and techniques, unless there is an overriding cost benefit to changing. As the business is about risk transfer, the precautionary principal will always apply.

Underwriting informational requirements are currently well served

Traditionally, information from historical claims has been the main data source for the industry. Where new sources of geospatial data are being used these are often relatively inexpensive. For example, daily forest fire hazard assessments are becoming readily available on the internet and while these are not perfect solutions for insurers, being very general over large areas, they provide underwriters with a risk awareness and some useful information (for free).

Resources are required to validate new products and services

Before new systems of measurement or analysis are likely to be adopted, insurers will insist that they are correlated to existing historic data sets or validated over extended periods of time (many years in some cases). This implies substantial development costs in terms of resources and time.

The insurance industry does not currently have the right skill sets to adopt EO methods

Most underwriters and insurers use geospatial data to the extent that they enter location information on risks (e.g. grid reference or post code) for risk aggregation and accumulation models. Major barriers to moving from existing geospatial information to EO based methods are availability of resources and the fact that the specialist skills required do not generally reside in the insurance industry.

Insurance is a global business

In general, insurance products are either national or global in coverage. EO data's potential to be provided on a global or regional basis could be a valuable quality, but will need validation against existing sources and methods.

There are concerns over data continuity and reliability

Continuity and consistency are critical qualities, and any system adopted must be able to guarantee very low probability of interruption of service. A key concern expressed by insurers of switching from current sources of geospatial data to EO data is the unknown technical reliability and continuity of EO data.

Insurance industry structures are inflexible

EO methods must be adaptable to the insurance industry business processes. Structural issues could limit the potential for EO data sources or technologies:

- The industry's ability to access and use EO data sources may be constrained by current systems and accepted methodologies (i.e. basically statistical rather than geospatial).
- The insurance industry, generally, has the option to adjust premiums annually which limits its interest in investing in very sophisticated long term data modelling techniques that might provide a better forecast of future losses.
- The insurance sector is dynamic in nature, where insurers' marketing and market share objectives can override technical evaluation of risk and therefore the value of data that improves that risk assessment process.
- In the claims process, the insurer needs two distinct data sets - establishing the cause and quantifying the impact of loss, and confirming the validity and size of the claim.

These processes have developed over time, with the buyer of insurance and insurer having to be

satisfied the process is fair and accurate. Any change will be constrained by these historic working practices and the perceived benefit being greater for one party.

Specific market opportunities

This section is developed from the contents of Report D1.2. In the following tables we have attempted to identify a range of insurance products where the geospatial data required would appear to have a potentially interesting fit with EO. They are categorised by the following phase in the risk transfer value chain:

- Risk forecasting
- Liability and policy compliance
- Loss adjustment and claims management

We have listed typical geospatial data measurements required, against an initial product specification using the following criteria:

- Frequency
- Coverage
- Accuracy
- Cost
- Accessibility

The list of products and their specifications are by no means complete. They are offered to encourage dialogue between the EO community and insurance sector, ideally leading to a constructive debate in identifying ways EO can improve the insurance sector efficiencies and the range of products it offers its clients.

Risk Forecasting			
Sector	Insurance Product	Measurements required	Key Product Specification Criteria
Property	Subsidence risk mapping	<ul style="list-style-type: none"> Vertical ground movement Soil type Soil moisture deficit Location trees / vegetation Buildings stock ² 	<ul style="list-style-type: none"> Frequency – monthly / quarterly Coverage – Nationwide (high risk areas = high resolution) Accuracy – high risk in cm, nationwide in m Costs – ground movement competitive as will be combined with other data Accessibility – expert provider²
Property	Windstorm catastrophe event forecasting	<ul style="list-style-type: none"> Wind speed Wind direction Digital elevation Surface roughness Buildings stock ² Meteorological measures (e.g. as used in Numerical Weather Prediction (NWP)) 	<ul style="list-style-type: none"> Frequency – DEM = single, NWP + other wind parameters = measuring parameters on regular basis. Coverage – OECD countries Accuracy – DEM = 2 - 5m, NWP = km Costs – competitive with alternative sources Accessibility – DEM configured for intermediate user, NWP for expert.
Property	Flood risk and impact forecasting	<ul style="list-style-type: none"> Digital Elevation Flood defences Land cover / land use Buildings stock² Historic floodplain 	<ul style="list-style-type: none"> Frequency – DEM = 1 off, land cover & flood defences = every 5 years Coverage – Global @ national level Accuracy – Detailed for urban and river basin / coastal catchments. Costs – competitive as premiums from flood limited in many countries. Accessibility – expert provider³.

² Buildings stock – information used to determine size, type and construction of buildings; could also be relevant for other assets such as vegetation / infrastructure, etc.

³ Expert provider – GIS and EO processing capable org such as MapInfo, ESRI, Ambiental

Risk Forecasting			
Sector	Insurance Product	Measurements required	Key Product Specification Criteria
Forestry	<p>Fire insurance Risk Index -</p> <p>A) For underwriting</p> <p>B) For buying reinsurance</p> <p>Product assumes that forestry portfolios have low numbers (<500) across globe. Hence index has to be specific to forest locations.</p>	<p>Direct Index measures</p> <ul style="list-style-type: none"> • El Nino cycle forecast • Rainfall departures from the mean • Soil and ground fuel moisture • Forest health/vigour • Hot spots & wildfires location intensity & extent • Burn scar <p>Asset information</p> <ul style="list-style-type: none"> • Forestry boundary/location identification • Forest species mix • Soil type • Human habitation 	<p>Direct Index measures</p> <ul style="list-style-type: none"> • Frequency El Niño/La Niña– quarterly; Rainfall: min monthly; max daily; Forest health – annual; Hot spots and wildfires - daily; Burn scar- monthly; Soil & fuel moisture - min monthly, max daily • Coverage El Niño/La Niña - global with regional implications; Rainfall & Forest health; minimum regional – ideally location specific for forests covering insurers' entire global forest portfolio • Accuracy Rainfall & soil moisture grid scale 25km2 measure accuracy + 2% of terrestrial measure; Wildfires 0.1km2, Hotspots 0.05km2 • Costs – competitive with aerial or land monitoring • Accessibility – data format compatible with insurers' systems; instant access over internet <p>Asset information</p> <ul style="list-style-type: none"> • Frequency – max monthly • Coverage – min regional maximum location specific and global – covering insurers global forest portfolio • Accuracy – + 2% of terrestrial measure • Costs – competitive with aerial or land monitoring • Accessibility – data format compatible with insurers

Risk Forecasting

Sector	Insurance Product	Measurements required	Key Product Specification Criteria
<p>Agriculture</p>	<p>MPCI Loss forecasting and risk rating</p> <p>Product assumes high volume of crop plots (100s) within any country. Hence much data is country /county-specific. There is risk spread within any country.</p>	<ul style="list-style-type: none"> • Planted areas by crop/type at specified date(s) • Harvested areas by crop/type at specified date(s) • Crop development – periodic yield estimates • Agronomic conditions; Soil moisture deficit; crop vigour/growth stages, crop disease etc • Weather events including hail, flood, drought, frost. 	<ul style="list-style-type: none"> • Frequency – data sets need to provide sufficient information on crop development, quality and yield to enable insurers to design programme and rate risks. Measurement frequency is therefore likely to be at least daily to cover mix of crops/locations. <ul style="list-style-type: none"> - Historical records – 10 years minimum correlated to terrestrial weather data • Coverage – max = EU 25 nations; minimum = individual countries as they come on line in non EU guaranteed programme. Drought is progressive and can be regional, all other weather events on field basis as have specific time of occurrence • Accuracy – crop location – exact grid ref coordinates; <ul style="list-style-type: none"> - yield estimates + 5% of actual accurate ground measurement⁴ - soil moisture etc - + 10% actual on a field basis - flood depth, extent and duration + 5% actual of areas effected on a field basis • Cost – comparable to the land based maps and aerial maps. • Accessibility – data format compatible with insurers' systems; instant access over internet

⁴ 5% as in many parts of the world, yield measurement is not accurate due to poor yield measurements in the crop, high harvest in-field losses and inaccurate field areas.

Risk Forecasting			
Renewable Energy	Revenue Guarantee - wind volume forecasting	<ul style="list-style-type: none"> • Correlated historical records – 10 years minimum • Forecast wind strength per site • Forecast wind strength per portfolio of sites • Forecast of wind strengths exceeding threshold for maintenance • Forecast of wind strength could result in physical loss or damage 	<ul style="list-style-type: none"> • Frequency – at least average wind strength per hour minimum 12 hours prediction, but longer forecasts also valuable. - as forecast period increases, need for accuracy declines. However accuracy needs to be better than 75%. • Coverage – site specific per windfarm. - some companies might need portfolio coverage of all windfarms • Accuracy – windfarm location – exact grid ref coordinates; <ul style="list-style-type: none"> - Power estimates vary with prediction period • Cost – value to utility will reflect forecast period, accuracy and reliability. High predictability could allow premiums for electricity in market. • Accessibility data format compatible with insurers' systems; instant access over internet
Terrorism (Property)	Property aggregation & concentration risk assessment	<ul style="list-style-type: none"> • Location of insured asset (most likely a building / floor of a building) • Asset value(s) per asset or policy • Aggregation of asset values and liabilities across insurers portfolio (per building/postcode/town/ country) • Enhanced visual data of assets providing information "beyond a map" • Identity of high risk assets outside insurers portfolio (e.g. nuclear power plants or public buildings) • Assessment of communication and transport nodes/bottlenecks 	<ul style="list-style-type: none"> • Frequency – monthly/quarterly updates • Coverage – OECD countries; metropolitan areas • Accuracy – Identifications to at least post code level – ideally at building level • Costs – Existing method of post-code value aggregation cheap, therefore costs must be minimal, unless demonstration of significant added value • Accessibility – Subscription based, access to online database / maps of underwriter's aggregated risks

Liability and Compliance Monitoring

Sector	Insurance Product	Measurements required	Key Product Specification Criteria
Property	Earthquake – seismic activity monitoring	<ul style="list-style-type: none"> • vertical and horizontal movement • duration / strength / depth • soil type • land cover / land use 	<ul style="list-style-type: none"> • Frequency – monitoring – daily / hourly, • Coverage –nationwide / detail on specific region or fault zone. • Accuracy – cm resolution • Costs – competitive as leakage with other free data sets common (USGS) • Accessibility –expert provider³.
Property	Exposure and vulnerability monitoring (Developing Countries)	<ul style="list-style-type: none"> • Urban area mapping • Urban sprawl mapping 	<ul style="list-style-type: none"> • Frequency – annual • Coverage – OECD countries and S America • Accuracy – 10m • Costs – Insurer collaboration incentive (e.g. CRESTA organisation) • Accessibility – universal data format compatible with all insurers.
Property	Windstorm – meteorological processes and track monitoring	<ul style="list-style-type: none"> • Wind speed • Wind direction • Buildings location • Buildings damage • Infrastructure damage 	<ul style="list-style-type: none"> • Frequency – dependent on season / probability (monthly to hourly) • Coverage – Europe / USA / Japan • Accuracy – Km and meters • Costs – competitive as products already available • Accessibility – data format compatible with insurers' systems: instant access over internet

Liability and Compliance Monitoring

Forestry	Fire insurance Forestry Portfolio Risk Aggregation	<ul style="list-style-type: none"> • The same as for forecasting above, with added data for checking area of planted forest under active forestry planting / reforestation programme • Maintenance of fire breaks/access roads • Monitoring weed/grass levels or infestation along roads and fire breaks • Monitoring of illegal burning within and outside of forest, activities of neighbours • Allocation of fire fighting teams and equipment during fires • Water availability by river, dams, streams, ponds, tanks 	<ul style="list-style-type: none"> • Frequency – forest area at start and end of insured period (usually annual) - maintenance of roads/firebreaks at start of dry season - maintenance of drainage channels at start of wet season to prevent flooding of plantation. - illegal burning daily as for forecasting. - weekly monitoring of water available during dry season • Coverage – global • Accuracy – daily fire monitoring at 0.05km2 resolution • Costs – competitive with aerial survey or land monitoring • Accessibility – data format compatible with insurers systems, instant access over internet
Agriculture	MPCI Insurance programme monitoring service	<ul style="list-style-type: none"> • Crop areas by location • Crop type • Crop development • Harvested areas by crop/type at specified date(s) • Crop yield • Soil moisture index • Crop vigour & health • Crop management (irrigation, disease & pest control etc) • Local weather • Resources – e.g. water resources for irrigation • Compliance measures (e.g. hail nets) 	<ul style="list-style-type: none"> • Frequency – monitoring: likely to be at least daily to cover mix of crops/locations. Individual crops/fields might be on a lower frequency or at specific dates. - specific loss events – see loss adjustment below • Coverage – EU 25 at most; individual countries as they come on line in non-EU guaranteed programme. • Accuracy – crop location – exact field grid ref coordinates; <ul style="list-style-type: none"> - yield estimates + 5% of actual ground surveyed yields (not official yields) - soil moisture etc - + 5% actual on a field basis - crop management – identification of planting, irrigation and crop protection programmes • Costs – comparable with frequent aerial surveying or on-ground crop yield sampling teams (if no mechanised systems in place). Ground surveys can be major cost for extensive crops ripening over a short harvest period. • Accessibility – data format compatible with insurers' systems; instant access over internet

Liability and Compliance Monitoring

<p>Marine</p>	<p>Storm tracking impact on shipping speeds and efficiency</p> <p>Currently not an insurable loss; but data could introduce possibility.</p>	<p>Correlation between vessel speed/efficiency and storm conditions including:</p> <ul style="list-style-type: none"> • Wave and swell height • Wind speed and direction • Tidal streams (where significant and wind driven) • Identification of other vessels • Identification of hazards (coast, sea ice etc.) 	<ul style="list-style-type: none"> • Frequency – daily; hourly where conditions exceed agreed trigger points • Coverage - major shipping lanes • Accuracy - wave height – nearest 0.5 m; - wind speed – nearest 5 knots for gusts; - wind/tidal stream direction + 5o actual • Costs – no existing costs to compare. <p>Accessibility data format compatible with insurers' systems; instant access over internet</p>
<p>Marine</p>	<p>Hull and Liability Insurance - Identification of deliberate oil discharges and pollution</p>	<ul style="list-style-type: none"> • Vessel location and tracking • Location of discharge • Nature of discharge • Sea state monitoring • Weather state monitoring 	<ul style="list-style-type: none"> • Frequency – daily or hourly, sufficient to link vessel to discharge • Coverage – major shipping lanes • Accuracy – sufficient to con firm vessel identity • Costs – no existing costs to compare. • Accessibility – national and international maritime protection agencies would be primary buyers; insurers could buy access on subscription basis

Liability and Compliance Monitoring

Sector	Insurance Product type	Measurements required	Key Product Specification Criteria
Property	Subsidence – post event claims management	<ul style="list-style-type: none"> • Ground movement – pre and post event • Building damage – by house / area • Soil and vegetation movement 	<ul style="list-style-type: none"> • Frequency – immediate post event and weekly • Coverage – national and high risk areas in detail • Accuracy – cm and metres • Costs – competitive with aerial or land monitoring • Accessibility – expert provider³
Property	Earthquake – post event claims management	<ul style="list-style-type: none"> • Ground movement – pre and post event • Building damage – by house / area • Soil and vegetation movement 	<ul style="list-style-type: none"> • Frequency – immediate post event and weekly • Coverage – national and high risk areas in detail • Accuracy – metres • Costs – competitive with aerial or land monitoring • Accessibility – expert provider³
Property	Windstorm – post event claims management	<ul style="list-style-type: none"> • Wind speed – pre and post event • Building damage – by house / area 	<ul style="list-style-type: none"> • Frequency – immediate post event and weekly • Coverage - national and high risk areas in detail • Accuracy – metres • Costs – competitive with aerial or land monitoring • Accessibility – expert provider³
Forestry	Fire loss or damage	<ul style="list-style-type: none"> • Exact time of fire that affects insured forest • Cause or source of fire (direction of travel) • Damage boundaries/location identification • Damage rating by species, • Salvage index 	<ul style="list-style-type: none"> • Frequency – post event, at maximum, within 24 hours; - repetitions daily for up to a month - if salvage and reinstatement included – monthly checks of a year • Coverage – fire source (even if outside plantation) location and damaged forest. May also require monitoring of third party forests • Accuracy – + 2% of terrestrial measure • Costs – competitive with aerial survey or land monitoring • Accessibility – data format compatible with insurers' systems; instant access over internet

Risk Forecasting

Sector	Insurance Product type	Measurements required	Key Product Specification Criteria
Agriculture	Crop Yield Guarantee based on precipitation index - Claims payment Integrating precipitation & EO crop data	<ul style="list-style-type: none"> • Insured crop areas by location • Crop type – species differentiation (sometimes) • Crop development • Crop vigour & health • Crop management (irrigation, disease & pest control etc) • Soil moisture index • Precipitation • Local weather patterns and extent of yield-affecting loss events 	<ul style="list-style-type: none"> • Frequency – min weekly, max daily OR at specified intervals to match programme • Coverage – insurers portfolio of insured crops (likely to be national/regional) • Accuracy – Areas - +5% accuracy Growth -+ 5% accuracy • Costs – On ground monitoring of precipitation with weather stations, rainfall gauges, other monitoring to determine impact of uninsured causes of loss (e.g. Fire, disease, flood, frost, theft) • Accessibility – data format compatible with insurers' systems; instant access over internet
Agriculture	MPCI	<ul style="list-style-type: none"> • Cause of damage • Timing and duration of insured loss event (drought will be progressive loss; other weather events are shorter duration. • Estimation of loss (% yield or actual crop volume) at time of measure • Harvested areas as well as planted areas 	<ul style="list-style-type: none"> • Frequency – normally within hours of event; possibly requiring continuous monitoring where damage is progressive (e.g. hail or flood). Drought – continuous assessment to policy trigger point • Coverage - damage/loss by field or zone within fields • Accuracy – Yield – +1% OECD countries and +5% developing countries as existing data can be poor reference - Areas - +1% of actual • Cost - comparable with aerial surveying or on-ground crop yield loss assessment (if no mechanised systems in place). Ground surveys will be less frequent than for monitoring, but timing is critical as crop can deteriorate and evidence of insured losses is degraded. • Accessibility – data format compatible with insurers' systems; instant access over internet

Risk Forecasting			
Sector	Insurance Product	Measurements required	Key Product Specification Criteria
Marine	Oil /chemical spill – Pollution assessment	<ul style="list-style-type: none"> • Cause of spill • Location of spill • Scale of spill (i.e. depth x area) • Nature of chemical(s) • Movement of spill • Location of coast line and threatened assets 	<ul style="list-style-type: none"> • Frequency – within hour(s) of event (e.g. collision or running aground); monitoring on hourly/daily basis • Coverage – specific event • Accuracy – location and area of spill – exact coordinates; - volume of spill - + 10% of actual; - nature of chemical – chemical family to link environmental impact index/scale • Costs – probably quite price insensitive if it can remove doubt on cause and increase accuracy in assessment of liabilities • Accessibility - data format compatible with insurers' systems; instant access over internet

EOMD

ESA's Earth Observation Market Development programme is in place to address the needs and problems of the EO service industry such that the sector can collectively grow and prosper. A number of market segments are known to have an interest in EO products and services.

This study aims to:

- Characterise present geo-information utilisation within the target market
- Identify market drivers and analyse the impact on geo-information demand
- Characterise EO service capabilities and develop responses to drivers
- Review results and findings with the EO service industry
- Test prototype EO responses to the drivers.

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