

GMES

TERRAFIRMA

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Global User Needs Directory

U1

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EXECUTIVE SUMMARY

This document describes the set of potential worldwide users of the Service Portfolio proposed by *Terrafirma*. This group of users is presented through segmentation into user segments according to the motivation behind their use of the *Terrafirma* service portfolio, and their sector of activity. Each of the user segments identified by the Core User Group is described with a typical end user from this segment and a detailed description of the segment's needs. Where policy constraints on the segment exist, these have also been briefly identified with a view to introducing the reader to the C1 dossier Policy Foundation Review. Using the criteria of need, technical accessibility and influence, 8 user segments were identified:

Public Sector:

- Regulators, Government ministries and public authorities

Extraction Industry:

- Extraction: Mineral, Oil and Gas

Structural Engineering:

- Builders and constructors including engineering consultants
- Utility Operators
- Transport providers

Risk Assessment:

- Development initiators and property owners
- Information providers
- Insurers

Out of these user segments, 3 key user segments were identified as together providing at least 70% of the users likely to benefit from the service portfolio in the next 5 years:

- Public Sector,
- Structural Engineering,
- Extraction Industry,

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1 INTRODUCTION

1.1 Objective

Terrafirma aims to implement an operational pan-European ground motion information service in support of policies aimed at protecting the citizen against natural and anthropogenic ground motion hazards. Space technologies can be used to detect and monitor ground movements in relation to subsidence (and associated flood risk), building stability, landslides and seismicity. In the first phase, the project concentrates on urban areas affected by non-seismic ground movement.

The main objectives of this document are threefold:

1. to establish current and potential future end users and report their needs;
2. to structure this set of users into segments reflecting similarities in common interests and characteristics (for example needs, size, organisation or location). This will facilitate the analysis of user needs;
3. to identify a number of key user segments and provide focus for promotion and user federation activities.

This document describes the set of all potential users of the products and services proposed in this project. This set of users, referred to as the Global User Base, has been identified by the partner organisations chosen as representatives of these users. The choice of partner organisations involved in the user-oriented activities in this project has been driven by the need to have representatives covering as many of the major groups of potential users of these products as possible. These partners cover a significant proportion of the global user base for products and services from the Service Portfolio. The partners participating in the core user group activities are the following:

- Representing civil engineering and building sector: Arup
- Representing utilities: Enel-Hydro
- Representing geological surveys: BGS, BRGM, TNO

1.2 Document Structure

The objectives defined above are addressed in order. Initially, the methodology used for familiarisation with the global user base is introduced and its segmentation described. Each of the segments is then described in detail. For each segment the following aspects are discussed:

- definition
- typical end user
- identification of the relevant policy sectors for the segment as discussed in the dossier C1, Policy Foundations Review
- synthesis of the segment's user needs

Finally, a number of key segments are identified and their operational requirements set out.

1.3 Terminology and Acronyms

Global User Base	This is the complete set of all potential users (in the world) for a given set of services. It is made up of a collection of different user-segments
End User Segment	A user-segment is a collection of end-user organisations that have something in common. (<i>eg; all needing same type of service; all from same geographic region; all reporting on the same environmental policy; all unlikely to use the service; etc..</i>)
Key User Segment	An End User Segment that has been identified as being of high importance and likely to constitute with the other Key User Segments at least 70% of the users likely to benefit from the service portfolio in the next five years.
Infrastructure	In the context of <i>Terrafirma</i> , this term is used to signify the complete range of man-made structures or interventions.

Acronyms

SP	Service Portfolio
CUG	Core User Group consisting of: Arup, BGS, BRGM, Enel-Hydro, TNO
GUB	Global User Base

2 THE GLOBAL USER BASE

2.1 Familiarisation with the global user base

2.1.1 Methodology

Discussion among the *Terrafirma* partners that constitute the Core User Group (CUG) allowed the definition of the following methodology for the generation of a complete description of the global user base:

1. Definition of the end user segments using the CUG's operational experience in these sectors.
2. Selection of a set of representative users for each segment. Alternatively, the partner organisation best placed to inform the CUG on the identified segments was selected.
3. Generation and dissemination of a "User Datasheet" in order to ensure homogeneity in the information received.
4. Analysis of the mission and influence of the end users described in the completed User Datasheets and identification of the specific ground movement information needs of each.
5. Detailed description of technical data needs

This approach concentrates on the definition of user segments as a first, high level overview of the global user base. Members of the CUG competent in the specific segments defined are then tasked with the completion of detailed end user datasheets for a number of example end user organisations for each user segment. In this way the relevant CUG members provide information on end user organisations most similar to themselves.

2.1.2 User Datasheets

In order to derive information on the global user base an inquiry sheet was generated and disseminated to each of the CUG members participating in the "User Needs" activities. According to the user segments under their responsibility, each CUG member was required to either have these sheets filled in by specific end user organisations or fill in a "summary" sheet covering a user segment and provide example end user organisations.

A high-level synthesis of the information required on each User Segment is provided:

- Who are they?
- Why are they interested in ground movements?
- What do they need?
- How do they do currently address their information needs?
- How can they benefit from the Service Portfolio?

These questions form the basis for the construction of the user datasheet. The full User Datasheet is provided in Annex 1.

2.2 Deriving User Segments from the Global User base

The segmentation of the global user base into groupings of similar end user organisations is intended to provide a more useful description of the market interested by service portfolio products and services. As well as allowing a preliminary synthesis of user needs, this process helps clarify promotional activities in other project work packages.

The segmentation of the global user base has been based on two factors:

- **Why is this end user organisation interested in ground movement information?**

For each segment, information about ground movements is required in proximity to certain infrastructure elements. The distillation of a useful segment structure from the global user base is thus driven by the relationship of the end user to the infrastructure element of interest to them.

- **What is the sector of activity of the end user organisation?**

A second factor, key not only to the way in which the user defines their data needs, but also how they can be most effectively targeted with promotional material, is their sector of activity.

2.3 User Segments

For Stage 1 and much of Stage 2 this project is focused on urban subsidence. The CUG has thus decided to take into consideration all organisations that intervene in these urban regions with potentially unstable ground. Such users include those organisations whose work might be affected, directly or indirectly, by the impact of ground motions. They might be interested in the cause of underground instability such as property owners or owners of equipment located in unstable areas, organisations whose responsibility it is to monitor instability, state decision makers, information providers or insurance companies. A difficulty that is already evident, is the **diversity of the users**.

The following user segments are proposed:

Public Sector

- Regulators, Government ministries and public authorities

Extraction industry

- Extraction: Mineral, Oil, Gas

Structural Engineering

- Builders and constructors including engineering consultants
- Utility operators
- Transport providers

Risk Assessment

- Development initiators and property owners
- Information providers
- Insurers

Note: Research organisations are also listed but not initially considered as users included in the global user base.

3 CHARACTERISATION OF USER SEGMENTS

3.1 Introduction

Section 3 introduces each of the user segments that have been defined through a brief description of a typical end user, the identification of relevant policy that applies to the segment and a summary of its main information requirements.

Information requirements for a given segment can change according to the timing of these needs. For this reason, timing of requirements is taken into account in the presentation of the information requirements for each segment. The information requirements are presented qualitatively classified into the two types described below:

- Technical needs:** There are many technical needs for information on ground motion. Basically, the information needed is measurements of ground motions over large areas, at useful accuracies, that are affordable, reliable and accessible. The requirements also cover near real time constraints and speed of access. For many users, more elaborate information products are needed which help improve understanding of the causes of the ground movement.
- Commercial needs:** There are also many commercial needs for delivering information on ground motion: (1) Cost reduction, management of risk and protection of reputation and brand image, (2) Confirmation of feasibility / suitability by exploitation of well documented existing datasets, (3) Confidentiality: either in terms of access to data to inform decisions, or through reducing intrusion by offering remote measurement of movements.

A further subsection which quantitatively details specific technical needs is also provided for each end user segment. For the different uses of the movement data as described in the User Datasheets, the technical requirements in terms of 1) Vertical Accuracy, 2) Area of Interest 3) Resolution and 4) Temporal frequency are provided. For each of these requirements, the following classification scheme has been defined in order to facilitate interpretation:

Vertical Accuracy (VA)

Required Accuracy (mm)	<	Name	<	Required Accuracy (mm)
30 mm	<	VA1	<	/
10	<	VA2	<	30 mm
1	<	VA3	<	10
/	<	VA4	<	1 mm

Area of Interest (AI)

Area of interest (m)	<	Name	<	Area of interest (m)
1000 × 1000	<	AI1	<	/
100 × 100	<	AI2	<	1000 × 1000
20 × 20	<	AI3	<	100 × 100
/	<	AI4	<	20 × 20

Resolution XY (R)

Resolution (m)	<	Name	<	Resolution (m)
25 × 25	<	R1	<	/
15 × 15	<	R2	<	25 × 25
	<	R3	<	15 × 15

Temporal Frequency (F)

Temporal Frequency	<	Name	<	Temporal Frequency
1 year	<	F1	<	/
3 months	<	F2	<	1 year
1 month	<	F3	<	3 months
/	<	F4	<	1 month

Data criticality (C)

A further technical requirement relates to the criticality of the information. This has been classified using the following qualitative definitions:

Name	
C1	For information only – data acquired give only additional information
C2	Data are quite valuable but can be acquired by other means or information could be “by-pass”
C3	Data are critical, they are requested for monitoring or design of an industrial process.
C4	Data are mandatory – lives or huge investment are dependent upon information

3.2 Public Sector**3.2.1 Regulators, Government ministries and public authorities**

- Definition**

End user stake in infrastructure element: *As a regulator, none. Their role is to set legal requirements on information in order to guarantee the protection of citizens. As Government Ministries in their role as large property owners, they own and are responsible for infrastructure.*

This segment consists of all institutional end users of the service portfolio. This will include specific technical committees who provide recommendations to legislative bodies. These committees are formed by local authorities (planners, building control, environmental health, legal), environmental regulators (e.g. Environment Agency), conservation regulators (e.g. English Nature, Historic Scotland), nuclear installations inspectors, civil defence planners/authorities. Examples of policy bodies are:

1. Planning policy: Office of the Deputy Prime Minister / Scottish Executive / Welsh Assembly [UK]

2. Environmental policy: Ministero dell'Ambiente [I], Ministère de l'Ecologie et du Développement Durable [F], Department for Environment, Food and Rural Affairs [UK], and similar ministries in other European member states
3. Regional planning and economic policy: ARPA's Regional Agencies for Environment protections and Regional Development Agencies [UK];. and the similar in other European member states
4. Technical regulations related to structural safety: Consiglio Superiore dei Lavori Pubblici [I], High Council of the Public Works Ministry [UK], Ministry of Equipment and associated services in France (CETE, LCPC, CSTB), Geological Surveys and similar organisations in other European member states
5. Transport policy: Ministry of Industry, and specific associated services in UK Department of Transport, GEODERIS and INERIS [F], and similar organisations in other European member states
6. National Geological Surveys e.g. BGS, BRGM, TNO: This group is frequently solicited to contribute technical input and recommendations to legislative bodies. They also play a significant role in the Risk Assessment user segment. They constitute a large part of the Core User Group and will be considered in detail in the Core User Needs Dossier (U5).

These institutional organisations set legal requirements on information in order to protect citizens.

- **Typical end user:** Dutch State Supervision of Mines (SODM) [NL]

The Dutch State Supervision of Mines is a regulatory body in the field of raw material mining. Dutch law regulates the measurement over specific areas of ground movements as a result of mining in two forms: ground movement information of fixed benchmarks in a spatial grid as a function of time and information on sudden ground movements (earth tremors) as a result of the mining of raw materials. The first information requirement is currently satisfied by levelling surveys performed on behalf of the mining companies by specialised survey companies. Reporting to the Dutch authorities is done by means of fixed electronic and paper data formats. The second requirement is addressed with a network of downhole seismometers operating in parallel to the national network of surface seismometers and accelerometers.

- **Relevant policy sectors**

Regulators at all levels have a duty to the citizen to protect their rights through policy. As a result, policy must impose restrictions on those who might potentially infringe on citizen's rights. Recently a number of documents and convention, both international and European¹, have highlighted the citizen's environmental rights derived from the basic human rights of the right to life, privacy, property rights or the right to health. The same is also true in a second domain of increasing interest to the Council of Europe that of emergency response and civil protection. The council has launched a community action programme which obliges member states to take measures to, for example, prevent risks and damage in the event of natural and

¹ See dossier C1, Policy Foundations Review

technological disasters. Local regulators are clearly also involved in the drawing up of civil protection emergency plans and can therefore also be liable in the area of natural or technological risks if their information on potential trigger phenomenon is inaccurate or incomplete.

- **User Needs**

Requirement type / timing relative to the authorisation of a new settlement)	User Need
Technical <ul style="list-style-type: none"> • Before authorising new settlement 	<ul style="list-style-type: none"> • Improving methods of prevention of risk in urban areas using new measurements combined with coherent and exhaustive information on stability of the subsoil. This governs the overall behaviour of all buildings and also the potential impact of human activities: from mining, from water pumping, or from underground construction projects.
Technical <ul style="list-style-type: none"> • Permanent monitoring of urban areas 	<ul style="list-style-type: none"> • Gather precursor information to possible catastrophic collapse – whole conurbations could be monitored with motions above specified thresholds being automatically flagged
Technical <ul style="list-style-type: none"> • During construction 	<ul style="list-style-type: none"> • To enable the most appropriate in-situ monitoring method to be identified (whether inspection or instrumental) and to optimise the network of local monitoring. • Standardisation of required data in order to optimise data management
Strategic	<ul style="list-style-type: none"> • To avoid the constraints associated with the requirement to have access to the sites (e.g. nuclear storage). This might be important, for example, if confidentiality is an issue

- **Detailed technical needs**

Tasks (as defined by End-Users Datasheets)	Provisional Rating				
	VA	AI	R	F	C
Accidental Collapse of underground structures (Crisis Management)	3	1-2	2-3	3-4	4
Asset Management	3-4	1-2	2-3	2	2
Filling of waste disposal areas	2-3	2	2	2	2
Subsidence Monitoring	3	1-3	2-3	2-4	2

3.3 Extraction Industry

3.3.1 Extraction: Mineral, Oil, Gas

- **Definition**

End user stake in infrastructure element: *Owners of extraction sites such as underground mines and quarries, oil and gas fields. Owners of distribution infrastructure (for gas and oil).*

Responsible for causing extraction-induced ground movement and for monitoring effects of extraction and remediation.

This segment covers organisations involved in the monitoring of sites under exploration or exploitation for mining & minerals and all the world’s oil and gas producing companies both private and state owned. The latter tend to be huge multinational companies with substantial social and political influence. This segment includes private or public companies such as ENCI [NL], Charbonnages de France [F], DTM [D], Deutsche Steinkohle AG DSK [D], Mondo Minerals Oy [FIN], RJB [GB], Exxon Mobil Corp., Ioukos Sibneft, ChevronTexaco, Total, BP Amoco Corp, ENI.

- **Typical end user:** A Dutch gas and oil company

This example is an anonymous Dutch company whose mission is the exploration and production of gas and oil. While it is noted by this company that the subsidence in gas fields is, in most cases, not large (it can be of the order of 5cm), there are costs involved in remedial action. For example, the company pays the Dutch water boards recharge groundwater levels affected by the extraction operations. Requirements highlighted by other users suggest that oil and gas field management might also become an important market for *Terrafirma* data products. Data products will need to be of similar resolution to current levelling techniques – 2/3cm in Z. Surveys are currently carried out every 1 to 3 years depending on the gas/oil field.

- **Relevant policy sectors**

The main policy sectors driving user needs in the extraction industry segment are laws obliging the mine owners or operators to monitor the effect of their extraction activity. Generally such laws apply to current and future effects and often, as in the case of the Netherlands for example, specify the need for the definition of a production plan for new extraction activities. In France when underground activity has been completed a post-mining assessment must be completed.

- **User Needs**

Requirement type / timing (relative to the extraction activity)	User Need
Technical <ul style="list-style-type: none"> • Before 	<ul style="list-style-type: none"> • capacity to detect slow ground movements over a large area, most useful for preventive and long term monitoring, and for an early identification of zones at risk • generation of an “initial conditions” benchmark for the site and assessment of probable ground deformation • following the identification of ground movement, more detailed movement data is required within a week • with continuous monitoring, the acceleration of a movement is an important parameter which can help predict a collapse information for preparation, updating and checking of plans in relation to the safety and efficiency of operations • preparation of appropriate subsidence mitigation strategies and measures which have included structural support of

	underground openings and the provision of surface and underground water drainage systems
Technical <ul style="list-style-type: none"> • Before and during 	<ul style="list-style-type: none"> • formulation of subsidence mechanisms • prediction of magnitude and distribution of the occurrence of subsidence • user-friendly data management systems to be used for long term monitoring as well as crisis management • ground motion data to an accuracy of 2/3 cm in Z over a time period of 2-3 years • linking of ground motion measurements to analytical and numerical methods for assessment of dilation, compaction and subsidence and their potential influence on wells, surface facilities, or on nearby faults. Techniques used include: <ul style="list-style-type: none"> • Simple analytical estimates • Three-dimensional elastic models • Two and three-dimensional numerical models
Technical <ul style="list-style-type: none"> • After 	<ul style="list-style-type: none"> • Needs of information about the residual movements after the extraction for proof of the safety of the site and / or clear definition of the legal responsibility of the mining companies
Technical	<ul style="list-style-type: none"> • Development of methods and software to link 3D modelling of the ground to 2D spatial displacements detected by satellite images and terrestrial instrumentation.
Technical / Commercial <ul style="list-style-type: none"> • Before 	<ul style="list-style-type: none"> • partial validations using validation protocols used to assess the accuracy of observations • demonstrations and training on real sites • Strategic and economic requirements of the acquisition of ground movement information: to be free from the constraints imposed by the need for on-site measurements (time, discretion and confidentiality). • Acquisition of ground motion information to be confidential in certain cases
Technical / Commercial <ul style="list-style-type: none"> • During 	<ul style="list-style-type: none"> • To monitor subsidence settlement in order to <ul style="list-style-type: none"> • anticipate the induced difficulty of extracting oil • reduce risk of damages to engineering structures, rigs and pumps or to • optimise the production (increase pressure and production rate and compaction drive)
Technical / Commercial <ul style="list-style-type: none"> • During and after 	<ul style="list-style-type: none"> • Input to inversion methods used to identify subsurface source mechanisms responsible for surface subsidence
Commercial <ul style="list-style-type: none"> • During 	<ul style="list-style-type: none"> • Cost optimum compromise of monitoring • Low-cost real-time instrumentation to check local soil movements, by optimising the conventional differential levelling network or repeated GPS instruments

Detailed technical needs

Tasks (as defined by End-Users Datasheets)	Provisional Rating				
	VA	AI	R	F	C
Extraction Monitoring	1	2	2	2	3
Lateral movement due to de-watering (or potential slope instability?)	3	2	3	3-4	3
Subsidence Monitoring	1	1	2	2	2
Detection of Chimney or sinkholes	3	1	3	3-4	4
Detection of potential slope instability	3	1	3	3-4	3
Extraction Monitoring (Open Pit)	1	2	2	2	3

3.4 Structural Engineering**3.4.1 Builders and constructors including engineering consultants**

- **Definition**

End user stake in infrastructure element: *Responsible for a site on behalf of an infrastructure owner during construction. Concerned that construction activity will not damage either the infrastructure element under construction or, in the case of underground works, other infrastructure in the vicinity.*

This group covers the market sector of urban underground works. It includes civil and structural engineering consultants, civil, structural engineering and building contractors, surveyors, architects but also private or public engineering consultants and specific public services (e.g. CTSB in France). Among builders and constructors three distinct activities can be distinguished:

- **Main Contractors** undertaking the initial construction of a facility.
 - **Specialist Contractors** (such as grouting contractors, survey companies etc.) are involved with only part of the construction such as controlling the rate of tunnelling and either providing data for decisions to be made, or modifying construction methods to suit the feedback from the monitoring.
 - **Maintenance Contractors / Asset Management Contractors** are involved with the ongoing maintenance and / or operation of an existing infrastructure facility
- **Typical end user:** SPIE Batignolles [FR]

With a turnover of approximately €1bn and around 6,000 employees, SPIE Batignolles are involved in many high profile projects ranging from industrial, office or housing complexes to underground or major infrastructure projects. Spie Batignolles carry out all three of the activities undertaken by contractors and thus have diverse ground movement information needs. These range from site studies to assist in the choice of site for development to

maintenance of the facility (e.g. a motorway) during a period of operation such as a concession period.

• **Relevant policy sectors**

This end user segment is impacted mostly either by local laws and policies relating to specific areas at risk or general planning policy guidelines. An example of the first case are areas of high hydro-geological risk in Italy. These zones, generally a specific watershed, must have a plan describing planning and programming within the zone. The UK government, on the other hand, has published a number of notes on planning policy. These are used by the landowner, local planning authority and the developers to determine where different responsibilities lie. In France local planning documents (the local town planning program and the risk prevention plan) are drawn up in each administrative district with the aim of distinguishing areas of potential development from zones that might be subject to specific geohazards.

In general, planning policy impacts on the zones available for development in most countries, however, responsibility for ground movements caused is retained by the construction company.

• **User Needs**

Requirement type / timing (relative to the construction activity)	User Need
<p>Technical</p> <ul style="list-style-type: none"> • Before 	<ul style="list-style-type: none"> • New needs driven by increasing demand for underground urban infrastructures: • Identification and location of specific ground hazards at a site: • knowledge of the geomechanical characteristics of the ground, • access to an archive of previous events of unstable phenomena • Input into urban planning and building control
<p>Technical</p> <ul style="list-style-type: none"> • During 	<ul style="list-style-type: none"> • Obtain and manage information for reduction of the risks and responsibilities due to the construction: Confirmation of design assumptions / feedback to allow modification to construction processes • accurate real-time monitoring, and remote display. • Access by effective delivery mechanism • Access to a set of defined targets (e.g. buildings) • Access to 'off the shelf' remote data not 'bespoke' monitoring • Combination of 'off the shelf' remote data and local 'bespoke' monitoring techniques • Early detection of currently occurring phenomena to provide information which can be used to ensure the correct installation of in-situ monitoring networks
<p>Commercial</p> <ul style="list-style-type: none"> • Before and during 	<ul style="list-style-type: none"> • Strategic information: no sensors on the site : interest :To avoid the constraints associated with the requirement to have access to the sites. This might be important, for example, if confidentiality is an issue • Minimise cost of ownership: and assist in asset management

	by providing cost effective monitoring <ul style="list-style-type: none"> • Ensure construction without damage to adjacent properties and / or infrastructure • knowledge of the history, magnitude and extent of ground motions before the site is purchased / selected and before work begins can increase cost and construction time certainty
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- **Detailed technical needs**

Tasks (as defined by End-Users Datasheets)	Provisional Rating				
	VA	AI	R	F	C
Construction Monitoring	2	2-3	2-3	3	3
Detection of neighbourhood Ground movements	3	2-3	3	3-4	3
Buildings and assets Follow Up	3-4	2-3	2-3	2-3	3

3.4.2 Utility companies

- **Definition**

End user stake in infrastructure element: *Owners of plant and distribution infrastructure.*

This group includes any and all agencies and companies responsible for transportation networks or infrastructure (pipelines, cables, sewers etc) e.g: Transco, National Grid, Water and sewage companies (pipelines), gas companies (pipelines and plant), oil companies (pipelines and plant), electricity companies (cables, pylons, poles and sites including nuclear) such as EDF in France or ENEL in Italy, Telecommunication companies (cables, poles and masts).

- **Typical end user:** EDF [F]

With a turnover of €48.4bn and approximately 110,000 employees, Electricité de France (EDF) controls 95% of the French market and owns electricity companies in Germany, UK and Italy. While there can be specific needs in geothermal and hydroelectric power production, EDF can be considered as a large property owner with specific monitoring requirements for industrial plants and distribution infrastructure. They therefore require ground movement information for 1) the design phase of new plants, 2) verification of the safety of this infrastructure 3) monitoring of distribution infrastructure such as pylons. Typically ground movement measurements are required over areas going from 4-6km² for plant monitoring to 20-50km² for the localisation of new infrastructure sites. Specific corridors of land are also of interest for surveillance of distribution infrastructure. Monitoring will be generally either continuous, for critical elements such as dams, or periodic for plant control and verification reasons and distribution lifelines. Current ground movement monitoring needs are filled principally by electronic and manual measurement instruments, with GPS system use becoming more widespread.

- **Relevant policy sectors**

Policy makers have an obligation to ensure critical infrastructure such as water, electricity, gas, telecommunications functions at all times and does not pose a risk to society in doing so. These lifelines can be critical because of the elements they transport are necessary (eg. water), or they can be critical because of the danger associated with their malfunctioning. In certain countries regulatory constraints oblige utilities to monitor ground and structure movements, requiring the installation of certified monitoring systems. Operators must demonstrate their efforts to reduce the risk of their activities. Other than the general environmental rights described in the Policy Foundations Review (C1 dossier) and basic human rights associated with these lifelines no additional laws or policy have been identified.

- **User Needs**

Requirement type / timing (relative to the lifetime of infrastructure)	User Need
Technical <ul style="list-style-type: none"> • Before construction 	<ul style="list-style-type: none"> • Information on the geological behaviour of possible construction sites are crucial in the phase of design of new plants, especially when these areas are chosen, as often, close to subsiding fluvial or sea-coastal zones, as for thermoelectric or nuclear plants • Geological investigations need coverage on extended areas (20-25-50km²). Geological surveillance can accept accuracies in the order of centimetre. • Geological investigations require analysis on long periods (to improve the accuracy of the trend velocity).
Technical <ul style="list-style-type: none"> • During construction 	<ul style="list-style-type: none"> • Combination of remote data and local monitoring techniques • Access by effective delivery mechanism • Early detection of currently occurring phenomena to provide information which can be used to ensure the correct installation of in situ monitoring networks
Technical <ul style="list-style-type: none"> • Before and during lifetime 	<ul style="list-style-type: none"> • Improvement of the methods of diagnosis: criticalities are in some cases related to the amount of information needed for interpretation of the investigated phenomena and to the necessity of integrating different information (e.g. monitoring systems, photographic) and competences (geological, structural and of the specific installations).
Technical <ul style="list-style-type: none"> • During lifetime 	<ul style="list-style-type: none"> • To receive information on vertical and/or horizontal displacements and velocities. Investigation of movements of structures or parts of plants require punctual estimations (typical coverage area 2-6km²). Periodic measurements (with daily, monthly and yearly frequency) are generally requested for control and verification reasons. • Structural monitoring may require accuracies in the order of millimetre <p>Precursor detection, needed in the case of emergency scenarios (e.g. in the case of landslides or gas losses), can impose relatively strict requirements (in the order of</p>

	<p>half an hour) on the speed of the entire detection process (acquisition plus processing plus decision making)</p> <ul style="list-style-type: none"> • Format compatible with GIS base. • Early detection of occurring phenomena to provide information which can be used to ensure structures or to alert population. • Early detection of currently occurring phenomena to provide information which can be used to ensure or adapt the correct installation of in situ monitoring networks • Access by effective delivery mechanism • Combination of remote sensing data and local in-situ monitoring techniques
<p>Technical / Legal</p> <ul style="list-style-type: none"> • Before installation 	<ul style="list-style-type: none"> • Reduction of the risks due to the unstable ground on the right operating of transportation network by reinforcement of structural stability and operability of barrage, dams, penstocks, channels, reservoirs as well as the annexed service structures
<p>Technical / Legal</p> <ul style="list-style-type: none"> • After a crisis 	<ul style="list-style-type: none"> • In case of breakdown or legal action: proof that all available information was taken into account • If subsidence is caused by other activities (e.g. mining) utility companies may also need evidence and independent assessments for legal use.
<p>Commercial</p> <ul style="list-style-type: none"> • During lifetime/ After a crisis 	<ul style="list-style-type: none"> • Improve the monitoring activity with reduced costs methods • Prevent disruption of the services and relevant direct and consequential economic losses • In many countries a single body is in charge of energy market policy, covering electricity as well as other sectors (such as gas production and distribution). Regulatory bodies do not prescribe observation of ground movements; however they may introduce penalties on service interruption.

- **Detailed technical needs**

Tasks (as defined by End-Users Datasheets)	Provisional Rating				
	VA	AI	R	F	C
Site Selection	2	2-3	1-2	1-2	2
Movements on buildings and/or infrastructures	3-4	2-3	2-3	2-3	3
Detection of neighbourhood ground movements	3	2-3	3	3-4	3
Detection of pipe leakage	4	1-2	3	3-4	4

3.4.3 Transport providers

- **Definition**

End user stake in infrastructure element: *Owners of infrastructure.*

This segment consists of owners and operators of transport infrastructure. It includes railway companies and regulators (e.g. Network Rail[UK], SNCF[F], NMBS/SNCB[B]), road management organisations (e.g. Highways Agency[UK], local authorities, Cofiroute[F],

Ministry of Transport, Public Works and Water Management[NL]) and airport management companies (BAA[UK], Aéroport de Paris[F]).

- **Typical end user:** Highways Agency [UK]

The Highways Agency is an Executive Agency of the UK Department for Transport with a budget of approximately £5bn and around 1,600 employees. They work closely with other transport operators and with local authorities to manage, maintain and improve the network of trunk roads and motorways in the UK. Their use of data products, similar to all major transport infrastructure operators, potentially would be in two specific areas: monitoring of the existing infrastructure and selection of future routes for schemes. Monitoring of roads requires millimetric ground movement accuracy over well defined corridors of land. In the case of remote sensing imagery, this involves coverage of substantial areas. Detected movements indicate degradation in the quality of the network and would initiate maintenance. For this, “real-time” monitoring is preferred, however a revisit time of the order of days or weeks would be useful. For new routes, information on movement history is required for the engineering design and mitigation of the possible consequences of ground movement. Currently standard levelling techniques are used, with the Highways Agency developing the use of airborne LiDAR (laser scanning) for monitoring.

- **Relevant policy sectors**

Transport infrastructure is another focus for the public’s right to safety and security. Policy makers are becoming increasingly aware of the need to apply operational constraints through the use of policy to increasing number of private companies that operate in this sector. No specific policy or laws have been identified in the Policy Foundations Review.

- **User Needs**

Requirement type / timing relative to the the timelife of network)	User Need
Technical <ul style="list-style-type: none"> • Before construction 	Technical information on ground motion for New Build, e.g. Route Planning <ul style="list-style-type: none"> • Sampled data • Rate of movement of parts of site • Spatial extent of movement at site • Correlation to ground investigation / desk study • Elevation change resolution, Accuracy and repeatability in centimetres. Relative level acceptable.
Technical <ul style="list-style-type: none"> • During lifetime 	Technical information on ground motion for Asset Management (Elevation change resolution, accuracy and repeatability in millimetres) <ul style="list-style-type: none"> • Aim is to detect change / deterioration in asset due to movement • Aim is to be able to initiate maintenance activity based on monitoring. • Absolute level required

	<ul style="list-style-type: none"> • Good correlation with 'ground truth' • Elevation change resolution, accuracy and repeatability in millimetres <p>Ability to input to 'real-time' monitoring systems.</p>
<p>Commercial</p> <ul style="list-style-type: none"> • Before construction and during lifetime 	<ul style="list-style-type: none"> • Availability of more cost effective ground movement data

- **Detailed technical needs**

Tasks (as defined by End-Users Datasheets)	Provisional Rating				
	VA	AI	R	F	C
Route Planning	2	1	2	3	2
Asset Management	3-4	1	2	3-4	3
New runaways	2	1	2	3	2
New coastal defences	2	1	2-3	3-4	

3.5 Risk Assessment

3.5.1 Development initiators and property owners

- **Description**

End user stake in infrastructure element: *Owners of infrastructure (at least on a temporary basis).*

This group includes property developers, supermarkets and other owners of significant real estate assets. This might also include public buildings such as hospitals and schools under the responsibility of government departments, local or regional authorities. These needs may be driven by commercial factors, for property developers, for example, concerned that no devaluation of the property occurs, or health and safety reasons for public buildings.

- **Typical end user:** Barratt Homes

Barratt Homes is one of the largest housebuilders in the UK with a budget of approximately £951m (~€1.4bn). With the current requirements from the UK government for the provision of new houses, Barratt Homes has substantial political influence. Major housebuilders have two concerns: 1) when buying land, that there are no hazards etc that will bring unacceptably high costs 2) having bought the land that they understand the nature of the ground so that foundations etc can be designed adequately. Ground movement information would be of help to them in both situations. At any one Barratt Homes owns hundreds of sites for development both large (for hundreds of houses) and small (for less than ten houses).

- **Relevant policy sector**

As organisations that invest in large development projects, this end-user segment has no direct regulatory constraints other than those mentioned for the construction industry.

- **User Needs**

Requirement type / timing relative to the construction	User Need
Technical <ul style="list-style-type: none"> • Before purchase 	<ul style="list-style-type: none"> • Need available information of previous events of ground deformation for the plot to be purchased • Need up to date information and guaranty of stable ground around the buildings to be purchase or to be built • In case of movement, they want additional information that indicates the causes of ground movements and the likelihood of future movements
Technical <ul style="list-style-type: none"> • After purchase 	<ul style="list-style-type: none"> • improved understanding of the nature of the ground for adequate design of the foundations
Commercial	<ul style="list-style-type: none"> • national coverage, because they buy sites all over the country • want some validation of data quality from authorised institutes or providers
Commercial <ul style="list-style-type: none"> • Before and during construction 	<ul style="list-style-type: none"> • Need information of previous events for identifying unacceptable high costs and for reducing unexpected problems (exploitation for housing and/or reduce value)

- **Detailed technical needs**

Tasks (as defined by End-Users Datasheets)	Provisional Rating				
	VA	AI	R	F	C
Ground movement	2	2-3	2	1-2	1
Follow Up (Site Investigation - feasibility)					
Single Home follow up	3-4	3-4	3	1-2	3

3.5.2 Geoinformation providers

- **Definition**

End user stake in infrastructure element: *None. Certain geoinformation providers have a role providing technical support to regulators (e.g. Geological surveys).*

This segment includes value added resellers of data and information (e.g. for house conveyancing), which gathers and distributes information.

We distinguished:

- a- Private companies providing a “one-stop shop” for individuals or organisations that require miscellaneous information regarding geographical areas, e.g. Landmark, Sitescope, Groundsure, Homecheck.
- b- National Geological Surveys e.g. BGS, BRGM, TNO

This second group are frequently solicited to contribute technical input and recommendations to legislative bodies. In this role they are strongly linked to the Public Sector user segment.

They play an significant role in the Core User Group and will be considered in detail in the Core User Needs Dossier (U5).

- **Typical end user:** Sitescope [UK]

Sitescope Limited, with a budget of £7m and 45 employees, is the UK's leading provider of on-line environmental information to lawyers, banks, surveyors, environmental consultants and other property professionals. Their services are based around one of the largest property and environmental risk databases in Europe built from information supplied under licence by The Environment Agency, British Geological Survey, National Radiological Protection Board, DEFRA, AEA Technology, Local authorities, Radiocommunications Agency, Ordnance Survey, Coal Authority, Countryside Agency, English Nature, Valuation Office and the ODPM. With the provision of environmental information to householders to potentially become compulsory in the UK, the social and political influence of one of the few private sector suppliers of such information is likely to grow. They require information on recent movements and a time-series for individual properties in the UK.

- **Relevant policy sectors**

With increasing awareness of their environmental rights and factors affecting their health and well being, citizens are demanding more and more information regarding these issues. This segment fills the vital role of provider of such information and as such is not directly subject to laws or policy, but more an instrument in the citizen's access to their environmental rights. Geoinformation providers have an important role to play in order that the aspirations (expressed in, for example, the Rio Declaration²) to a more active participation of the public in environmental decision making come to fruition.

- **User Needs**

Requirement type / timing	User Need
Technical	<ul style="list-style-type: none"> • Ground movement information for individual properties • complete UK coverage, with most important being the urban areas • GIS formats used: Map Info, ArcInfo, ArcView, datamap

- **Detailed technical needs**

Tasks (as defined by End-Users Datasheets)	Provisional Rating				
	VA	AI	R	F	C
Ground movement Follow Up	2	1-2	3	1-2	1-2

² See dossier C1, Policy Foundations Review

3.5.3 Insurers

- **Definition**

End user stake in infrastructure element: *Insurers of the infrastructure element. Need to correctly judge the risk involved in insuring a specific infrastructure element in order to set an appropriate insurance premium.*

This user segment includes any organisation involved in the insurance of infrastructure elements.

- **Typical end user:** Norwich Union [UK]

Norwich Union are the market leading house insurer in the UK with a market share of approximately 19%. They have an annual turnover of in the region of £2bn (~€3bn) and employ 35,000 people in the UK. The objective of the insurance industry is to reduce their exposure to risk and to focus their business on the most profitable aspects, information regarding potential areas prone to certain geohazards such as subsidence allows them to do this. Norwich Union have in the past used DEMs generated from Earth Observation radar data to assist the definition of flood plains for this purpose. Their ideal data requirements are for ground movement information on individual houses to millimetric accuracy. However, less accurate interpreted information products would most likely prove to be useful.

- **Relevant policy sectors**

The main impact of policy on the insurance sector is the reduction of risk through the correct functioning of the planning cycle. Having an effective planning process which restricts development to zones with low geohazard, entails a reduction in the risk and so the likelihood of a claim.

- **User Needs**

Requirement type / timing relative to the activity	User Need
Technical <ul style="list-style-type: none"> • Before a policy is issued 	<ul style="list-style-type: none"> • spatial requirements: at least at postcode sector level, particularly in populated areas • temporal requirements long term <p>Accuracy requirements as accurate as possible, but in association with any additional information that is relevant (to provide interpreted products)</p>
Technical <ul style="list-style-type: none"> • After a ground movement event 	<ul style="list-style-type: none"> • spatial requirements: at least at postcode sector level, particularly in populated areas • temporal requirements short term • Accuracy requirements as accurate as possible with any additional information that is relevant as ancillary information • Delivery within 7-14 days
Technical	<ul style="list-style-type: none"> • Data format and compatibility with GIS: Map Info or Arc View • Means of delivery: directly from specialist data supplier
Commercial	<ul style="list-style-type: none"> • Insurance payouts for ground movement events to be taken into

<ul style="list-style-type: none"> Before a policy is issued 	<ul style="list-style-type: none"> account in the definition of future premiums Information required at national level, and if possible, European level
<p>Commercial</p> <ul style="list-style-type: none"> After a ground movement event 	<ul style="list-style-type: none"> Fraud reduction through more effective verification of claims Decrease the time to process dossiers for individual damage cases Improve the assessment of damage and, assist in assessment of the economic consequences of disruption to infrastructure

- Detailed technical needs**

Tasks (as defined by End-Users Datasheets)	Provisional Rating				
	VA	AI	R	F	C
Ground movement	3	1-2	3	1-2	1
Follow Up					

3.6 Geohazard Research Organisations

3.6.1 Leading research organisations

- Definition**

End user stake in infrastructure element: *None. Scientific interest in the use of this data for the development of our understanding of the geohazards that cause the subsidence.*

Numerous research teams, in addition of specific research groups in the core user group, are currently using ground motion data derived from InSAR. This segment has not been fully described because they represent institutional users and not commercial or operational users, but they could have significant influence on the dissemination of good information and practices.

- Example research groups**

Research in remote sensing and metrology

- GRGS-CNRS (F).
- Univ. Zurich (CH)
- DLR (D)
- JRC (UE)

Environmental and Natural Hazards Research

- Centre for Ecology and Hydrology [UK]: ecological and hydrological research including flooding.
- INGV [I]: National Institute for geophysics and Vulcanology - the institutional body in charge of seismic hazards studies and earthquake forecasting.
- CNR-GNDCI: Group of the Italian National Research Council in charge of risk studies associated with hydrology.
- ORFEUS Observatories and Research Facilities for European Seismology, Univ. Innsbrück [A]
- IPG-P(F), IPG-S(F), UCBLyon (F)

Research in built environment and technological risks

- Building Research Establishment (UK); research into the built environment, construction methods and best practice and sustainability in construction.
- CEA (F)
- **Scientific Needs**

Requirement type / timing	User Need
Technical <ul style="list-style-type: none"> • During a ground motion event 	<ul style="list-style-type: none"> • Near real-time access to the objective measurements that have been generated using understandable and proven processing methods • Combination of remote data and in-situ monitoring techniques for identification of reliable thresholds associated with the start of an event
Technical <ul style="list-style-type: none"> • After a ground motion event 	<ul style="list-style-type: none"> • Availability of an inventory of all detected ground movement events in a defined period for the assessment and validation of deterministic deformation models.

4 KEY USER SEGMENTS

This document describes the Global User Base by decomposing it into a set of User Segments. Having described these segments, a set of *key segments* is identified to facilitate the user federation and promotion tasks. The following criteria are proposed for the choice of these key user segments:

Needs: segments whose users have a problem which can be addressed by the products proposed in the SP and have economic or policy driven reasons for the use of SP products.

Technical accessibility: Specific technical requirements and the ability to exploit the ground movement information in the SP.

Influence: segments that can have an effect on the development of the global user base through different motors.

The following **key segments** have been identified as together providing at least seventy percent of the users likely to benefit from the service portfolio in the next five years.

Segments are listed in order of importance:

1. Public Sector
2. Structural Engineering
3. Extraction Industry

The reason for the identification of the **Public Sector** segment as a key segment, is based on the critical role their associated technical bodies play in policy definition. The users in this segment will generally have a mission as a public organisation in charge of providing expertise and reliable diagnosis to various Ministries and State services. This expertise includes different levels of action from improving knowledge of geohazard mechanisms to hazard and risk mapping and recommendations for land-use management. Setting up national databases and observational methodologies are amongst the major priorities. *Terrafirma* must target these organisations that provide technical expertise to the state in order to demonstrate the utility of ground movement information for policy and legislative pressure. The adoption by European member states or Europe of new laws concerning ground motion should, in time, stabilise the market for information products. Clearly the Public Sector segment can have a significant influence on the global user base. This can happen in two ways: 1) the definition of new laws 2) the issuing of guidelines on best-practice.

The second and third key user segments (**Structural Engineering** and **Extraction Industry**) highlighted above are best equipped to directly exploit the basic ground motion products proposed in the service portfolio as they are used to dealing with conventional levelling data products. It is anticipated, therefore, that the initial demand for *Terrafirma* service portfolio products will be from users included in these segments. This demand should come on line immediately and should contribute to a better expression of specific requirements for higher level value added products. By becoming regular users of EO ground movement information, this segment can influence the wider scale adoption of these data products and their development.

It should be noted that, with the exception of the **Oil and Gas** sub-segment, the key consequences associated with all key segments apply to urban areas.

There are a number of reasons that the fourth user segment that has been identified is not also considered to be a key segment. Of the geoinformation providers, the geological surveys play a significant role in the public sector segment. Other geoinformation providers have a potentially significant future requirement, but up until now no real commercial products or services have been offered. As regards insurers, according to the FERMA (Federation de Risk Management Européennes) and the CEA (Comité Européen des Assurances) their priority is to have a tool that provides visibility of flood risk which represents 75% of claims. While ground movement risk is still significant (approx 10% of claims) the insurers current emphasis is on floods.

As regards to the evolution of the global user base, the choice of segments set out above should facilitate a natural progression of the market through a series of stages of maturity. The initial stages will see ground movement products being used directly by intelligent users who will exploit their complementarily with current in-situ ground movement measurement networks to improve coverage of ground movement phenomena. This will allow *Terrafirma* data products to become established with the user community and help provide feedback for providers developing more elaborate interpreted products in response to the demand from other segments. With the improved credibility and perceived reliability of *Terrafirma* data products, regulators will be convinced of the utility of such products for numerous legal applications.

ANNEX 1

End-user datasheet

Who are they?

- Name and Location
- Nature (Public, Private, SME) and Mission
- Dependent & subsidiary organisations
- Total Annual Budget; Number of staff
- Social and political influence

Why are they interested in ground movements? (regulatory constraints, economic reasons)

- What stake do they hold in infrastructure elements (owners, responsible for movements, policy makers)
- Decision-making responsibility for *policy sector*

What do they need?

- Movement Information needs
 - Spatial requirements (continuous coverage, sampled)
 - Temporal requirements (repeat interval)
 - Accuracy requirements
 - Extent of targeted areas
 - Speed of data acquisition and compatibility with precursor detection
 - Data format and compatibility with GIS
 - Data quality and validation
- Ancillary information (e.g. for movement generators: are there valuable exposed elements?, for owners: is a natural and/or induced ground movement likely?)
- Criticality of information needs
- Key operational timescales & future milestones

How do they do currently address their information needs?

- In-house IT capacity and proprietary (conventional) monitoring infra-structures
- Current existing geo-spatial monitoring capacity & EO-based information. Evolution potential.
- How is the performance of their current monitoring system assessed? In terms of
 - Spatial
 - Temporal
 - Accuracy
- Do they currently have industrial suppliers? Who are they?
- Procurement processes, cycle, timescales
- Current monitoring costs

How can they benefit from Service Portfolio?

- What are their performance bottlenecks and their causes?
- How can these be resolved by the Service Portfolio?

ANNEX 2

Completed End-user datasheets

Segment ID	Segment Description	Profiles Generated
1	Mineral extraction	UDS 1.1 Dutch mineral extraction company UDS 1.2 Mining
2	Abstraction Oil & Gas	UDS 2.1 Dutch gas and oil company UDS 2.2 Oil and Gas
3	Builders and constructors including engineering consultants	UDS 3.1 Main contractors UDS 3.2 Specialist contractors UDS 3.3 Maintenance contractors UDS 3.4 Engineering Consultants
4	Utility companies	UDS 4.1 Electricity UDS 4.2 Water UDS 4.3 Gas
5	Transport providers	UDS 5.1 Highways UDS 5.2 Rail UDS 5.3 Airports UDS 5.4 Coastal/River Management
6	Regulators, Government ministries	UDS 6.1 UK DEFRA UDS 6.2 UK ODPM UDS 6.3 UK Telford and Wrekin UDS 6.4 UK Environment Agency UDS 6.5 NL State Supervision of the Mines UDS 6.6 NL Waterboards UDS 6.7 NL National Hydraulic and Road Engineering Division

		UDS 6.8 City Authorities (ex: Hanoi)
7	Information providers	UDS 7.1 Landmark UDS 7.2 Sitescope
8	Development initiators and property owners, large scale house builders, supermarkets	UDS 8.1 Barratt UDS 8.2 Wimpey UDS 8.3 Tesco
10	Insurers	UDS 10.1 Norwich Union UDS 10.2 Direct Line UDS 10.3 ABI

END
