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Coordinating an Observation Network of Networks EnCompassing saTellite and IN-situ to fill the Gaps in European Observations

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Acronyms

AQUASTAT FAO's global water information system

BUT Bottom-Up Thread

BUT1 Bottom-Up Thread 1

BUT2 Bottom-Up Thread 2

BUT3 Bottom-Up Thread 3

CAS Copernicus Atmospheric Service

CGT ConnectinGEO Gap Table

CLC CORINE Land Cover

ConnectinGEO Coordinating an Observation Network of Networks EnCompassing saTellite and IN-situ to fill the Gaps in European Observations

CoPs Communities of Practice

CUAHSI Consortium of Universities for the Advancement of Hydrological Sciences, Inc.

CV Controlled Vocabulary

CVs Controlled Vocabularies

DAB Discovery and Access Broker

DOM Dissolved organic matter

DRS Document Requirements Specification

DRR Disaster Risk Reduction

EARSC European Association of Remote Sensing Companies

EC European Commission

ENEON European Network of Earth Observation Networks

EO Earth Observation

EO4OG Earth Observation for Oil and Gas

EV Essential Variable

EBA expert-based approach

EBV Essential Biodiversity Variable

ECV Essential Climate Variable

EEA European Environmental Agency

EMEP European Monitoring and Evaluation Programme

EOV Essential Ocean Variable

ESDGV Essential SDG Variable

EUBON European Biodiversity Observation Network

ExCOM Executive Committee

FAO Food and Agriculture Organization

FWEN Food-Water-Energy Nexus

GAIA-CLIM Gap Analysis for Integrated Atmospheric ECV Climate Monitoring

GAID Gaps Assessment and Impacts Document

GAW Global Atmosphere Watch

GBA goal-based approach

GCI GEOSS Common Infrastructure

GCOS Global Climate Observing System

GEMI Global Environmental Monitoring Initiative

GEO Group on Earth Observations

GGMN Global Groundwater Monitoring Network

GMOS Global Mercury Observing System

GOFC Global Observation for Forest Cover

GOLD Global Observation for Land Dynamics

GOOS Global Ocean Observing System

GTN Global Terrestrial Network

HAB Harmful Algal Bloom

HIS Hydrologic Information System

HRL High Resolution Layer

IGOS Integrated Global Observing Strategy

IGOS-P Integrated Global Observing Strategy Partnership

IAEG Inter-Agency Expert Group

ICSU International Council for Science

IOC International Oceanographic Commission

IoT Internet of Things

IRENA International Renewable Energy Agency

IUCN International Union for Conservation of Nature

JERICO Joint Research Infrastructure for Coastal Observations

LTER Long Term Ecological Research

LUCAS Land use and land cover survey

MACC Monitoring Atmospheric Composition and Climate

MBON Marine Biodiversity Observation Network

MCA multi-criteria assessment

MSCA Marie Sklodowska-Curie Actions

O&G Oil and Gas

OGC Open Geospatial Consortium

OI Observation Inventory

ROI Region of Interest

POP Persistent organic pollutants

PV Photo Voltaic

SBA Societal Benefit Area

SDG Sustainable Development Goal

SDI Spatial Data Infrastructures

SEE-IN KB Socio-Economic and Environmental Information Needs Knowledge Base

SME Small Medium Enterprise

SoS System of Systems

SSI Surface Solar Irradiance

SST Sea-Surface Temperature

STC Science and Technology Committee

SWOS Satellite-based Wetland Observation Service

TDT Top-Down Thread

TDT1 Top-Down Thread 1

TDT2 Top-Down Thread 2

UIC User Interface Committee

UN-ECE United Nations Economic Commission for Europe

UNFCCC United Nations Framework Convention on Climate Change

URR User Requirements Registry

VOC Volatile organic compound

WMO World Meteorological Organization

WP Work Package

Executive Summary

This document provides a detailed discussion of the ConnectinGEO approach to gap analysis and prioritization. It presents the preliminary list of gaps detected in the five threads of the ConnectinGEO approach. The steps to condense the list of gaps into a set of prioritized gaps with information on how to address these gaps are listed, and action items to achieve the final goal of presenting a prioritized list of gaps are identified.

Gap analyses have been attempted in many Earth Observation (EO) communities. In the Group on Earth Observations (GEO), the former Science and Technology Committee (STC) convened a dialog that culminated in a paper presented to the Executive Committee in 2011. Another example if the Horizon 2020 Project GAIA-CLIM, which developed a gap analysis approach applied to climate change and atmospheric monitoring.

Gap analyses in general require information on what is needed on the one side, and on what is available to meet these needs on the other side. In GEO, several efforts have been made to capture both what is needed and what is available to meet these needs. The GEO Work Plan Task US-09-01 conducted an extensive review of published documents to extract observational needs. The Task also developed and populated the Global Earth Observation System of Systems (GEOSS) User Requirements Registry (URR) with the goal to collect comprehensive information on who the users benefiting from EOs are, what they do, and what they need in order to do this. Recently, the URR has been transformed into the Socio-Economic and Environmental Information Needs Knowledge Base (SEE-IN KB) as part of the developing GEOSS Knowledge Base.

An important concept in linking societal knowledge and information needs to observational requirements is that of Essential Variables (EVs). Several EO communities have developed set of theme-specific EVs using an expert-based approach (EBA), which starts from thematic expertise of EO feasibility and eventually links the resulting EVs to societal impacts. ConnectinGEO added a complementary goal-based approach (GBA), which starts at a set of agreed-upon societal goals and identifies the EVs required in support of implementing the goals and monitoring process towards these goals.

GEO also made extensive efforts to provide information on what is available. A core element for this is the GEOSS Discovery and Access Broker (DAB), which is part of the GEOSS Common Infrastructure (GCI).

Based on these previous efforts, ConnectinGEO developed a threaded approach with five threads.

- **Top-Down Thread 1 (TDT1)**: Identification of a collection of observation requirements and specifications from generic goals for sustainability of the global civilization.
- **Top-Down Thread 2 (TDT2)**: Review of documents from international programs and community assessments of socio-economic benefits of Earth observations.
- **Bottom-Up Thread 1 (BUT1)**: Consultation process in the current EO networks, consisting of collaboration platforms, surveys and discussions at workshops.
- **Bottom-Up Thread 2 (BUT2)**: A careful analysis of the observations and measurements that are currently in GEOSS DAB.
- **Bottom-Up Thread 3 (BUT3)**: The realization of a series of real industry-driven challenges to assess the problems and gaps emerging during the creation of business opportunities.

In doing so, ConnectinGEO builds on previous efforts and uses the gap typology developed by GAIA-CLIM with minor modifications.

Each of these threads provided a list of gaps, which are included in the ConnectinGEO Gap Table (CGT). The CGT is available to the public at http://twiki.connectingeo.net/foswiki/bin/view/ConnectinGEOIntranet/-GapAnalysisTable?cover=print, and it is open to publish gap information and give feedback. The *ConnectinGEO Gap Table (CGT)* has the advantage of being easily accessible for partners to publish their results. However, it has the disadvantage of limited functionality. Therefore, the results are also included in the SEE-IN KB. The data model for the representation of gaps in the SEE-IN KB allows for more information to be associated to each gaps and to track the development of reviewing and addressing the gap over time.

The CGT includes more than 200 gap entries. Currently, a review of these gaps is in progress with the goal to describe remedies and assess the feasibility of closing the gaps. Feasibility together with the potential impacts a gap would have, the estimated costs and the required time frame for closing the gaps are used to get an indication of the priority. The functional relationship used is

$$p = \frac{f \cdot i}{c \cdot t}, \tag{1}$$

where p is priority, f feasibility, i impact, c cost, and t time frame. The estimation of impact is supported by a rank determined in the SEE-IN KB based on the number of links between a gap and other instances of users, applications, research needs, etc.

In the **TDT1**, focus was on the Sustainable Development Goals (SDGs) as the primary societal goal set. There are two main areas where EO provides a substantial contribution to the quest of reaching the SDGs by 2030, namely the monitoring of progress and the development of actions for the implementation. The SDG indicator framework used for the monitoring requires EOs for the quantification of a number of the more than 240 indicators. Many of the indicators are found to require socio-economic data, while others depend on EVs characterizing the built environment. A focus needs to be on how such EVs could be extracted from traditional EOs possibly in combination with Big Data analysis, citizen scientists, and crowd-sourcing.

There is an urgent need to integrate socio-economic and environmental data such that the inte- grated data base can be used to aggregate indicators and to support model simulations for policy development. However, the strategy for exploiting these opportunities does not exist.

Data Integration: *It is recommended that a strategy be developed for the integration of socio-economic and environmental data and a platform be developed for this integration.*

Only a minority of indicators depend on variables that can be extracted directly from EOs. This is found to be due to the current indicator frame work being strongly result focused with little emphasis on monitoring the actual systemic processes that can lead to achieving the targets. A preliminary review of several targets shows that adding system-relevant indicators would provide valuable monitoring that could be used to monitor the impacts of policies and other actions prior to achieving the results.

Indicator Assessment: *It is recommended that a thorough analysis of all targets be conducted to identify additional process-focused indicators that could be proposed to the Inter-Agency and Expert Group (IAEG) responsible for the revision of the SDG Indicator framework.*

Understanding the linkage of the SDGs and associated Targets to sustainability and the interconnection between the different goals and targets requires research that depends to a large extent on EOs. Policy development requires tools to assess the future policy impacts. Understanding of interdependencies between goals is currently limited and tools for policy developments are lacking. Taking a nexus approach

provides a methodology to assess the interdependencies.

SDG Interdependencies: *It is recommended that a comprehensive assessment of interdependencies between different SDGs and the associated targets be conducted to ensure that synergies are exploited and detrimental interactions are avoided.*

Implementation of the SDGs is hampered by the lack of methodologies and tools to create and validate transformation knowledge, required to develop policies and actions that can divert the current system trajectory such that progress towards the SDGs and associated targets is made. In the context of the developing field of sustainability science, there is an urgent need to develop tools that can be used to create transition knowledge and to develop epistemic concepts for the validation of this knowledge. For the former, complex system-of-system (SoS) models can provide a means for scenario-based simulations. For the latter, so-called "real world laboratories" (RWLs) are an emerging approach. In both cases, a collaboration between EO communities, science communities and those developing and implementing policies for the SDGs is a necessity.

Policy Development: *It is recommended that tools for scenario-based creation of transition knowledge and policy impact assessments be developed in support of policy development. Of particular interest are tools that can answer "What if" questions and support scenario-based simulations.*

Policy Validation: *It is recommended that a concept of "Real-World Laboratory" be developed, including the required traditional and emerging EO elements, for the validation of policies developed and implemented to achieve progress towards specific SDG targets.*

In the **TDT2**, a large number of documents were reviewed. The review resulted in numerous gaps added to the CGT. In many cases, theme-specific EVs could be identified, but the link to specific observational requirements is often lacking.

Observational Requirements: *It is recommended that best practices for the process leading from the identification of EVs to the specification of observational requirements be developed and promoted.*

In the **BUT1**, the main source for the identification of gaps was a survey conducted in EO and user communities. Most of the issues identified by the participants were in the field of data coverage and data access, as well as obstacles hampering data exploitation. In terms of unmet needs, the participants indicated direct data download in harmonized formats and portals offering both discovery and access to data as common issues. Other common needs referred to higher spatial and temporal resolutions of datasets.

In the **BUT2**, the comparison of an Observation Inventory (OI) established with the help of the DAB and additional enrichment tools to a set of generic observational requirements showed that most of the entries in the OI did not meet the requirements for spatial and temporal resolutions.

In the **BUT3**, five specific industry-driven challenges were addressed. Common to all challenges was the need for improved data access and the harmonization of semantics and the lack of collaboration across stakeholders, disciplines, and societal sectors.

Data access: *It is recommended that efforts to improve data access, particularly direct data access through discovery portals, be continued as a core focus of GEOSS.*

Semantic Harmonization: *It is recommended that efforts to harmonize data-related semantics be significantly elevated to improve data discovery, integration, and usability.*

Cross-Domain and Cross-Sector Collaboration: *It is recommended that additional efforts be made to increase collaboration between stakeholders in different disciplines and societal sectors using complex issues such as the Food-Water-Energy Nexus and the interdependency of SDGs as a catalyst to trigger*

the collaboration, and building upon efforts such as ENEON.

The "Industry energy challenge" demonstrated that building a platform can increase data access and use and bring stakeholders together. However, extra efforts were found to be necessary to identify, convince, access and connect private sector data. It was indicated that ENEON could play a role here.

The "In-situ data compatible to satellite mission challenge" built on results from several European projects and identified a number of functional gaps of generic type in in-situ data. Among them were insufficient geographical and temporal coverage required to meet the needs of Cal/Val applications and the lack of complete uncertainty and covariance matrices required for error propagation and comparisons. The lack of metadata harmonization and supportive data policies were identified as obstacles to data access and exchange. Data documentation is found to be often incomplete limiting traceability and data governance. Moreover, parameters are often missing or cannot be extracted from the monitored EVs.

In-Situ Observations: *It is recommended that an elaborate effort be made to improve the documentation, coverage, access, and quality of in-situ data with particular focus on the needs of satellite-based observations. It should be assess to what extent ENEON could play a role in this effort.*

The "In-situ integration into the CGI challenge" addressed the lack of interoperability for discovery, access and use of data from new systems with the GCI.

The "Private sector challenge "European EO Product of the year"" addressed the lack of involvement of the private sector in GEO activities. A competition for the "product of the year" award was utilized to stimulate increased involvement. It was noticed that the participants in this competition in general did not make use of the GCI to discover or access data.

The "Interdisciplinary cooperation on the food-water-energy nexus (FWEN)" challenge focused on a review of documents related to the FWEN. Main issues identified include a lack of collaborations across relevant disciplines and across the societal sectors. The study also revealed that GEOSS has limited capabilities to support theme-based approaches and that there is a missing link between relevant stakeholder communities in industry and science. Importantly, there is a lack of coordination mechanisms to establish links between different networks providing data in support of addressing the FWEN. The nexus approach is found to be very valuable to address complex issues and could be a model for other complex challenges. Using recommendations made for the FWEN, generic recommendations for the implementation of the SDGs from a nexus point of view can be developed.

Nexus Indicators: *It is recommended that a nexus approach be used to address SDG interdependencies and to develop nexus-based indicators that account for the complexity of the interdependencies.*

Nexus Tool Box: *It is recommended that appropriate data and information systems and diagnostic tool boxes be developed that support a nexus approach to interdependencies between SDGs.*

The statistics of the gaps collected in the CGT show that most gaps are associated with the Climate theme followed by the Ocean theme. This uneven distribution indicates that the two communities in the fields were more active than other communities. Most of the identified gaps resulted from TDT2, which shows that a review of documents prepared by major international communities is an important source for the identification of gaps.

The lack of coordination between, and collaboration of, stakeholders across disciplinary and sectoral boundaries is recognized as a major obstacle for the full exploitation of traditional and emerging EOs. There is a significant lack of policy frameworks that explicitly address the coordination required by complex nexus issues as exemplified by the FWEN. In many cases, complex issues are not addressed from a nexus point of view but rather segmented and distributed of several governmental departments, with little collaboration across departmental boundaries.

ENEON has made an effort to map the landscape of the EO networks and research infrastructures in Europe. Equally important is to map the landscape of societal stakeholders and users who depend on knowledge created on the basis of EOs.

Mapping Societal Landscape: *It is recommended that the societal landscape of beneficiaries, users, and applications depending on EO-based knowledge be mapped as a basis for matching users to providers.*

There is a need to develop capacity and skilled experts for bringing together providers and users (match-making). While there are funding programs that aim at regional mobility (in space) there appears to be a lack of programs that facilitate mobility across disciplinary and sectoral boundaries.

Mobility: *It is recommended that mobility funding programs such as the Marie Sklodowska-Curie Individual Fellowships emphasize mobility across disciplinary and sectoral boundaries with the goal to increase skills in matching providers and users.*

Abstract

This report describes the ConnectinGEO approach to the gap analysis and prioritization and discusses the preliminary results of the gap analysis. In general, the gap analysis compares specified needs to what is available and identifies those needs that are not met by corresponding data, infrastructure, capacity, information, or knowledge. Key elements of any gap analysis are the collection of information on the needs and requirements on the one side and the available knowledge, information and data that could meet these needs on the other side. The Group on Earth Observations (GEO) has considered different methods for the development of inventories of needs and available products as well as approaches to gap analyses. However, a community consensus on the approach has not been reached. The ConnectinGEO project therefore makes on effort to develop an approach to gap analysis and prioritization as a potential template for GEO. Based on the process used to specify and collect needs and requirements, the gap analysis in ConnectinGEO follows five distinguished threads, namely (1) Top-down thread 1: identification of a collection of observation requirements; (2) Top-down thread 2: research program aims and targets; (3) Bottom-up thread 1: consultation process; (4) Bottom-up thread 2: GEOSS Discovery and Access Broker analysis; and (5) Bottom-up thread 3: industry-driven challenges. All specified needs are collected in the Socio-Economic and Environmental Information Needs (SEE-IN) Knowledge Base (KB). They are used in the five threads to identify gaps and these gaps are compiled in the ConnectinGEO Gap Table (CGT). The CGT is open to publish additional gaps as well as providing feedback on already published gaps. The preliminary resulting CGT contents demonstrate the validity of the threaded approach and reveal a large number of gaps. It is found that importing the information on gaps into the SEE-IN KB is a way to increase the functionality of the gap analysis and prioritization.

The implementation of the approach for prioritization is in progress, with two main processes being considered: For each need published in the SEE-IN KB, the number of links of this need to applications and the relevance of the applications are used to compute a rank that indicates to some extent the impact meeting the need would have. For those needs currently not met, the ranks can be used to prioritize gaps. A second approach is based on a community consultation process, in which expert communities are invited to provide feedback, including rankings, on the identified gaps.

1 Introduction

1.1 Scope of the Deliverable

One of the objectives of the *Coordinating an Observation Network of Networks EnCompassing saTellite and IN-situ to fill the Gaps in European Observations (ConnectinGEO)* project is to provide a prioritized list of gaps relevant to GEO and to provide recommendations to funding agencies concerning options to address these gaps. It is the intent to propose the developed approach as a template for gap analysis and prioritization to the *Group on Earth Observations (GEO)*.

Any gap analysis requires two main ingredients, i.e., an inventory of needs or requirements, and an inventory of what is available to meet those needs or requirements. There is a long history of attempts in the Earth observation and scientific communities to establish both inventories and to carry out gap analyses. GEO is no exception and has made considerable efforts to enable gap analyses by establishing these inventories. The deliverable summarize the activities in GEO concerning the collection of user needs, available products, and gap analyses. Comparing the ConnectinGEO approach to the relevant GEO activities ensures that the results of the ConnectinGEO project can be communicate to the GEO community.

The preliminary gap analysis summarized in this deliverable is based on the ConnectinGEO gap analysis approach described in Deliverable 6.1, which defines five threads for the gap analysis and specifies the format of the resulting CGT. These threads have been used in several ConnectinGEO Work Packages. The present deliverable discusses the preliminary results and the resulting CGT, which is available at http://twiki.connectingeo.net/foswiki/bin/view/ConnectinGEOIntranet/GapAnalysisTable?cover=print. It also provides an overview of the data model used in the *Socio-Economic and Environmental Information Needs Knowledge Base (SEE-IN KB)* for the documentation of gaps and discusses the correspondence between the CGT and the SEE-IN KB gap model.

The deliverable also provides details on the development of approaches for the prioritization of gaps. Two approaches to prioritization are considered, which can be combined to achieve a validated list of prioritized gaps.

1.2 Structure of the Document

In the next section, selected approaches to gap analysis and prioritization are reviewed. The challenge of developing a user-driven EO system is introduced in Section 2.1. A key ingredient for gap analyses is the knowledge of the needs that are to be satisfied or the outcomes that are to be achieved. Section 2.2 provides an overview of the collection of relevant needs and observational requirements in GEO. A core concept for linking these needs to Earth observations is that of *Essential Variables (EVs)*, which is briefly described in Section 2.3. A full discussion of the concept and use of EVs can be found in the Deliverables 2.1, 2.2. and 2.3. The other key ingredient for gap analysis is knowledge of what is available to meet the needs. Section 2.4 summarizes the approaches in GEO to discover the products that meet the identified needs, mainly be developing the *Discovery and Access Broker (DAB)*. Section 2.5 documents the development of a conceptual approach to gap analysis in GEO. The current development towards a GEOSS Knowledge Base is reviewed in Section 2.6.

The approach taken by the GAIA-CLIM project is summarized in Section 2.7 since it informed the approach taken by ConnectinGEO as described in Deliverable 6.1 and impacted the gap typology used by ConnectinGEO. A network approach provides an alternative typology of gaps, which is described in Section 2.8.

The ConnectinGEO approach and its five threads are introduced in Section 3. The section also discusses the CGT and the *Controlled Vocabularies (CVs)* used for the on-line CGT. This table is currently maintained with the goal to collect the preliminary results of the gap analysis. The table is available to the public at http://twiki.connectingeo.net/foswiki/bin/view/ConnectinGEOIntranet/GapAnalysisTable?cover=print, and it is open to publish gap information and give feedback. Using the CGT has the advantage of being easily accessible for partners to publish their results, but it has the disadvantage of limited functionality. Therefore, the results will be transfered fully to the SEE-IN KB before project end. In Section 3.4 the current state of the gap model of the SEE-IN KB is introduced.

Section 4 presents the preliminary results of the gap analyses carried out in the project so far. For each thread, the activities and outcomes are discussed. The state of the CGT is presented and reviewed in Section 5.1.

The current state of the deliberations on prioritization is presented in Section 6. The deliverable concludes in Section 7 with a brief summary of the issue to be addressed in the process of the gap analysis and identifies actions to be carried out to finalize the gap analysis and prioritization.

2 Selected Approaches to Gap Analysis: A brief history

2.1 The Challenge of Building a User-Driven Earth Observation System

From the onset, GEOSS was intended to integrate Earth observations, socio-economic data and Earth system models to provide decision support for policy and management decisions (GEO, 2005b). This has not changed, and the Ministerial Summits held after 2005 have reconfirmed this overarching conceptual goal for GEOSS. The focus on the global and regional sustainable development goals during the 2015 Summit in Mexico City and the 2016 GEO Plenary in St. Petersburg, Russia confirms this concept. Consequently, GEOSS needs to focus on the integration of Earth observation with socio-economic data and the assimilation of Earth observations and other data into models that can provide answers to the questions that decision makers might have.

The original concept for GEOSS provided a clear structure that connects data through models to knowledge (see Figure 3 in Deliverable 2.1, modified from GEO, 2005b). Up to now, GEOSS has been focused mainly on Earth observation data, while social, economic and crowd-sourced data as well as Earth system models have not been integrated to the required extent. As a result, most of the connections between observations and the knowledge needs of decision making have been through improved data delivery, visualization, and narrow domain models. Most of the gap analysis efforts also were focused on gaps in meeting specific user requirements.

Any gap analysis requires a knowledge of what is needed or desired on the one side and available on the other side. The comparison of what is need to what is available helps to identify gaps. In order to prioritize gaps, rules are required that allow to measure the importance of a gap.

The dialog between users and beneficiaries of Earth observations and derived products, information and knowledge and those engaged in designing, deploying, and maintaining observation systems and processing the data has been complicated by a large communication gap between these groups. Using the style of R.D. Laing in “Knots” (Laing, 1970), who presents a series of dialogue-scenarios mainly between Jack and Jill describing the “knots” and impasses in various kinds of human relationships, Figure 1 illustrates this dialog. In most cases, user requirements registries are developed in Earth observation communities and associated scientific communities with little communication with other societal stakeholders who potentially could benefit from the observations and derived knowledge. Even more so, the dialog between societal stakeholders, who are challenged with an issue, and those Earth observation and scientific communities who could provide valuable observations and knowledge supporting the development of solutions, is limited. User requirements registries often are the results of Jacks talking to Jacks assuming that they know what the Jills out in society need. A serious gap is the absence of matchmaking institutions and experts that could effectively engage users (Jills) and providers (Jacks) in a dialog. We will come back to this challenge in Section 7.4.

2.2 Collecting Observation Needs

An important step prior to any gap analysis is the development of observational specifications based on well defined user needs. Considerable effort has been made by Earth observation communities to develop registries of user needs and observational requirements. Since 1984, the *Integrated Global Observing Strategy (IGOS)* initiated by the G7 as a framework for Earth Observations was developed with the goal to identify the essential variables that need to be observed in order to document the changes that are happening on the planet. In 1998, the *Integrated Global Observing Strategy Partnership (IGOS-P)* was established, bringing together major organizations in the scientific and Earth observation fields in

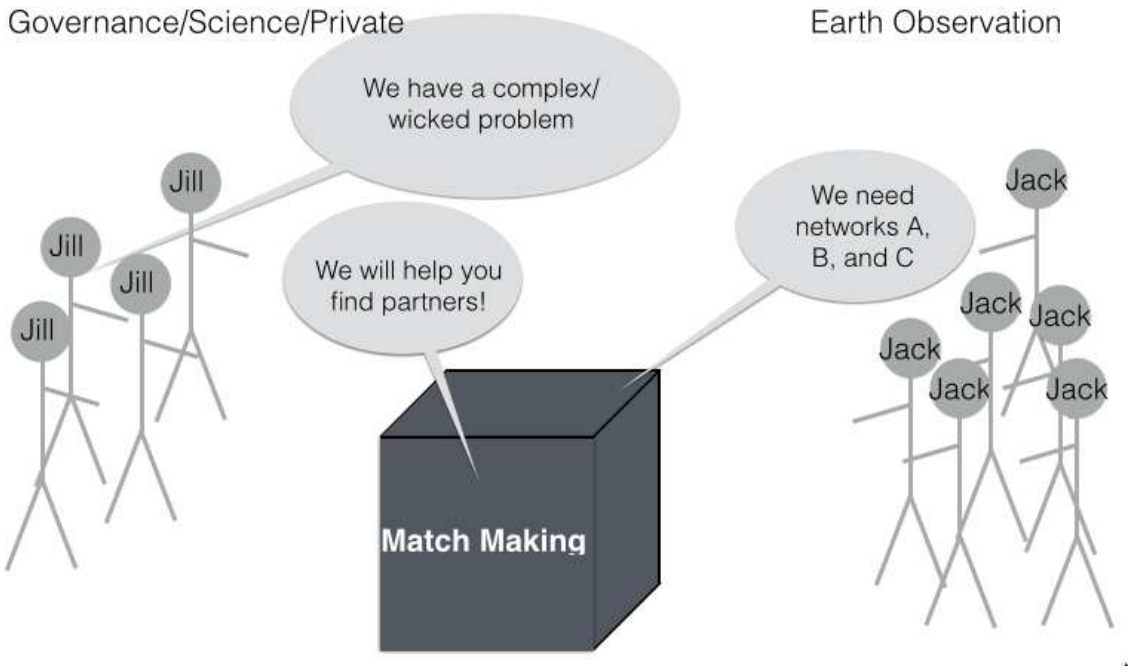

Figure 1. Dialog between Earth observation providers and users.
Assessments of user requirements often result into a dialog of "Jacks" with other "Jacks" while the societal users (Jills) are not involved. In the goal-based approach (GBA) *starting with a societal goal or issue, there is a need for match making.*

an effort to first identify what needs to be monitored and then to implement the corresponding observing systems (Dahl, 1998; Smith, 1998). IGOS-P used a well-defined theme approach to define the overall strategy, which "*recognises that in reality it is impossible, in one step and for all eventualities, to complete the exercise of defining all the necessary observational requirements and hence the observational systems, data handling, processing and analysis infrastructure for a comprehensive global system. The theme approach allows the coherent definition and development of an overall global strategy whilst recognising the different state and stage of development in different areas. Themes have not a priori been defined, rather it is anticipated that the user communities will identify areas that require action and bring forward themes for agreement and action*" (IGOS-P, 2003). The resulting IGOS-P theme reports were excellent outcomes of the first step defining observational needs for societally relevant themes (e.g., IGOS-P Ocean Theme Team, 2001; Barrie & the IGACO Writing Team, 2004; Key & the IGOS-Cryo Writing Team, 2004; Lawford & the Water Theme Team, 2004; Marsh & the Geohazards Theme Team, 2004; Townshend & the IGOL Writing Team, 2004; IGOS, 2006). However, the implementation of the findings by the space agencies and other providers did not follow suit.

After the establishment of Most of the IGOS-P Theme teams were transitioned into GEO Since the initiation of GEO in 2003 (again by the then G8) and the full establishment in 2005, most of the IGOS-P Theme teams established GEO *Communities of Practice (CoPs)* and in 2008 were fully transitioned into GEO (Marsh & Rast, 2008). Most teams continued to update their reports on observational requirements (e.g. Salichon et al., 2007; LeCozannet & Salichon, 2007).

In GEO, collecting comprehensive information on user needs was a core activity from its initiation. Two major efforts were carried out in parallel: The collection of observational requirements from published literature (Group on Earth Observations, 2012) and the development of the *User Requirements Registry*

(URR) (e.g., Plag et al., 2010).

A major effort was done in GEO in the period from 2006 to 2012 to identify observational requirements based on published documents. This approach is comparable to the ConnectinGEO Top-Down Thread 2 (see Table 5 in Section 3). The effort was part of the GEO Tasks US-06-1a (2006-2008) and then US-09-01 (2009-2012) and the results are summarized in Group on Earth Observations (2012). For each GEO *Societal Benefit Area (SBA)* one or more reports were produced detailing the results of the assessment. The general structure of the process was to have an "advisory group" and an "analyst" working together to develop the priorities within each SBA. The advisory groups included on the order of ten SBA experts from developed and developing countries. The advisory groups helped to identify documents, commented on analytic methods and priority-setting criteria, and reviewed the analysts' findings, priorities, and reports. The analysts were the primary persons to read and analyze the documents, develop analytical methods and the priority-setting criteria, and conducted the meta-analysis to identify common priorities within each SBA. Since some SBA spanned a range of issues, for several SBAs the process was conducted in sub-sets of issues. There was a recognition that observation priorities may change over time as needs are met, technologies develop, and new needs arise. Therefore, it was assumed that GEO would periodically conduct the process to account for the range of issues in a SBA and for changes in priorities.

The process description included a list of nine steps of which some could be carried out in parallel:

- Step 1: *User Interface Committee (UIC)* Members identify Advisory Groups and Analysts for each SBA
- Step 2: Determine scope of topics for the current priority-setting activity
- Step 3: Identify existing documents regarding observation priorities for the SBA
- Step 4: Develop analytic methods and priority-setting criteria
- Step 5: Review and analyze documents for priority Earth observations needs
- Step 6: Combine the information and develop a preliminary report on the priorities
- Step 7: Gather feedback on the preliminary report
- Step 8: Perform any additional analysis
- Step 9: Complete the report on Earth observations for the SBA

Although the very extensive process led to a series of highly valuable reports (which are all available at http://sbageotask.larc.nasa.gov/), a serious drawback is that the outcomes are not available in a database or knowledge base and therefore cannot be directly used in a gap analysis based on inference rules.

In parallel, the GEOSS URR was developed as part of the GCI with the goal to capture the full value chain from Earth observations to the end users in an effort to enable a comparison to the data and products discoverable through the DAB. There are a number of databases that register observation needs. Common to all of these databases is a separation of the process that identifies the observation needs from the documentation of these needs in the registries. Likewise, most of the databases focus solely on the question of "What is needed?" As a result, the registries contain specifications of observation needs in terms of variables, their spatial and temporal resolution and coverage, as well as other attributes such as accuracy and latency. Some databases also provide information on observing technologies. Most databases do not provide information on the questions of "Why is it needed?" and "Who needs it?"

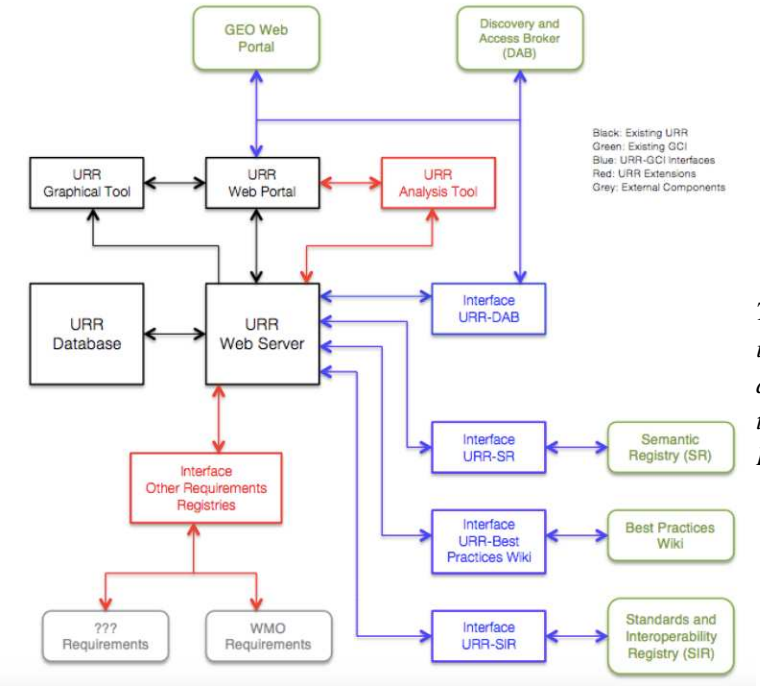

Figure 2. Integration of URR into the GCI.

The URR was intended to be integrated into the GCI with links to GCI registries and the DAB. The URR was also linked to other user requirements registries. From Plag, H.-P. (ed.) (2012).

The links between the observation specifications and applications that depend on the observations are normally not documented, and information on the users that benefit from the observations and the applications is not collected. Most existing databases are focusing on specific domains, while very few have a global scope.

In principle, the existing databases could be utilized in gap analyses by comparing the documented needs to the available observations that are, for example, discoverable through the GEOSS DAB. However, the lack of information on the links between observations and the benefits that result from them being used strongly reduces the value of the existing databases for prioritization of gaps and existing observations.

An exception is the URR, which aims to fully document the users, their applications, and the resulting observation specifications in all GEO SBAs (Plag et al., 2010). The basic questions addressed by the URR are "Who are the users?" "What are they doing?" and "What do they need to do what they are doing?" Moreover, the URR collects information on the societal benefits associated with applications and therefore supports to some extent prioritization (Plag et al., 2012a).

Core relations in the URR included user types, application, observational requirements and four needs (research, technology, infrastructure, capacity building). The URR was designed as a crowd-sourcing tool allowing basically anyone to publish in the URR. Most of the information published, however, came from experts engaged as members of the experts groups or analysts in the efforts in US-06-1. Another source for populating the URR was harvesting of existing requirements registries. Most of the exiting registries are, however, restricted to observational requirements, which does not support prioritization.

Most of the existing registries of observation specifications are limited in scope, usage, and services. In particular, they do not integrating knowledge creation in the sense that societal goals could be linked to observational requirements. Moreover, the access means available for the existing registries do not support deliberations on what is needed and why. They also are not integrated with tools that support discovery and provide access to data. The URR has very simple means for deliberations. A connection with the GEOSS DAB is feasible and could support the chain from information and knowledge needs to data discovery and access. The linkages of the URR to other elements of the GCI are shown in Figure 2.

The second ingredient for the gap analysis, i.e., knowledge about the available datasets and products in GEO is mainly provided by the DAB.

There is a need for a more elaborated approach to the identification of observation requirements that truly can help to meet the information and knowledge needs, and the connection from the information and knowledge needs to data. This is the rational for the development of the GEOSS Knowledge Base. This current development of relevance for the ConnectinGEO Project is documented in Section 2.6.

2.3 Essential Variables

The concept of EVs is increasingly used in Earth observation communities to identify and prioritize variables and observations that are key to the missions of these groups. Initial efforts were made by the *Global Climate Observing System (GCOS)* under the *United Nations Framework Convention on Climate Change (UNFCCC)*, which developed a set of *Essential Climate Variables (ECVs)*. GEO provides an important framework for the development of set of EVs for each SBA and thematic area, including *Essential Ocean Variables (EOVs)* for marine, chemical, and physical aspects of the oceans, and *Essential Biodiversity Variables (EBVs)* for biodiversity. A review of the current status is provided by Deliverable 2.2. In most cases, all these efforts utilized the so-called *expert-based approach (EBA)*, where experts in the relevant field identify what they need and what is feasible to observe. In most cases, a link to the societal benefits is constructed after the domain-specific EVs have been identified.

This EBA gives high weight to feasibility and may not sufficiently cover the currently low-feasibility but high impact areas in the impact over feasibility diagram (see Figure 1 in D2.1). Therefore, in the frame of ConnectinGEO, a complementary GBA for the identification of EVs has been developed that starts with the societal goals and benefits and identifies EVs independent of their current feasibility. With this, there are two basic approaches to the process that leads to community-accepted EVs (Table 1):

- EBA: the “expert-based” approach widely used in scientific and EO communities starts at feasibility and expert preferences and establishes a link to societal benefits in a retrospective way;
- GBA: the “goal-based” approach starts at societal goals, the associated targets, and the indicators established as report card and planning tool and identifies the EVs required to quantify the indicators.

In order to capture the flexible nature of EVs, in the context of ConnectinGEO the definition given in Table 1 is used. This concept of EVs assumes that there is a (small) number of variables that are essential to characterize the state and trends in a system without losing significant information. It is this set of variables that needs to be observed if past changes in the system have to be documented and if predictability of future changes is to be developed. Identifying this set of EVs allows for a commitment of inherently scarce resources to the essential observation needs. It also supports and eases the management of data and observations all along the chain from the measurement of raw data, through the processing and to the delivery of products, information and services needed by end users.

The concept of EVs is an approach to identify priorities for EO efforts. Groups planning and conducting programs to collect EOs could benefit from the existence of a set of commonly agreed EVs as a basis to prioritize and commit resources and to support progress towards an evidence-based knowledge base for decision making. For any given subject area, the EVs are those variables for which observation requirements need to be specified. Efforts need to be made to provide observations meeting these requirements. In the frame of GEO, the concept of EVs can be applied to focus the efforts on a smaller set of variables characterizing one or more GEO SBAs on global scale. An aggregation of the sets of EVs identified in

Table 1. Concept of essential variables.
From Deliverable 2.1.

Definition	A set of Essential Variables EVs is a minimal set of variables that determine the system's state and developments, are crucial for predicting system evolution, and allow us to define metrics that measure the trajectory of the system.
Why do we want to know EVs?	(a) prioritizing: to make sure we know what to measure; (b) gap analysis: to make sure we measure what is needed.
How do we identify set of EVs?	**Expert-based**: Based on community objectives, expertise and capabilities, a community agrees on a set of variables that is essential for this community; **Goal-based**: Starting from agreed-upon societal goals, a process leads to targets and metrics to monitor and predict progress towards the targets, and from there to variables required to quantify the metrics, which is mostly defined through a set of indicators.

Figure 3. High-Level process for populating the Observation Inventory.

From Santoro et al. (2016).

SBAs and CoPs would promote collaboration among different GEO communities by emphasizing the needs for common EVs.

2.4 Finding the Available

The main tool to discover through GEOSS what is available in terms of data, products and services that could meet the user needs is the DAB, which is a part of the GCI. The DAB provides access to an OI developed in WP 4 (see Figure 3). In the following we reproduce the slightly edited conclusions of Santoro et al. (2016), which summaries the status of the OI. WP4 defined a high-level process for the population of the OI (Santoro et al., 2016). Based on this process, the architecture for the creation of the OI was designed and developed (Figure 4). The first version of the OI was created and populated using the current information in the metadata concentrated in the DAB. The first population process was run in December 2015, resulting in a total of more than 1.6 million harvested metadata records. The developed OI is accessible online by client applications using all service interfaces supported by the GEO DAB, including JavaScript APIs with an ad hoc extension to execute complex queries. In this way, it is possible to use the OI as a data source for different analysis tools, which create plots, reports, or summary statistics useful for the ConnectinGEO gap analysis. A simple Web Client was developed to demonstrate how to interrogate the OI. In the "Documentation" section, the Simple Web Client provides also basic examples of how the developed OI can be used by web-based tools to provide views and statistics of currently available observations useful for the gap analysis. It is planned to fully connect the SEE-IN KB to the OI so that the OI can be utilized for the gap analyses in the SEE-IN KB.

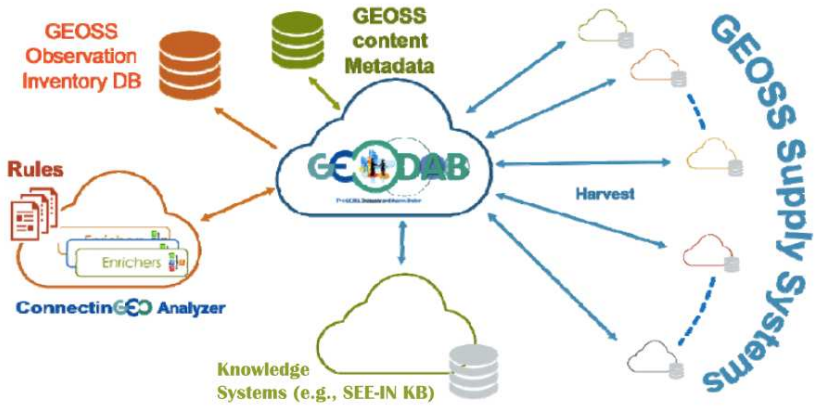

Figure 4. Architecture of the Observation Inventory.

Modified from Santoro et al. (2016).

2.5 GEO's Approach to Gap Analysis

In the context of GEO, several attempts have been made to carry out gap analysis. The former *Science and Technology Committee (STC)* of GEO discussed gap analysis approaches in 2010 and 2011. The FAR GEO Assessment proposed to the STC in 2010 (Plag, 2010) would take a rather comprehensive approach to the assessment of EO needs and capabilities. It would include the identification of what is essential to observe in order to understand the coupled socio-economic and environmental systems and to monitor variability and changes in these systems (basically the EVs across all domains), the discussion of which of these variables are observable or derivable from observations with the goal to identify knowledge and technology gaps, and assess the observing systems with respect to the delivering of the observations meeting the requirements for the EVs.

The STC developed a document summarizing different approaches to gap analyses and presented this to the *Executive Committee (ExCOM)* in 2011. The discussion of gap analysis in GEO was discontinued shortly after the STC was dissolved. Subsequent attempts to revitalize the gap analysis discussion have not been successful. The GEO Work Programme 2016 included a Foundational Task on user needs and gap analysis, and this Task is continued in the GEO Work Programme 2017. The results of ConnectinGEO will play a crucial role for this Foundational Task.

Here we briefly summarize the main outcomes of the STC discourse. The status of the gap analysis discussion in GEO is summarized in Science and Technology Committee (2011), which also proposed a process to the GEO ExCOM. Figure 5 reproduces the introduction, which underlines the intended importance of gap analyses in the context of GEO.

Reviewing the gap analysis activities in GEO, the STC team found a number of cross-discipline and SBA specific activities. While most of them were focused on observational requirements, only a few considered infrastructure and capacity gaps. Only GCOS in the Climate SBA utilized the concept of EVs in the gap analysis. As a result of the review, the STC team identified different types of gaps summarized in Table 2.

The issue of prioritization is also addressed in Science and Technology Committee (2011), particularly since "*any gap analysis process inherently contains some value judgments about the worth or importance of those gaps.*" It is acknowledge that there will be difference in prioritization between different stakeholder groups. Therefore, a need is identified for GEO to agree on a set of prioritization principles if a gap analysis is to do more than simply list gaps. An example presented is the user feedback used in US-09-01a Task "Critical Earth Observation Priorities" (see Page 25), which asked users for the most critical observations and then highlighted those critical observations identified by the largest number of user communities. Other potential principles for prioritization discussed in Science and Technology

Development of a GEOSS Gap Analysis Strategy (for decision)

1. Background:

At the 19th Geo Executive Committee Meeting, a discussion on the outcomes and recommendations of the GEOSS mid-term evaluation, and a proposal put forward by STC to suggest the development of an Earth Observation Capacity Assessment process led to a recognition by ExCom that the GEO community needed an overall strategy for analysis of observational and structural gaps. It was further identified during 19th ExCom that the GEOSS Strategic Targets document (as adopted by Plenary) commits GEO to undertaking: "comprehensive gap analysis and gap filling, integrated across all SBAs as a cornerstone of GEOSS implementation. "

It envisions that GEO will:

- Elucidate practical methods for filling critical gaps in, inter alia, observation specifications and parameters, geographical areas, and observation and information accessibility;
- Identify opportunities and measures to minimize gaps in data, metadata, and products;
- Set and address priorities for filling gaps.

The recognition by Executive Committee that a clear strategy was needed to achieve this aim led to the creation of the following action:

Action 19.11 – The STC, the M&E WG, the Secretariat, and other interested members of the GEO Community to draft an initial outline of a process that can eventually lead to a coherent overall mechanism being put in place for required GEO/GEOSS gap analyses

Figure 5. Introduction to Science and Technology Committee (2011).

The introduction emphasizes the importance of a comprehensive gaps analysis for GEO.

Table 2. Gap typology identified by the GEO STC.
The table is based on Science and Technology Committee (2011).

Type	Description
Geographic	Observation systems or data set has good coverage in one geographic region or country but not in others.
Observational	Observation technologies or systems are not available or have not been sufficiently developed for key analyses or issues of global importance.
Structural	Structural gaps are internal to GEOSS, e.g., missing tasks required to meet our targets. Tasks or products not meeting expectations from other components of GEOSS (this may be common when analysis is done across SBAs).
Qualitative/quantitative	Product exists but at insufficient timeliness, frequency or quality for use in key products or utility for other GEOSS components.
Capacity	Products are available but there is insufficient technical capacity or capability to make use of such products.

Committee (2011) are the degree of contribution to meeting Millennium Development Goals (or now the *Sustainable Development Goals (SDGs)*), the degree of consistency with GEOSS Data Sharing Principles, the rating of continuity of measurements higher than new measurement types, and the value for money, etc.

The report discusses five steps towards gap analysis and prioritization:

a) SBA or Domain focused gap analysis (existing with some gaps)

b) Structural gap analysis (proposed)

c) Observational gap analysis (partly existing/proposed)

d) Periodic meta-analysis of gaps (proposed)

e) Development of GEOSS Prioritization Principles

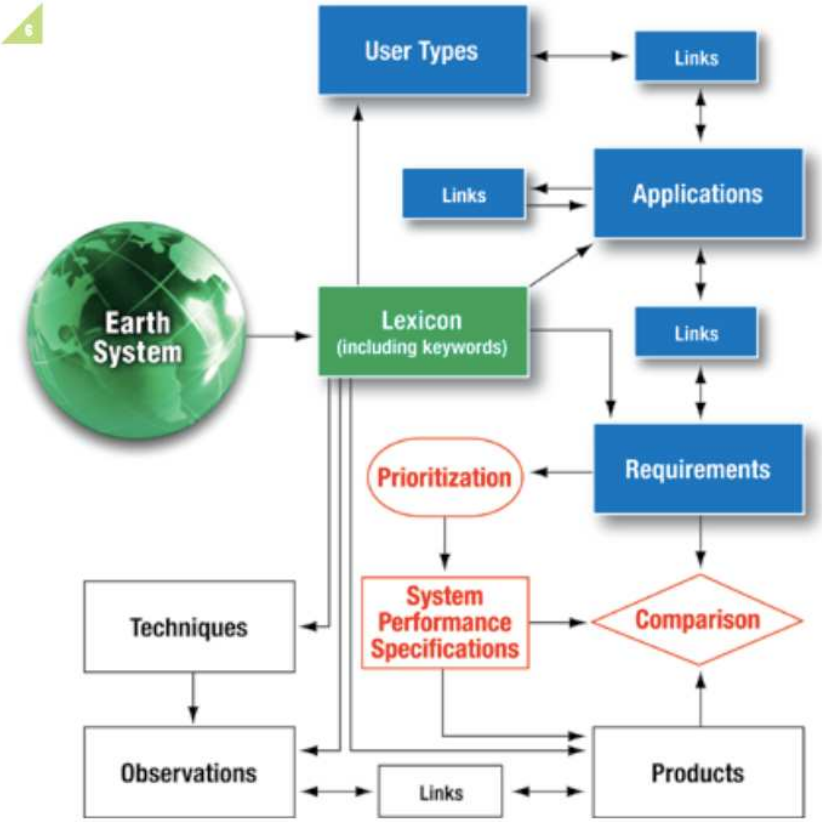

Figure 6. Structure of the URR indicating the gap analysis approach.

From Plag et al. (2010). In the URR, gap analysis was based on the comparison of observational requirements with data discovered through the DAB. Prioritization was based on the ranking of the observational requirements.

It is mentioned here that these steps are all included in the ConnectinGEO gap analysis approach. Concerning the development of the GEOSS prioritization principles, the report states "*there is an important requirement to undertake a process to define common GEOSS Prioritization Principles or GEOSS Common Values to inform relative prioritization of gaps within a GEOSS Gap Analysis Strategy. These principles, just like the GEOSS Data Sharing Principles would not over-ride Member or Participating organizations own prioritization processes, but would articulate the shared principles whereby an agreed GEO prioritization may occur.*" The discussion in Section 6 will considers these guiding thoughts.

The work on the GEOSS URR summarized in Section 2.2 had the ultimate goal to facilitate a gap analysis and to support prioritization (Plag et al., 2010, 2011, 2012a). A main goal of the development of the GEOSS URR was the identification of gaps in the available observations and the observing system of systems in a way that would inform prioritization.

2.6 The GEOSS and SEE-IN Knowledge Bases

The Ministerial Guidance provided to GEO during the Ministerial Summit in 2014 implicitly requested an extension of the URR to a more versatile knowledge base: The Ministerial Guidance identifies focus area 4 as: "*Develop a comprehensive interdisciplinary knowledge base defining and documenting observations needed for all disciplines and facilitate availability and accessibility of these observations to user communities*." The detailed response to this guidance is described in Deliverable 2.1. There it is concluded that the guidance asks for a knowledge base with (1) all the relevant facts for all disciplines; (2) well-defined rules how to use the facts to derive specifications of the observations needed; (3) and an *inference engine* that can derive the observation requirements based on these rules.

A core function of the GEOSS Knowledge Base is to facilitate the linkage between societal goals and

Table 3. Gap types defined by the GAIA-CLIM Project.

No	Name	Description
1.	Coverage	Gaps in geographical and/or temporal coverage, i.e. a lack of measurements
2.	Vertical Resolution	Insufficient vertical resolution
3.	Measurement Uncertainty	Uncertainty budget including calibration, i.e. uncertainties intrinsic to one measurement
4.	Comparator Uncertainty	Uncertainties relating to comparator measures, i.e. uncertainties related to comparisons between measurements which have different attributes
5.	Technical	Data dissemination, specific missing tools (specifically excluding governance)
6.	Governance	data policy incl. (free) data access, unclear QA/QC methodologies, traceability/documentation/learning (specifically excluding pure technical gaps)
7.	Parameter	missing parameter knowledge, missing auxiliary information for an ECV, etc.

targets to EVs (see Deliverable 2.1 for details). The primary goals of the GEOSS Knowledge Base include:

- capture the socio-economic and environmental knowledge needs of a wide range of societal stakeholders;
- link societal goals and targets to essential variables and observational requirements;
- use the value chains from observations to end users to facilitate access and improve applicability of EO data and products;
- enable gap analyses and prioritization;
- support the identification of EVs and document the EVs.

As one element in this knowledge base, the SEE-IN KB is under development. This knowledge base aims to connect societal goals and targets to EVs that need to be observed in order to quantify indicators that provide the metrics for measuring progress towards these goals. For each indicator, specific observational requirements can be derived that need to be met. In the frame of the SEE-IN KB, the goal of gap analyses is to identify those EVs that are not available to satisfy the observational requirements. The SEE-IN KB also considers observational requirements derived from a wide range of applications and aims to determining the societal benefits depending on each of these requirements. In a gap analysis, the requirements not met are identified and the associated societal benefits are used to prioritize the gaps.

2.7 The GAIA-CLIM Approach

In the *Gap Analysis for Integrated Atmospheric ECV Climate Monitoring (GAIA-CLIM)* Project, a gap analysis is carried out with the objective "*to identify and assess through careful analysis against both existing and envisaged user requirements – yet unfulfilled user needs (gaps) in the observation capability of ECVs within the sphere of the GAIA-CLIM project*" (van Weele, 2015). Gaps are identified and updated regularly in the individiual project work pages of the project. User needs are extracted from surveys, workshops, and external documents. Available lists of gaps are reviewed by experts. The gaps are classified in seven gap types listed in Table 3.

Table 4. Gap typology based on the linkage between observations and societal knowledge needs.

Acronym	Name	Description
O	Observation Gap	Observations meeting required specifications of an (essential) variable are missing. The specifications are derived from indicators in a relevant metrics or applications generating the information and knowledge needed by users.
P	Processing	The processing capacity or tools are not available to generate required knowledge.
D	Discovery	The discovery processes, including access policies, are not in place to make the information and knowledge available and usable.
K	Knowledge and Information Gap	Knowledge or information required by a user to make informed decisions is not available to this user.

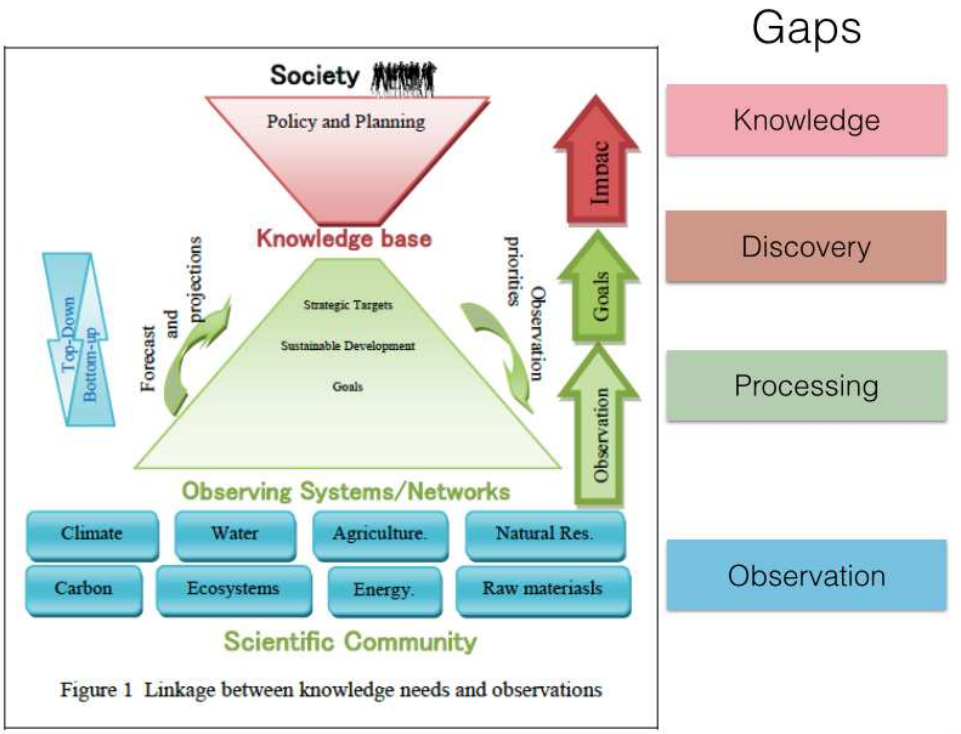

Figure 7. Location of the gaps in the value chain from observations to societal knowledge needs. *See Table 4 for the description of the gaps.*

2.8 Network-Based Gap Typology

Another approach to gap classification takes a point of view based on the chains and networks connecting EOs to societal knowledge needs and classifies gaps according to the location in the chains from observation to societally usable knowledge as well as the level of the products from observations to knowledge. Table 4 summarizes the four types of gaps from the lack of observations (O gaps), gaps in the processing and knowledge generation (P gaps), gaps in discovery (D gaps), to gaps in the available knowledge (K gaps). Fig. 7 links these gap types to the different parts of the value chain from observations to knowledge, and Fig. 8 reflects on the linkage between these gap types and the ConnectinGEO approach.

There is a hierarchy in this gap typology in the sense that O gaps result in P, D, and K gaps, P gaps

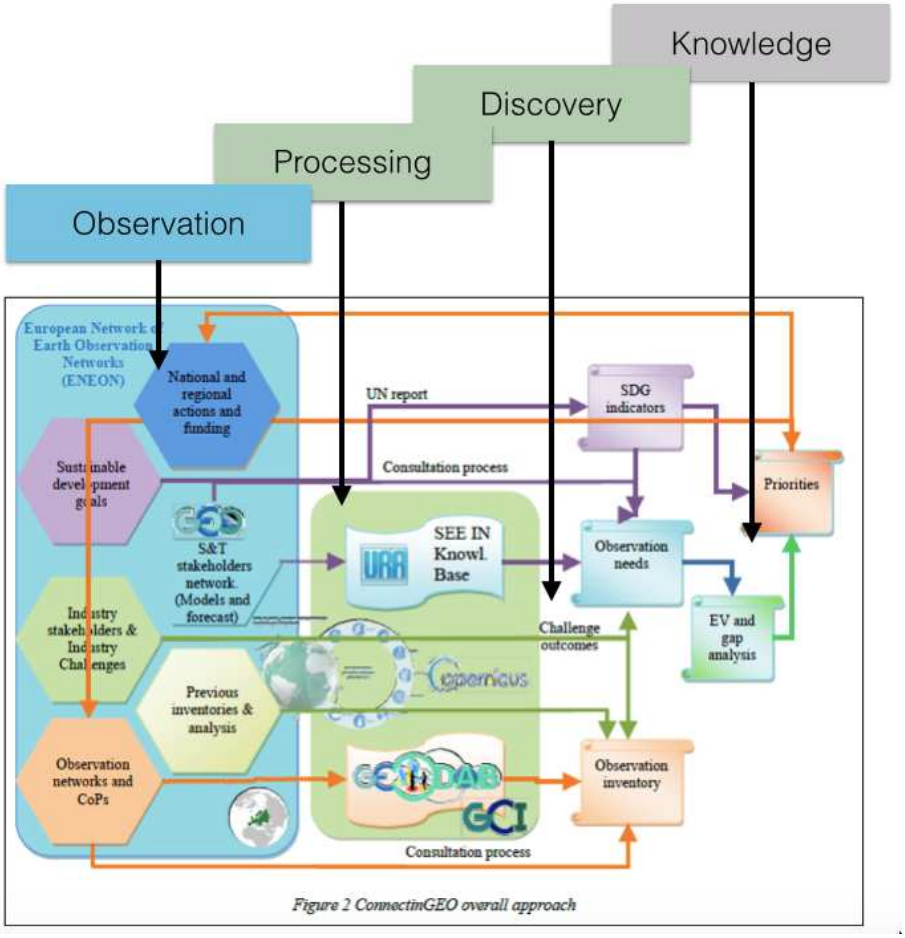

Figure 8. Location of the gaps in the ConnectinGEO scheme.
See Table 4 for the description of the gaps.

result in D and K gaps, and D gaps result in K gaps. Depending on the reason for the gaps, they define infrastructure, technology, research, and capacity building needs:

O: Observation gaps can be due to a lack of sufficient observational infrastructure, thus defining an infrastructure need; the lack of sensors to carry out the observations, thus defining a technology need; or insufficient capacity to install, operate and maintain the infrastructure required for the observations, thus defining a capacity building need. Observations of the required variable may actually be available but not of the quality, spatial and temporal coverage and resolution, latency, etc. to match a given specification.

P: Processing gaps can be the result of a lack of processing tools (data access tools, models, algorithms, visualization), thus defining infrastructure and/or technology tools; a lack of capacity to carry out the processing, thus defining a capacity need; or the gap may be a consequence of absent, insufficient, or inaccessible observations (an O gap).

D: Discovery gaps can be the result of a lack of search tools and inventories, resulting in infrastructure needs; a lack of meta data, resulting in capacity needs to better document the data; a lack of access due to data sharing policies, resulting in a governance and policy need.

K: Knowledge gaps can be the result of non-existing knowledge, resulting in the need to create the knowledge; a lack of capacity to use the knowledge, resulting in capacity building needs; a lack of usability of the knowledge, resulting in the need to make the knowledge usable by educating those who created the knowledge; and a lack in accessibility of knowledge due to economic, policy or technology barriers, resulting in needs for systemic changes, policy changes, and infrastructure development.

The SEE-IN KB uses the above typology to link infrastructure, technology, research, capacity building and other needs to gaps and thus captures steps for the remedy of gaps and information for prioritization.

A thorough gap analysis has to consider all four types of gaps. Starting from the societal knowledge needs as outlined in the GBA has the advantage that prioritization of identified gaps can be directly linked to the societal impact. However, very often communities engaged in EO are basing gap analyses on incomplete registries of observational requirements and focus strongly on O gaps, while less attention is paid to the P, D, and K gaps. The approach developed by the GAIA-CLIM project (see Section 2.7) is taking a more comprehensive view on gap analysis.

3 The ConnectinGEO Approach to Gap Analysis and Prioritization

3.1 Overview

As described in detail in the Deliverable 6.1, the ConnectinGEO approach to gap analysis is a threaded approach with currently five threads summarized in Table 5. The threads are discussed in more detail in Section 3.2. The grouping in *Top-Down Threads (TDTs)* and *Bottom-Up Threads (BUTs)* is indicative of community involvement in the identification of gaps. The two TDTs approach gap analysis from a collection of needs and requirements, which are compared to available products. The three BUTs use consultation processes or the analysis of existing product inventories to gain knowledge about gaps.

As a first step towards the gap analysis using the TDTs, ConnectinGEO formalized the GBA, which first translates user knowledge needs linked to well-defined societal goals into indicators and then identifies the EVs required to quantify these indicators (see Deliverable 2.1). As a next step, observation requirements are specified for the EVs depending on specific applications. For the gap analysis, these requirements are compared to information on available observations to identify key gaps.

In the ConnectinGEO project, all five threads have been used. The *European Network of Earth Observation Networks (ENEON)* has been engaged in the gap analysis in several threads using the concept of thematic ambassadors. Table 19 on page 118 lists the current ambassadors.

The web-based CGT is the main medium in ConnectinGEO to collect the results of the gap analysis and to facilitate the review and prioritization of these results. The structure of the CGT and the contents of subsidiary tables with CVs are documented in Section 3.3. The CGT is currently maintained by the project consortium under the URL http://twiki.connectingeo.net/foswiki/bin/view/-ConnectinGEOIntranet/GapAnalysisTable?cover=print. It is being considering to keep the table on-line as Google spreadsheet alive, but the exact format is still under discussion.

The contents of the CGT will also be transferred into the SEE-IN KB. Importing the table contents into the SEE-IN KB is currently in progress. The gap model used in the SEE-IN KB is described in Section 3.4. Besides aiming at a comprehensive repository of various needs, the SEE-IN KB will have full functionality to identify, publish, review, accept, and prioritize gaps.

3.2 A Threaded Approach to the Identification of Gaps

The threaded approach is described in detail in Deliverable 6.1. Here we summarize the key elements of each of the five threads.

3.2.1 Top-Down Thread 1: Observational Requirements

This thread uses the GBA (see Deliverable D2.1) to identify observational requirements. Originally, the *Top-Down Thread 1 (TDT1)* was intended to start from a number of sets of goals and targets that current and future users of GEOSS might have. Based on these sets, indicators to measure progress towards the goals and targets could be identified. The EVs required to quantify the indicators would provide a basis to specify observational requirements.

The goal sets considered included the GEOSS Strategic Targets, the SDGs, the global boundaries, *Disaster Risk Reduction (DRR)*, and monitoring of global change. The feedback during the Midterm review of the project indicated that the focus of the gap analysis should be on the SDGs. This is consistent with the general development in GEO, which is paying increasing attention to the SDGs.

Table 5. Gap analysis threads and their connection to similar approaches.

Thread	Acr.	Description	Similar Approaches
Top-Down Thread 1	TDT1	Identification of a collection of observation requirements and specifications from generic goals for sustainability of the global civilization as expressed in the GEOSS Strategic Targets, the SDGs, and the adherence to the planetary boundaries.	GEOSS URR, SEE-IN KB
Top-Down Thread 2	TDT2	Incorporation of material from international programs such as Future Earth, Belmont Forum, the Research Data Alliance and community assessments of socio-economic benefits of Earth observations	GEO US-09-01 analysis, see (Group on Earth Observations, 2012)
Bottom-Up Thread 1	BUT1	A consultation process in the current EO networks, consisting of collaboration platforms, surveys and discussions at workshops and even involvement of citizen science.	GAIA-CLIM
Bottom-Up Thread 2	BUT2	A careful analysis of the observations and measurements that are currently in GEOSS Discovery and Access Broker complemented by other means (e.g. scientific literature)	
Bottom-Up Thread 3	BUT3	The realization of a series of real industry-driven challenges to assess the problems and gaps emerging during the creation of business opportunities	

In D6.1, the (slightly modified) steps for TDT1 were identified to be:

1. Define the gaps taxonomy.
2. Identifying the strategic goals we want to achieve. This can come from the SDG but also by scientific goals that we can identify in scientific literature.
3. Express the goals as precise user requirements.
4. Identifying the essential variables that can be used to measure the achievement of the goals.
5. Identifying the metrics and measurements used to achieve the goals.
6. Determine if the EO necessary fits the purpose of the user requirements. If not, a gap has been detected.

Related to step 1, the gap taxonomy has been defined in D6.1 and is compiled in Table 20 on page 118. Related to step 2, in this thread, observational requirements are derived from societal goals with a preference on generic goals for sustainability of the global civilization. The goals to be consider in this project have been discussed in D2.1, and based on the review of societal goals and the feedback during the mid-term review, the main focus is on the SDGs. For steps 3 to 5, details of the GBA used to derive corresponding EVs are discussed in Deliverable 2.1. For the gap analysis indicated in step 6, the observational requirements are compared to datasets and products that can be discovered using the DAB. A key issue is the development of rules used to decide whether a product actually matches a requirement, potentially matches a requirement, or does not match a requirement.

The achievement of goals poses a new challenge to science and epistemology, i.e., the creation of transformation knowledge that is required to transition from the current state to a desired future. This challenges is discussed in more detail in Section 4.1.

3.2.2 Top-Down Thread 2: International Programs

For the *Top-Down Thread 2 (TDT2)*, documents of international programs such as Future Earth, Belmont Forum, and the Research Data Alliance as well as community assessments of socio-economic benefits of Earth observations, including those of the IGOS-P Themes, have been studied with the primary goal to extract explicit observational requirements. In addition, other needs (such as infrastructure, capacity, technology and research needs) were considered. The extracted information is published in the SEE-IN KB so that it can be included in the gap analysis. An initial set of requirements is being compiled based on the review of literature done by the GEO Task US-09-01 and the reports published as a result of these task activities (Group on Earth Observations, 2012).

3.2.3 Bottom-Up Thread 1: Consultation

The consultation process of *Bottom-Up Thread 1 (BUT1)* has been implemented in form of a survey. This survey was conducted by WP 3 and the results are described in detail in Deliverable 3.4. The results of the survey are reviewed to extract gap information. The results were augmented during the Gap Analysis and Prioritization Workshop and ENEON Plenary in October 2016.

3.2.4 Bottom-Up Thread 2: Discovery and Access Broker

In this thread, a limited set of observational requirements was used to demonstrate the feasibility of the thread. The initial results in the *Bottom-Up Thread 2 (BUT2)* of the analysis of the observations and measurements that are discoverable through the GEOSS DAB has been presented at the Project meeting in April 2016 in Münster, Germany. The results were also presented at the Gap Analysis Workshop in October 2016. The result of this analysis are being reviewed to identify gaps and these gaps will be included in the SEE-IN KB.

3.2.5 Bottom-Up Thread 3: Industry Challenges

In the *Bottom-Up Thread 3 (BUT3)*, a series of industry-driven challenges to assess the problems and gaps emerging during the creation of business opportunities are carried out in WP 5. The challenges are described in detail in Deliverable D5.1. They include:

1. A experiment based on *Surface Solar Irradiance (SSI)* measurements and the gaps in them. ARMINES is leading this challenge. This activity started in August 2015.

2. An experiment to combine in-situ and satellite data. The text in the DoA frames the scope to SAR and atmospheric data for CalVal. Sentinel 1 will have a role. S&T is leading. Start was in September 2015.

3. Integrate more in-situ networks in the GEOSS DAB with the scope on CZEN and terrestrial ecosystems. CNR is leading and the activity started in July 2016.

4. A private sector challenge consisting of a competition. *European Association of Remote Sensing Companies (EARSC)* leads this activity and it started in December 2015.

5. An interdisciplinary cooperation on the *Food-Water-Energy Nexus (FWEN)*. This activity is lead by Tiwah and started in December 2015.

3.3 The ConnectinGEO Gap Table

All threads are in the process of generating and finalizing lists of gaps, which are combined into a joint list in the CGT. In order to compile the CGT and for subsequent analyses and prioritizations, the description of gaps has been formalized both for the CGT and for the upload into the SEE-IN KB. The formalization also supports the review and exploration of the gap list. The CGT is currently available at http://twiki.connectingeo.net/foswiki/bin/view/ConnectinGEOIntranet/GapAnalysisTable?-cover=print. This list is open to publish additional gaps as well as providing feedback on already published gaps.

The formal data structure for the description of gaps is based on initial ideas of the GAIA-CLIM project, which have been adapted to the needs of ConnectinGEO. The attributes of a gap entry are defined in Table 6. Note that the status captured in the CGT deviates significantly from the table definition in D6.1. The status reflected is of 3 December 2016 and additional changes may have to be made in the future. The use of the formal structure defined in the on-line version of the CGT is mandatory for all threads.

The CGT utilizes a number of CVs for the entries:

- Gap Type Code: Adapting the GAIA-CLIM project methodology (van Weele, 2015), gaps can be classified using the taxonomy provided in Table 20 on page 118.
- Gap Status: Each gap has a status in terms of identification, review and feedback, acceptance, prioritization, and actions to close the gap, and this status is coded using the states specified in Table 21 on page 119. Note that the different states to some extent are inclusive. For example, the state "Accepted" implies that the gap has been reviewed, and the state "Prioritized" implies that the gap has gone through a full process of identification, review, acceptance and prioritization.
- Essential Variables: The list of known EVs is dynamic and likely to grow over time. The list of known EVs as of 3 December 2016 is reproduced in Table 23 on page 120.
- Themes: The gaps are associated with broad themes. The *Controlled Vocabulary (CV)* for the themes is listed in Table 22 on page 119.

3.4 The Gap Model of the SEE-IN Knowledge Base

A Ministerial guidance provided to GEO during the Ministerial Summit in 2014 requested that GEO "develop a comprehensive interdisciplinary knowledge base defining and documenting observations needed for all disciplines and facilitate availability and accessibility of these observations to user communities." In response to this guidance, the GEOSS URR has been transformed and extended into the SEE-IN KB.

The SEE-IN KB is at the core of the GEOSS Knowledge Base (see Deliverable D2.1). The SEE-IN KB provides the capability of conducting gap analyses. As outlined in D2.1, the functions of the SEE-IN KB include the identification and documentation of societal knowledge needs and the resulting observational requirements, the support of user access to existing observations and services meeting knowledge needs, and different approaches to gap analysis. The SEE-IN KB also "facilitate availability and accessibility of these observations to user communities," as requested in the Ministerial guidance.

The data model of the SEE-IN KB is that of unstructured objects (Figure 9). The instances in the SEE-IN KB can belong to one or more groups, and the inherit attributes, properties and capabilities from these groups. With the group concept, new groups can be introduced as needed. A group is defined by a set of

Table 6. Definition of the ConnectinGEO Gap Table.
Modified from D6.1. Status is as of 3 December 2016. The current status is available at http://twiki.connectingeo.net/foswiki/bin/view/ConnectinGEOIntranet/GapAnalysisTable?cover=print. Column N indicates the number of values the attribute can have. An asterisk in this column indicates that one entry is mandatory. The codes for GapTypeCode are given in Table 20 on page 118. The codes for StatusCode are given in Table 21 on page 119. In the SEE-IN KB, gap descriptions are instances of the group "Gaps". The SEE-IN Tags are used in the XML files of the SEE-IN KB for the respective attributes. Tags printed in small letters indicate linked objects in the SEE-IN KB.

Name	Definition	Data type and values	N	SEE-IN Tag
Gap Identifier	Unique identifier within the gap inventory	Character String, not empty	One *	ID
Gap Type	Type of gap	GapTypeCode	One *	GAPTYPECODE
Status	Status of the entry in the ConnectinGEO process	StatusCode	One *	GAPSTATUS
Theme	Thematic association of gap	ThemeName	One*	THEME
Other Themes	Other thematic association of gap	ThemeName	multiple *	THEME
EV	Name of the EV	EVCode	One *	EVs
Other EVs	Name of relevant other EVs	EVCode	multiple *	EV
Description	Description of the gap	Character String, not empty	One *	DESCRIPTION
Thread	Thread that generate this gap from the threads defined in this methodology	ThreadCode	One *	THREAD
RS/InSitu	Observational mode relevant to the gap	RsInsitu	One *	OBSERVATIONMODE
Editor	Last person to edit the gap information	Character string, name	One	OWNER
Ambassador	ConnectinGEO/ENEON Ambassador	Character string, name	One *	n/a
Traceability	Provenance information about the gap.[1)] Who formulated it and where was found. Note: In the SEE-IN KB, this is split into the trace description and the owner/author of the gap information.	Character String, not empty	Zero or one	TRACE
Purpose	Need (requirement) associated with this gap[2)]. Note: In the SEE-IN KB, many requirements can be linked to a gap.	Character String, not empty	Zero or one	RELEVANCE
Date	Date when last status was entered	DateTime	One *	DATE
Review	Comments provided by reviewers. Note: In the SEE-IN KB, these comments are added separately as an entry in the group "Reviews".	Character String, not empty [3)]	Zero or more [4)]	Reviews
Remedy	Possible remedy to fill the gap	Character String, not empty	Zero or one [4)]	REMEDY
Feasibility	Difficulties in filling the gap	Character String, not empty	Zero or one [4)]	FEASIBILITY
Impact	Impact of closing the gap	Character String, not empty	Zero or one [4)]	Impacts
Impact Rationale	Rationale for impact estimate	Character String	zero or one	Impacts

Table 6 continued.

Name	Definition	Data type and values	N	SEE-IN Tag
Cost	Quantitative estimation of the cost of closing the gap	Positive Integer	Zero or one [4)]	Costs
Cost rationale	Rationale for cost estimate	Character string	Zero or one	Costs
Timeframe	Estimation of the timeframe for closing the gap	Positive Integer	Zero or one [4)]	Timeframes
Timeframe rationale	Rationale for timeframe estimate	Character string	Zero or one	Timeframes
Priority	Priority degree.	Positive Integer	Zero or one [4)]	Priorities
Priority rationale	Rationale for the priority degree.	Character string	Zero or one [4)]	Priorities
Recommendation	Recommendation to a funding agency on how to finance and implement a remedy. Note that in the SEE-IN KB, recommendations are a separate group and linked to, e.g., gaps.	Character String, not empty	Zero or one [4)]	Recommendations

1) Each thread in this approach can potentially generate a Trace. For examples, in the DAB we can trace back the source of the gap to the "rule" or the "filter" applied to find the gap. In the consultation process, we can associate it to a scientific paper of a network name that provided this gap.
2) For example, the SEE-IN KB contains requirements that once analyzed and compared with the DAB, can provide gaps. The requirement in the SEE-IN KB is the Purpose.
3) In ConnectinGEO, the review and feedback is stored in an independent user feedback database as described in Section 4 Synergy with the Users' Feedback task and as described in the *Open Geospatial Consortium (OGC)* draft standard document OGC 15-097 following the UserFeedbackItem data type. Here only the result of this user feedback revision by a moderator will be summarized as a text. In the SEE-IN KB, reviews and feedback are groups and instances in these groups can be linked to the gap entries.
4) These elements are introduced during the revision and prioritization phase.

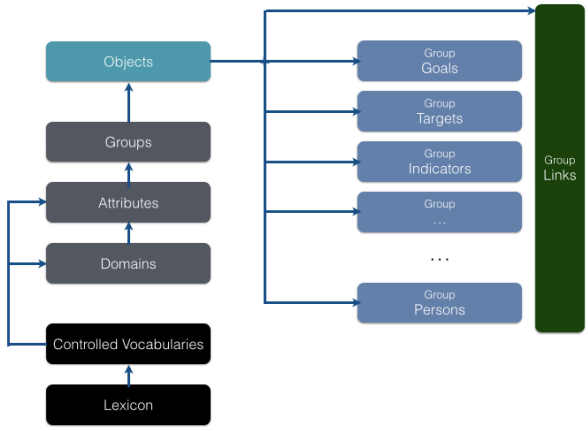

Figure 9. Main elements of the data model of the SEE-IN KB.

The Lexicon (black box) contains the full language usable within the SEE-IN KB, including the CVs, which are domains for some of the attributes. The dark-gray boxes define the domains for attributes, the list of attributes, and the known groups. Each instance in the SEE-IN KB is in the "Objects" group and associated with one or more additional groups. The instances in the "Links" group capture the connectivity and relationships between two instances in one or two groups.

attributes selected from the CV for attributes. Each attribute comes with a specified domain taken from a master set of domains. Examples of domains are an interval of real number, a list of variables, or a list of specific terms, denoted here as "Controlled Vocabularies." All CVs and all other language elements are defined in the lexicon. Groups also are associated with rules for how members of the group can act and interact with other objects.

A special group are "Links" (which are also objects). The instances in the "Links" group define the relationship between two instances in the same or in two different groups. This link concept is used to capture connectivity. This approach creates an external connectivity layer that is detached from the instances. In many other approaches, for example, JSON, the connectivity information is internal to the

instances, i.e., each instance "knows" which other instances it is related to. The disadvantage of the internal approach is that connectivity networks need to be constructed with information obtained from each instance. The external approach to connectivity provides easy access to the connectivity information and supports the development of graph data and network analyses. However, for a local approach to construct the environment of any given instance, the internal approach is advantageous. In the external approach, links can be added without changing the information "owned" by an instance.

The groups inherited from the URR include User Types, Applications, Requirements, Research Needs, Infrastructure Needs, Technology Needs, Capacity Needs, and Links. Additional groups in the SEE-IN KB include, among others, Persons, Models, Services, Datasets, Essential Variables, Variables, and several groups for various types of gaps (see below).

The concept of EVs is implemented in the SEE-IN KB. Based on the results of Task 2.1 in the ConnectinGEO WP2, rules are made available to link societal goals to EVs. Existing set of EVs can be linked to societal goals and benefits. The results of the review of the EV developments in the GEO SBAs reported in Deliverable 2.2 are being published in the SEE-IN KB.

The SEE-IN KB serves as the primary source for "user need" for the TDT1. The outcomes of the ConnectinGEO gap analysis are being published in the SEE-IN KB. The SEE-IN KB will also be used to determine priorities.

In the SEE-IN KB, gaps are represented with the attributes shown in Table 7. As mentioned above, several of the columns in the on-line CGT are represented through links to instances of corresponding groups. The relevant groups are included in Table 7. In most cases, these links are from the group instances to an instance representing a gap. For example, the publication Geijzendorffer et al. (2015) (ID CG-REF-014 in Table 33 on page 170) is linked to the gaps with IDs CG-035 and CG-036 (see Table 36 on page 178). In both cases, the link is from the reference to the gap, i.e., DIRECTION is set to "Left," because the gap is extracted from the publication, but there is no impact or feedback from the gap instance to the publication instance.

Figure 10 shows the structure of the SEE-IN KB gap model. The instances in all groups are all instances of the group "Objects" where they have an identification, owner/author, date, maturity, group, and access code. Instances in the group Gaps describe individual gaps. These instances can be linked to instances of Gap Analysis Threads, Themes, Reviews, Recommendations, References, Essential Variables, Indicators, Targets, Goals and a number of other groups not shown in the figure.

Table 7. SEE-IN KB objects used for gap-related information.
All instances have the attributes listed for Group Object. In addition, they have group-specific attributes. CV stands for "controlled vocabulary."

Group	Attribute	Description
Object	ID	Unique identification of instance
	OWNER	Owner of the instance
	DATE	Date the instance was created
	MATURITY	Maturity of the instances (CV)
	GROUP	Groups the instance belongs into
	ACCESS	Specifies the access rights to the instance (CV)
Link	LEFT	ID of instance on the "left" side of the link.
	RIGHT	ID of instance on the "right" side of the link.
	DIRECTION	Direction of the link, which can be "left" for connections with flows from the right to the left instance, "right" for connections with flows from the left to the right instance, or "bidirectional' for connections with bidirectional flows where both sides of the link are actively participating in the connection.
	LEVEL	Indicates the level of relevance of the link. The CV for this attribute includes 'weak', 'strong','crucial', among other characterizations of the relevance of the link.
	IMPLEMENTATION	Reports the extent to which the link is actually in existence. The CV includes 'pending', 'in planning', 'partially implemented', 'fully implemented'.
	DESCRIPTION	Free format description of the link, its relevance and its implementation.
	VALUE	Estimate of the economic, social, and environmental value of the link, if fully established.
	RULES	ID of a set of rules for links.
Gap	GAPTYPE	Type of gap. The CV for the gap type is summarized in Table 20 on page 118.
	DESCRIPTION	Free format description of the gap.
	OBSERVED	Observation area the gap applies to. The CV is 'space-based', 'in-situ', and 'both'.
	PURPOSE	Indicates the need or requirement associated with this gap. This attribute is temporarily included to capture information in the on-line table. It will be replaced by links between the gap and instances in the various need and requirement groups in the SEE-IN KB.
	REMEDY	Description of options to close the gap. This may be moved into a separate groups.
	FEASIBILITY	Description of the feasibility of addressing the gap (CV). This may be moved into a separate groups.
	IMPACT	Description of the economic, social, and environmental impacts addressing the gap would have (CV). This may be moved into a separate groups.
	COST	Estimate of the costs of addressing the gap (CV). This may be moved into a separate groups.
	PRIORITY	Priority rating of the gaps (CV). This may be moved into a separate groups.
	STATUS	Status of the gap (CV). The CV includes 'identified', 'draft', 'reviewed', 'accepted','open','filled'.
	RULES	ID of a set of rules for gaps.
GapAnalysisThread	NAME	Name of the thread. The threads developed in ConnectinGEO are listed in Table 5.
	DESCRIPTION	Free format description of the thread.
	STATUS	Extent to which the thread is implemented in SEE-IN KB.
	COMMUNITY	One or more communities engaged in using the thread for gap analyses (CV).

Table 7 continued.

Group	Attribute	Description
EssentialVariable	NAME	Name of the EV. The names constitute a CV that is used throughout the SEE-IN KB as the domain for the attribute 'EssentialVariable'.
	DESCRIPTION	Free format description of the EV.
	EXPDOMAIN	The domain or domains of expertise relevant to this EV (CV).
	GEOSYSTEM	One or more subsystems of the planet (or beyond), in which the EV is of relevance (CV).
	COMMUNITY	One or more communities engaged in the process of identifying and validating the EV (CV)
	RULES	ID of a set of rules for Gaps
Theme	NAME	Name of the theme.
	DESCRIPTION	Description of the theme.
	COMMUNITY	One or more communities engaged in exploring the theme
Review	DESCRIPTION	Full text of the review.
Recommendation	DESCRIPTION	Full text of the recommendation.
Reference	DESCRIPTION	Full reference[1)].

1) Note that the current group definition for references is temporary and is currently changed to be compatible with the BibTex model.

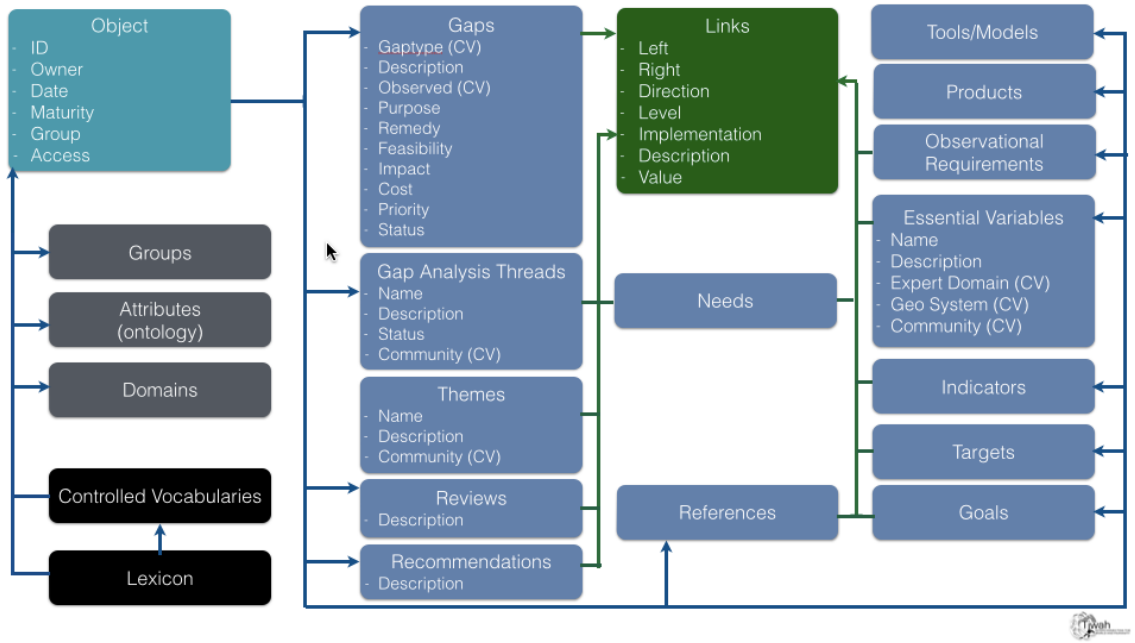

Figure 10. Data model for gaps in the SEE-IN KB.
The blue boxes show groups relevant to gaps. Each instance of a group is included in 'Object' with the common attributes of all instances in the SEE-IN KB. The group-specific attributes are shown for Gaps, Gap Analysis Threads, Themes, Reviews, and Recommendations. Note that 'References' links to a number of other objects such as Journals, Publishers, Institutions, etc.

4 Identifying the Gaps

In ConnectinGEO, all five threads have been used in the gap analysis. The current status in each thread is at different levels with some threads having published all gaps in the CGT while other threads are still identifying additional gaps and have not yet finalized the process of publishing gaps.

4.1 Top-Down Thread 1: Identification of a Collection of Observation Requirements

As pointed out in Section 3.2.1, in the frame of the ConnectinGEO project, the focus in the TDT1 is on the SDGs. There are several roles for EO and science support in the implementation and monitoring of the SDGs, which are addressed in the following sections. Figure 11 identifies quantification of indicators, exploring additional indicators, data integration, and research and tools in support of policy development as activities depending on EOs. Work is in progress to analyze these activities and to identify the gaps. In TDT1, focus is not solely on observational gaps but also include all other gaps in EO and science support for SDG implementation and monitoring.

The current status of the gap analysis in TDT1 is reflected in the tables in Appendix B on page 110. There, Table 14 provides several initial examples of gaps. Relevant references are listed in Table 15 and the links between gaps and references are included in Table 16. Note that these tables are preliminary and will be completed in Deliverable 6.3.

4.1.1 Transformation Knowledge for Sustainability

A particular challenge of the quest for sustainability arises from the need to create transformation knowledge guiding the development of policies and means to make progress towards the SDGs. Science needs to support society in the creation of the knowledge required for this transformation. The SDGs present policy makers with a complexity individually and through many interconnections (e.g., Jules-Plag & Plag, 2016a,b; Obersteiner et al., 2016; Nilsson et al., 2016a). At the same time, the unsustainability of the current global trajectory and the global consensus of reaching these goals introduces an unparalleled urgency to develop the necessary transformation knowledge. A major gap exists in the absence of an epistemology for the creation of transformation knowledge. While there are increasingly efforts to carry out transformation research in “real-world laboratories” (e.g., Evans, 2016; Karvonen & van Heur, 2014; Sengers et al., 2016), there is no thorough epistemological approach available for this new type of research.

Sustainability science is a developing research field addressing complex socio-ecological problems of our time ranging from climate change and mass extinction to pandemics and rapid urbanization (Kates et al., 2001; Clark & Dickson, 2002). A major goal for sustainability science is to provide knowledge in support of societal transformations towards sustainability. To achieve this, sustainability science generates, tests, and integrates (a) system knowledge about sustainability problems, (b) goal knowledge about desirable futures, and (c) transformation knowledge about disturbances and interventions that can lead from the current state to the desired futures (Fig. 12). In the past, epistemological work primarily has focused on the creation of system and goal knowledge (Grunwald, 2015). System knowledge is associated with the analysis of complex systems across different domains (e.g., society, environment, economy) and local to global scales and is essential for understanding and detecting complex sustainability problems. Transdisciplinary approaches integrating scientific and societal knowledge present challenges and opportunities for our understanding of sustainability problems (Wiek et al., 2012). Both the assessment of (un)sustainability and the envisioning of a sustainable world that we aim for involve normative claims.

Goal knowledge has attracted the attention of epistemologists because of the importance of normative components requiring a rethinking of the standards used in producing and evaluating scientific knowledge in sustainability science (Miller, 2013). It also has attracted the interest of ethicists because of the link of goals to normative ethics and the potential to reach the goals to descriptive ethics (e.g., Rieder, 2016).

However, the epistemological basis for the creation of transformation knowledge has been neglected to a large extent. A major unsolved problem for epistemology of sustainability science is therefore the understanding of how transformation knowledge can be generated, tested, and validate. Because of its transformational and transdisciplinary character, sustainability science differs from traditional modes of knowledge production. This raises important epistemological questions: How is knowledge for transformation produced? What is the role of experimental interventions in producing transformation knowledge? What theories can support knowledge production for transformational sustainability (Miller, 2013; Miller et al., 2014). What are the observations that can support the creation and validation of transformation knowledge? It would be important to include these questions in a thorough gap analysis of then data and knowledge needs related to the SDGs and sustainability in general. The iterative nature of implementing transformation (Fig. 13) requires detailed monitoring of the complex system trajectory after interventions in order to ensure that the resulting trajectory brings the system closer to the desired future and accepted goals and to detect in a timely manner the need for further interventions. The indicator framework for the SDGs only provides a zero-order concept for this monitoring and more comprehensive monitoring of the system state and trajectory is needed.

4.1.2 Essential SDG Variables

Concerning the observation requirements, in this thread, the GBA introduced in Deliverable 2.1 is used to first identify EVs required to quantify the metrics for the goals, and then to specify observational requirements for these EVs. In the ConnectinGEO project, we are in the process of carrying out the gap analysis with specific focus on the SDGs.

In D2.1, the GBA to link societal goals to EVs was introduced and this approach has been applied in the project to the SDGs. The seventeen goals are listed in Table 13 on page 110. For each goal, a set of targets has been defined. In total, 169 targets have been agreed upon (see Table 3 in D2.3). As mentioned earlier, progress towards these targets is measured with indicators (see https://sustainabledevelopment.un.org/topics/indicators). A proposal for the global SDG indicator framework was developed by the *Inter-Agency Expert Group (IAEG)* on SDG Indicators and this framework was accepted by the UN Statistical Commission in March 2016 as an initial set of indicators. A list of the indicators can be found in Table 4 in D2.3.

Several efforts have been made to link the indicators to EOs and geospatial information. Table 5 in D2.3 indicates relevant geospatial information for each SDG without going through targets and indicators. Table 6 in D2.3 links domain-specific EVs to indicators and targets for selected goals.

The GEO Initiative GI-18 in 2016 also reviewed the SDGs indicator framework and identified a number of SDGs that depend on Earth observations for quantification (Figure 15). In this process, a number of goals could be linked to information needs that can be met based on EOs.

In an initial screening in ConnectinGEO, the SDG indicators have been used to identify those indicators that either directly depend on EOs for quantification or would benefit from additional information derived from traditional EOs. Table 5 in D2.3 lists those indicators together with the EVs and the corresponding targets and goals.

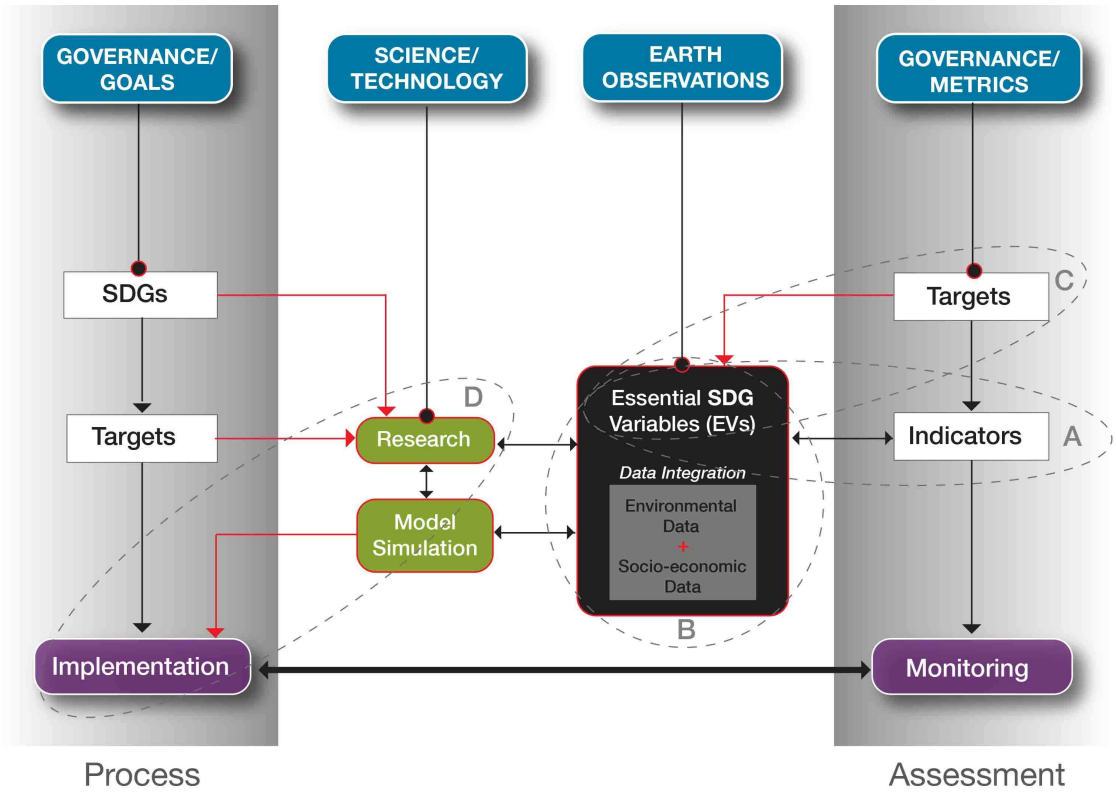

Figure 11. EO in support of monitoring SDG progress and tools in support of policy development.
A. GEO in its GEO Initiative 18 (GI-18) of the 2016 Work Programme and ConnectinGEO are developing methods for the quantification of those indicators that depend on EOs for quantification. B. For many of the indicators, the integration of socio-economic statistical data with environmental data is of importance. C. Applying the GBA to the SDG Targets shows that many of the Targets would benefit from indicators that are directly related to the natural environment. D. There is an urgent need to support the planning of actions and the development of policies that would facilitate progress towards the SDG Targets. From Jules-Plag & Plag (2016a).

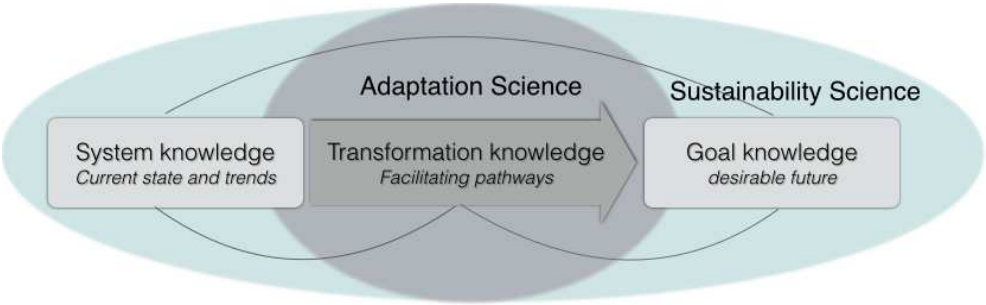

Figure 12. The three main parts of sustainability science.
Sustainability science relies on three main kinds of knowledge: system knowledge, goal knowledge, and transformational knowledge. While the epistemology of creating system and goal knowledge is well developed, the epistemology of creating transformation knowledge is in its beginning.

Figure 14 shows two examples illustrating the process used to identify the *Essential SDG Variables (ESDGVs)*. It is obvious that only some of the ESDGVs are directly observable with traditional EO techniques or extractable from EOs.

From Table 6 in D2.3 it is immediately clear that out of the 240 indicators, only a small fraction has a

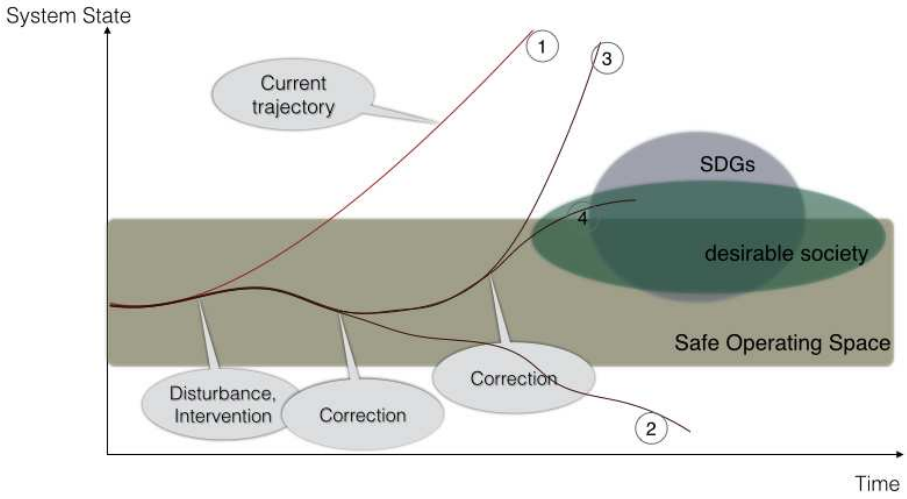

Figure 13. The iterative nature of bending system trajectories towards desirable futures.
Achieving the transformation from the current state and trend to a desired future requires an iterative process of disturbances exceeding the system's resilience and corrections to bring the system's trajectory closer to the desired future.

direct dependency on, or benefit of, traditional environment-focused EOs. The SDG indicator framework is to a large extent focusing on statistical variables related to human activities and human conditions. These variables are inherently social or economic in their nature.

In D2.3 it was noted that geospatial data is of high relevance for the monitoring of progress towards the SDG targets (see Table 5 in D2.3). In many cases, the geospatial information could be derived from a combination of statistical, economic, and environmental data obtained with traditional EOs and novel approaches such as citizen scientists, crowd-sourcing, big data analysis and the *Internet of Things (IoT)*.

4.1.3 Review of SDG Indicators

A detailed review of the SDG indicators was carried out. The indicators are found to be focused strongly on human needs and biased toward socio-economic information and the build environment. As a consequence, only very few indicators can currently be quantified based on information extracted from EOs. A comparison of the SDG indicators to the *European Environmental Agency (EEA)* indicators shows that the latter are far more focused on environmental characteristics (see EEA, 2014, and for a general description, www.eea.europa.eu/data-and-maps).

The metrics defined by the current SDG indicators provide information on progress towards the targets mainly for socio-economic variables but not necessarily the environmental sustainability. In order to increase the link between the SDGs and environmental sustainability, the GBA used for a review of the targets reveals a need to add indicators that increase the connection of the metrics to environmental variables. In the following we provide a few examples to illustrate this important issue.

For SDG 3 "*Good Health and Wellbeing*," the Target 3.9 aims at "*by 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination.*" The current indicators focus on consequences of environmental conditions: 3.9.1 "*Mortality rate attributed to household and ambient air pollution,*" and "*Mortality rate attributed to unsafe water, unsafe sanitation and lack of hygiene (exposure to unsafe WASH services).*"

This focus on the consequences of air pollution does not account for a time lag between changes in

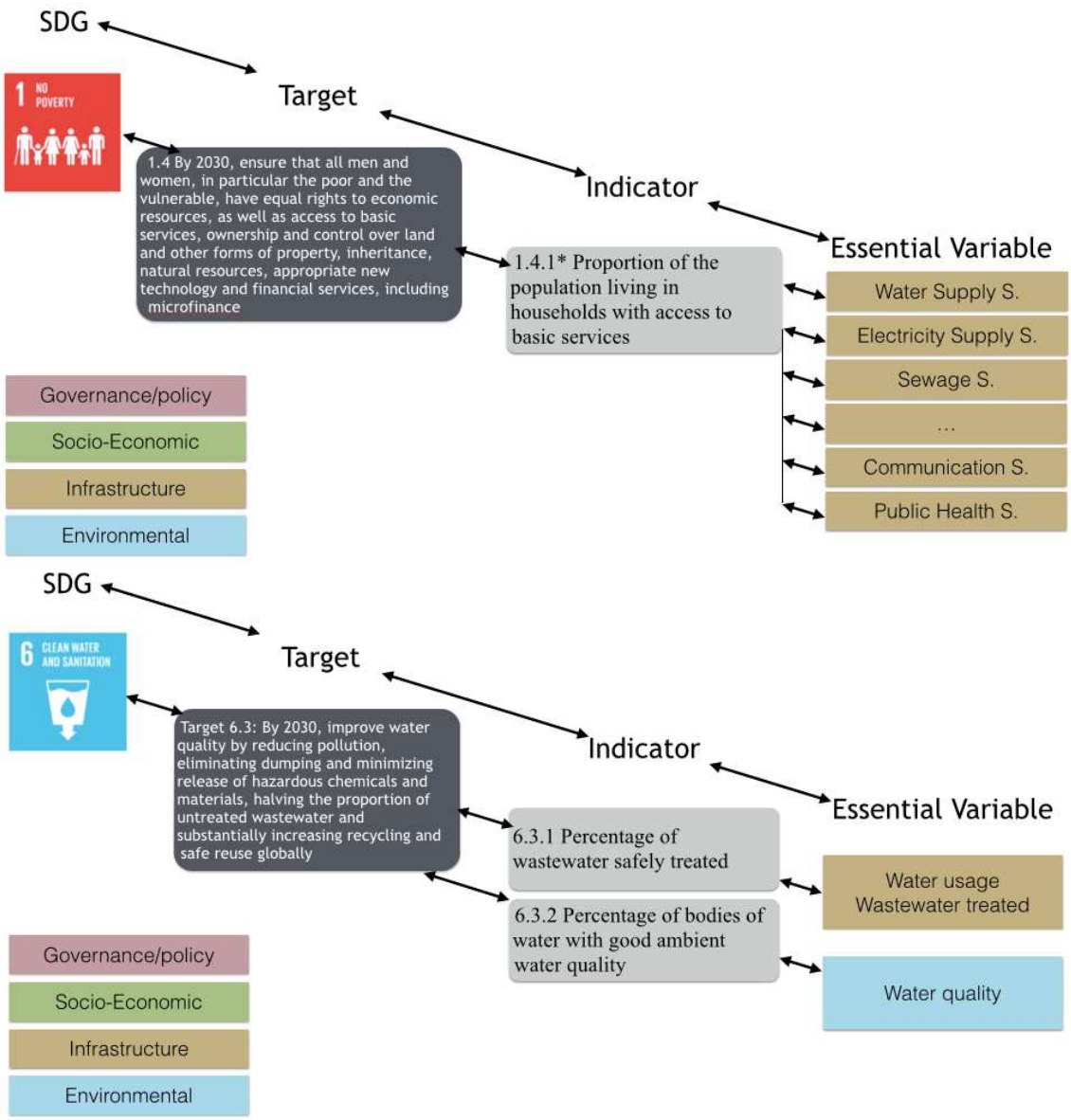

Figure 14. Link between goals and EVs.
The examples of SDGs 1 and 6 and the associated targets 1.4 and 6.3 are used here to illustrate the GBA to identifying EVs needed for the indicators.

environmental conditions and the changes in mortality rates. Mortality is not a good indicator because there is an accumulative effect that generates a huge delay. A decrease in mortality can happen even if pollution is increasing in the short term. The SDG indicators for Target 3.9 do not recognize the relationship between pollution and mortality. *European Commission (EC)* directives in place do recognize it. Adding indicators focusing on the causes, i.e., the environmental conditions such as pollution would be important to account for the time lag between cause and consequences.

Examples of relevant environmental variables include NO_2 and tropospheric O_3, which could be deduce from EOs (e.g., spectrometer from satellite). Tropospheric ozone is a gas harmful to vegetation and human health, and acts also as a climate forcer. Regional monitoring at European wide scale at in-situ sites was established in the early 1980s (Tørseth et al., 2012, and references therein), and with

Figure 15. GI-18 review of SDG Indicators and linkage to EOs.

From Group on Earth Observations (2016).

higher site densities from the 1990s in response to EC-regulations for air quality. The major frameworks organizing ozone measurements are the *European Monitoring and Evaluation Programme (EMEP)* (a program under the Convention on Long Range Transboundary Air Pollution), national networks operated in response to the Directive 2008/50/EC and the *World Meteorological Organization (WMO) Global Atmosphere Watch (GAW)* program. The latter also include activities towards stratospheric ozone. As sensitive groups of the population suffer during episodes with high ozone concentrations, there are efforts to forecast ozone levels to warn population of such events. This is also a key activity within the Copernicus Atmosphere Monitoring Service, where also data from satellite instrumentation, together with data from in-situ sites are utilized to improve the forecast through data assimilation (products available at: http://macc.copernicus-atmosphere.eu/catalogue/). The EEA operates a near-real time data service as part of the ozone web (http://www.eea.europa.eu/themes/air/air-quality), while EMEP and WMO-GAW data are available at http://ebas.nilu.no. As satellite products for stratospheric ozone have significant limitations in relation to human exposure assessments, the combined used with data from various in-situ data sources demonstrate the feasibility of a combined use of data to address a major concern in relation to human health and air quality.

Recently, the *United Nations Economic Commission for Europe (UN-ECE)* conducted an assessment to address the European trends in tropospheric ozone concentrations, in response to political abatement measures under the revised Gothenburg protocol (emission reductions of NOx and *Volatile organic compounds (VOCs)*). Results will be made available late 2016.

Satellite do not see the lower levels in tropospheric O_3. In-situ observations in populated areas are important. Satellite data in combination with in-situ observations give better result for near real time prediction. There is a role for GEO in facilitating the integration of satellite and in-situ observations to

generate products and data for new indicators. Harmonizing standard operating procedures for monitoring priority pollutants, such as Mercury and *Persistent organic pollutantss (POPs)*, and their compounds in air, atmospheric deposition, water, soil, sediments, vegetation and biota would also help to improve the current situation. There are already several networks relevant for quantifying new indicators, including EMEP, Copernicus Atmosphere, *Global Mercury Observing System (GMOS)*, and acGMPPOP.

Another example is SDG 6 "Clean water and Sanitation" and the Target 6.6 "*By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes*." The sole indicator for this target is Indicator 6.1 "*Percentage of change in the extent of water-related ecosystems over time*." The extent of water-related ecosystems could be extracted from EOs to some level. However, there are many other EOs relevant to the target that could be used to monitor progress to a higher degree of detail, such as change in wetland extent, and water resources monitoring. The global monitoring community is building an integrated water monitoring framework with data sources from EOs, completing those from surveys, regulatory frameworks and other administrative sources, as well as new and novel sources, including big data. Available networks include the *Satellite-based Wetland Observation Service (SWOS)*, *Global Groundwater Monitoring Network (GGMN)*, and *Global Terrestrial Networks (GTNs)* for Glaciers, Rivers, Lakes and others.

For SDG 7 "*Affordable and Clean Energy*", the Target 7.2, which aims "*by 2030, increase substantially the share of renewable energy in the global energy mix*" has the Indicator 7.2.1 "*Renewable energy share in the total final energy consumption*." To achieve this target, the availability and long-term acquisition of data from satellite, in-situ and models make it possible to effectively deploy, operate and maintain infrastructure for renewable energy and the integration of this energy source into the grid. Relevant user networks include the *International Renewable Energy Agency (IRENA)*. EO providers include Copernicus Atmosphere and the COPERNICUS *Monitoring Atmospheric Composition and Climate (MACC)* service for solar radiation.

For SDG 14 "*Life Below Water*," Target 14.2 is "*By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans*." The Indicator 14.2.1 is defined as the "*Proportion of economic zones managed using ecosystem-based approaches.*" This indicator relies on socio-economic data. There are, however, many environmental variables that have information relevant for progress towards the target, which can be extracted from EOs. Example include water quality, pollution, algae blooms, and salinity. Moreover, EOs can contribute to better define integrated coastal management plans. In Europe this is strongly linked to the implementation of several framework directives (e.g., water quality, habitat). Relevant organizations and networks include Copernicus Marine, *Marine Biodiversity Observation Network (MBON)*, Euro-GOOS and *Joint Research Infrastructure for Coastal Observations (JERICO)*, just to name a few.

As a last example, SDG 15 "*Life on Land*" has Target 15.2 "*By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally.*" The corresponding indicators are 15.2.1 "*Forest cover under sustainable forest management*" and "*Net permanent forest loss*."

In this case, EOs play an important role and there is a need for continued coordination of data streams and the addition of new data streams and products to ensure multiple annual global coverages of the world's forested areas. The continued development of data services tools and pilots for data acquisition planning, data storage, data processing and delivery of tailored data packages is equally important. Relevant programs include *Global Observation for Forest Cover (GOFC)* and *Global Observation for Land Dynamics (GOLD)*, Copernicus Land, *European Biodiversity Observation Network (EUBON)*, *Long Term Ecological Research (LTER)* Network, and the Geo Wiki "Land Cover Citizen Science."

4.1.4 Gaps Related to Essential SDG Variables

The availability of EOs and derived information for the implementation and monitoring of SDGs is hampered by a potential mismatch between what policy-making and research communities need and what EO communities provide. In particular, a lack of standardization, a lack of coordinated concepts, methods, and approaches (as indicated in Figure 1 on page 24) and the absence of institutional leadership are obstacles that hinder full exploitation of EOs for reaching the SDGs.

In the following, examples are given for a number of gap types that impact the quantification of SDG indicators, the monitoring of EVs derived from the SDG targets, as well as the research needed to support policy development for the implementation of the SGDs. A positive development is the rapidly changing approach to data management and access to data. To enable the exploitation of very large datasets, there is a transition towards bringing analysis tools to the data repositories and the development of data-to-knowledge services that make the download of big data sets obsolete. Although specific scientific analyses cannot be provided easily by such services, there are many programs available that can be made jointly available with the data. However, the development of best practices to progress from data to information is still in a very early stage. A challenge remaining to be addressed is the full integration of environmental, social, and economic data with relevant models. This integration was an initial goal for GEOSS expressed in the 10-year implementation plan (GEO, 2005a,b), and progress toward this goal is slow.

A particularly challenging gap in coordination is the coordination of in-situ network on regional to global levels across different networks and domains (Plag & Maso, J. (eds.), 2016). In Europe, there is currently no in-situ coordination across domain boundaries. Consequently, there is no coordinated representation of the in-situ networks in GEO and GEOSS. A potential coordination could come from the EEA. An example illustrating the situation is the case of coastal observations, which are fragmented and unevenly developed among European Seas. Although the data are public, little is done to publicize the data (e.g., high resolution bathymetry, fishery data) and integrated data portals are not available.

For data discovery and access, it will be important to add a brokering among data formats and projections to the brokering of data sources. Tools are needed that automatically access data available through the broker and process it. Standardization of data classifications and vocabularies is crucial to improve discovery, access and usability. It is important to overcome national policies that still limit data access. On European level, homogeneous data access should be imposed. Eventually, the auto-registering of sensors and the standardized managing of sensor data in general can provide for improved discoverability and access to data.

Gaps related, but not limited to many of the EVs for SDGs are technological in nature, leading to low technological feasibility for closing the gaps. Examples are the EVs for coastal ecosystems (pollutants, plastics, marine litter, dissolved substances), where observation techniques for operational observations are lacking.

In terms of capacity, there are gaps related to the collocation and multi-purpose usage of in-situ measurements. For example, coastal meteo-ocean buoys were designed for marine security purposes (i.e., meteo-ocean forecasting systems) and not for coastal ecosystem monitoring. A focus on the SGD targets will help to facilitate the needed cross-cutting approach and the development of the required capacity.

Gaps in the spatial and temporal coverage result from the fact that for EVs related to coastal ecosystem, there are few long time series that are uninterrupted. The costs of maintenance operations and vandalism affect the sustainability of the networks. New technologies are costly for deployment (e.g., HVF coastal radars).

For the terrestrial domain, knowledge gaps result from the challenge of detecting land use change. The lack of robust statistics of land use changes and mapped data of spatial change hampers this detection of land use change. The frequency of land cover and land use products (such as *CORINE Land Cover (CLC) High Resolution Layer (HRL)*) along with in-situ data collected in the *Land use and land cover survey (LUCAS)* is low, particularly in urban areas and for higher elevations. Moreover, national inventories are generally not shared. There is also a lack of forest biomass in-situ data. The low level of preparedness for use of in-situ data for Cal/Val via citizen science, social media and more hampers exploitation of the available data.

The example of renewable energy in the context of SDG 7 illustrates knowledge gaps related to renewable energy. The integration of relevant in-situ observations is underway. However, there is a lack of structure in the renewable energy domain, and access and sharing of in-situ data between companies and organizations requires improvements. There are also gaps in the data model suited to make best use of the available data.

Atmospheric research is relevant to a number of SDGs, including but not limited to SDG 3 (Good Health) and SDG 2 (No hunger). Additional efforts are needed to link in-situ observations with emerging capacities of the Sentinel missions, which would strengthen atmospheric and climate research capabilities. Efforts should include CalVal of new sensors, and improved integration of observation systems in the atmospheric composition domain.

In general, communication and exchange of information between all actors would benefit from the promotion of standards and more progress toward open data. For in-situ observation, there are a number of technical issues that need to be addressed, including quality check, harmonizing of in-situ repositories, promotion of interoperable data management systems, increased transparency for models, methods, and documentation. For satellite data, access, sharing and quality are issues deserving more attention.

To promote the SDGs as well as EOs, there is a need to educate the public about the EO products and their usefulness. Examples of how data and tools can be used to generate information should be made available publicly. An effort should be made to develop promotion and education material in form of on-line tutorials as animations and narrated documentations.

4.1.5 Interconnection Between SDGs

A level of complexity in the implementation of the SDGs results from the interconnections between the SDGs, which is not reflected in the SDG indicator framework. Likewise, tools to assess the impact of a policy aiming to achieve a goal on the achievability of other goals are currently not available. The development of such tools depends on comprehensive and integrated databases for validation.

The complexity arising from the interconnection of the SDGs receives increasing attention. Nilsson et al. (2016a) addressed the interaction of SDGs and proposed a methodology for characterizing the interconnection. Obersteiner et al. (2016) focused on the food-nexus of interconnected SDGs. The *International Council for Science (ICSU)* is currently in the process of developing a community report on the interconnection between SDGs.

Nilsson et al. (2016b) introduced a scale from -3 to 3 to assess the interaction between pairs of SDGs or targets (Fig. 16). This scale-based approach has been applied to domain-specific sets of targets (e.g., Lawford, 2016). The results can by displayed in a matrix reflecting the level of interdependence between pairs of targets. Considering, for example, the FWEN, the goals SDG 2, SDG 6, and SDG 7 are the most relevant ones, and a matrix of all targets associated with these goals provides an initial information on the coherence and incoherence between the targets (Fig. 17).

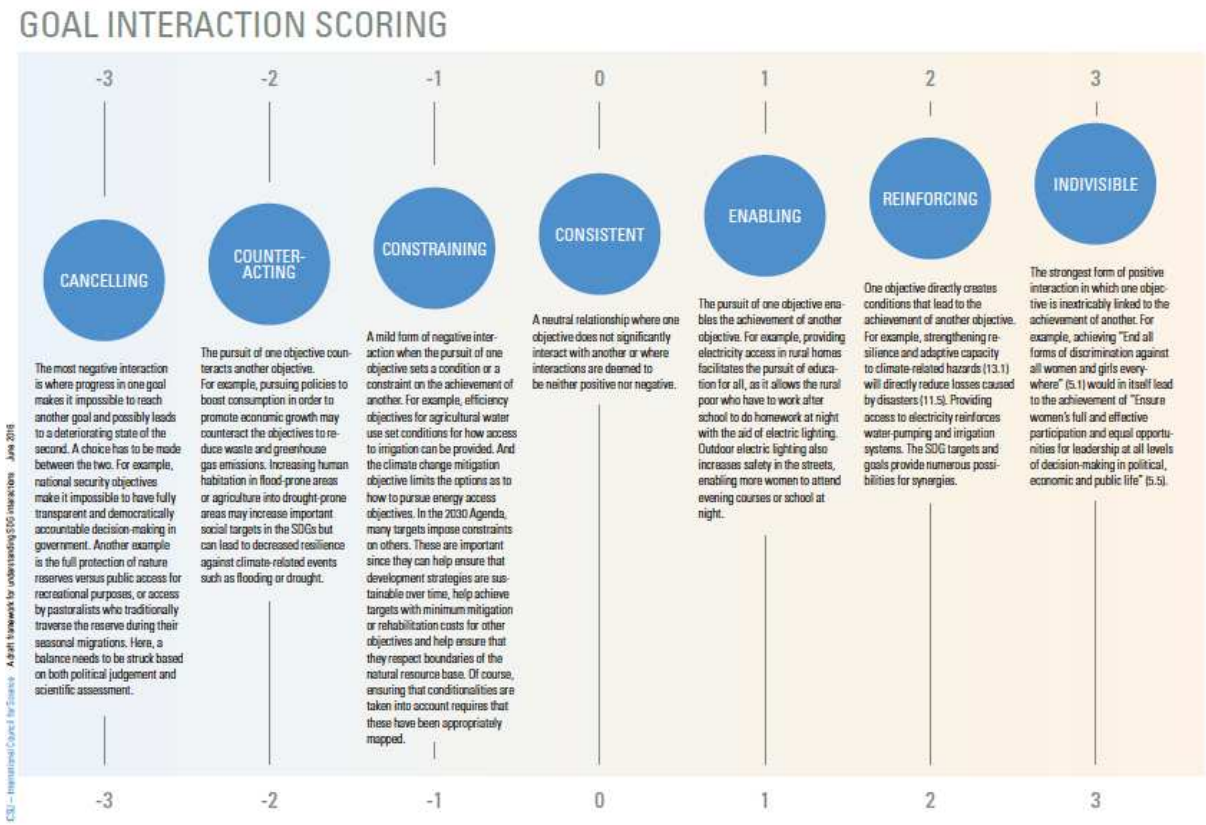

Figure 16. Scale for assessing SDG coherency.
From Nilsson et al. (2016b).

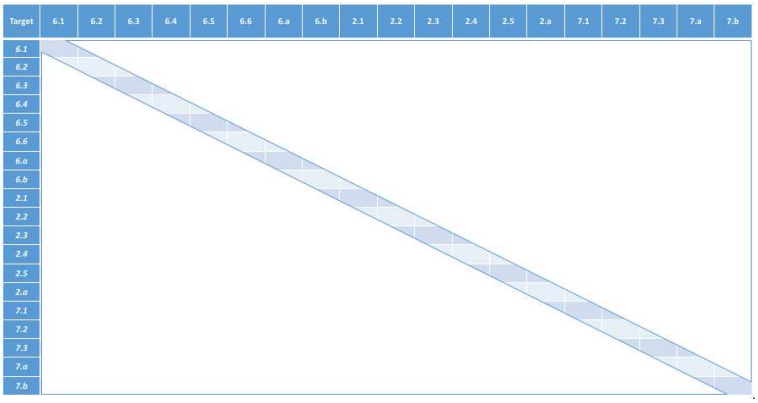

Figure 17. Example of a SDG coherence-incoherence matrix.

The matrix shows all targets for the core SDGs related to the FWEN. The scale numbers have been hidden because the finalizing the numbers is still in process. Modified from Lawford (2016).

Jules-Plag & Plag (2016b) use a different approach to demonstrate the complexity resulting from the interconnections between SDGs and their targets. This approach starts from a specific goal and target and maps the "local environment" of the target within the "social network" of the SDGs. Examples are SDG 5 (Gender Equality) and SDG 11 (Sustainable Human Settlements). Figures 18 and 19 give overviews over selected aspects of these goals.

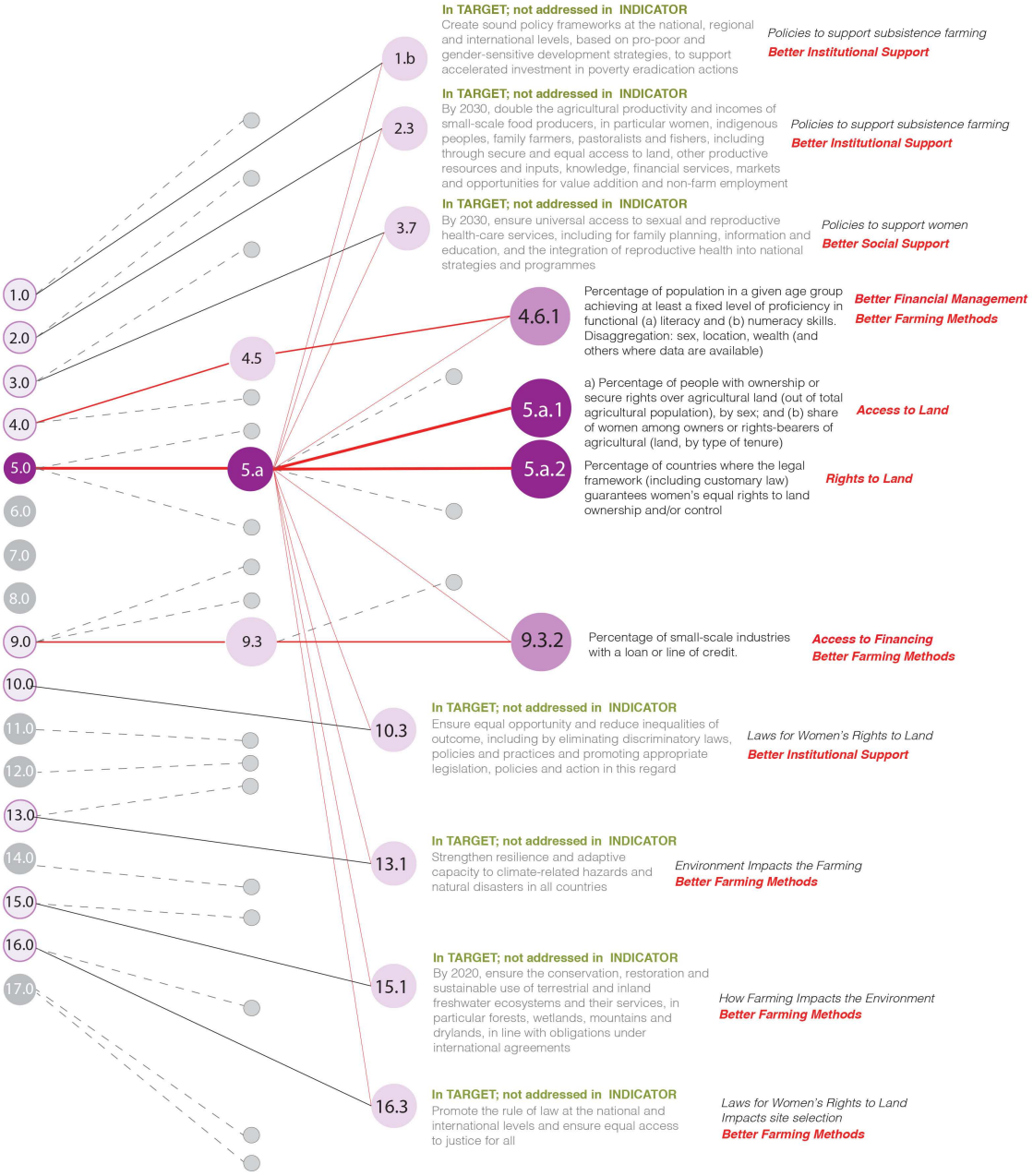

Figure 18. Interconnection of SDG 5 with other SDGs and Targets.
The example considers the special case of gender equality and subsistence farming. From Jules-Plag & Plag (2016b).

4.1.6 Environment and SDGs

In the preparatory discussion of the SDGs, efforts were made to integrate the environment into the SDGs, targets and the indicators (see D2.3 for a more detailed discussion). However, most of the seventeen SDGs are focusing on social, economic, or socio-economic issues, while only very few integrate environmental aspects directly. Therefore, most of the targets fall into the classes of "social" and "economic," while the number of targets that are purely environmental or integrated is small.

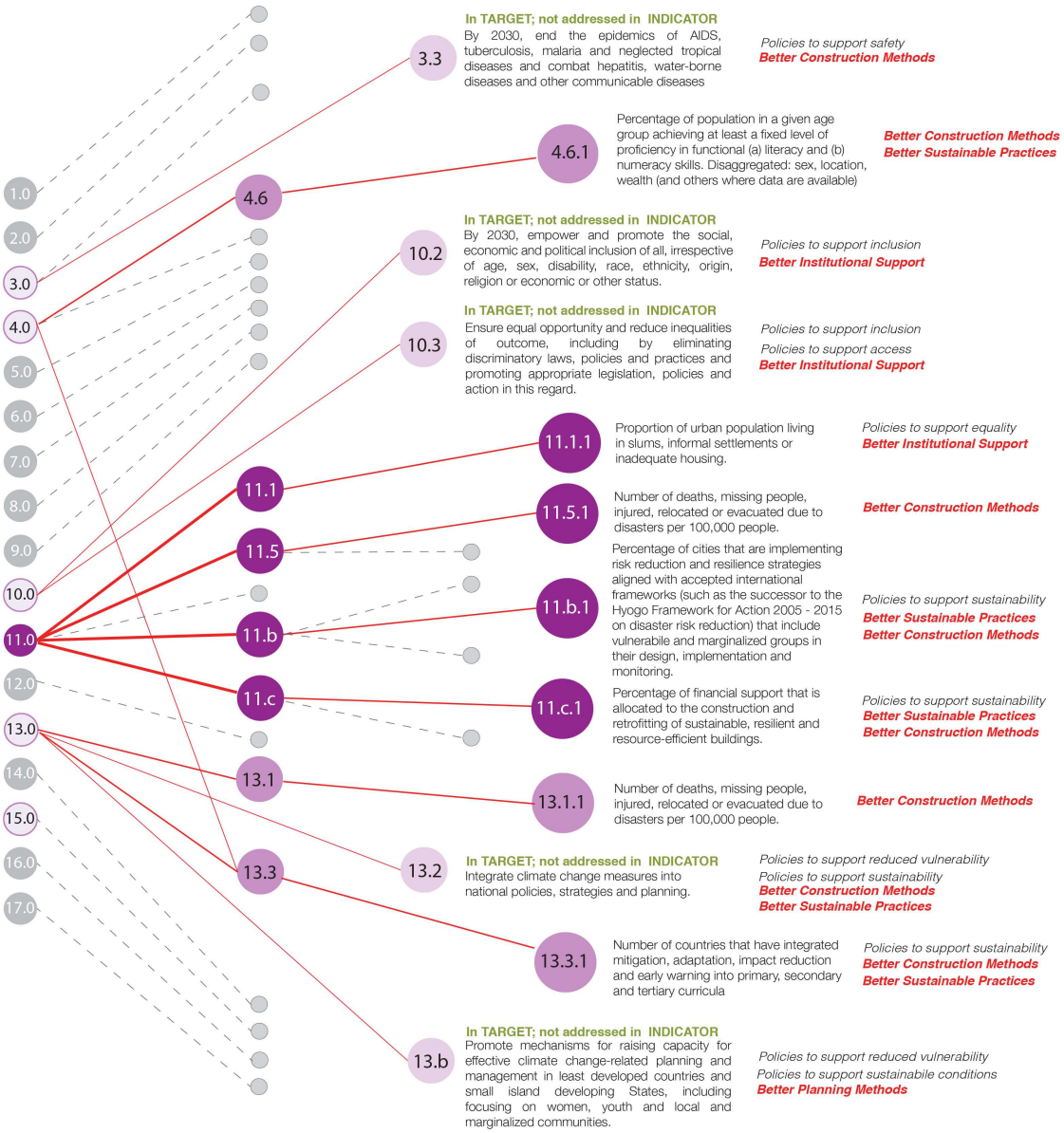

Figure 19. Interconnection of SDG 11 with other SDGs and Targets.
From Jules-Plag & Plag (2016b).

Concerns have been raised that the environment is not sufficiently represented in the SDGs and the targets. The indicators proposed to monitor progress towards the targets are also strongly focused on social and economic aspects. The discussion in D2.3 provides a basis to identify a number of gaps in the structure of goals, targets and indicators that will be included in the SEE-IN KB for further analysis. An important analysis is the review of the targets to identify those environmental aspects of targets that have not been accounted for in the set of current indicators (see also Section 4.1.3 above for examples of this).

For a number of goals, information on the built environment is crucial. For example, Goals 3 and 4 would benefit from information on health facilities and educational facilities, respectively. Goal 9 fully depends on information on all public services. Monitoring progress towards Goal 6 depends to a large extent on information of all aspects of the water cycle and particularly the terrestrial part of the water

cycle, including human interference with the water cycle and use of water.

The Goals 12, 13, 14, and 15 all address environmental aspects of sustainable development, but the current indicators do not fully utilize the available EOs. There is an important role for GEO in complementing the current indicators with comprehensive data and products, including geospatial products directly relevant for the monitoring of the targets for these goals.

Table 17 on page 113 list the EVs relevant to SDGs that have been determined using the GBA and also includes those EVs that were reported in Table 6 of D2.3 up to Goal 6. For Table 6 of D2.3, the goal was to single out those EVs that can easily be derived from Earth observations, while in the GBA all EVs are considered. Many of the identified EVs are related to the built environment, which raises the question to what extent these variables can be determined from Earth observation.

Table 18 on page 115 lists the links between the EVs listed in Table 17 and the indicators as well as targets and SDGs. These tables are preliminary and will be completed for the final gap analysis. Note that these tables were generated from the contents in the SEE-IN KB.

Observational requirements for the ESDGVs have not yet been determined. This work is currently in progress. It is expected that the availability of observational requirements will extend the list of SDG-related gaps considerably.

4.2 Top-Down Thread 2: Research Programs Aims and Targets

The TDT2 is a top-down gap analysis that incorporates and reviews material from international programs. The main work of this thread consisted of a search for relevant documents produced by international programs and to review these documents to extract information on gaps identified in these documents.

In this thread, several activities were carried out:

- The documents produced by US-09-01 (see e.g., Group on Earth Observations, 2012) were reviewed to extract observational requirements.
- The documents produced by Future Earth and the Belmont Forum were reviewed to extract challenges, gaps, and observational requirements.
- Selected domain specific documents, including *International Union for Conservation of Nature (IUCN)* (IUCN, 2016; Laffoley, D. and Baxter, J. M. (eds.), 2016) were used to get problem-specific sets of user needs and requirements.
- The FWEN Working Group of ENEON reviewed a number of documents to extract knowledge needs, challenges, and gaps.

A broad search was conducted on web sites with a focus on discovery of development documents, such as objectives, road maps, strategic plans, white papers or mission objectives. Some of these documents have statements on what is considering missing and needs to be improved among particularly the European Earth observation networks. Several bibliographies developed under the umbrella of these programs have been included in this thread too. The gaps identified in this thread have been published in the CGT.

The following list provides an overview of the main international programs and the documents analysed:

- Group on Earth Observations:
  - GEO Strategic Plan 2016-2025: Implementing GEOSS;

  - GEO 2016 WORK PROGRAMME;
  - GEOBON- Global Biodiversity Observation'
  - GEOBON Strategic Workplan 2014-2016, Gill et al. (2014);
  - EUBON: Geijzendorffer et al. (2015), O'Connor et al. (2015);
  - GI-18: Support for SDGs;
  - GI-20: GEO Global Water Sustainability (GEOGLOWS);
  - Oceans and Society: Blue Planet;
  - The Marine task in GEO;
  - GEO 2017 – 2019 Implementation Plan;
  - GEO-DARMA: Data Access for Risk Management.
- UNISDR: UNISDR (2015).
- European Strategy report on research infrastructures (ESFRI)
  - ESFRI (2016);
  - ESFRI Project reviewed: ISCAT-3D, EPOS, SIOS, EMSO, IAGOS, EURO-AGO ERIC, ICOS ERIC.
- Copernicus:
  - Sentinel-3 Mission Objectives document: https://sentinels.copernicus.eu/web/sentinel/missions/-sentinel-3/objectives;;
  - Sentinel-4 Mission Objectives document: https://sentinels.copernicus.eu/web/sentinel/missions/-sentinel-4/objectives;
  - Sentinel-5 Mission Objectives document: https://sentinels.copernicus.eu/web/sentinel/missions/-sentinel-5/objectives;
- Global Biodiversity Information Facility: http://www.gbif.org/.
- Convention on Biological Diversity: COP of Convention on Biodiversity (2010).
- Economic Commission for Europe: ECONOMIC COMMISSION FOR EUROPE (2011), also EMEP Progress reports.
- Belmont Forum: Belmot Forum (2011), Belmont Forum (2015).
- Future Earth: Future Earth (2014b), Future Earth (2014a).

A detailed summary of the analysis of the above documents will be included in D6.3.

4.2.1 Observational Requirements in GEO

The work so far has focused on the identification of EVs and the gap analysis. This section on observational requirements will be completed in D6.3. It is, however, obvious that the current status of explicit observational requirements is incomplete. As discussed in Section 2.2 above, most available collections of observational requirements are domain specific, and in most cases, the requirements are not linked to user needs or societal benefits.

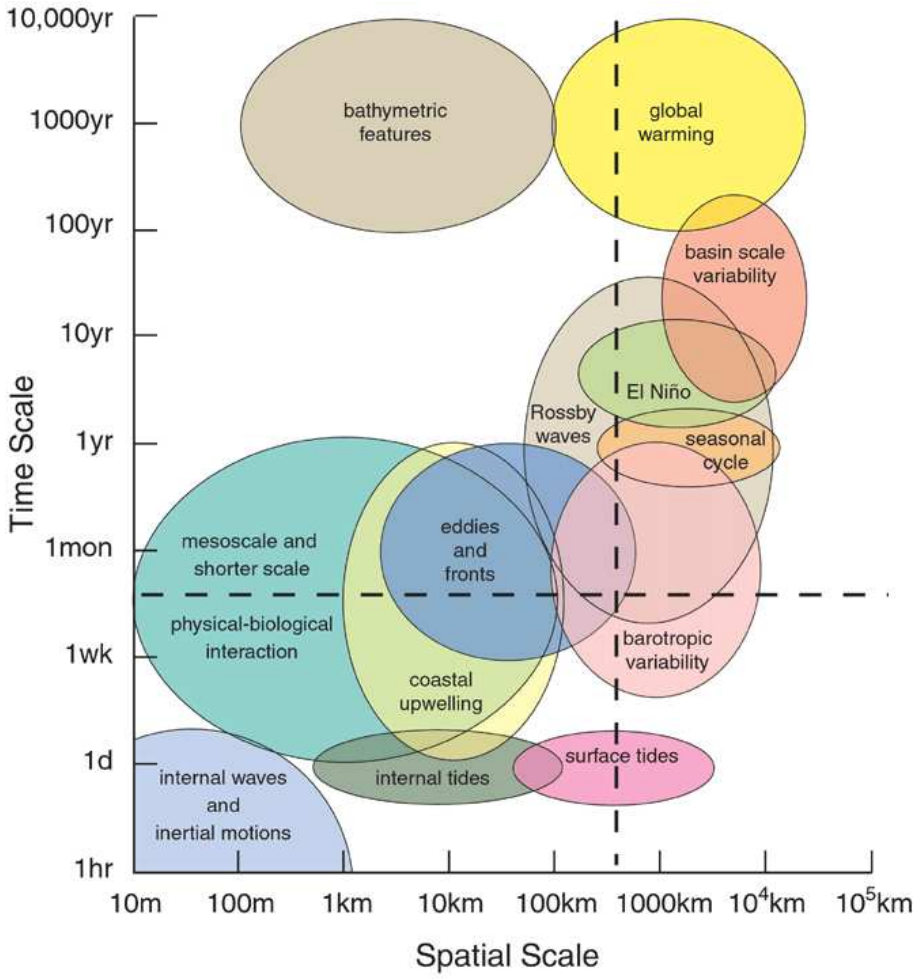

Figure 20. Spatial and temporal scales of ocean phenomena.
From Chelton, D. (ed.) (2001). Note that recent observations of ocean warming lower the temporal scales of global warming (e.g. IUCN, 2016; Laffoley, D. and Baxter, J. M. (eds.), 2016; Cheng et al., 2016) significantly to the interdecadal range.

4.2.2 Marine Context and Ocean Warming

An detailed gap analysis in the TDT2 was carried out for the ocean domain with a focus on ocean warming. This analysis is summarized here as an example. The gap analysis for the ocean domain used an EBA and focused on the set of EOVs as promoted by *Global Ocean Observing System (GOOS)* and *International Oceanographic Commission (IOC)* as detailed in Lindstrom et al. (2012). Main focus was on in-situ data and networks. The specific issues addressed included sea state, sea ice, and spatial splitting of EVs (SST, SSS, etc.). A large range of spatio-temporal scales was consider (Figure 20).

EOVs have been discussed in a number of publications. Considering the challenge of predictions, Bojinski et al. (2014) identified fifty ECV, which included a number of EVs for the ocean surface including *Sea-Surface Temperature (SST)*, sea-surface salinity, sea level, sea state, sea ice, surface current, ocean color, carbon dioxide (partial pressure), ocean acidity, phytoplankton, and for the sub-surface, including temperature, salinity, current, nutrients, carbon dioxide (partial pressure), ocean acidity (pH), oxygen (O_2), and tracers. It is obvious that some of these EVs refer to single physical of chemical variables, while others denote groups of variables.

For the development of EOVs, three themes have been established for the marine context. Among others, these themes were addressed in the GEOWOW project. The themes and the number of EOVs identified are:

- Ocean Physics – 18 variables (Heat Content);
- Marine biogeochemistry – 9 variables;
- Marine Biology and Ecosystem - 10 var (Marine Noise).

Ocean Physics
A) SURFACE
Sea-surface temperature (SST)
Sea-surface salinity (SSS)
Sea level
Sea state
Sea ice
Surface current
Ocean colour
Carbon dioxide partial pressure
Ocean acidity
Phytoplankton

B) SUB-SURFACE
Temperature
Salinity
Current
Nutrients
Carbon dioxide partial pressure
Ocean acidity
Oxygen
Tracers

Biogeochemical EOVs (Lindstrom et al., 2012)
Oxygen
Macro Nutrients: NO_3, PO_4, Si, NH_4, NO_2 Carbonate System: DIC, Total Alkalinity, pCO_2 and pH (at least 2 of 4)
Transient Tracers: CFC-12, CFC-11, SF6, tritium, 3He, 14C, 39Ar,
Suspended particulates (POC, PON or POM) and PIC ++ laboratory, beam attenuation, backscatter, acid-labile, beam attenuation
Particulate Matter Export: POC export, $CaCO_3$ export, BSi export
Nitrous Oxide: Carbon-13: 13C/12C of dissolved inorganic carbon
Dissolved organic matter (DOM), DOC, DON, DOP

Biology and Ecosystems (Fischer & Grimes, 2012; GOOS, 2013)
Chlorophyll
Coral Cover
Mangrove Area
Harmful Algal Blooms (HABs)
Zooplankton (biomass/abundance)
Salt Marsh Area

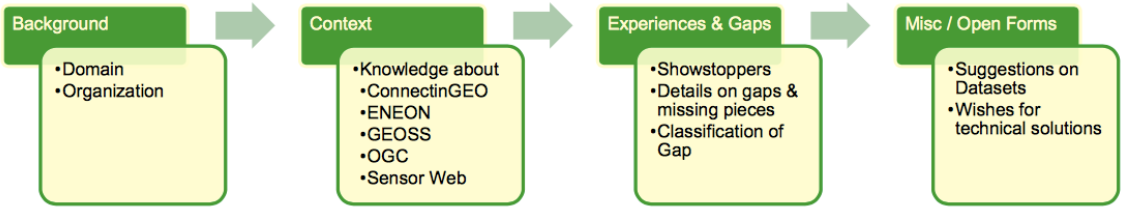

Figure 21. Survey methodology.
From Rieke (2016).

Large marine vertebrates: abundance/distribution
Seagrass Area
Tags and Tracking of species of value/large marine vertebrates
Zooplankton (Krill)

A first proposal of systematic gap analysis for EOVs has been carried out based on international initiatives (e.g., GCOS-195, GAIA-CLIM), technical reports and peer-reviewed literature. However, the analysis is incomplete, at least for several EOVs within the biogeochemical and marine biology/ecosystem panels. These EV sets are less mature and therefore lack specialized work on observational needs, data networks and the relationships with GEO SBAs and SDGs.

A case study for ocean temperature was carried out (García et al., 2016). Ocean temperature is needed to characterize deep water masses, to monitor the ocean heat content and to determine the general structure of the ocean circulation. Observations are necessary to determine the geostrophic circulation, heat transport and steric sea level and indirectly to understand changes in the marine biology and biogeochemistry. Observations are also needed to resolve the processes linking the surface with the ocean interior. Moreover, ocean temperature is a proxy for climate change trends. SST is measured through remote sensing techniques using infrared, microwaves radiometers. In-situ observations of the temperature in water column (but not necessarily SST) utilize CTD, XBT, XCTD profilers; drifters, autonomous profilers (Argo, Gliders), fixed moorings (TAO, PIRATA, RAMA), and termistors, and other means. The Argo example shows that the impact on models of observational networks is a way to refine and fix observational requirements and should be taken into account within prioritization procedures (García et al., 2016).

4.2.3 Food-Water-Energy Nexus

The FWEN was addressed in the frame of the *Work Package (WP)* 5 and Task 5.6. Although the gap analysis mainly used TDT2, the report is included in Section 4.6.

4.3 Bottom-Up Thread 1: Consultation Process

For this thread, a separation into collectives of data user and data producers is a challenge. The mechanisms used to address this challenge include collaboration platforms, surveys, and discussion at workshops. A main activity in this thread was an on-line survey, which was used to collect feedback from scientists and potential users with the goal to detect gaps in the accessibility of observation data. The results are discussed in detail in deliverable 3.4. Here the main aspects of the survey are summarized.

The survey of user needs and gaps in European spatial data had a focus on data coverage, data quality, discovery, data access, metadata and description, and availability. In total, eighty responses were received from participants in heterogeneous sectors and domains (Rieke, 2016). The methodology is illustrated in Fig. 21. The on-line survey tool was selected for convenience reasons. Invitations to take the survey were

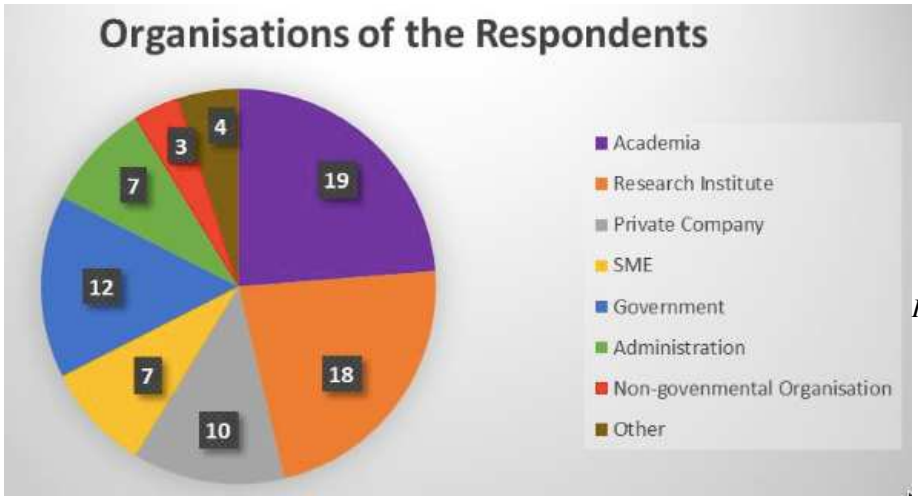

Figure 22. Distribution of survey participants in communities. *From Rieke (2016).*

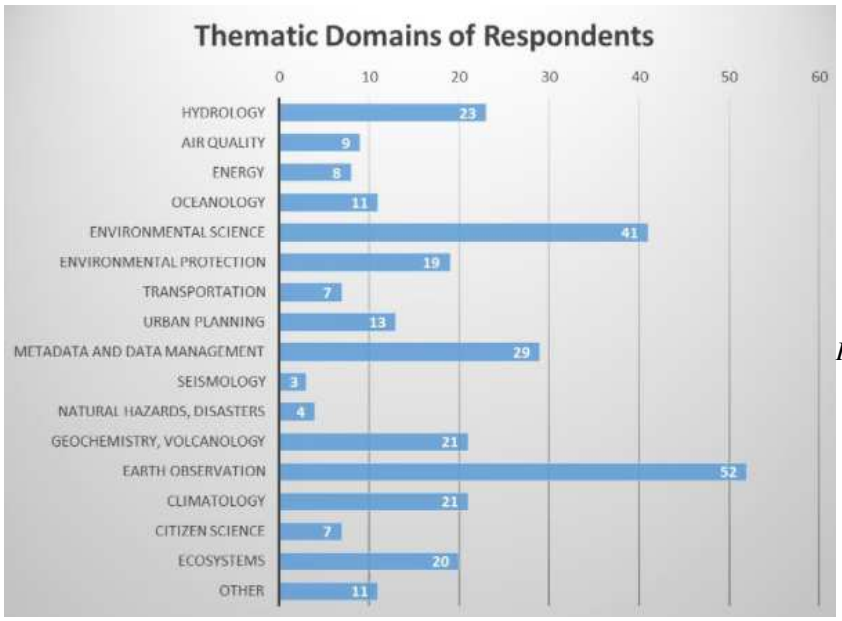

Figure 23. Thematic distribution of survey participants. *From Rieke (2016).*

distributed widely through domain networks, mailing lists, forums, and workshops. The biggest share of participants originated in academia and other research institutions (Fig. 22). Consequently, the survey results are biased towards a more scientific view on working with different types of EO data. Other relevant communities included *Small Medium Enterprises (SMEs)* and other private companies and governmental agencies. In terms of thematic background, the largest numbers of participants indicated EO and environmental science (Fig. 23). The participants could indicate multiple thematic fields, as the limitation to one field is often not possible. Well represented disciplines included hydrology, environmental Protection, geochemistry, climate Science, and ecosystems.

Interestingly, 68% of the participant did not know about ConnectinGEO and ENEON, which indicates that the survey invitation reached beyond the immediate project network. It also indicated the need to further the awareness of the activities, in particular of ENEON. On the positive side, a large share of the participants indicated their familiarity with the idea of data sharing via *Spatial Data Infrastructuress (SDIs)* (88%) and GEOSS.

Only 13% of the participants were not familiar with SDIs and two-third were aware of the OGC standards. About one quarter of the participants indicated that they have worked or interfaced with OGC Sensor Web technology. This results in the recommendation to further promote the use of standards for

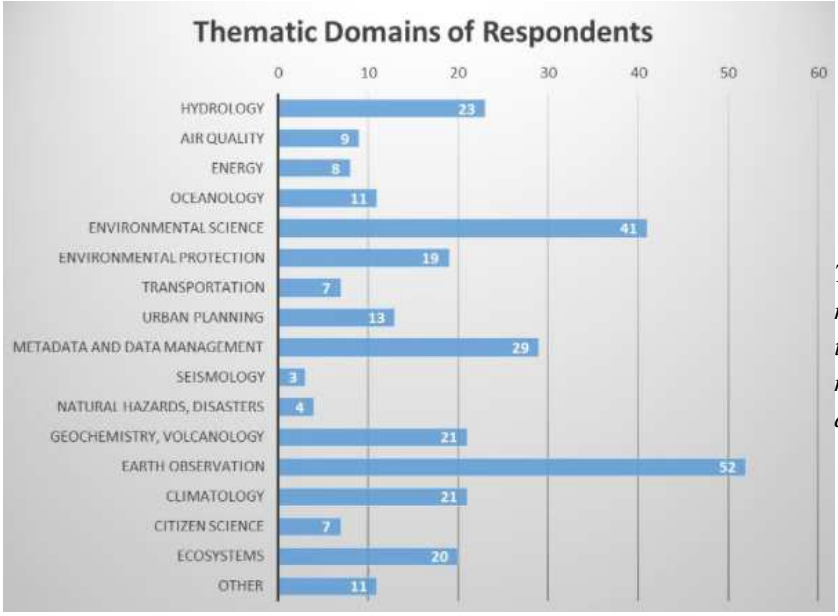

Figure 24. Main issues identified by the survey participants. *The categories in the diagram summarize multiple issues; survey participants were allowed to select multiple of these issues from a predefined list. From Rieke (2016).*

enabling the interoperable sharing of observation data.

Most of the issues identified by the participants are in the fields of data coverage and data access and exploitation (Fig. 24). Other important issues are related to data offered under open data licenses, unclear data quality or a lack of data quality, and insufficient discovery mechanisms. In more details, the data access and exploitation issues resulted from a lack of direct data downloads and the need to contact many different data providers to access comprehensive data sets for larger regions. There are difficulties to deal with heterogeneous data formats, and the unclear semantics of the available data hampers exploitation. This result emphasizes the relevance of several ConnectinGEO and GEO objectives, including the promotion of standardization and interoperability, the provision of metadata, and the encouraging of the sharing of observation data sets.

The survey concluded with a section on suggestions, needs and wishes regarding observation data. Under the heading of technology needs, the participants indicated the need for central repository and portal offering discovery and access to data sets (7 responses); direct data download in harmonized formats (14 responses); increased use of Linked Data technology, and public cloud infrastructures for processing of observation datasets. These aspects are highly relevant for ConnectinGEO and emphasize the need for better data discovery solutions; portals and tools for directly downloading the needed data sets.

In terms of dataset needs, the responses were very diverse, corresponding to the broad range of thematic backgrounds of participants. Satellite data was indicated relevant to nearly all domains, and there was a desire for higher spatial and temporal resolutions (17 responses). Also emphasized were data needs for hydrological data (e.g. river discharge, irrigation data, data on water extraction) and climate data (Rieke, 2016). The gaps indicated by the issues identified by the participants have been included in the CGT.

4.4 Bottom-Up Thread 2: GEOSS Discovery and Access Broker Analysis

This thread consists of the analysis of the observations and measurements that are currently registered in the GEO DAB. The analysis aims to assess the resources contributed to GEOSS through the GCI and the GEO DAB, and to identify possible gaps between user needs and the information in the metadata presently concentrated in the DAB. To achieve this, an OI has been created and populated using the current metadata information harmonized by the DAB (Fig. 25). A set of observational requirements

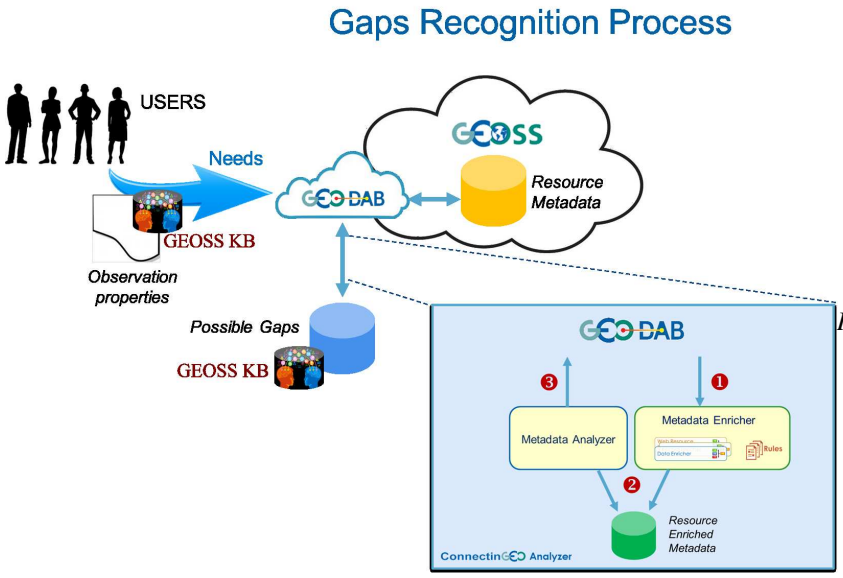

Figure 25. The role of the OI in the BUT2 gap analysis. *From Nativi & Santoro (2016).*

Table 8. List of observational requirements used in the BUT2 gap analysis.

The columns for Spatial and Temporal contain the desired spatial and temporal resolutions, respectively. The requirements were provided by IIASA (McCallumn, personal communication). From Nativi & Santoro (2016).

Parameter	Spatial	Temporal
River Discharge	1 km	daily
Water Use	1 km	Monthly
Groundwater	1 km	Monthly
Lakes	1 km	Annual
Snow Cover	1 km	Annual
Glaciers	1 km	Annual
Ice Sheets	1 km	Annual
Permafrost	1 km	Annual
Albedo	1 km	Monthly
Land Cover	1 km	Annual
FAPAR	1 km	Monthly
LAI	1 km	Monthly
Above Ground Biomass	1 km	Annual
Soil Carbon	1 km	Annual
Fire Disturbance	1 km	Daily
Soil Moisture	1 km	Monthly

was provided by IIASA (Table 8).

WP4 defined a high-level process for the population of the OI:

1. retrieving the full metadata content for each record in the GEO DAB,
2. extract/infer extra semantics (connecting to external knowledge systems when needed), and
3. generate enriched metadata and write it to the OI.

The OI system architecture was designed and developed. Details about the architecture are available in the ConnectinGEO Deliverable 4.2. The first version of the OI was created and populated using the current information in the metadata concentrated in the GEO DAB. The first population process was run in December 2015, resulting in a total of more than 1.6 million harvested metadata records.

The developed OI is accessible by client applications using the GEO DAB supported interfaces available at http://www.geodab.org. In order to support the ConnectinGEO gap analysis, the OI content can be accessed by means of the GEO DAB Javascript APIs available at http://api.eurogeoss-broker.eu. Such

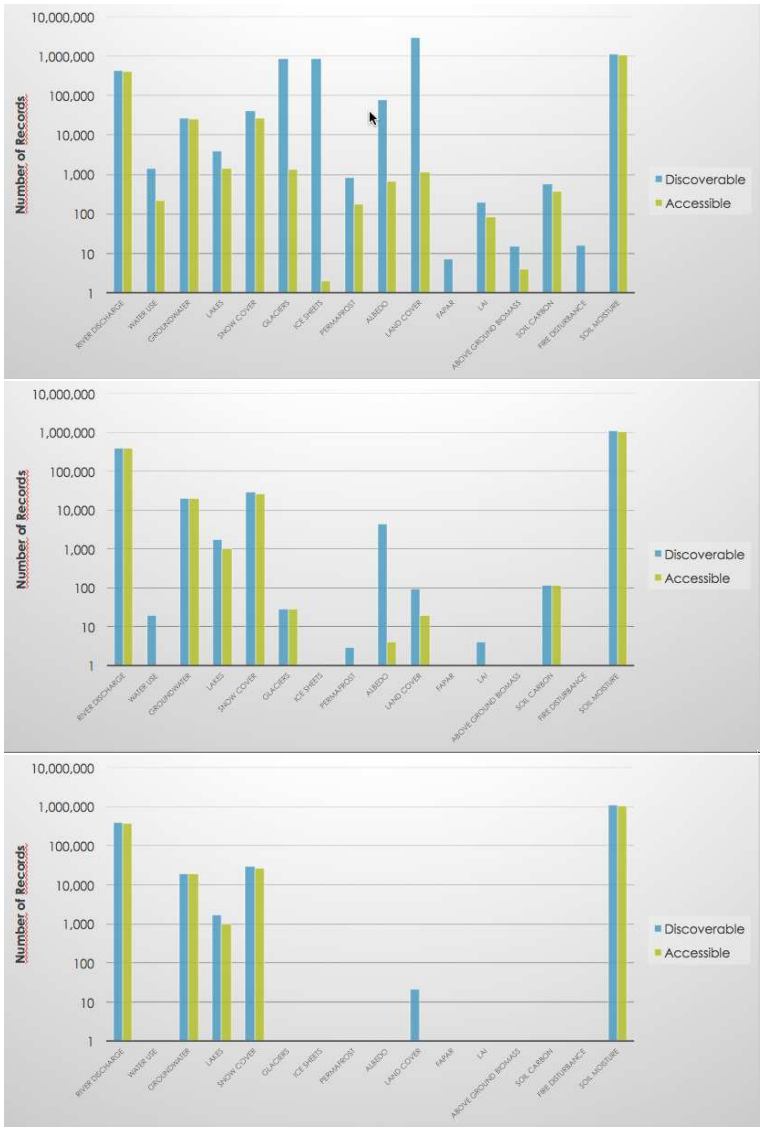

Figure 26. Dependence of discoverable resources on matching criteria used in the BUT2 gap analysis.

Upper panel: Text match only; middle panel: Text and spatial resolution; lower panel: Text, spatial and temporal resolution. From Nativi & Santoro (2016).

APIs allow web applications to easily interrogate the OI. In this way, web-based analysis tools can provide useful views and statistics of currently available observations from GEOSS can exploit the content of the OI.

A simple Web Client was developed to demonstrate how to interrogate the OI and provide also basic examples of how the developed OI can be used by web-based analysis tools.

The gaps identified in this thread will be added to the CGT and discussed in detail in Deliverable 6.3.

At the time of the gap analysis, more than 150 system were brokered and about 190 million granules included. For the matching between observational requirements and datasets, two modes were considered: (1) a strict mode, which required an match in title or keywords, matching spatial resolutions, and matching temporal resolution; (2) a relaxed mode, which required a match in title, keywords, or abstract and accepted any spatial and temporal resolution.

Using the observational requirements for EVs listed in Table 8, about 1.5 million entries were found using the text only (Fig. 26 upper panel). This number is somewhat reduced if also the required spatial resolution is considered (Fig. 26 middle panel). If both temporal and spatial resolution are considered, the number of discoverable entries matching the requirements is much lower (Fig. 26 lower panel). In

all cases, the number of accessible resources is much lower than the discoverable resources. Interestingly, the use of spatio-temporal constraints mainly impacted the number of discoverable resources, not the number of accessible ones. Those resources that are fully described are commonly also "directly" accessible. In most cases, the spatio-temporal resolutions are not provided as metadata fields. The ConnectinGEO metadata enricher addresses this issue.

4.5 Bottom-Up Thread 3: Industry-Driven Challenges

Most of the work on this Thread was carried out in WP 5 "Stakeholder and industry challenges." This WP has the objective to test and improve supporting actions and networking activities to ensure viability in real world scenarios. The WP aims to identify gaps in the procedures and methods and to demonstrate business opportunities. The tasks in the WP are

5.1 Focus of testing

5.2 Industry energy challenge

5.3 In-situ data compatible to satellite mission data challenge

5.4 In-situ network integration into the GCI challenge

5.5 Private sector challenge "European EO product of the year"

5.6 Interdisciplinary cooperation on the food-water-energy nexus (FWEN)

In the following, the preliminary results of the Task 5.2 to 5.6 are summarize. Task 5.1 identified initially two common gaps:

- Data access and data semantics harmonization are two common gaps addressed by several of the challenges.
- Lack of collaboration across stakeholders, disciplines, and societal sectors also appeared as gaps in several challenges.

4.5.1 Task 5.2 – Industry energy challenge

This task aimed to extend the GEO Energy SDI to allow access and sharing of in-situ data between companies and organizations. It addressed a gap in the data model. It developed a profile for XML encodings defined as Schematron rules suitable for in-situ SSI observations. It also improved access to in-situ measurements by deployment of a platform to access, visualized and download in-situ measurement for the GEOSS Energy community. The platform is open source, includes metadata and quality control procedure. It integrates eight data providers, fifteen stations and 276 time series of up to 11 years. Feedback from numerous stakeholders (universities, institutions and private sector) was positive. A first private sector company shared in-situ measurement on the platform.

This platform is linked with the GCI and gives access to in-situ measurements from hundreds of privately operated *Photo Voltaic (PV)* plants throughout Europe. The task provided several presentations of the platform to stakeholders and collected feedback for further analysis. There was a positive reception of the platform and numerous feedbacks from stakeholders (University, institution and private sector). However, extra efforts are needed to identify, convince, access and connect private sector data, and ENEON could play a role here.

4.5.2 Task 5.3 – In-situ data compatible to satellite mission challenge

Gaps addressed in this task include: (1) Gaps in inter-comparability of in-situ measurements related to satellite-based data; (2) Accessibility of detailed in-situ data; (3) Standardization of data.

This task focused on an analysis of results and conclusions of relevant related projects:

- HORIZON 2020 GAIA-CLIM: in this project, selected atmospheric ECVs were identified, cataloged and studied for the characterization of remote sensing data by surface based and sub-orbital measurement platforms.
- FP7 NORS: this project aimed to improve the quality and validation of the *Copernicus Atmospheric Service (CAS)* using ground-based data from the NDACC network, focusing on a limited amount of stations.
- FP7 QA4ECV: this project has the objective to establish quality assurance for ECVs to allow interoperability across different missions.

These projects identified a number of functional gaps of generic type applicable to any in-situ data provider:

- Geographical and temporal Coverage: for Cal/Val applications wide distribution of locations and consistent long time series are needed.
- Knowledge of uncertainties and covariance matrices: for error propagation and comparisons, these matrices are needed.
- Technical: data policies, lack of metadata harmonization hamper data access and exchange.
- Traceability and Governance: there is often a lack of information on data derivation and a lack of data and observation documentation.
- Parameters: there are missing parameters or parameters that are hardly traceable in the monitored ECVs.

The projects also identified harmonization activities for in-situ data networks for Cal/Val:

- Improvement of quality and consistency: evaluation of uncertainties and update of documentation;
- Improvement of timely delivery: commitment by the partners to deliver within one month from sensing;
- Web-based validation server: daily comparison reports from CAS and NDACC network.

In several areas a potential for improvements was identified. The improvements include:

- Quality control and estimate of uncertainties (for harmonization and intercomparison);
- Clear traceability chains for products;
- Comprehensive documentation of observations, processing, metadata;
- Coordinated and Comprehensive scientific approach of assessing the gaps.

4.5.3 Task 5.4 – In-situ integration into the GCI challenge

This task addressed mainly the lack of interoperability for discovery, access and use of data from new systems (ENEON networks) with the GEOSS Common Infrastructure (GCI). The GEO DAB as part of the GCI run several interoperability tests with selected in-situ networks, for example, the *Consortium of Universities for the Advancement of Hydrological Sciences, Inc. (CUAHSI) Hydrologic Information System (HIS)*. The test reports were published and the GCI is still waiting for feedbacks. As part of this activity, GEO DAB improved its support to OGC *System of Systems (SoS)* technology.

4.5.4 Task 5.5 – Private sector challenge "European EO product of the year"

This task addressed the lack of involvement of companies in the private sector in GEO activities. As a result of this gap, sustained research results achieved by commercial exploitation are not yet applied in the context of GEO.

The involvement of the private sector in providing data and products has been stimulated by the EARSC initiative on the product of the year. The competition has been established under the umbrella of the ConnectinGEO project and rewarded a company, which developed the most innovative product integrating an element of open data.

The participation called European services providers. During the whole process about 16 companies got interested in the award and the four nalists were:

- AnsuR Technologies (NO): GEO-ASIGN: the solutions for communication of operational EO data,
- Jeobrowser (FR): Rocket: the Earth in your pocket,
- Noveltis (FR): TIPS- Tidal Prediction Services: current and water elevation now only a click away and
- Planetek Italia (IT): Rheticus displacement: monitoring of terrain surface movements.

The details of the finalists products are summarized in Tables 9 and 10.

EARSC was supported by an international jury formed by GEO secretariat, EC, CREAF, ARMINES and EARSC. The entire board recognized "Rocket: The Earth in your pocket" by Jeobrowser as the best commercial product based on the jury criteria:

- integrating an element of open data resources;
- type of innovation of the product;
- its challenge – the problem to be solved and solution this product will solve;
- expected impact and clients to address.

The rocket application provides a unique entry point to search, visualize and download Earth Observation products from various catalogs. Collections are available:

- for search: Sentinel-1, Sentinel-2, Landsat 8, SPOT 6-7 and Pleiades

- images for download: Sentinel-1, Sentinel-2 and Landsat 8 data.

The database is updated daily from the CNES PEPS platform (Sentinels) and from the USGS platform (Landsat). One of the coolest feature is the density result map. Basically, each result of a search request is represented as a density layer. in which the red parts indicate high density of results and the blue parts a low density of results (web).

A generic analysis of the responses from the four finalist of the "EO product of the year competition" opens tracks for reflexions regarding the use of the DAB/GCI but does not provide a thorough gap analysis of the industry challenges. A major concern was that industry would provide tools far from the GEO interest but all of the proposals aim at making data more visible and easy to use. Regarding inputs, the proposals presented use cases of multiple EO sources with data inputs from satellite missions, in-situ data and Copernicus program combined with models for a value-added final product.

Some proposals were focused on creating new products, i.e., subsidence and tides, while others were for tools to make "raw" data available. The use cases addressed the need of searching and fully leveraged the benefit of having a large collection of data searchable at a single location.

The call encouraged the integration of open data ideally discover through the GEOSS broker services. It was not a surprise that industry is currently not building upon the GCI, a fact also revealed during a Webinar with the participants. The participants were required to cover gaps and some of them solved this by creating new data or at least data visualization as "EO WebGIS based product" development ecosystem (WebGIS is integrating spatial data with business practices in diverse applications), while others addressed this through data discovery. However, none of them used the GCI or the DAB.

Some products provided access to resources via interoperable mechanisms, e.g., open format (OpenDAP) accessed on-line via an interactive tools. Doing so, the companies assumed that this method could be the right source for building the value-added product from their tool. There was knowledge of where the data is and there was no need for further search. Therefore, the product award did not leverage the use of the DAB and GCI as components in the scenario roll-out.

Analyzing whether some of the key words from the products were searchable on the GCI revealed some gaps. E.g., Copernicus services (i.e., altimetric data from the Copernicus CMEMS program) should be discoverable through the GCI, however, it will take time before that type of information is integrated. Thus, a company wanting to develop that service needed to look into another type of resources available.

Other products might be more inclined to benefit from using the GCI and this needs to be addressed in future business and market analyses. E.g., applications that need to search widely for resources regarding a certain area in a short time frame to gather various sources of information for decision making could use the DAB as a single source that could be search via a packaged product.

It should be noticed that EO technology is developing rapidly, with the commercial development of sophisticated satellite EO platforms by government agencies and the private sector, or the development of small and low cost satellite EO platforms, and commercial development of airborne un-manned aerial vehicles. Normally a gap scenario for industry will evaluate EO capabilities in relation to industry requirements that cannot be met based on the EO products and services that are currently available. It will also try to cover the extent to which this could change over the next five years, taking into account new satellite missions, technology developments, and possible development of new, adapted data products and changes in data policy.

In the previous years, EARSC recognized a need to structure products and services and prepared and issued a taxonomy (Figure 27), which will help suppliers and users arrive at a common understanding of what can be offered. The EO taxonomy proposed addresses the products and services from two

Table 9. Summary of the four finalist products of the EARSC Award. Part 1.

Theme (SBA)	EV used	Addressed gap, challenges	Types of Outcome	Data (and meta-data) produced	Spatial and temporal extent
Communication operational EO data	All, DI	Low-bandwidth, broadband connectivity, big-data; fast visualization	Catalog: rapid discovery of availability of EO images and bandwidth-efficient communication relevant regions	EO imagery	World, years
Terrain surface movements	DI, HU, HS	High volume data processing, (High Processing Computing (HPC)); ensuring at the same time continuity and sustainability for the information services provided.	continuous, subscription-based service, landslide areas, stability of infrastructure, subsidence. Displacement, the cost of the analysis per square kilometer is several times lower than in the past.	historical datasets, Displacement (RADAR signal processing algorithms based on Persistent Scatterer Interferometry)	World, years, (continuous monitoring of wide areas)
Tidal atlas	OC, WA, WC	Access to global, regional and local datasets	datasets	Open Data EO discovery	World, years
Visualization and download data	All	Big Data analysis: merge time series, maps and statistics; Visual application	tidal atlases: bathymetry and coastline databases, Altimetric data, Tide Gauges databases		World, regional and local time series

perspectives:

- A market segmentation providing a tool to help classify and understand the markets for EO services as well as to define the type of customer. The market view includes definitions of the likely organizations included in each sector and the list of EO services, which are considered relevant. The market is broken down into 6 major segments: managed living resources, energy and natural resources, industrial, services, public authorities and international bodies. As a result of the work on the *Earth Observation for Oil and Gas (EO4OG)* community we have a first comprehensive view of the challenges faced by a market sector for which EO technology can be a solution.

  The EO4OG challenges reflect the requirements of the *Oil and Gas (O&G)* industry. They have been organized into 7 groups; 2 for off-shore and 5 for on-shore challenges. Each challenge maps to one or more EO products, which are able to meet or partially meet it. The full list of those EO products can be found under the O&G sector of the market taxonomy. EO4OG has identified a total of 224 challenges faced by the O&G industry where there is a potential for satellite EO data to play a role in providing a solution. This led to the definition of 94 products. Each product describes requirements, spatial resolution, spatial coverage, temporal resolution, etc.

- A thematic segmentation provides a tool to help describe and classify the products that are offered by the service providers. This thematic taxonomy starts with the major thematic areas of which there are 6 (land services, built environment and human factors, ocean and marine, atmosphere and climate, disaster and geohazards, security). Each of these is broken down into a number of thematic segments giving 25 in total. For each segment, a number of EO services are identified for which keywords are given, which help define the products that can be part of an EO service

The studies conducted under EO4OG followed a *multi-criteria assessment (MCA)* as an efficient tool to screen EO products where gap analysis could be considered: (i) capability (ii) demand, quality level, drivers (iii) utilization. This type of gap analysis of EO products provides information to support the

Table 10. Summary of the four finalist products of the EARSC Award. Part 2.

Theme (SBA)	Open Research Data pilot collaboration	Standards that are going to be used	Mean of Dissemination	Connection to ENEON	Connection with GEO – GEOSS	Stakeholder Profile
Communication operational EO data	Yes , builds on open data, rapid access to detailed EO images, open Eo data discovery	System architecture	Ideally GEOSS DAB (tbc), future marketplace alliance (tbc), EOpages	H2020 GEOVISION project -via EARSC	In process, Rapid discovery and application of relevant data.	Maritime users, Arctic navigation, Safe path-finding on snow ,Big-data EO browsing , Flight planning in the field
Terrain surface movements	Yes, free SRTM Digital Elevation Model provided by NASA.	Persistent Scatterer Interferometry (PSI) techniques	Ideally GEOSS DAB (tbc), Planetek customer services and EARSC (EOpages)	Via EARSC and Nereus	Important free open satellite data, Via EARSC	Stability of infrastructures: engineering and Oil&Gas company; infrastructure management (road, rail, and pipeline); local Public Administrations, like municipalities and governmental entities; NGOs.
Tidal atlas	Yes, high resolution tidals maps; rapid access to detailed EO images	System architecture	GEOSS DAB (tbc), future marketplace alliance (tbc), EOpages	Via EARSC	No yet	Public and private organizations
Visualization and download data	Yes from Copernicus and other open data sources)	In process	GEOSS DAB (tbc), future marketplace alliance (tbc), EOpages	Via EARSC	Search on Sentinel-1 collection; Could be adapted to open data repository	Shipping industries (Containers, ferries, LNG, etc.) , Marine Renewable Energies Offshore Oil & Gas, dredging, submarine cables, etc.

process of evaluating current and future capabilities and how to improve the EO industry's response to the geo-information requirements of a particular sector. There are a number of factors that can contribute to addressing the gaps in EO product capabilities, which include guidelines and increased awareness, technology development, and changes in data policy and data access. Data policies affect the availability of EO products and services in the form of timeliness, costs, access to archives, and continuity. Data policy directly affects the sharing of knowledge and expertise, and either promotes or hampers the use of advanced EO technologies. The technology development clearly has a key role to play in addressing the capability gap in EO product capability compared to market requirements.

EO data are growing in volume and diversity at an exceptionally fast rate. Open data policies, exemplified by the Copernicus data policy could increase the pace of development of EO products and services for

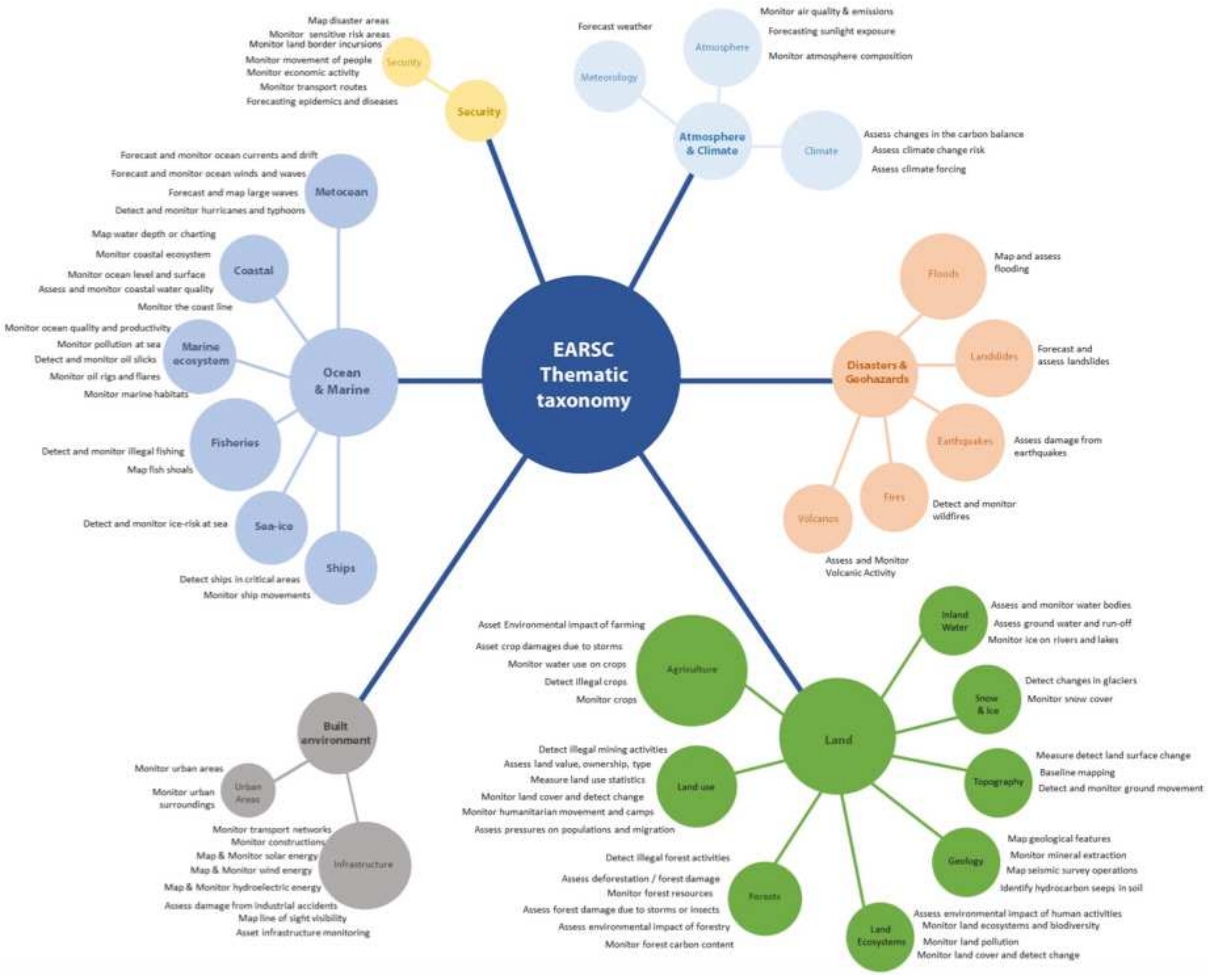

Figure 27. EO taxonomy for EO services and products.

the uptake of other sectors.

Standards and guidelines are common rules or conditions for data and related processes, technology, and organization. The adoption of a set of common product standards and documentation between the different sectors and EO service providers would enhance the utility of EO products and services, decrease data costs, and help avoid redundancies and waste.

EARSC has issued a *Document Requirements Specification (DRS)* for EO product specifications as a guideline for industry, which is available for use by EO companies and their customers to ease the preparation of product specifications (Table 11). The use of the DRS will provide a common format for product specifications across the industry, enabling customers to request a common format across bidders and reduce the effort on the part of suppliers in producing specifications for each customer. The DRS is being tested. In the example specification sheet, information is entered as follows:

- Content
- Geographic coverage
- Input data sources: Input data, Input data provided by Customer, Ancillary input data
- Methodology of classification

Table 11. Document requirements definition for EO product specifications.

Section	Content
TITLE PAGE	Name of the Product. The title page may also include any required signatures. If not, a Signature Page is to be included (Annex A)
CHANGE RECORD	Change reference, affected sections or pages and brief summary of the change. Possible change record table is shown in Annex A.
TABLE OF CONTENTS	Table of contents should include at least all titles to the second level. In addition, there shall be an indication of the number of pages on the Table of Contents page, and/or with the page number in the Header or Footer.
1. INTRODUCTION	Brief introduction for the company, its product range and the specific product under consideration.
2. SCOPE	Defines the scope of the document i.e. that it represents the Product Specification for a product and supports the certification of the Product
3. RELATED DOCUMENTS	
3.1 Applicable Documents	Lists documents that contain applicable requirements
3.2 Reference Documents	Lists documents that contain reference information
4. DEFINITIONS AND ABBREVIATIONS	
4.1 Definitions	This section lists specific definitions required for the understanding of the document. General definitions can be referenced via an applicable or reference document
4.2 Abbreviations	This section lists abbreviations used in the document.
5. PRODUCT DESCRIPTION	
5.1 Background	Brief description of the background for the Product, for example if it is derived from a science project or from a bespoke (customer driven) project.
5.2 Objectives	Defined the purpose of the product, how it benefits the customer
5.3 Design Approach	Brief description of the design approach used and any applied design standards
5.4 Product Use	Defined the intended purpose of the product, what it is used for. Can reference a user manual as an Applicable Document. Can reference a user manual as an Applicable Document.
5.5 Limitations	Defines limitations on the use of the product, the limits of its capability, accuracy. May refer to confidence limits.
6. REQUIREMENTS	
6.1 Customer Requirements	Customer requirements are those requirements that are specific to an individual customer or customer group. These tend to be requirements that are domain or user specific. Can refer to a Requirements Document as an Applicable Document. Note: The identity(ies) of the customer(s) are normally NOT to be included in the document.
6.2 Internal Requirements	List requirements that have been identified by the Organization (such as style guide or design review process) to allow full compliance with customer and others. Can refer to a Requirements Document as an Applicable Document.
6.3 Industry Requirements And Norms	Lists industry requirements and Norms that with which the product is designed to comply. These may be requirements relating to calculations carried out within the product itself, or requirements relating to the Man-Machine interface or format in which results are presented. Where needed, this section may also sate norms that may not have been adopted. Can refer to a Requirements Document as an Applicable Document.
6.4 Regulatory Requirements	Regulatory requirements are National and/or International standards or regulations with which a product has to comply to be able to be used. This section shall list those regulatory requirements with which the product is designed to comply.
7. TECHNICAL SPECIFICATION	Can refer to Standards and/or Regulations as Applicable Documents.

- Spatial resolution and coverage
- Minimum Width of linear features:
- Coordinate Reference System
- Accuracy, Constraints
- Accuracy assessment approach Methodology of aggregation Frequency
- Availability
- Delivery/Output format
- Data type
- Raster coding
- product scale (image, mapping products)
- metadata
- quality control process applied

Finally, EARSC is also promoting the concept paper on the Marketplace Alliance for EO Services an e-commerce platform, which will enable customers to find suppliers and companies to find business. The Marketplace Alliance will define the requirements and operate the service. It would not do business directly but would act on behalf of all users of the Marketplace by negotiating terms, assembling market information and promoting the Marketplace as the best location to find services. The Alliance could also represent the downstream industry on regulatory matters and for the standardization of products and services.

4.6 Task 5.6 – Interdisciplinary cooperation on the food-water-energy nexus (FWEN)

The FWEN is an important example of the interdependency of SDGs. It directly involves the SDGs 2, 6, and 7 and impacts a number of other goals. It also is linked to 70% of the consumed water and 33% of the global anthropogenic energy usage (Fig. 28). Taking a nexus approach helps to consider the interdependencies in a comprehensive way.

The task was implemented as an ENEON Working Group. The main activities included an analysis of existing review papers on the FWEN. This analysis identified the following gaps:

- There is a lack of collaborations across disciplines and domains linked to the FWEN;
- GEOSS has limited capabilities to support a theme-based approaches to data and product discovery;
- There are missing links between industry and science communities that are stakeholders in the FWEN.
- There are no coordination mechanism to establish links between different observing networks to address a complex issue such as the FWEN.

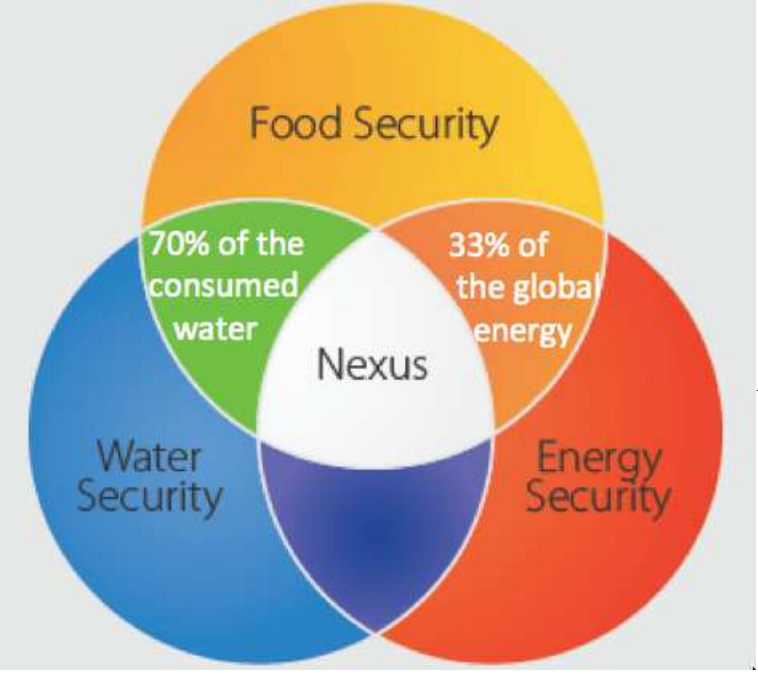

Figure 28. Water and energy usage are tightly linked to food security.

From Lawford (2016).

Water	Potential Data Sources
Source water for irrigation	FAO (AQUASTAT) Water withdrawals for agriculture
Source water for fracking	No data sources
Water used for biofuel production and processing	Does not appear to be monitored
Wastewater reclamation	FAO (AQUASTAT)
Water for food processing	FAO (AQUASTAT)
Decreased lake water quality from fertilizers and pesticides	No data source
Thermally polluted water from power plants and industry	No data source
Urban water demand	No data source

Figure 29. Potential data sources for interactions of water with the food and energy sectors.

From Lawford (2016).

Looking at, for example, the interaction of water with the food and energy sectors, Lawford (2016) reports a number of potential data sources and gaps (Fig. 29). No data sources could be identified for water usage in biofuel production, lake water quality, thermally polluted water, and urban water demands. A challenge is associated with the implementation of climate change mitigation action in a way that benefits the FWEN and the relevant SDGs. The aim to keep CO_2 emissions at a level that limits global warming to 2° C above the pre-1900 average will require CO_2 reductions impacting the energy sector as well as food production and processing. At the same time, the expected increase in atmospheric CO_2 will change the Earth's radiation balance and atmospheric circulations, affecting evaporation, evapotranspiration rates, precipitation patterns, extreme floods, droughts, heat waves, rates of crop growth and productivity, water availability, and water and energy use.

To monitor the targets of the Water SDG, the *Global Environmental Monitoring Initiative (GEMI)* has been launched and the *Food and Agriculture Organization (FAO)* will serve as a clearing house for information related to water use using national data submitted voluntarily to *FAO's global water information system (AQUASTAT)*. Big data and citizen data provide important opportunities to complement the available information relevant to the FWEN and the monitoring of SDG targets. However, the strategy for

exploiting these opportunities does not exist.

At regional and global levels, additional independent monitoring capabilities are needed to meet the knowledge needs associated with the FWEN and the relevant SDGs. A central FWEN knowledge platform could address multiple needs including those associated with the relevant SDGs.

Concerning the SDG indicators, Lawford (2016) emphasizes that these indicators focus on final results but provide limited information on how these results could be achieved. For the SDG indicators, information needs to be aggregated to the national and global scale and accumulated over several years. For the FWEN, disaggregated data are required. An open question is whether these two types of data can be brought together. Moreover, in addition to data needs, there is a need to increase modeling capabilities (see also Section 4.1.1). Systems have to be identified or developed that can combine modeling and observations in a way best suited to meet the needs of the FWEN and the associated SDGs.

Lawford (2016) underlined the lack of policy frameworks that explicitly address the coordination of the FWEn. The process of implementing the SDGs could be instrumental in supporting transformative changes at different levels. However, local communities and stakeholder groups have to be involved in the implementation, the processes of developing meaningful indicators, and the monitoring of progress towards the targets. The FWEN could provide guidance and options on how to achieve the relevant SDGs. For the EO communities, a question is how to provide information that could support the governments in their quest for the SDGs. For that, an environment needs to be created that enables policy development.

Lawford (2016) provided a number of recommendations, which are summarized here in slightly modified form:

- The FWEN community should develop indicators that could illustrate progress made during the implementation process and improve the coherence of the targets with respect to the goals.
- Interventions initiated by the FWEN community could be directed at SDG implementation and priority should be given to those strategies that benefit both the FWEN and the three directly associated SDGs.
- An analysis of the FWEN elements should be undertaken to assess inequalities among sectors in different countries.
- An inventory of tools for FWEN assessments should be developed and made available to efforts involved in the SDGs.
- Modified appropriate data and information systems, governance instruments and diagnostic toolboxes should be developed for the FWEN and for the SDGs.
- The FWEN community should build liaisons with international organizations and activities such as UN-Water and its High-level Panel on Water, GEO, and space agencies.

As another example, the report published by the World Energy Council (2016) is considered here. The report addresses the FWEN from a energy point of view. Energy is found to be the second largest freshwater user after agriculture. In primary energy production (coal, oil, gas, biofuels) and in power generation (hydro, cooling), water is used all along the energy value chain. As much as 98% of the power currently produced needs water. The growing demands for energy, water and food are expected to increase the risks associated with the FWEN. Some of the regions that experience already today water stress are also likely to have significant population growth, changing consumption behavior, and economic growth, increasing the FWEN risks. At the same time, there is an increasing uncertainty

concerning water availability resulting from climate change impacts on freshwater availability(Pachauri et al., 2014). Data needs to reduce these uncertainties include better information on ocean temperatures, extreme weather events, and shifting weather patterns. van Vliet et al. (2016) highlight that from 2014 to 2069, reductions in usable water capacity could impact two-thirds of the nearly 25,000 hydropower plants analyzed and more than 80% of the more than 1,400 thermal electric power plants assessed. A lack of location-specific knowledge on water issues and a lack of modeling tools for the assessment of nexus risks impacts energy infrastructure investment decisions. The economic risks can be substantial. For example, in 2015, drought-related energy and water rationing measures resulted in sustained economic losses of more than US$4.3 billion for hydropower facilities in Brazil. In many areas, the lack of sound water governance, including well-defined water rights for competing users and water pricing and trading arrangements, further exacerbates the risks associated with the nexus. A key issue is cross-border cooperation. According to World Energy Council (2016), 261 international transboundary basins cover 45% of the Earth's land surface and these basins serve 40% of the world's population and provide 60% of the Earth's entire freshwater volume. Therefore, there is a need to ensure that adequate cross-border water management frameworks are in place. The FWEN poses a systemic risk and disruptions resulting from this nexus can impact energy supply and demand for decades. In order to reduce the dependency on FWEN resources, there is a necessity to reduce the amount of water needed for energy production. There is a potential to lower the overall water footprint of the energy sector if more power or heat were produced by renewables such as wind, photovoltaics, or natural gas, which show comparatively low water usage (International Energy Agency, 2012). However, some of the technologies highlighted as part of the low-carbon transition, such as biofuels or carbon capture and storage, which nearly doubles the water requirements of a coal power plant (Byers et al., 2014), may in fact increase water stress.

It is clear from the above discussion that there are specific data, modeling and capacity needs that are currently not met. A detailed list of gaps is in preparation and will be included in D6.3.

5 The Preliminary Results of Gap Analysis

5.1 Status of the ConnectinGEO Gap Table

The preliminary results of the gap analyses carried out in the context of the project have been collected in the CGT, which is an on-line table in the ConnectinGEO wiki available at http://twiki.connectingeo.net/-foswiki/bin/view/ConnectinGEOIntranet/GapAnalysisTable?cover=print. The definition of this table is given in Table 6. The discussion of the contents of the table in this document are based on the status of December 3, 2016.

For the discussion here, the CGT has been decomposed into parts that are reproduced in Appendix D. The individual parts correspond to the objects used in the SEE-IN KB to represent gaps. In the SEE-IN KB, several columns in the CGT have been replaced by links to entries in groups. These columns include the columns EV, Thread, Editor, Ambassador, and Traceability, which provide information on the detection and publishing of the gaps. Most of the columns related to feedback on the gaps and how to address them are currently attributes of the object gap but will also be replaced by links to corresponding instances. These include the columns Feasibility, Feasibility rational, Impact, Impact rational, Costs, Cost rational, Time frame, Time frame rational, Priority, and Priority rational. The gaps being linked to the corresponding instances of the objects Review and Recommendation. One advantage of the linked approach is that more information can be added to each entry than what reasonably could be included in the columns of a table. Another advantage is that information does not have to be duplicated. Moreover, a gap can be linked, for example, to several instances of Review and Recommendation provided by different authors. Finally, consistency between entries is easier to achieve in the linked approach.

Table 30 on page 125 includes for each gap identified so far the columns GAPTYPE, STATUS, DESCRIPTION, OBSERVED, PURPOSE, and REMEDY. The columns related to Feasibility, Impact, Cost, Priority and Time Frame are reproduced in Table 31.

The information on the EVs used in the CGT has been extracted and included in Table 32 on page 168. The references extracted from the column Traceability are listed in Table 33 on page 170. Reviews available so far are listed in Table 34 on page 175 and available recommendations can be found in Table 35 on page 177. The links between gaps and EVs, threads, themes, references, reviews, and recommendations are collected in Table 36 on page 178.

5.2 Statistics of Gaps

Preliminary statistics were determined based on the status of the CGT on 7 December 2016. At that time, 222 gaps were identified and collected in the table, mainly through community contributions.

The distribution of the gaps over themes is dominated the Climate theme with 52% of the gaps associated with this theme followed by the Ocean theme with 30% of the gaps (Fig. 30). This uneven distribution is mainly due to the climate and ocean communities being the most active one in contributions to the CGT.

Most of the gaps currently in the CGT resulted from TDT2 (67%, Fig. 31), i.e., the review of published literature from international programs such as Future Earth, Belmont Forum, the Research Data Alliance and community assessments of socio-economic benefits of Earth observations (see Section 4.2). The BUT1 provided 20% of the gaps. These gaps come from the consultation process in the current EO networks, consisting of collaboration platforms, surveys and discussions at workshops and the involvement of citizen science (see Section 4.3). These gaps are identified by the relevant communities themselves. TDT1, i.e., the identification of a collection of observation requirements and specifications

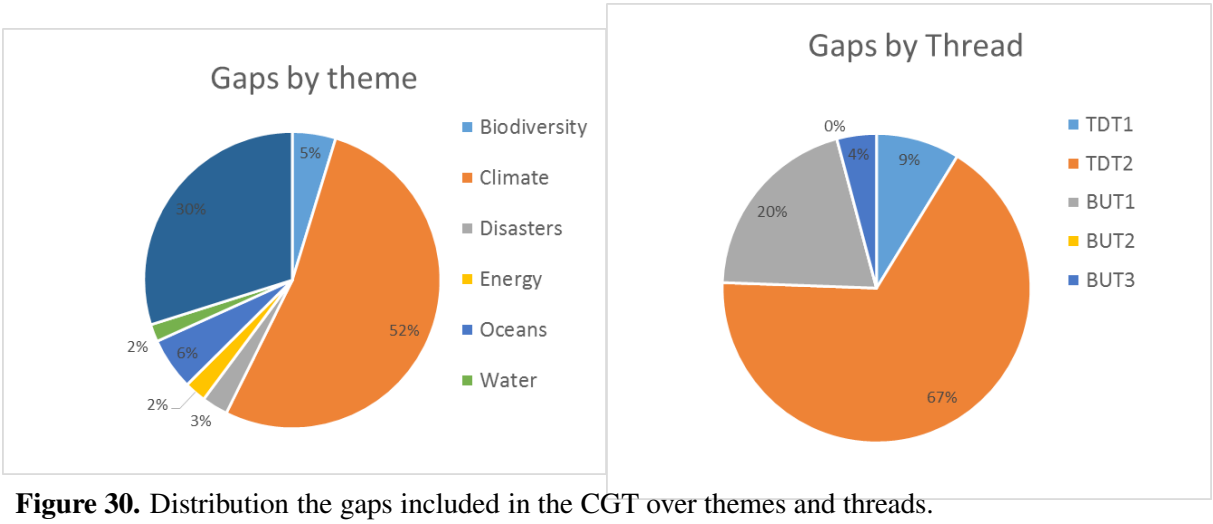

Figure 30. Distribution the gaps included in the CGT over themes and threads.

from generic goals for sustainability as expressed in the SDGs (see Section 4.1), has resulted in a number of gaps, which have not been added to the CGT (see Table 14 on page 111). Likewise, the gaps identified in BUT2, i.e., the careful analysis of the observations and measurements that are currently accessible through the GEOSS DAB (see Section 4.4, still need to be added to the CGT. BUT3, i.e., gaps coming from the realization of a series of real industry-driven challenges to assess the problems and gaps emerging during the creation of business opportunities (see Section 4.5) contributed 4% of the currently published gaps.

Concerning the gap type, most gaps are found with respect to required temporal resolution followed by temporal extent and geographical coverage (Fig. 32). The distribution of the gaps over groups of EVs is heavily biased towards the ECVs with 91% of all gaps being associated with this group of EVs. However, many of the ECVs are also EOVs and/or EBVs, which may not be reflected in the statistics.

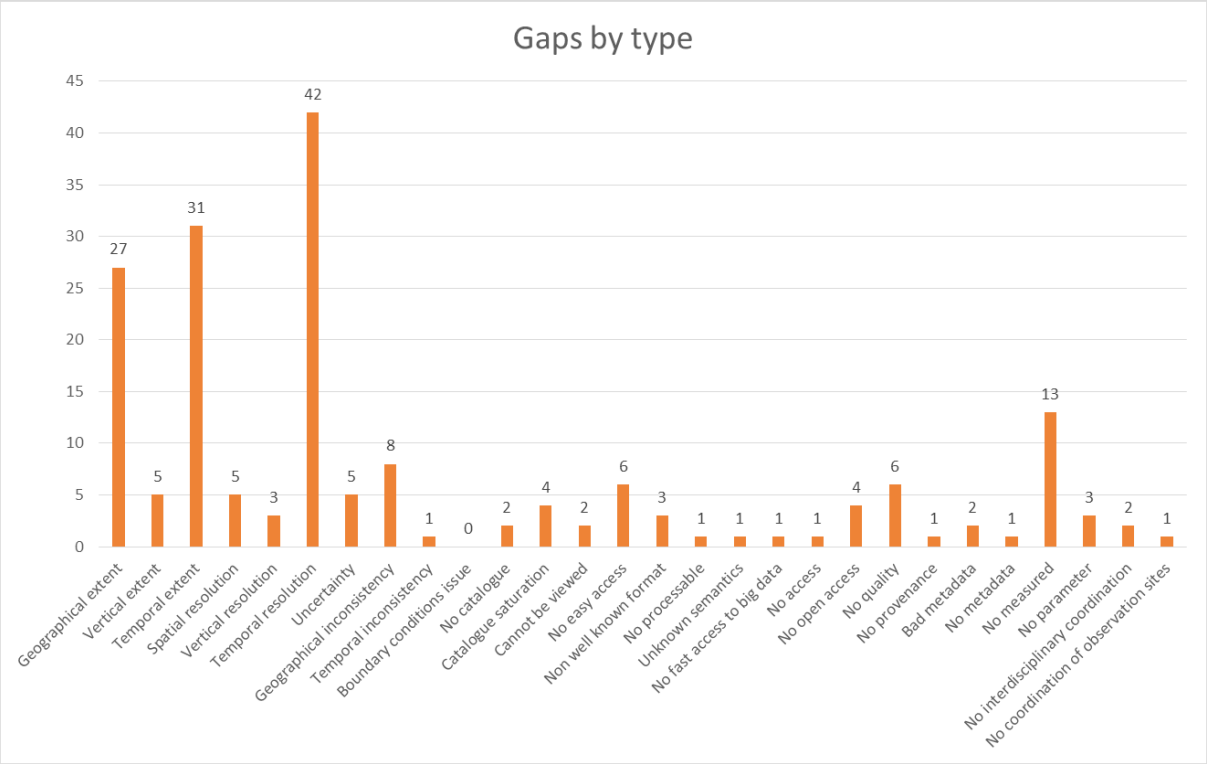

Figure 31. Distribution of gaps over gap types.
Note that not all gaps are represented in the diagram. The diagram shows 181 out of the 222 gaps.

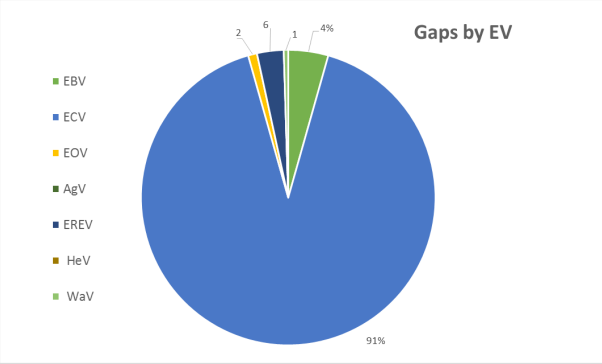

Figure 32. Distribution of gaps over EV groups.

AgV	*Agriculture Essential Variable*
EBV	*Essential Biodiversity Variable*
ECV	*Essential Climate Variable*
EOV	*Essential Ocean Variable*
EREV	*Essential Renewable Energy Variable*
HeV	*Health Essential Variable*
WaV	*Water Essential Variable*

6 Best Practices for Prioritization

Prioritization is a process that has to involve community deliberations leading to a consensus of what to prioritize. However, the deliberations can be informed by ranking schemes. Moreover, the deliberations can utilize crowd-sourcing within the relevant communities to ensure that a broad basis is engaged in the prioritizing process.

In principle, priority can be considered to be a product of feasibility and impact divided by the product of costs and time frame, i.e., gaps with a high feasibility of the solution, a high impact if closed, low costs and short time frames for the solution should have high priority. Thus,

$$p = \frac{f \cdot i}{c \cdot t}, \tag{2}$$

with p priority, f feasibility, i impact, c costs, and t time frame. The challenge is in estimating the values of the variables f, c, i, and t. In most cases, expert estimates have to be used.

For estimating i, the knowledge of user needs can be very helpful. Based on the relevance of a gap to user needs, the potential impact of closing the gaps can be estimated. The SEE-IN KN provides an opportunity to compute a ranking based on the number of applications and users a gap is linked to. In Section 6.2 below more details on an approach to ranking are provided.

6.1 Prioritization Based on Community Deliberations

The impacts of gaps collected in the CGT and other tables in the previous sections will be assessed. A first step in this process is to suggest remedies to fill the gap. These remedies will be more or less technically feasible and they will be associated with costs. There is a need for setting priorities and to aim to address those gaps that have high priority first. The final list of prioritized gaps will inform funding agencies and generate recommendations on how to remedy these gaps.

Some of the current gaps are likely not to be addressed because they are not feasible to be closed due to technical barriers, high costs, or a lack of interest in closing them. The balance between these three criteria can help to determine the priority of gaps. Gaps that are feasible to be closed with high impact if filled and low cost of filling them will have a very high priority (Figure 33). In a second step, less feasible and more costly gaps can be addressed.

Importantly, impact is related to user needs in general. A gap that has been detected in more than one thread with relevance to several themes and/or many applications and users is supposed to have higher impact. The SEE-IN KB will provide additional tools to connect gaps to user needs.

Feasibility is related to the availability of a remedy for a gap and the technical, financial, and governance barriers to implementing the remedy. The feasibility needs to be documented in these various aspects. To be able to determine the feasibility and cost, first details about the possible remedies to fill the gaps need to be determined. Then, feasibility and cost can be assessed.

To reduce missing points and misunderstandings to the extent possible, the gap analysis and prioritization is being carried out in two loops. Therefore, the results presented here will be exposed to a second loop to refine the list of gaps and to complete the prioritization. The loop includes the specific steps:

- Review the gap and determine if it is well know or can be accepted by the consulting experts.
- Determine the impact of the gap by detecting and quantifying the applications of the data. It is related with the requirement that generated the gap in the first place.

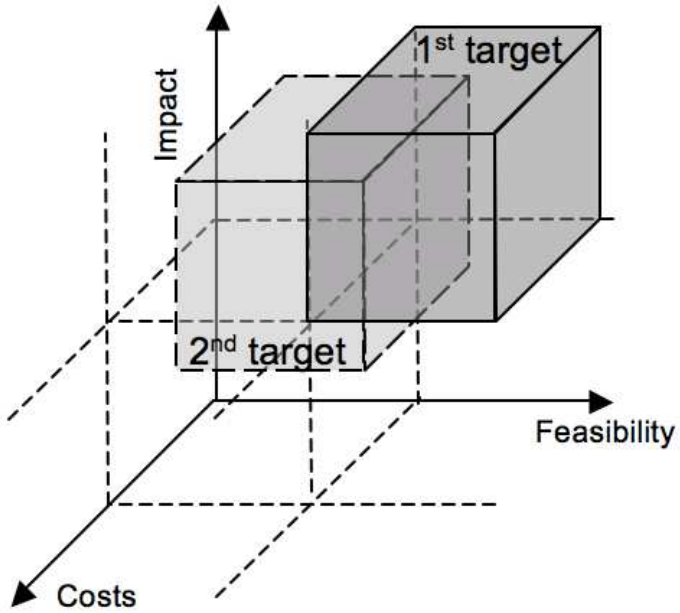

Figure 33. Criteria for gap prioritization.
Gaps that need to be prioritized as first target (higher priority) should be situated on high feasibility, high impact and low cost (dark gray area). As a second target, a more difficult (less feasible) and more costly gaps can be filled (light gray area).

- Determine remedies to fill the gap.
- Determine the feasibility to implement the remedy.
- Determine the cost of apply the remedy.
- Determine a priority degree base on the feasibility, the cost and the impact.
- Sort the gap table by priorities.
- Classify priorities in the 3 described targets and present recommendations to funding agencies.
- Determine if the gap is been covered later on.

For the ranking, ConnectinGEO is using an approach originally proposed for the GEOSS URR, see Plag et al. (2012b). Below, parts of this document are reproduced to ensure that the further discussion in ConnectinGEO is based on this approach.

For the crowd-sourcing, there are two options for feedback. One of them is connected to the CGT and the other is a feedback tool implemented in the SEE-IN KB. The latter allows comments and rankings on subsets of the gaps documented in the SEE-IN KB. With this, community-specific sets of gaps can be included in a survey and the community input can then inform expert deliberations leading to a consensus on which gaps to prioritize.

6.2 Ranking Gaps Based on Connectivity

Note that part of this following sections are taken and modified from Plag et al. (2012b).

Based on the information collected in the SEE-IN KB, it is possible to measure the relevance of an entry or of an available dataset or product. In order to have credibility, the metrics for measuring relevance will have to be based on a GEO-wide consensus.

One way of ranking observation gaps would be to assess the importance of the requirements that are impacted by the gap. However, there is a significant benefit in being able to prioritize the applications, as well as the needs mentioned above. For example, an answer to the question of "How important is this research need?" could guide researchers and support them in soliciting funds for their research. Answering the question "How important is this infrastructure need?" would help to prioritize efforts and secure funding for the implementation of important infrastructure.

There are many options for the metrics to measure the relevance of a gap. A simple measure could consist of the number of other entries depending on entry A or dataset B. A more comprehensive measure would take into account the relevance of the linked dependent entries, especially the applications, and the strength of the links between entries. The societal value of the links in the measure could also be used as part of the metrics.

A measure of relevance can also be deduced from the status of an entry in the mathematical network constituted by the entries and the links between them. We discuss to what extent network theory can be used to support a measure of relevance. Factors such as pervasiveness, uniqueness, difficulty, completeness, and uncertainty will be considered.

6.3 Relevance Related Parameters

The measure of relevance r for the various entries in the SEE-IN KB as well as for datasets and products will be a function of a number of measurable or quantifiable parameters. We express r as

$$r = f(p_1, p_2, ..., p_n), \tag{3}$$

where $p_i,\ i = 1, ..., n$ are quantitative (measurable) and qualitative (but quantifiable) parameters.

Potential candidates for the parameters determining the relevance of an entity A (entry in the SEE-IN KB or dataset outside the SEE-IN KB) are the number and weight of links for which A is the source, the relevance r_i of each target B_i to which A is linked, the relative position in a value chain. Characteristics such as pervasiveness, uniqueness, difficulty, completeness, and uncertainty also could be considered.

Our first task is to identify all parameters that somehow relate to the relevance of an entry in the SEE-IN KB and to assess to what extent they are measurable or quantifiable in an objective way. The next step is then to develop a function f that combines these parameters into a single number, i.e., the relevance r. In the following, we develop a matrix of the parameters and describe their characteristics in terms of quantification (see Table 12).

6.4 The Relevance Function

We will develop the relevance function in several steps, starting with a straight-forward part and then moving on to more intricate functions.

A rather straight-forward measure is based on the number of links in which entry A is the source or the number of requirements a dataset meets. For an entry A, we can define a local relevance r^{loc} as

$$r^{\text{loc}}(A) = \sum_{i=1}^{L_A} w_i, \tag{4}$$

Table 12. Parameters that are related to the relevance of a SEE-IN KB entry.
Column Q has a (Y)es, if the parameter is quantitative. Column W has a (Y)es if the parameter can be weighted.

Parameter	Q	Rationale	Measurement	W	Comments
No. sources	Y	The relevance of entry A directly relates to the no. of entries depending on A.	Counting the links with A as source.	n/a	Can be determined based on SEE-IN LB contents. Is being used indirectly.
Strength of links	N	The relevance of entry A can depend on the strength of the links with A as the source. The strenght can be converted into a weight.	Link attribute.	n/a	Can be determined based on link attribute. Needs to be converted into a quantitative weight.
Relevance of targets	Y	The relevance of entry A can depend on the relevance of the targets of the links with A as the source.	Relevance of all target entries.	Y	Can be determined starting with those entries that do not appear as a source, and then working backwards.

where L_A is the number of links in which A appears as the source, and $w_i, i = 1, ..., L_A$ are the weights assigned to each link. In the most simple case, we can set all $w_i = 1$. Taking into account the the strength of a link (weak, strong, crucial), we could assign the values 1, 2, or 3 for weak, strong and crucial links, respectively.

The next level of complexity would take into account the relevance of the target. In this case, all relevances would become interdependent and would have to be determined in a recursive way. In this case, publishing a new entry and linking it to one other entry has the potential to change the relevance of a large number of other entries. However, at this level, the relevance would not just be derived from the immediate environment of an entry but reflect its global relevance. A measure for the global relevance r^{glob} is defined here as

$$r^{\text{glob}}(A) = \sum_{i=1}^{L_A} r_i^{\text{glob}} \tag{5}$$

Combining equations (4) and (5), we can define a weighted global relevance by

$$\hat{r}^{\text{glob}}(A) = \sum_{i=1}^{L_A} w_i \cdot \hat{r}_i^{\text{glob}} \tag{6}$$

Based on the global relevance of requirements, we can define the relevance $r(B)$ of a dataset or product B. If B meets the requirements $R_i, i = 1, ..., K_B$, then the relevance of B is defined as

$$r^{\text{glob}}(B) = \sum_{i=1}^{K_B} \hat{r}_i^{\text{glob}}. \tag{7}$$

Since there is no predefined strength of the match between a dataset and requirement entry, we cannot define a weighted relevance here.

In summary, we propose to use the following two measures for relevance of SEE-IN KB entries and external datasets, which then can be used to propose the relevance of related gaps:

For SEE-IN KB entries:

$$\hat{r}^{\text{glob}}(A) = \sum_{i=1}^{L_A} w_i \cdot \hat{r}_i^{\text{glob}}, \tag{8}$$

L_A: number of entries E_i that are targets in the links with entry A being the source;
w_i: weight of the link between A and E_i;
r_i^{glob}: global relevance of E_i.
For external datasets or products:

$$r^{\text{glob}}(B) = \sum_{i=1}^{K_B} \hat{r}_i^{\text{glob}}, \tag{9}$$

K_B: number of requirement entries R_i that are met by dataset or product B;
r_i^{glob}: global relevance of requirements R_i.

6.5 Algorithms

The specific algorithms to compute the relevance of a SEE-IN KB entry are currently under development. The main task is a network analysis to find all relevant connections. Parameters to constrain the search will include SBAs and themes, selected groups, and selected goals and/or targets. This will allow to get user-specific rankings.

7 Conclusions and Outlook for Final Review

7.1 Summary of the Gap Analysis so far

The gap analysis in ConnectinGEO has resulted in a preliminary list of gaps published in the CGT. This list demonstrates the feasibility of the ConnectinGEO threaded approach to gap analysis. The list is comprehensive for selected themes (climate and ocean), while other themes require more work.

The approach to collect the results of the gap analysis in an on-line table (the CGT) has the advantage that the table is operational and accessible to all participants. However, as outlined in the previous section, CVs are not strictly enforced and this leads to inconsistencies between different tables (e.g., the list of agreed-upon EVs and the EV information in the CGT). There is also a duplication of information for different gaps, e.g. for references, reviews, and recommendations.

In each of the five threads of the ConnectinGEO gap analysis initial steps have been made towards a comprehensive gap analysis:

- In TDT1 many of the ESDGVs identified in the GBA characterize the built environment, and data for these ESDVs are currently sparse.
- In TDT2 the review of technical reports, GEO documents, EC project calls, etc. has provided many gaps more connected to the EBA.
- In BUT1 the review of scientific literature, surveys, conference conversations and expert opinions, have provided many gaps connected to the EBA.
- In BUT2 the review of the content of the DAB has revealed gaps in the GEOSS GCI mainly related to the spatial and temporal resolution of data sets not matching the required resolutions.
- In BUT3 the review of the activities in the WP5 of the ConnectinGEO project revealed some gaps in the Energy sector and the EO industry in general.

The gaps identified in these threads are included in Table 30 on page 125. The review of the current status of the CGT has revealed a few issues mainly related to consistency in the use of CVs and that need to be addressed in the remaining period of the project.

In order to prioritize investments in Earth observations, it would be helpful to make an explicit choice of which societal goals have highest priority in GEO's effort to meet their observational and information needs. The recent Ministerial Summit (in 2015 in Mexico City) and the GEO Plenaries in 2015 and 2016 confirmed the high importance of the SDGs for GEO as a primary goal set. Likewise, the midt-term review of the ConnectinGEO project provided guidance to focus on the SDGs as the primary goal set. The final choice of the goal set and subsets of goals could be based on an assessment not of the goals themselves but rather the impact EOs and information on EVs could have for reaching the targets.

The SEE-IN KB in connection with the GEOSS Knowledge Base could play a central role for this assessment. It is obvious that developing the SEE-IN KB such that it can capture the full complexity of goals, targets and indicators and connect them to EVs, Earth observations and gaps is an important step towards a tool to support prioritization.

For the final documentation of the gaps, it is important to ensure that there are no inconsistencies in the use of the CVs and to reduce the amount of duplication of information. This is best achieve by fully integrating the gap documentation in the SEE-IN KB. The required steps and the actions to be taken are listed is Section 7.3 below.

7.2 Summary of Findings

In all threads, two common gaps were identified that can significantly limit the exploitation of EOs and the realization of the societal benefits:

- The lack of access to data and harmonization of data semantics are two common gaps identified in most threads.
- The lack of collaboration between stakeholders across disciplines and societal sectors is a gap that appears in almost all thread.

Particularly for complex issues such as the FWEN, there is a lack of collaborations across disciplines and domains relevant to the issue. GEOSS has limited capabilities to support a theme-based approaches to data and product discovery. Particularly for in-situ observations, there are currently no coordination mechanism to establish links between different observing networks to address a complex issue.

For the SDGs, three primary issues were identified:

- Understanding and monitoring progress towards the SDG targets requires comprehensive information on the built environment and the embedded social fabric. The question to what extent such information can be extracted from EOs, potentially in combination with Big Data analyses, citizen science data, and crowd-sourcing needs to be addressed.
- There is an urgent need to integrate socio-economic and environmental data such that the integrated data base can be used to aggregate indicators and to support model simulations for policy development. However, the strategy for exploiting these opportunities does not exist.
- The complexity and interdependency of the SDGs requires new tools to generate the transformation knowledge required for the implementation of the SDGs. Of importance are modeling tools that can answer "What if" questions and support scenario-based simulations. The integration of a comprehensive data base with modeling tools such as agent-based and equation-based models in a GeoDesign approach can provide important parts of such a toolbox.

At regional and global levels, additional independent monitoring capabilities are needed to meet the knowledge needs associated with complex issues such as the FWEN and the relevant SDGs. This includes in-situ observations as well as new approaches, such as Big Data, crowd-sourcing and citizen science. A central knowledge platform could address multiple needs including those associated with the SDGs including the interdependencies between them. Such a knowledge platform also would provide a basis to take a nexus approach to complex issues linking several goals together.

Concerning the SDG indicators, is has to be emphasized that the current indicator framework focuses on final results and not on the systemic properties that are relevant to these results. Most of the indicators are focused on socio-economic aspects while environmental aspects and their impacts on the social fabric are underrepresented. As currently defined, the indicators provide limited report cards and target outcomes for simulations required for policy development, but they do not inform the simulation tools urgently needed to support policy development. Importantly, a validation of the indicators with respect to their relevance to the goals and targets is needed.

For the indicators, information needs to be aggregated to national and global scales and accumulated over several years. For implementation of the targets and for addressing complex issues and interdependencies, disaggregated data are required. It is challenging to bring these two types of together, and it needs to be studied whether the knowledge platform can help to address this challenge.

In addition to data needs for the quantification of the indicators, there is a need to increase modeling capabilities to create the transformation knowledge for the implementation of the targets. Systems have to be identified or developed that can combine modeling and observations in a way best suited to meet the needs of the SDG implementation taking into account the complexity arising from the interdependencies between the goals.

There is a significant lack of policy frameworks that explicitly address the coordination required by complex issues such as the FWEN. In many cases, complex issues are not addressed from a nexus point of view but rather segmented and distributed of several governmental departments, with little collaboration across departmental boundaries. If the process of implementing the SDGs would take a nexus-focused approach, it could be instrumental in supporting transformative changes at different levels. To achieve this, local communities and stakeholder groups have to be involved in steps towards implementation and monitoring of progress, as well as the processes of developing meaningful indicators. The FWEN could be a model case providing guidance on how to achieve the relevant SDGs of a nexus.

For the EO communities, an important question is how to provide information that could support the governments in their quest for the SDGs. While the provision of data for the quantification of indicators is an important contribution, of equal importance is the support of policy development for SDG implementation. For that, an environment needs to be created that enables the integration of EOs, models and simulation tools for the assessment of policy options.

7.3 Specific Actions To Finalize Gap Analysis and Prioritization

In this section we list a number of actions that need to be taken in order to complete the gap analysis and make progress towards the goal of a prioritized list of gaps.

For the completion of the list of gaps, the following actions have been identified so far:

- TDT1-1: Complete the identification of ESDGVs using the GBA for the existing indicators and the identification of domain-specific EVs that match these ESDGVs.
- TDT1-2: Complete the review of the targets with respect to additional indicators that would ensure that progress towards the targets accounts for environmental indicators.
- TDT1-3: Add the gaps identified in this thread to the CGT.
- TDT2-1: Complete the review of the US-09-01 documents and add the gaps identified in this review to the CGT.
- TDT2-2: Include a detailed summary of the analysis of the documents listed in Section 4.2 in D6.3.
- TBU1-1: Prepare the meta-information of the survey for inclusion in the SEE-IN KB.
- TBU2-1: Add the gaps identified in the assessment of the OI to the CGT.
- TBU3-1: Review all gaps resulting from this thread and add missing gaps.
- TBU3-2: A detailed list of gaps related to the FWEN is in preparation and will be included in D6.3.

For the completion of the documentation of the gaps, the following actions are pending:

- CGT-1: Merge the list of domain-specific EVs and the ESDGVs into one comprehensive and consistent master list of EVs.
- CGT-2: Ensure that all gaps are linked to proper EVs included in the master list of EVs.

For the prioritization, the action required include:

- PI-1: The algorithms for the ranking based on links has to be finalized and implemented in the SEE-IN KB.
- PI-2: A more complete matrix of potential parameters to be used to define a set of metrics need to be compiled. Table 12 is a starting point. For datasets and products, continuity (length of time series) needs to be accounted for. The uniqueness of a dataset also increases the relevance. For a requirement, the frequency of its appearance in various databases indicates relevance. For both, datasets and requirements, user rating can be included as a component of relevance.
- Implement the computation of a priority index based on Eq. 2 in the SEE-IN KB.

7.4 Relevance for ENEON

The exercise of a comprehensive gap analysis carried out in ConnectinGEO has underlined the need for improved interactions between communication between the providers and users. Fig. 1 on page 24 indicates the need for matchmaking institutions and experts that effectively can bring users and providers together in mutually beneficiary relationships. ConnectinGEO has made an effort to map the landscape of the EO networks and relevant research infrastructure and coordination mechanisms in Europe (Fig. 34). With the establishment of ENEON, a new coordination component has been added, which could participate in the matchmaking between societal users and the European EO communities. Fig. 35 shows a scenario in which coordination mechanisms on the user and provider sides are potential entry points for the matchmaking and maps of the user and provider landscapes support the matchmaking.

While ConnectinGEO has developed both the coordination mechanism and the map of the landscape for the provider side, there is a lack of these elements on the user side. It would be important that GEO in its effort to map users and user requirements would focus on mapping the user landscape and identifies coordination mechanisms that could provide an entry point for matchmaking. It is also recommended to develop use cases that require matching and coordination across disciplinary and sectoral boundaries to demonstrate the validity of the approach sketched in Fig. 35. The FWEN could be an excellent starting point for such a use case.

A particular gap identified is the lack of experts that have the acquaintance with, and understanding of, both sides of the matchmaking. The lack of mobility between societal sectors and the lack of educational efforts to create this mobility are reasons for the limited number of experts that can work and communicate across societal sector boundaries.

The existing mobility programs, such as *Marie Sklodowska-Curie Actions (MSCA)*, aim mainly at geographical and intercultural mobility. There is a lack of programs that would encourage mobility across disciplinary and sectoral boundaries. It is recommended that the European Commission makes an effort to extend existing mobility programs to also facility mobility across disciplinary and sectoral boundaries.

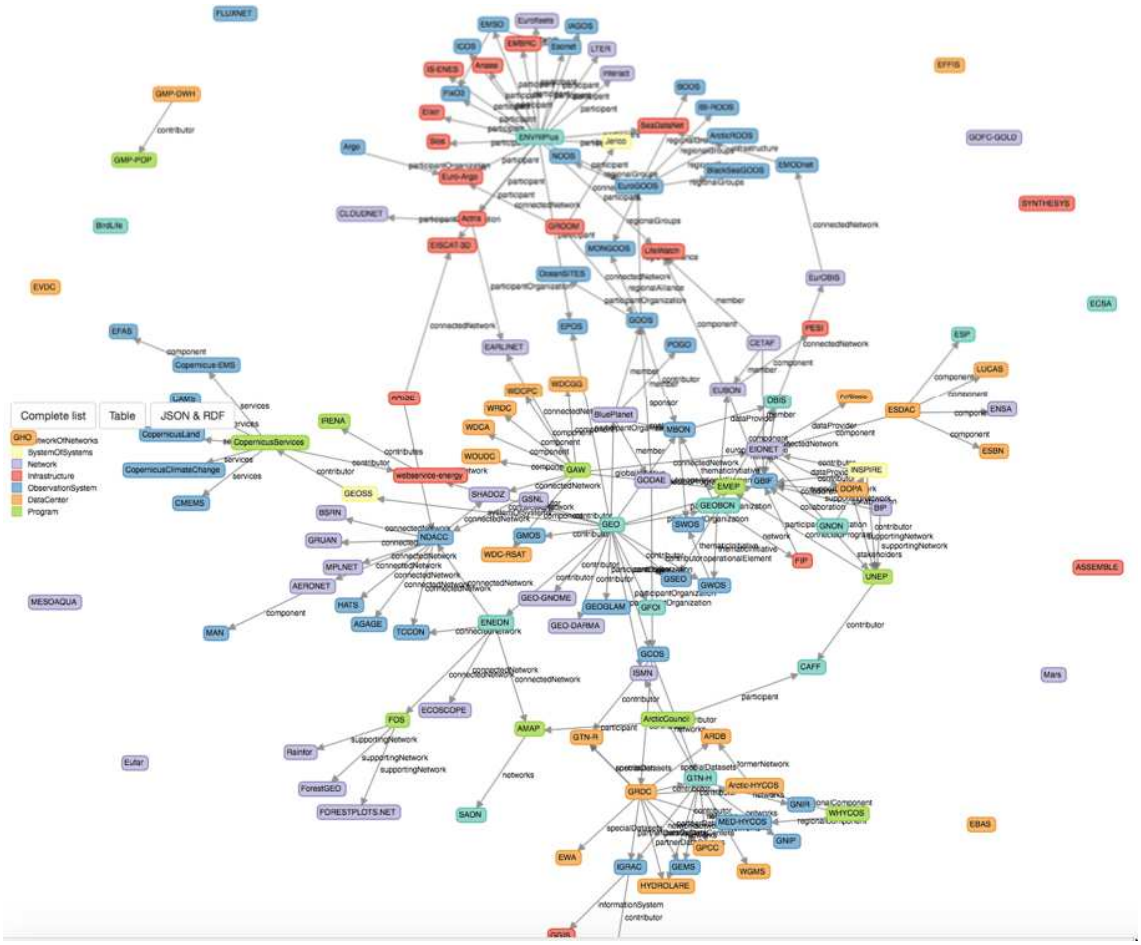

Figure 34. Landscape of European EO networks and research infrastructures.

7.5 Finalizing of Prioritized Gap List

At the Project Team meeting on October 14, 2016 at IIASA, the process of finalizing the list of prioritized gap by the end of the project was discussed and agreed upon. The process includes the completion of the ConnectinGEO Gap Table (CGT), the review of the CGT contents, and a prioritizing of the gaps. The following action items were agreed:

A1 : All partners will complete the publishing of their gas in the CGT, and those who have published gaps will clean up their entries. The cleaning up will include ensuring that the gap type is consistent with the gap description; making the entries for the EVs consistent with the ConnectinGEO list of EVs; and ensuring traceability by providing full references to documents with URLs for technical reports and other non-journal/book references.
Deadline for this Action Item is November 10, 2016.

A2 : All partners will review the CGT and provide feedback on the gaps, including their prioritization. See below for details on how to provide the prioritization.
Deadline for this Action Item is December 1, 2016.

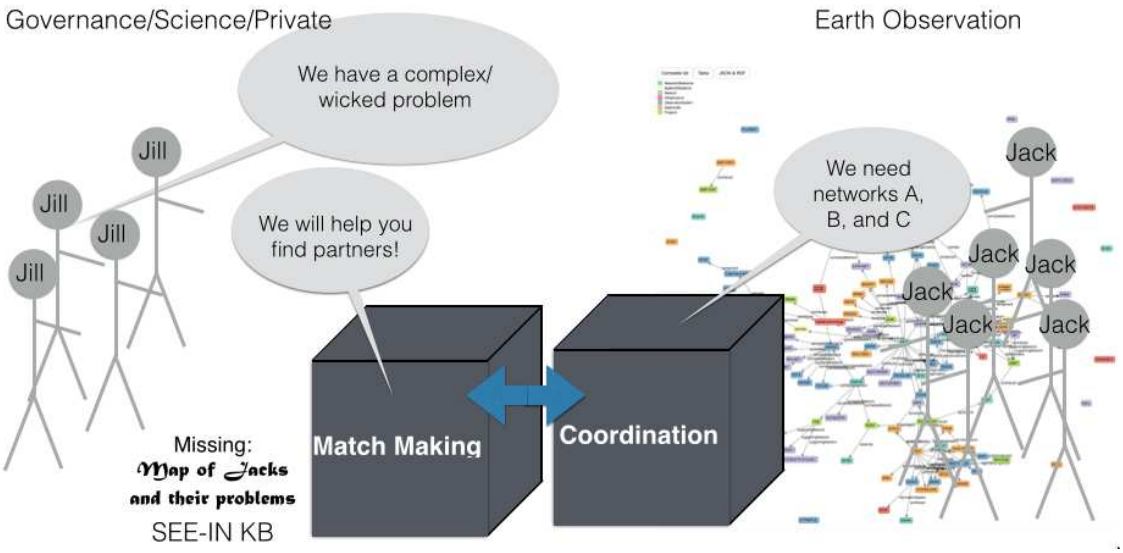

Figure 35. Mapping the provider and user landscapes provides a basis for matchmaking.
ConnectinGEO has mapped the provider landscape and add new coordination mechanisms. This provides an entrance point for matchmaking. A similar mapping of the user landscape is needed, including the identification of coordination mechanisms on this side as potential entry points for matchmaking. The SEE-IN KB could be the platform for the mapping and matchmaking.

A3 : A group of (eight) representatives of the partners engaged in WP6 will review the feedbacks and based on them prepare a prioritized list of gaps. This list will be distributed to all partners.
Deadline for this Action Item is December 20, 2016.

A4 : All partners will review the fully prioritized list and send comments and/or their approval of the list to Hans-Peter Plag.
Deadlines for this Action Item is January 10, 2017.

A5 : The group of representatives will go through all comments and finalize the list of prioritized gaps.
Deadline for this Action Item is January 15, 2017.

A6 : If there are many comments as a result of A4, it may be necessary to have another round with feedback from the partners. If so, the list will be sent out on January 15, 2017, comments will be due on January 22, 2017 and finalized list will be compiled by January 31, 2017.

As part of the feedback provided in A2, if possible, estimates should be given of the cost of addressing the gap, feasibility of closing the gap, and the impact if the gap is closed. Alternatively, the impact/cost ratio could be estimated. For all criteria the scale to be used is: (1) very high (2) high (3) medium (4) low (5) not known

When providing a prioritization, it was asked to describe the rational for the rating. For the priority rating the scale to be used is: (1) crucial/extreme (2) very high (3) high (4) medium (5) low (6) not relevant

The members of the group of representatives of the WP6 partners includes: Tiwah: Hans-Peter Plag (chair)
CREAF: Joan Maso

CNR/CMCC: Palma Blonda
CSIC: Emiglio Garcia-Landano
IIASA: Ian McCallum
NILU: Kjetil Tørseth
IEEE: Siri Johda Khalsa
S&T: Madleine de Mazerie

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A Workshop Report

The ConnectinGEO Gap Analysis and the ENEON workshop took place at the International Institute of Applied Systems Analysis (IIASA) located in Laxenburg, Austria. The Gap analysis workshop was held on October 10-11, 2016 and it was followed by the ENEON workshop on October 12-13, 2016. The ConnectinGEO Project meeting took place on October 13-14, 2016. Although the main discussions related to the gap analysis were part of the Gap analysis workshop, the issue of gaps was also addressed during the ENEON workshop and the subsequent project team meeting.

The full documentation of the workshop is available at http://www.gstss.org/2016_Laxenburg_Gaps/.

A.1 Workshop Theme

Providing Earth Observation Support to the Monitoring and Implementation of the Sustainable Development Goals: Gaps and Priorities: Solving complex societal issues increasingly depends on information and knowledge derived from Earth observations and in Europe a rich landscape of Earth observation

networks and actors aims to collect and process the necessary observations to satisfy these information and knowledge needs. Nevertheless, there are many gaps and the goal is to identify and assess these gaps in support of decisions on which gaps to address with high priority.

A.2 Scope and Objectives

The Gap Analysis workshop discussed the outcomes of the gap analysis and prioritization performed in the ConnectinGEO project. This gap analysis was guided by the information and knowledge needs resulting from humanity's "Road to Dignity" detailed in the Agenda 2030 and specified in the 17 Sustainable Development Goals (SDGs) agreed upon by the United Nations. Both the monitoring and implementation of actions to achieve these goals require extensive support from Earth observation and science communities. Several directives and crosscutting issues in Europe provided further guidance for the gap analysis.

The workshop provided a forum to review the methodology for gap analysis and prioritization, discussed the relevant gaps and priorities in the European Earth observation networks and developed a strategy to address those gaps that have a high priority assigned.

The objectives of the gap analysis and prioritization workshop were to:

- Assess the ConnectinGEO methodology for gap analysis and prioritization;
- Review the list of gaps identified and the prioritization achieved;
- Produce a final list of gaps with high priority;
- Discuss a strategy to address these gaps and provide recommendations for the European Network of Earth Observation Networks (ENEON) and the European Commission concerning high-priority gaps.

A.3 Committees

- Local Organizing Committee:
  - Ian McCallum
  - Stephen Fritz
  - Ivette Serral
- Program Committee Gap Analysis and Prioritization Workshop:
  - TIWAH: Hans-Peter Plag, Shelley Jules-Plag
  - CREAF: Joan Mas, Ivette Serral
  - IIASA: Ian McCallum
  - GEO Secretariat: Giovanni Rum
  - CMCC: Antonio Bombelli
  - CNR-ISSIA: Palma Blonda
  - IEEE: Jay Pearlman, Franoise Pearlman, Siri Jodha Khalsa
  - CISC: Emili Garca-Ladona

- BIRA-IASB: Martine De Maziere
- NILU: Kjetil Trseth, Wenche As
- ARMINES: Lionel Menard, Lucien Wald

A.4 Workshop Program

Monday, October 10, 2016

1200 - 1330:	*Registration*
1330 - 1530:	**Introduction to the ConnectinGEO Approach to Gap Analysis and Prioritization (Chairs: Ian McCallum, Steffen Fritz)**
1330 - 1340	*Steffen Fritz (IIASA)*: Welcome to IIASA
1340 - 1405	*Michael Obersteiner (IIASA)*: IIASA, Earth Observations and the Sustainable Development Goals
1405 - 1430	*Ivette Serral (CREAF)*: The ConnectinGEO project
1430 - 1500	*Giovanni Rum (GEO Secretariat)*: GEO's approach to User need definition and Gap Analysis
1500 - 1530	*de Maziere, M., Thorne, P., van Weele, M. and the GAIA-CLIM project team*: GAIA-CLIM Gap Analysis
1530 - 1555:	*Coffee Break*
1555 - 1800:	**Session 2: "Top-Down" approach to Gap Analysis: Thread 1: Identification of a collection of observation requirements; Thread 2: Research programs aims and targets (Chairs: Hans-Peter Plag and Joan Maso)**
1555 - 1605	*Hans-Peter Plag*: Remarks on the Workshop Goals and Expected Outcomes
1605 - 1625	*Joan Maso (CREAF)*: The ConnectinGEO Approach to Gap Analysis
1625 - 1650	*E. Garcia-Ladona, Joan Maso, Ivette Serral and ConnectinGEO team*: Gap analysis for the marine component within ConnectinGEO
1650 - 1715	*Daniele Ehrlich (JRC), Martino Pesaresi, Thomas Kemper*: The GHSL framework for monitoring International Framework Agreements
1715 - 1745	*Hans-Peter Plag et al.*: From Essential Variables to Observational Requirements: The SEE-IN KB: Bringing it all Together for Gap Analysis
1745 - 1800	*Discussion*: How can the gaps in available observations be identified and how can they be closed?

Tuesday, October 11, 2016

0830 - 0900:	*Registration*
0900 - 1200:	**Session 3: "Bottom-Up" approach to Gap Analysis: Thread 1: Consultation process; Thread 2: GEOSS Discovery and Access Broker analysis and Thread 3: Industry-Driven Challenges (Chairs: Ian McCallum, Stefano Nativi, and Lionel Menard)**
0900 - 0940	*Matthes Rieke et al.*: Summary of Bottom-Up Thread 1
0940 - 1020	*Kjetil Tørseth*: Air pollution and air quality monitoring in Europe: Gaps limiting further developments
1020 - 1100	*Mattia Santoro and/or Stefano Nativi*: Summary of Bottom-Up Thread 2
1100 - 1130:	*Coffee Break*
1130 - 1200	*Mónica Miguel Lago*: WP 5 Activities
1200 - 1430:	**Session 4: Making Gap Analysis Results Usable (Chairs: Giovanni Rum)**
1200 - 1240	*van Weele, M., de Maziere, M., Thorne, P. and the GAIA-CLIM project team*: The GAIA-CLIM online Catalogue of Gaps and Gaps Assessment and Impacts Document
1240 - 1400:	*Lunch*
1400 - 1430	*Haris Kontoes*: The GAP Analysis process in the GEO-CRADLE project
1430 - 1630:	**Session 5: Assessment of the Gaps Identified so far (Chairs: Joan Maso)**
1430 - 1510	*Hans-Peter Plag*: Assessment of Gap Analysis Outcomes and Integrating Gap Analysis in the SEE-IN Knowledge Base
1510 - 1520	*All*: Distribution of gaps to groups and introduction of the questions *All*: Discussion of gaps
1520 - 1610	Group 1 (chair and rapporteur Joan Maso): Gaps about: Climate, biodiversity, oceans Group 2 (chair and rapporteur Hans-Peter Plag): Gaps about: water, energy, disasters Group 3 (chair and rapporteur Siri Jodha Khalsa): Gaps about: Transversal.
1610 - 1630:	*Coffee Break*
1630 - 1700:	*Rapporteurs*: Brief Summary of Group Discussions
1700 - 1815:	**Session 6: Steps Towards Prioritization (Chairs: Giovanni Rum and Hans-Peter Plag)**
1700 - 1725	*Giovanni Rum*: GEO's approach to Prioritization
1725 - 1750	*Thorne, P., De Maziere, M., van Weele, M.*: From a gaps analysis and impacts assessment to prioritization: the current GAIA-CLIM plans
1750 - 1810	*Hans-Peter Plag and Joan Maso*: ConnectinGEO Prioritization: Actions for the Remaining Project Life-Time
1810 - 1815	*Joan Maso, Hans-Peter Plag, Ian McCallum*: Wrap-Up and Closing of Workshop
1900 - 2100:	*Social Dinner in Laxenburg*

A.5 Workshop Participants

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A.6 Workshop Minutes

The workshop was opened by Ian McCallum and Steffen Fritz. Steffen Fritz welcomed the participants, giving a brief overview of the history of IIASA, which was founded in 1972.

Michael Obersteiner presented a study published as Obersteiner et al. (2016). He explained that the GEO SBAs were almost as comprehensive as the SDGs, although the approach in the SBAs was more from a EO point of view. An important question concerning prioritization is where to get the highest return for a minimum costs. He used the example of food to underline that the SDGs are about societal issues, with very different impacts, for example, for a European and some African families. To fully understand the relevance of gaps in the observation systems requires to look into the future, which can be done to some extent using model simulations of what the future could be. He emphasized that most of the SDGs are about humans and the anthroposphere, and not so much about the other part of the biosphere. Some of the SDGs are institutional. While we may wish for everything, there is only a certain amount of actions that can be funded, and that requires prioritization of actions. Question relevant for GEO include: What are the observing systems to deliver info of importance for these action? How can trade-offs between goals be managed? He reported that the group at IIASA looked at several targets that are quantifiable. They also looked at targets that appear to not to be feasible. Depending on the scenario selected, they found different impacts on land use, which in turn had different impacts on food price. He concluded that there are strong interactions between different environmental resources (incl. spatial leakage) and conflicts between economic interests and environment. The details of policies therefore are important.

Ivette Serral provided an overview of ConnectinGEO and reported the main results achieved so far. She pointed out that the gap analysis to a large part was community driven, which might have led to a bias towards communities that are more active. It is still an open question of how these biases can be avoided. The mix of domains and communities involved should be clarified.

Giovanni Rum introduced the GEO approach to gap analysis and introduced the Foundational Task on user needs and gap analysis. The core function is to identify user needs and address the gaps in the information chain. He asked whether the EV approach is suitable for all SBAs. Is it a general concept or more applicable to specific communities? Is the EV concept working and ready to be used across all SBAs? Can the SDGs be used as a reference? Is it possible to link essential observations to the EVs? He identified "*the need of a well-defined and structured process engaging stakeholders from different*

domains, different regions, and different roles, including from end users to data providers and public and private sector." The process should build on similar processes/activities already running. Contributions to the process should come from different sources, such as:

- Similar processes running for a partial set of SBAs, such as those running within GFCS and WIGOS, under WMO leadership;
- Ad hoc processes to be gradually established with all GEO Initiatives and Flagships to "distillate" their needs;
- A systematic, SBA-related process to complement those identified above."

Martine De Maziere introduce the GAIA-CLIM approach to gap analysis. GAIA-CLIM is concerned with improving utility of non-satellite observations to characterize satellite data (focusing on a selection of atmospheric, ocean and land ECVs). The objectives of this projects are to improve identification and use of non-satellite measurements to characterize, calibrate and validate satellite measurements and to ensure that best metrological practices are followed. The project makes use of statistical, modeling and data assimilation tools. The principal outcomes are a Virtual Observatory tool and the documentation of gaps and remedies as well as prioritization. Gaps are restricted to domain of project. The documentation of the gaps is a living document with 5 scheduled versions during project lifetime, which is associated with an interactive Web version. The updates reflect internal (from underlying WPs) and external (from user workshops and an initial user survey) inputs (essentially bottom-up approach). A set of recommendations for future work to address the identified gaps will be created in 2017. The gap assessment is a living process and it is hoped that GAIA-CLIM can learn from ConnectinGEO (and vice-versa) to improve the process and to look at the gaps in the wider context of GEOSS.

In Session 2, Hans-Peter Plag briefly introduced the expected outcomes of the workshop, i.e., a list of well-defined actions required to finalize the ConnectinGEO gap analysis and prioritization of the the gaps. Joan Maso reviewed the ConnectinGEO approach to gap analysis.

Emilio Garcia-Ladona discussed the detailed gap analysis carried out for the marine domain. This analysis used an expert-based approach in the context of the BUT1. The first version of of systematic gap analysis for EOVs was carried out based on international initiatives, technical reports and peer-reviewed literature. However, the analysis is incomplete particularly for for several EOVs within the biogeochemical and marine biology and ecosystem panels. These EV sets are less mature and therefore lack specialized work on observational needs, data networks and its relationships with SBA and SDG.

Daniele Ehrlich introduced the ***GHSL! (GHSL!)***, which makes comprehensive information on human settlements available. He identified the need for continue the mapping settlements with improved datasets (Sentinel). There is a need to improve details and assure continuity. The development of a system for the validation of settlement maps and the characterization of settlements (slums, other) are further needs. Measurements of the height and estimate volume of settlements are needed. The combination of the existing layers with socio-economic variables need to be addressed as well as the exposure to natural hazards and energy demands and consumption. In the discussion, the transition from rather static layers to a more dynamic approach that represent all forms of flows (humans, materials, energy, information, traffic, ...) was identified as a desirable extension. The lack of validation data was identified as a gap.

Hans-Peter Plag presented thoughts on the core gaps between users and providers. He introduced Jack and Jill, which appear in the dialogs in Laing (1970), and which have considerable communication issues. He asked for a "market place" for collaborations between Jills (providers) and Jacks (users) to overcome the current issues in matching and communicating. In the subsequent discussion, it was commented that

there is a need for a third participant, Jane, to help with the matching. There was agreement that this establishes a skill need in terms of matching capabilities. This should be included as a gap and also as a recommendation to the Commission. For that, it would be important to have mobility not just between regions but also between disciplines and societal sectors. It was asked whether the Horizon 2020 MSCA could be a way to achieve this? Stefano Nativi remarked that a dialog between Jill and Jack was not needed since in his opinion, the GCI with the DAB is already discovering what is there, and that would be sufficient. The question was raised whether Copernicus could be the market place, which should be a translator or mediator. Would this market place give priorities? The market place would connect what is needed with what is available.

The second day started with Session 3 on "Bottom-Up approach to Gap Analysis: Thread 1: Consultation process; Thread 2: GEOSS Discovery and Access Broker analysis and Thread 3: Industry-Driven Challenges'.' Matthes Rieke presented the results of the community survey conducted as part of BUT1. The survey had 80 participants. The results are described in detail in Delivery D3.4 and in Section 4.3 in this document. He mentioned that GAIA-CLIM also conducted a similar survey, which produced comparable results. Most issues identified by the participants are in the field of data coverage, data access and data exploitation. The fact that 54 of the 80 respondents did not know ConnectinGEO and ENEON pointed to a need to improve outreach particularly for ENEON.

Kjetil Tørseth discussed air quality observations and services in Europe. Air quality is governed by several conventions and initiatives. EU-legislation include the clean air policy package and the clean air act. Globally, the UN, WMO, UN-ECE and WHO are directly involved in relevant regulations and agreements. Science related to air quality is based on measurements funded by national institutions like NILU and on collaborative projects using a variety of research infrastructures. The research is academically rewarding. However, funding goes increasingly to services addressing high-level users, and not so much scientists. Assessing gaps related to air quality, Kjetil Tørseth pointed out that the gaps are not specific enough for any prioritization. He underlined the importance of applying the GBA to selected SGDs and Targets and merging the outcomes with the EBA. He also proposed a process that (1) identifies gaps in indicators for targets with focus on environment, (2) proposes new indicators to fill the gaps, and (3) prioritizes the missing indicators based on potential impact.

Mattia Santoro presented the result of the BUT2 activities. These results are summarized in Section 4.4 on page 63. The OI established in for the gap analysis has a large number of entries (order several million). However, if required spatial and temporal resolutions are applied as search criteria the number of matching entries is drastically reduced.

Monica Miguel Lago summarized the activities in WP 5. She gave an overview of the membership and activities of EARSC, which includes 75 full members and additional observers from 22 European countries. Most of the member companies are micro and small companies (a total of 96%). EARSC provides a number of services to the members, including a market watch, a news letter, an assistance to strategy development. She discussed the evolving market for remote-sensing related products, which is still fragmented, and underlined the importance of services to the public sector. There is a shift from products specific to one customer to services as one products for many customers. EARSC has prepared a position paper that addresses numerous challenges faced by European companies engaged in product development based on remote sensing. Details on the position paper are provided in Section 4.5.4.

Monica Miguel Lago then provided a brief summary of the gap analyses carried out in the Tasks of WP 5. She emphasized that all tasks identified gaps related to data access and the harmonization of data semantics. A lack of collaboration was another gap frequently identified. The details for each Task are provided in Section 4.5 on page 66.

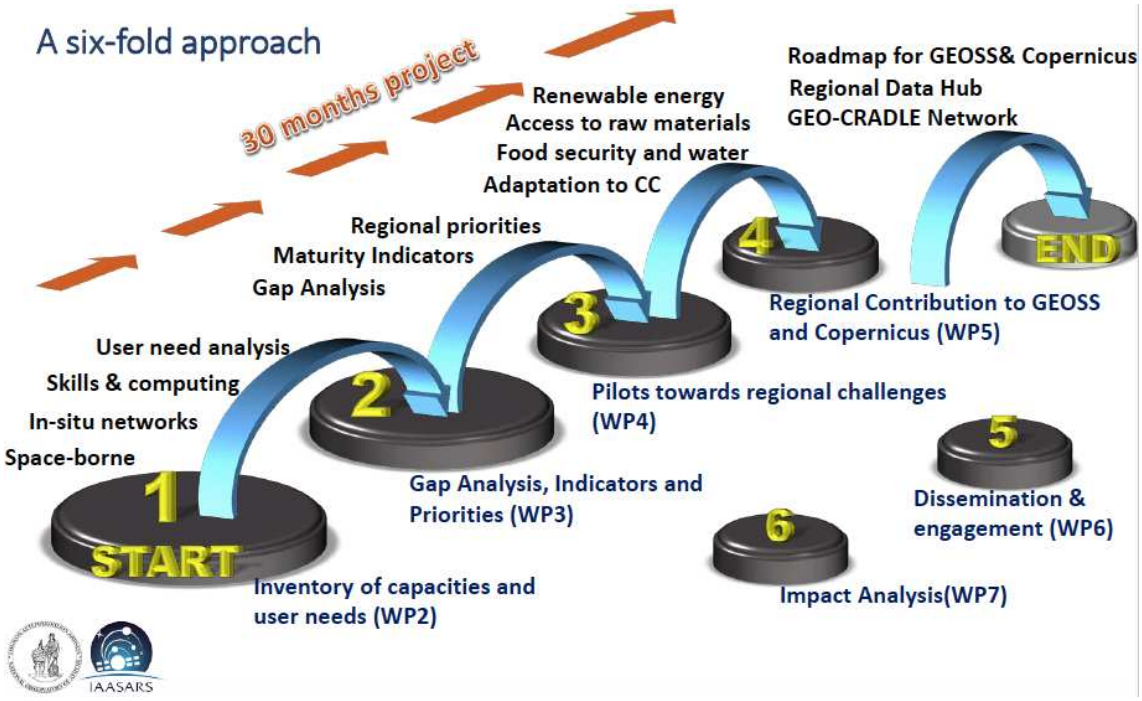

Figure 36. Six-step approach to the implementation of the GEO-CRADLE project.
From Kontoes (2016).

In Session 4 on "Making Gap Analysis Results Usable," M. van Weele gave an overview of the GAIA-CLIM approach to gap analysis. In this approach, gaps are unmatched user needs. The identification of gaps is based on a bottom-up approach. The approach uses the SMART gap formulation: Specific, Measurable, Achievable, Relevance, Time-Bounded. GAIA-CLIM uses seven types of gaps. The results are collected in an on-line catalog, which provides the option to give feedback. The number of gaps identified is 88. The *Gaps Assessment and Impacts Document (GAID)* document describing the gap analysis approach is a living document (van Weele, 2015). It is expected that the version 4 to be published in February 2017 will include more support for prioritization.

Haris Kontoes introduced the gap analysis process applied in the GEO-CRADLE project. The GEO-CRADLE project is an EU-funded Coordination Action that aims at fostering regional cooperation and to develop a road map for GEO and Copernicus implementation in North Africa, the Middle East, and the Balkans. Among others, the project supports the effective integration of EO capacities in the *Region of Interest (ROI)*, facilitates the engagement of the comprehensive ecosystem of EO stakeholders, promotes the uptake of EO services and data meeting regional needs, and enhances the contribution to the implementation of GEO, GEOSS and Copernicus in the ROI. The conceptual approach has four pillars focusing on exploiting synergies and cross fertilization, applying an impact-driven methodology, combine a top-down with a bottom-up approach to GEO and Copernicus, and aim for a lasting and sustainable effect in the ROI. For the implementation, the project uses six steps illustrated in Fig. 36.

The methodology for the gap analysis in GEO-CRADLE project has three main elements, i.e., EO capacities documented in an inventory of the key EO actors; and inventory of EO end-user needs identified through in-depth end-user interviews of a representative sample, and indicators characterizing gaps and pinpointing where in the value chain these gaps occur. The gap analysis is an on-going process in the project based on results from previous projects, gaps resulting from the inventorying phase, and gaps detected in reviewing research. The indicators fall into five groups: (1) geographic, i.e., discrepancies in spatial coverage of the observational capacities and the data; (2) observational, i.e., a lack or insufficient

availability of technologies and systems for EO providing the required data in the required quality; (3) structural, i.e., the lack of connectivity enabling the flow of data freely within organization and networks; (4) qualitative and quantitative, i.e., the available EO products are not sufficient in terms of timeliness, frequency and/or quality to be fit for purpose; (5) capacity for use, i.e., insufficient technical capacity in regards to infrastructure and personnel to make use of it. In total, the project has identified 41 indicators along the value chain. The questions to be asked are:

- Geographical: Is there EO capacity to collect data from the area from which it is needed?
- Observational: Is there capacity to measure and model attributes that are needed?
- Structural: Is there a problem with connectivity in the EO value chain?
- Quantity/quality: Is the quantity and quality of the data satisfactory?
- Capacity: Does the end-user have technical capacity to use the EO products?

A survey resulted in 260 responses distributed over Balkans (183), North Africa (59) and Middle East (15), with most of the respondents in the fields of food security and climate change. The main gaps identified related to EO being dominated by the public sector, while private companies provide data products and resell satellite data. There is a reluctance to share data between organizations. There is also a lack of educational capacity. There is, however, a large difference between countries and within countries. The lack of institutionalization leads to vulnerability to politics.

Session 5 on the "Assessment of the Gaps Identified so far", Hans-Peter Plag summarized the gap analysis approach taken in ConnectinGEO and discussed issues to be addressed in order to finalize the CGT and the prioritization. He then introduced the SEE-IN KB and discussed the gap data model used in this knowledge base.

Session 5 concluded with a discussion of specific gaps in three breakout groups. Group 3 looked at transversal gaps related to multiple or all themes. The question was raised to collapse gaps into larger aggregates. However, it was decided to maintain the atomic structure because it was better for the remedies. A new category for boundary conditions was introduced. There was confusion between temporal coverage and temporal resolution. A number of gaps were classified as impossible to address since they referred to events in the past. Gaps that anticipate a problem in the future were considered more realistic to address. Three steps were proposed for the finalization: review of gaps, proposal for remedies, decision on priorities.

Group 2 considered gaps related to the themes of climate, ocean and biodiversity. The main issue identified was the heterogeneous nature of the entries in the CGT. Some entries were not considered to be gaps.

Group 1 discussed the gaps in associated with the themes of energy, water, and disasters. The gaps were found not specific enough for prioritization. It was suggested to focus on a few SDSGs and targets. The prioritization should consider the impact on measuring the indicators relevant for these targets. The SDG indicators in tiers 2 and 3 should be included for indication of gaps.

In Session 6 on "Steps Towards Prioritization", Giovanni Rum reported that the priority for GEO is on the SDGs. The Ministerial Summit on Earth Observations held in November 2015 in Mexico City guided GEO to focus on:

- Support for the Framework Convention on Climate Change;

- Support for the Sendai agreement;
- Housing and Urban development;
- Ecosystem accounting defined by UN Statistical commission.

Giovanni Rum pointed out that GEO currently has no process to prioritize gaps. He indicated that such a process might be an outcome of the user needs collection process to be developed by the Foundational Task on user needs and knowledge base.

Peter Thorne presented the GAIA-CLIM plans and considerations for prioritization and the development of recommendations. These considerations are valuable input for the development of the final list of prioritized gaps in the ConnectinGEO project. GAIA-CLIM aims to lay a basis for drawing up the need for dedicated calibration and validation campaigns and is highly reliant on consensus with the scientific community involved in climate change and atmospheric measurements and modeling. Priorities are expected to arise exclusively from GAID. The living GAID provides a set of possible recommendations, and a sub-set of those will be carried forward to form recommendations. Questions requiring close attention include the issue of balance between different communities and engaging all communities sufficiently and consistently.

In terms of developing recommendations, an important question is the audience for the document, which could include the European Commission, national funding agencies, international agencies, scientific communities, and others. Can the document reach all these communities or should it be targeted for a sub-set of selected communities? An open question is the nature of the document, which could be a short document complementing the GAID or a stand-alone document. It could provide a targeted and prioritized set of recommendations in form of an implementation plan or a selection of possible future work avenues. The structure of the document could be by impact, priority, time of resolution, and likely costs. A decision has to be made whether all gaps should be included or focus should be on a subset of gaps. If the latter, the question is by whom and how the decision what to include should be made. The current preference is on a subset of high priority gaps with justification of the prioritization and a clear linkage between the recommendations. This would result in a short document of less than 20 pages with references to supporting material. It is planned to hold a workshop in late 2017 to work out the details of the document to be delivered in February 2018 to the Commission. It is hoped that the document will have an impact on future H2020 calls.

The last presentation given by Hans-Peter Plag introduced an algorithm for the computation of a ranking of gaps based on their relevance for other applications and users as captured in the SEE-IN KB. He also reviewed the initial list of action items included in the draft D6.2 for the finalizing of the prioritized gap list. In the subsequent discussion it was underlined that remedies need to be established for each gap. Without such remedies, prioritization cannot be started. There was a brief discussion of how the different gap analyses activities can benefit from synergies, and it was agreed that further interactions between the project is important to ensure a balanced representation of the most relevant gaps. The GEO Foundational Task on User Needs and Gap Analysis could provide the appropriate framework for such an interaction.

B Tables of SDG-Related Gaps Determined in TDT1

Table 13. List of the seventeen Sustainable Development Goals.

Name	Short Description	Description
Sustainable Development Goal 1	No Poverty	End poverty in all its forms everywhere
Sustainable Development Goal 2	Zero Hunger	End hunger, achieve food security and improved nutrition and promote sustainable agriculture
Sustainable Development Goal 3	Good Health and Well-being	Ensure healthy lives and promote well-being for all at all ages
Sustainable Development Goal 4	Quality Education	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
Sustainable Development Goal 5	Gender Equality	Achieve gender equality and empower all women and girls
Sustainable Development Goal 6	Clean water and Sanitation	Ensure availability and sustainable management of water and sanitation for all
Sustainable Development Goal 7	Affordable and Clean Energy	Ensure access to affordable, reliable, sustainable and modern energy for all
Sustainable Development Goal 8	Decent Work and Economic Growth	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
Sustainable Development Goal 9	Industry, Innovation and Infrastructure	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
Sustainable Development Goal 10	Reduced Inequalities	Reduce inequality within and among countries
Sustainable Development Goal 11	Sustainable Cities and Communities	Make cities and human settlements inclusive, safe, resilient and sustainable
Sustainable Development Goal 12	Responsible Consumption and Production	Ensure sustainable consumption and production patterns
Sustainable Development Goal 13	Climate Action	Take urgent action to combat climate change and its impacts
Sustainable Development Goal 14	Life Below Water	Conserve and sustainably use the oceans, seas and marine resources for sustainable development
Sustainable Development Goal 15	Life on Land	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
Sustainable Development Goal 16	Peace Justice and Strong Institutions	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
Sustainable Development Goal 17	Partnership for the Goals	Strengthen the means of implementation and revitalize the global partnership for sustainable development

Table 14. Gaps related to the implementation and monitoring of SDGs.
Note that this table is preliminary and work is in progress to extend this table significantly.

ID	GAPTYPE	THEME	DESCRIPTION	PURPOSE
SDG-GP-0	9.1	SDGs	There is a lack of an epistemology for the creation of transition knowledge from the current state and system trajectory to the desired future identified in the Agenda 2030.	
SDG-GP-1	8.1	SDGs	No integrated environmental and socio-economic data bases	Quantification of SDG indicators: many indicators require the integration of socio-economic and environmental data
SDG-GP-2	8.1	SDGs	Insufficient accounting for environmental variables in SDG indicators	Integrating the environment into the monitoring framework: Monitoring progress towards many targets would benefit from additional or modified indicators that integrate more information on the environment.
SDG-GP-3	8.1	SDGs	Missing link between SDGs and sustainability	Sustainable development requires a functioning Earth's life-support system and the SDGs need to acknowledge this need. The SDGs, Targets, and Indicators do not reflect sufficiently the need to safeguard the Earth's life-support system.
SDG-GP-4	8.3	SDGs	Missing tools and capacity to assess cross-SDG dependencies	Developing policies and actions for the implementation of the SDGs: Modeling tools are needed to better link the indicators to the targets and to ensure that changes in the indicators are related to trends towards the targets.
SDG-GP-5	8.3	SDGs	Missing tools for assessing cross SDG impacts of policies.	Reducing negative impacts between SDGs: most policies for the implementation of SDGs will be developed by specific governmental departments. Modeling tools are needed to support departments in assess impacts of specific SDG policies on other SDGs handled by other departments.
SDG-GP-6	8.2	SDGs	Skills required for matching providers and policy makers	Developing policies and actions for the implementation of SDGs: the matching of providers who can provide products and tools supporting policy developments for the implementation and the monitoring of SDGs with those engaged in the implementation and monitoring of SDGs is not happening sufficiently because of a lack of people with matching skills. Educational efforts need to be made to address this gap.

Table 15. References relevant to the SDG gaps.
Note that this table is preliminary and work is in progress to extend this table significantly.

ID	DESCRIPTION
SREF-001	Griggs et al. (2013)
SREF-002	Lu et al. (2015)
SREF-003	Rockström et al. (2009)
SREF-004	Nilsson et al. (2016a)
SREF-005	Jules-Plag & Plag (2016a)
SREF-006	Jules-Plag & Plag (2016b)
SREF-007	Obersteiner et al. (2016)
SREF-008	Grunwald (2015)
SREF-009	Wiek et al. (2012)
SREF-010	Miller (2013)

Table 16. Links between references and the SDG gaps.
Note that this table is preliminary and work is in progress to extend this table significantly.

ID	LEFT	RIGHT	DESCRIPTION
SDG-LINK-001	SDG-GP-3	SREF-001	Griggs et al. (2013) introduce the concept of the Earth's life-support system.
SDG-LINK-002	SDG-GP-4	SREF-002	Lu et al. (2015) make a case for global monitoring and more modeling tools.
SDG-LINK-003	SDG-GP-4	SREF-004	Nilsson et al. (2016a) provide a methodology to assess interconnections between SDGs.
SDG-LINK-004	SDG-GP-5	SREF-006	Jules-Plag & Plag (2016b) discuss tools to assess policy interactions for selected SDGs.
SDG-LINK-005	SDG-GP-5	SREF-007	Obersteiner et al. (2016) discuss tools to assess policy interactions for selected SDGs.
SDG-LINK-006	SDG-GP-4	SREF-005	Jules-Plag & Plag (2016a) discusses tools to assess indicator interactions for selected SDGs.
SDG-LINK-007	SDG-GP-0	SREF-008	Grunwald (2015) considers lack of epistemology for transformation knowledge.
SDG-LINK-008	SDG-GP-0	SREF-009	Wiek et al. (2012) considers lack of epistemology for transformation knowledge.
SDG-LINK-009	SDG-GP-0	SREF-010	(Miller, 2013) identifies the need of rethinking the standards used in producing and evaluation scientific knowledge in sustainability science.
SDG-LINK-010	SDG-GP-3	SREF-003	Rockström et al. (2009) introduce the concept of the safe operating space for humanity and its global boundaries, which is central to sustainability.

Table 17. EVs derived from SDG Indicators.
The table combines the results of the goal-based analysis with those reported in Table 6 in D2.3 up to SDG 6. Note this table is preliminary and only covers the first nine SDGs.

Name	Description	ExpDomain	GeoSystem
Water Supply Services	Availability of water supply services	EXPD-PubSER	GS-BuildEnv
Electrical power services	Availability of electrical power supply services	EXPD-PubSER	GS-BuildEnv
Sewage Services	Availability of sewage services	EXPD-PubSER	GS-BuildEnv
Transportation Services	Availability of public transportation services	EXPD-PubSER	GS-BuildEnv
Internet Services	Availability of Internet services	EXPD-PubSER	GS-BuildEnv
Mobile Phone Services	Availability of mobile phone services	EXPD-PubSER	GS-BuildEnv
Landline Phone Services	Availability of landline phone services	EXPD-PubSER	GS-BuildEnv
Public Health Services	Availability of public health services	EXPD-PubSER	GS-BuildEnv
Internet Phone Services	Availability of internet phone services	EXPD-PubServ	GS-BuildEnv
Population Migration	Information on migration	EXPD-Demography	GS-Population
Land cover vegetation		EXPD-LandCover	GS-Surface
Malaria infection potential		EXPD-InfectDisease	GS-Surface
Malaria infections	Number of infections over a given time interval per a given number of people	EXPD-InfectDisease	GS-Surface
Productivity of Forests		EXPD-Forestry	GS-Surface
Productivity of Farms	Including crop area and crop yield	EXPD-Agriculture	GS-Surface
Sustainability of agriculture		EXPD-Agricuture	GS-Surface
Irrigation level of agriculture		EXPD-Agricuture	GS-Surface
Fertilizer usage of agriculture		EXPD-Agricuture	GS-Surface
Drought indicator		EXPD-Climate	GS-Surface
Flood level		EXPD-Climate	GS-Surface
Productivity of Pastures		EXPD-Agriculture	GS-Surface
Surface water quality	Quality of surface water on the land surface	EXPD-Water	GS-Surface
Water stress	Water stress in terms of demands compared to availability	EXPD-Water	GS-Surface
Land use	Index for land use groups	EXPD-LandCover	GS-Surface
Particulate matter PM2.5	Particulate matter in the atmosphere with radius up to 2.5 micrometers	EXPD-AirQuality	GS-Troposphere
Particulate matter PM10	Particulate matter in the atmosphere with radius up to 10 micrometers	EXPD-AirQuality	GS-Troposphere
Nitrogene flux	Flux of Nitrogene into or out of an area	EXPD-Agriculture	GS-Surface
Coastal ecosystems	Aggregation of coastal ecosystems	EXPD-Ecosystems	GS-Surface
Wetlands	Wetland ecosystems	EXPD-Ecosystems	GS-Surface
Ocean acidity	Ph of the ocean water	EXPD-Oceans	GS-Oceans
Fish stock	Fish stocks for commercial and non-commercial fish	EXPD-Oceans	GS-Oceans
Protected area index	Index for the protection status of a location	EXPD-LandCover	GS-Surface
Forest area index	Index indicating type of forest	EXPD-LandCover	GS-Surface
Forest status index	Index indicating the quality and healthiness of forest	EXPD-LandCover	GS-Surface
Mountain Green Cover Index	Index for the land cover of mountainous areas	EXPD-LandCover	GS-Surface
Invasive species index	Index for invasive species	EXPD-Biodiversity	GS-Surface
Biodiversity index	Index for biodiversity	EXPD-Biodiversity	GS-Surface
Ecosystem service index	Index for ecosystem services	EXPD-Ecosystems	GS-Surface
Carbon dioxide emission	Emission of CO2 per area	EXPD-AirQuality	GS-Troposphere
Precipitation	Amount of precipitation over certain time intervals	EXPD-Weather	GS-Troposphere
Air Surface Temperature	Temperature of the air close to the Earth surface	EXPD-Weather	GS-Troposphere

Table 17 continued.

Name	Description	ExpDomain	GeoSystem
Surface Ozone	Atmospheric ozone contents close to the Earth surface	EXPD-Air-Quality	GS-Troposphere
Aerosol	Atmospheric content of aerosols close to the Earth surface	EXPD-Air-Quality	GS-Troposphere
River runoff	Runoff in rivers	EXPD-Hydrology	GS-Terrestrial-Hydrosphere
Land water storage	Storage of water in all land-based reservoirs including groundwater	EXPD-Hydrology	GS-Terrestrial-Hydrosphere

Table 18. Links between SDGs, Targets, Indicators and ESDGVs.

SDG	Target	Indicator	EV
SDG-1	SDG-1 Target 1.4	SDG Indicator 1.4.1	Water Supply Services
SDG-1	SDG-1 Target 1.4	SDG Indicator 1.4.1	Internet Services
SDG-1	SDG-1 Target 1.4	SDG Indicator 1.4.1	Electrical power services
SDG-1	SDG-1 Target 1.4	SDG Indicator 1.4.1	Public Health Services
SDG-1	SDG-1 Target 1.4	SDG Indicator 1.4.1	Transportation Services
SDG-1	SDG-1 Target 1.4	SDG Indicator 1.4.1	Internet Phone Services
SDG-1	SDG-1 Target 1.4	SDG Indicator 1.4.1	Landline Phone Services
SDG-1	SDG-1 Target 1.4	SDG Indicator 1.4.1	Mobile Phone Services
SDG-1	SDG-1 Target 1.4	SDG Indicator 1.4.1	Sewage Services
SDG-1	SDG-1 Target 1.5	SDG Indicator 1.5.1	Population Migration
SDG-2	SDG-2 Target 2.1	SDG Indicator 2.1.2	Drought indicator
SDG-2	SDG-2 Target 2.1	SDG Indicator 2.1.2	Flood level
SDG-2	SDG-2 Target 2.3	SDG Indicator 2.3.1	Productivity of Forests
SDG-2	SDG-2 Target 2.3	SDG Indicator 2.3.1	Productivity of Farms
SDG-2	SDG-2 Target 2.3	SDG Indicator 2.3.1	Productivity of Pastures
SDG-2	SDG-2 Target 2.4	SDG Indicator 2.4.1	Sustainability of agriculture
SDG-2	SDG-2 Target 2.4	SDG Indicator 2.4.1	Irrigation level of agriculture
SDG-2	SDG-2 Target 2.4	SDG Indicator 2.4.1	Fertilizer usage of agriculture
SDG-2	SDG-2 Target 2.5	SDG Indicator 2.5.2	Land cover vegetation
SDG-3	SDG-3 Target 3.3	SDG Indicator 3.3.3	Malaria infection potential
SDG-3	SDG-3 Target 3.3	SDG Indicator 3.3.3	Malaria infections per population
SDG-3	SDG-3 Target 3.3	SDG Indicator 3.3.3	Precipitation
SDG-3	SDG-3 Target 3.3	SDG Indicator 3.3.3	Air Surface Temperature
SDG-3	SDG-3 Target 3.9	SDG Indicator 3.9.1	Carbon dioxide
SDG-3	SDG-3 Target 3.9	SDG Indicator 3.9.1	Methane
SDG-3	SDG-3 Target 3.9	SDG Indicator 3.9.1	Surface water quality
SDG-3	SDG-3 Target 3.9	SDG Indicator 3.9.1	Water stress
SDG-3	SDG-3 Target 3.9	SDG Indicator 3.9.1	Aerosol
SDG-3	SDG-3 Target 3.9	SDG Indicator 3.9.1	Ozone
SDG-4	SDG-4 Target 4.a	SDG Indicator 4.a.1	Water Supply Services
SDG-4	SDG-4 Target 4.a	SDG Indicator 4.a.1	Public Health Services
SDG-4	SDG-4 Target 4.a	SDG Indicator 4.a.1	Sewage Services
SDG-4	SDG-4 Target 4.a	SDG Indicator 4.a.1	Electrical power services
SDG-4	SDG-4 Target 4.a	SDG Indicator 4.a.1	Transportation Services
SDG-4	SDG-4 Target 4.a	SDG Indicator 4.a.1	Mobile Phone Services
SDG-4	SDG-4 Target 4.a	SDG Indicator 4.a.1	Landline Phone Services
SDG-4	SDG-4 Target 4.a	SDG Indicator 4.a.1	Internet Phone Services
SDG-5	SDG-5 Target 5.b	SDG Indicator 5.b.1	Mobile Phone Services
SDG-6	SDG-6 Target 6.1	SDG Indicator 6.1.1	Water Supply Services
SDG-6	SDG-6 Target 6.1	SDG Indicator 6.1.1	Sewage Services
SDG-6	SDG-6 Target 6.3	SDG Indicator 6.3.1	Surface water quality
SDG-6	SDG-6 Target 6.3	SDG Indicator 6.3.2	Surface water quality
SDG-6	SDG-6 Target 6.3	SDG Indicator 6.3.2	Water stress
SDG-6	SDG-6 Target 6.4	SDG Indicator 6.4.1	Water stress
SDG-6	SDG-6 Target 6.4	SDG Indicator 6.4.1	River runoff
SDG-6	SDG-6 Target 6.4	SDG Indicator 6.4.1	Land water storage
SDG-6	SDG-6 Target 6.4	SDG Indicator 6.4.2	Water stress
SDG-6	SDG-6 Target 6.4	SDG Indicator 6.4.2	Wetlands
SDG-6	SDG-6 Target 6.6	SDG Indicator 6.6.1	Ecosystem health
SDG-9	SDG-9 Target 9.4	SDG Indicator 9.4.1	CO2 Emission
SDG-9	SDG-9 Target 9.c	SDG Indicator 9.c.1	Mobile Phone Services

Table 18 continued.

SDG	Target	Indicator	EV
SDG-11	SDG-11 Target 11.3	SDG Indicator 11.3.1	Land use
SDG-11	SDG-11 Target 11.6	SDG Indicator 11.6.2	Particulate matter PM2.5
SDG-11	SDG-11 Target 11.6	SDG Indicator 11.6.2	Particulate matter PM10
SDG-13	SDG-13 Target 13.1	SDG Indicator 13.1.1	Population Migration
SDG-14	SDG-14 Target 14.1	SDG Indicator 14.1.1	Nitrogene flux
SDG-14	SDG-14 Target 14.2	SDG Indicator 14.2.1	Coastal ecosystems
SDG-14	SDG-14 Target 14.3	SDG Indicator 14.3.1	Ocean acidity
SDG-14	SDG-14 Target 14.4	SDG Indicator 14.4.1	Fish stock
SDG-14	SDG-14 Target 14.5	SDG Indicator 14.5.1	Protected area index
SDG-15	SDG-15 Target 15.1	SDG Indicator 15.1.1	Forest area index
SDG-15	SDG-15 Target 15.2	SDG Indicator 15.2.1	Forest status index
SDG-15	SDG-15 Target 15.4	SDG Indicator 15.4.2	Mountain Green Cover Index
SDG-15	SDG-15 Target 15.8	SDG Indicator 15.8.1	Invasive species index
SDG-15	SDG-15 Target 15.9	SDG Indicator 15.9.1	Biodiversity index
SDG-17	SDG-17 Target 17.8	SDG Indicator 17.8.1	Internet Services

C Tables Related to the ConnectinGEO Gap Table

Table 19. Thematic ambassadors engaged in gap analysis.

Theme	Ambassador
Air Pollution	NILU
Atmosphere	BIRA
Marine	CSIC
Carbon Cycle	CMCC
Agriculture	IIASA
Biodiversity	CNR
Renewable Energy	ARMINES
Interoperability	52N
Industry	EARSC
Copernicus	IIASA

Table 20. List of GapTypeCode values.
Column GCC gives the GAIA-CLIM class. Note that the gap types in group 8 are added and not reflected in the GAIA-CLIM code table 3.

Code	Name	GCC	Definition
1.1	Geographical extent	1	Incomplete geographical extent
1.2	Vertical extent	1	Incomplete coverage in vertical extent (applicable for atmosphere, geology, oceanography etc)
1.3	Temporal extent	1	Incomplete coverage in temporal extent
2.1	Spatial resolution	2	Insufficient spatial resolution
2.2	Vertical resolution	2	Insufficient resolution of vertical column
2.3	Temporal resolution	2	Insufficient temporal resolution
3.1	Uncertainty	3	Uncertainties are too large for the application. (Uncertainty budget including calibration, i.e. uncertainties intrinsic to one measurement)
5.1	No catalogue	5	Lack of tools for discovery
5.2	Catalogue saturation	5	Difficulty for discovery due to to many similar products in catalogue
5.3	Can not be viewed	5	Lack of tools for visualization
5.4	No easy access	5	Lack of easy download
5.5	Known format	5	Format difficult to use, not well documented, proprietary format
5.6	Not processable	5	Lack of tools to process the data
5.7	Semantics	5	No clear semantics of the data
6.1	No access	6	Data is not available
6.2	No open access	6	Data policy incl. (free) data access
6.3	No quality	6	Unclear or undocumented QA/QC methodologies
6.4	No provenance	6	Traceability not documented
6.5	Bad metadata	6	Metadata is not complete or wrong
6.5	No metadata	6	Metadata cannot be found
6.6	No model or proxy	6	There is a lack of model to extract the variable from direct measurement or by a proxi
6.7	Long term data preservation	6	No long term data preservation strategy in place
6.8	No future	6	Insecure financing to continue the data acquisition activities.
7.1	Not measured	7	The variable is not measured
7.2	No parameter	7	An aspect of the variable is missing
8.1	Conceptual	n/a	Conceptual gaps, e.g. lack of integration, unmatched goals
8.2	Educational	n/a	Lack of skills and relevant educational programs
8.3	Capacity	n/a	Lack of capacity to carry out a task to generate knowledge.
9.1	Epistemological	n/a	Lack of epistemological basis

Table 21. StatusCode values.

Code	Name	Definition
1	Detected	A possible gap has been detected but can not be prioritised due to a lack of review.
2	Reviewed	There is a review available. The gap needs to be accepted or discarded.
3	Accepted	The gap has been reviewed and accepted as valid. It is ready for looking for remedies and assessing impacts
4	Discarded	The gap was never a gap. The gap has been reviewed and discarded as a mis-detection and will no longer be considered valid.
5	Remedy found	A remedy has been found so feasibility and cost can be determined.
6	Prioritized	The gap has been associated with a numerical priority. A recommendation will be issued.
7	Filled	The gap is no longer a gap because it has been addressed and filled.

Table 22. Themes used in the CGT.

Theme	Short	Description/Comments
Climate	CL	Partly covered in ENEON by a Carbon Cycle ambassador
Oceans	OC	Partly covered in ENEON by a Marine Ambassador
Water	WA	
Water Cycle	WC	
Weather	WE	Partly covered in ENEON by air pollution and atmosphere ambassadors
Biodiversity	BI	Covered in ENEON by a biodiversity ambassador
Disasters	DI	
Energy	EN	
Health	HE	
Agriculture	AG	
Human Settlements	HU,HS	

Table 23. List of EVs identified so far in ConnectinGEO.
This list has been compiled based on D2.3. Status is as of 1 October 2016. The list does not include the EVS derived from the goal-based approach for the SDGs (see Table 17). Note that the code is the one that should be used in the CGT to indicate the EVs in the column "EV". However, many entries in that column are not using

Code	EV Domain	EV Name
1	EBV	Genetic composition (Co-ancestry, Allelic diversity, Population genetic differentiation, Breed and variety div.)
2	EBV	Species populations (Species distribution, Population abundance, Population structure by age/size class)
3	EBV	Species traits (Phenology, Body mass, Natal dispersion distance, Migratory behavior, Demographic traits, Physiological traits)
4	EBV	Community composition (Taxonomic diversity, Species interactions)
5	EBV	Ecosystem function (Net primary productivity, Secondary productivity, Nutrient retention, Disturbance regime)
6	EBV	Ecosystem structure (Habitat structure, Ecosys. extent and fragmentation, Ecosys. composition by functional type)
7	ECV	Air temperature (Atmosphere surface)
8	ECV	Wind speed and direction (Atmosphere surface)
9	ECV	Water vapour (Atmosphere surface)
10	ECV	Pressure(Atmosphere surface)
11	ECV	Precipitation (Atmosphere surface)
12	ECV	Surface radiation budget (Atmosphere surface)
13	ECV	Temperature (Atmosphere upper-air)
14	ECV	Wind speed and direction (Atmosphere upper-air)
15	ECV	Water vapour (Atmosphere upper-air)
16	ECV	Cloud propierties (Atmosphere upper-air)
17	ECV	Earth radiation budget, including solar irradiance (Atmosphere upper-air)
18	ECV	Carbon dioxide (Atmosphere composition)
19	ECV	Methan, and other lon-lived greenhouse gases (Atmosphere composition)
20	ECV	Ozone and aerosol, supported by their precursors (Atmosphere composition)
21	ECV	Sea-surface temperature (Ocean surface)
22	ECV	Sea-surface salinity (Ocean surface)
23	ECV	Sea level (Ocean surface)
24	ECV	Sea state (Ocean surface)
25	ECV	Sea ice (Ocean surface)
26	ECV	Surface current (Ocean surface)
27	ECV	Ocean colour (Ocean surface)
28	ECV	Carbon dioxide partial pressure (Ocean surface)
29	ECV	Ocean acidity (Ocean surface)
30	ECV	Phytoplankton (Ocean surface)
31	ECV	Temperature (Ocean sub-surface)
32	ECV	Salinity (Ocean sub-surface)
33	ECV	Current (Ocean sub-surface)
34	ECV	Nutrients (Ocean sub-surface)
35	ECV	Carbon dioxide partial pressure (Ocean sub-surface)
36	ECV	Ocean acidity (Sub-surface)
37	ECV	Oxigen (Ocean sub-surface)
38	ECV	Tracers (Ocean sub-surface)
39	ECV	River discharge (Land)
40	ECV	Water use (Land)
41	ECV	Groundwater (Land)
42	ECV	Lakes (Land)
43	ECV	Snow cover (Land)
44	ECV	Glaciers and ice caps (Land)

Table 23 continued.

Code	EV Domain	EV Name
45	ECV	Ice sheets (Land)
46	ECV	Permafrost (Land)
47	ECV	Albedo (Land)
48	ECV	Land cover,including vegetation type (Land)
49	ECV	FAPAR (Land)
50	ECV	LAI (Land)
51	ECV	Above-ground biomass (Land)
52	ECV	Soil carbon (Land)
53	ECV	Fire disturbance (Land)
54	ECV	Soil moisture (Land)
55	ECV	Atmospheric pressure
56	ECV	Relative humidity
57	ECV	All Global Numerical Weather Prediction (NWP) variables?(e.g., PBL + Tropopause height) and others yet to be determined by WMO/GAW.
58	ECV	Aerosols (aerosol mass, size distribution (or at least mass at 3 fraction sizes: 1, 2.5 and 10 micron), speciation and chemical composition, Aerosol Optical Depth (AOD) at multiple wavelengths, AAOD, water content, ratio of mass to AOD, vertical distribution of extinction).
59	ECV	Reactive Gases, Trace gases (incl GHG), Ozone Precursors (Total ozone, profile ozone, surface ozone, NO, NO2 (surface, column, profile), PAN, HNO3, NH3, CO, VOC (isoprene, terpenes, alcohols, aldehydes, ketones, alkanes, alkenes, alkynes, aromatics
60	ECV	Others: Actinic flux, fire radiative power, land proxies, lightning, dry and wet deposition, pollen (key species), OCS
61	EOV	Sea Level Pressure (Physical surface)
62	EOV	Surface Wind (Physical surface)
63	EOV	Surface Current (Physical surface)
64	EOV	Sea Ice (Physical surface)
65	EOV	Sea Level (Physical surface)
66	EOV	Sea State (Physical surface)
67	EOV	Sea Surface Salinity (Physical surface)
68	EOV	Sea Surface Temperature (Physical surface)
69	EOV	Upper-Air (Physical surface)
70	EOV	Ocean Color (Physical surface)
71	EOV	Carbon Dioxide Partial Pressure (Physical surface)
72	EOV	Ocean acidity (Physical surface)
73	EOV	Oxigen (Physical surface)
74	EOV	Tracers (Physical surface)
75	EOV	Current (Physical sub-surface)
76	EOV	Salinity (Physical sub-surface)
77	EOV	Temperature (Physical sub-surface)
78	EOV	Carbon Dioxide partial pressure (Physical sub-surface)
79	EOV	Global Ocean Heat Content (Physical sub-surface)
80	EOV	Ocean Acidity (Physical sub-surface)
81	EOV	Oxigen (Physical sub-surface)
82	EOV	Tracers (Physical sub-surface)
83	EOV	Current (Physical sub-surface)
84	EOV	Oxygen (Biogeochemical)
85	EOV	Macro Nutrients: NO3, PO4, Si, NH4, NO2 (Biogeochemical)
86	EOV	Carbonate System: DIC, Total Alkalinity, pCO2 and ph, at least 2 of 4 (Biogeochemical)
87	EOV	Trascient Tracers: CFC-12, CFC-11, SF6, tritium, 3He, 14C, 39Ar (Biogeochemical)
88	EOV	Suspended particulates (POC, PON or POM) and PIC ++ laboratory, beam attenuation, backscatter, acid labile, beam attenuation (Biogeochemical)
89	EOV	Particulate Matter Export: POC export, CaCO3 export, BSi export (Biogeochemical)
90	EOV	Nitrous Oxide (Biogeochemical)
91	EOV	Carbon-13: 13C/12C of dissolved inorganic carbon (Biogeochemical)
92	EOV	DOM: Dissolved organic matter, DOC, DON, DOP (Biogeochemical)

Table 23 continued.

Code	EV Domain	EV Name
93	EOV	Chlorophyll (Biology and Ecosystems)
94	EOV	Coral Cover (Biology and Ecosystems)
95	EOV	Mangrove Area (Biology and Ecosystems)
96	EOV	Harmful Algal Blooms HABs (Biology and Ecosystems)
97	EOV	Zooplankton: biomass/abundance (Biology and Ecosystems)
98	EOV	Salt Marsh Area (Biology and Ecosystems)
99	EOV	Large marine vertebrates: abundance/distribution (Biology and Ecosystems)
100	EOV	Seagrass Area (Biology and Ecosystems)
101	EOV	Tags and Tracking of species of value/large marine vertebrates (Biology and Ecosystems)
102	EOV	Zooplankton,Krill (Biology and Ecosystems)
103	AgV	Crop Area
104	AgV	Crop Type
105	AgV	Crop Condition
106	AgV	Crop Phenology
107	AgV	Crop Yield (current and forecast)
108	AgV	Crop Management and agricultural practices
109	RE-EV	Solar Surface Irradiance and its components (global, direct, diffuse)
110	RE-EV	Surface air temperature
111	RE-EV	Land use, Land cover,including urbanization, hydrology, grid description
112	RE-EV	Elevation, Orography
113	RE-EV	Wind speed and direction
114	RE-EV	Land surface temperature
115	RE-EV	Surface atmospheric pressure
116	RE-EV	Surface humidity
118	RE-EV	Ocean, fixed and floating offshore wind, wave, tidal, currents, OTEC
119	RE-EV	Wave, height, direction, period
121	RE-EV	Tidal (min, max, sea surface elevation)
122	RE-EV	Current, speed, direction
123	RE-EV	Temperature, sea-surface, sub-surface and deep-sea
124	RE-EV	Ocean bathymetry
128	RE-EV	Cloud Cover (demand in energy)
129	RE-EV	Precipitation
130	RE-EV	Urbanization
131	HeV	Famine early warning
132	HeV	Short term forecasting of comunicating diseases
133	WaV	Precipitation
134	WaV	Evaporation and Evapotranspiration
135	WaV	Snow cover
136	WaV	Soil Moisture/Temperature
137	WaV	Groundwater
138	WaV	Runoff/streamflow/river discharge
139	WaV	Lakes/reservoir levels and aquifer volumetric change
140	WaV	Glaciers/ice sheets
141	WaV	Water quality
142	WaV	Water us/demand (agriculture, hydrology, energy, urbanization)
143		All of them
144		None of them
145		Multiple (specified in the gap description)
146	RE-EV	sunshine duration (demand in energy)

Table 24. Codes for the mode of observation.

Code	RS/In-situ	Comment
1	RS	
2	In-Situ	
3	Both	
4	Not determined	

Table 25. Codes for Feasibility.

Code	Feasibility	Comment
9	TBD	
4	Very high	There is a mature technique
3	High	There was already research and maturing the technique is needed
2	Medium	There is an idea to fill the gap that needs research
1	Low	There is not technology forseen to fill the gap
0	Unknown	

Table 26. Codes for Impacts.

Note that in the CGT impact is measured in number of communities impacted by the gap. In the SEE-IN KB, impact is the societal benefit resulting from closing the gap.

Code	Impact	Comment
9	TBD	
4	Very high	Most of the communities or topics will be impacted
3	High	More than one community or topic will be impacted
2	Medium	A community or topic is identified
1	Low	Not able to identify a community of topic
0	Unknown	

Table 27. Codes for Costs.

Note that in the SEE-IN KB, the costs estimates for closing the gaps are given in USD, not EUR.

Code	Cost	Comment
9	TBD	
4	Very high	more than 20 MEUR
3	High	more than 5 MEUR less than 20 MEUR
2	Medium	more that 0.5 MEUR less than 5 MEUR
1	Low	less that 0.5 MEUR
0	Unknown	

Table 28. Codes for Timeframe to implement a solution.

Note that in the SEE-IN KB, the estimates for the time frame to close a gap are given in years.

Code	Timeframe	Comment
9	TBD	
4	Long term	more than 10 years
2	Mid term	less than 5 and more than 2 years
1	Short term	less than 2 years
0	Unknown	

Table 29. Codes for Priority.

Note that in the SEE-IN KB, codes ranging from 0 to 10 are used, with 10 being the highest priority and 0 having no priority at all.

Code	Description	Comment
0	TBD	
1	Crucial	
2	Very high	
3	High	
4	Medium	
5	Low	
6	None	

D ConnectinGEO Gap Table

Table 30. Current Status of Gap Table.

ID	GAPTYPE	STATUS	DESCRIPTION	OBSERVED	PURPOSE	REMEDY
CGTG-1	Geographical extent (1.1)	Detected (1)	The scarce of microclimatic data (air temperature) from the beneath of trees.	TBD (4)	Find out how temperatures are changing beneath the trees	
CGTG-2	Temporal resolution (2.3)	Detected (1)	Daily monitoring of inorganic compounds in precipitation	TBD (4)	Monitoring of inorganic compounds in precipitation (SO4, NO3, NH4, H+ (pH), Na+, K+, Ca2+, Mg2+, Cl-	
CGTG-3	Temporal resolution (2.3)	Detected (1)	Daily/weekly monitoring of heavy metals in precipitation	In-Situ	Monitoring of heavy metals in precipitation As, Cd, Ni, Cd, Pb, Cu, Zn	
CGTG-4	Temporal resolution (2.3)	Detected (1)	Daily monitoring of Inorganic compunds in air	In-Situ	Daily monitoring of inorganic compounds in air. SO2, SO4, NO3, HNO3, NH4,NH3, HCI,NA+, K+, Ca2+, Mg2+	
CGTG-5	Temporal resolution (2.3)	Detected (1)	Daily/hourly monitoring of NO2 in air	In-Situ	Hourly/daily monitoring of NO2	
CGTG-6	Temporal resolution (2.3)	Detected (1)	Monthly monitoring of gas particle ratios of N-species	In-Situ	Monthly monitoring of NH3, NH4, HCI, HNO3, NO3 (in combination with filtre pack sampling)	
CGTG-7	Temporal resolution (2.3)	Detected (1)	Hourly monitoring O3	In-Situ	Hourly monitoring of the ozone contained in the air	
CGTG-8	Temporal resolution (2.3)	Detected (1)	Monthly monitoring of PM mass in air PM 2.5, PM 10	In-Situ	Monthly monitoring	
CGTG-9	Temporal resolution (2.3)	Detected (1)	Not enouhgt temporal monitoring of Precipitation amount in ecosystem obs. sites	TBD (4)	Daily and mounthly monitoring	
CGTG-809	Temporal resolution (2.3)	Detected (1)	Not enouhgt temporal monitoring of Temperature in ecosystem obs. sites	TBD (4)	Daily and mounthly monitoring	
CGTG-810	Temporal resolution (2.3)	Detected (1)	Not enouhgt temporal monitoring of Wind direction (dd), wind speed (ff), in ecosystem obs. sites	TBD (4)	Daily and mounthly monitoring	
CGTG-810	Temporal resolution (2.3)	Detected (1)	Not enouhgt temporal monitoring of Relative humidity in ecosystem obs. sites	TBD (4)	Daily and mounthly monitoring	
CGTG-810	Temporal resolution (2.3)	Detected (1)	Not enouhgt temporal monitoring of Atmospheric pressure in ecosystem obs. sites	TBD (4)	Daily and mounthly monitoring	
CGTG-10	Temporal resolution (2.3)	Detected (1)	Acidification and eutrophication: Observations contributes to the assessment of nitrogen chemistry, influence by local emissions and dry deposition fluxes	In-Situ	Monitoring hourly/daily gas particle ratio (NH3/NH4, HNO3/NO3) and monthly Ammonia in emission areas (NH3)	

Table 30 continued.

ID	GAPTYPE	STATUS	DESCRIPTION	OBSERVED	PURPOSE	REMEDY
CGTG-11	Temporal resolution (2.3)	Detected (1)	Photochemical oxidants: observations contributes to the assessment of oxidant precursors	In-Situ	Monitoring hourly NOx, hourly Light hydrocarbons, 8hourly twice a week Carbonyls, and hourly Methane.	
CGTG-12	Temporal resolution (2.3)	Detected (1)	Heavy metals: observations contributes to the assessment of mercury and heavy metals fluxes	In-Situ	Monitoring weekly mercury in precipitation, daily mercury in the air, weekly heavy metals in air	
CGTG-13	Temporal resolution (2.3)	Detected (1)	Persistent organic pollutants: observations contributes to the assessment of persistent organic pollutants	In-Situ	Monitoring weekly POPs in precipitation and in the air	
CGTG-14	Temporal resolution (2.3)	Detected (1)	Particulate matter: observations contributes to the assessment of particulate matter and its source apportionment	In-Situ	Monitoring daily/weekly: mineral dust in PM10 (Si, Al, Fe, Ca), Elemental and Organic Carbon. Hourly/daily: Aerosol absortion, Aerosol size number distribution (dN/dlogDp), Aerosol scatering. Hourly: Aerosol Optical Depth at 550 nm	
CGTG-15	Temporal resolution (2.3)	Detected (1)	Tracers observations contributes to the assessment of individual long-range transport events and their source apportionment	In-Situ	Monitoring hourly: CO, Halocarbons (CFCs, HCFCsd, HFCs, PFCs, SF6)	
CGTG-16	Temporal resolution (2.3)	Detected (1)	Research based and voluntary -monitoring: Observations contribute to the understanding of processes relevant for long-range transport of air pollutants and support model development and validation	In-Situ	Monitoring hourly: Dry deposition flux, Dry deposition flux of O3, Dry deposition flux of VOCs, Greenhouse gases, Hydrogen. Hourly/Daily: Hydrocarbons, NOy chemistry, Vertical profiles, OC fractionation, Major inorganics in both PM2.5 and PM10. Daily/weekly:Mercury speciation , Congener-specific Organic tracers PM2.5 and PM10.	
CGTG-17	Geographical inconsistency (4.1)	Detected (1)	Develop high-resolution global land-cover and land-cover change data sets, based on international community consensus and including a robust accuracy assessment.	Both (3)	Reduce inconsistencies between land cover products	
CGTG-18	No measured (7.1)	Detected (1)	In mineral resources there is the lack dedicated EO system or program and currently use EO systems and programs from other SBAs.	TBD (4)	Develop global coverage by high-spectral resolution sensors	

Table 30 continued.

ID	GAPTYPE	STATUS	DESCRIPTION	OBSERVED	PURPOSE	REMEDY
CGTG-19	No quality (6.3)	Detected (1)	In order to gain an understanding of the physical processes that are related to water vapor, clouds, aerosols and precipitation, a new observation paradigm needs to be established that focuses on the physical processes rather just on the final quantity.	TBD (4)	Develop an observation strategy to improve the synergistic understanding between water vapor and clouds, and if feasible, aerosols and precipitation.	
CGTG-20	No access (6.1)	Detected (1)	There is not timely and reliable access to in-situ data required in emergency events.	TBD (4)	Promote timely and reliable access to in situ data required in emergency events	
CGTG-21	No parameter (7.2)	Detected (1)	Combine the use of remote sensing and EO to better estimate overfloods	TBD (4)	Develop, test and apply methods to utilize satellite remote sensing and other Earth observations with models and maps to estimate location, intensity and duration of floods globally in real-time and a durable monitoring system of flood risk with climate	
CGTG-22	No easy access (5.4)	Detected (1)	There are many excellent tools, protocols and software in use that facilitate effective biodiversity monitoring but these are not easily discoverable or available to all regions of the planet. As well, current efforts to monitor biodiversity are not interoperable, thereby limiting our ability to detect change and the underlying mechanisms driving change in biodiversity.	TBD (4)	Aims to serve as a tecnology transfer, increase the interoperability and the accesibility of biodiversity data, models and tools	
CGTG-23	Geographical extent (1.1)	Detected (1)	LIDAR global dataset	TBD (4)	Estimate biomass globally and with a good resolution. Carbon sequestration global estimation in forestry	
CGTG-24	Temporal resolution (2.3)	Detected (1)	Absence of a near real-time operational and timely manner a global coverage Sea Surface Height (SSH) for ocean and coastal areas	RS (1)	Develop global coverage Sea Surface Height (SSH) for ocean and coastal areas	
CGTG-25	Temporal resolution (2.3)	Detected (1)	Absence of a near real-time operational and timely manner a enhanced resolution SSH products in coastal zones and sea-ice regions	RS (1)	Enhanced resolution SSH products in coastal zones and sea-ice regions	

Table 30 continued.

ID	GAPTYPE	STATUS	DESCRIPTION	OBSERVED	PURPOSE	REMEDY
CGTG-26	Temporal resolution (2.3)	Detected (1)	Absence of in a near real-time operational and timely manner global coverage Sea Surface Temperature (SST) and sea-Ice Surface Temperature (IST)	RS (1)	Global coverage Sea Surface Temperature (SST) and sea-Ice Surface Temperature (IST)	
CGTG-27	Temporal resolution (2.3)	Detected (1)	Absence of in a near real-time operational and timely manner a global coverage ocean colour and water quality products%RED%MODIS and VIIRS are operating regularly on such bands ??%ENDCOLOR%	RS (1)	Global coverage ocean colour and water quality products	
CGTG-28	Temporal resolution (2.3)	Detected (1)	Absence of in a near real-time operational and timely manner a global coverage ocean surface wind speed measurements%RED%??? There are already real time scatterometers running with global coverage%ENDCOLOR%	RS (1)	Global coverage ocean surface wind speed measurements	
CGTG-29	Temporal resolution (2.3)	Detected (1)	Absence of in a near real-time operational and timely manner a global global coverage significant wave height measurement	RS (1)	Global coverage significant wave height measurement	
CGTG-30	Temporal resolution (2.3)	Detected (1)	Absence of in a near real-time operational and timely manner global coverage atmospheric aerosol consistent over land and ocean	TBD (4)	Global coverage atmospheric aerosol consistent over land and ocean	
CGTG-31	Temporal resolution (2.3)	Detected (1)	Absence of in a near real-time operational and timely manner a global coverage total column water vapour over land and ocean	TBD (4)	Global coverage total column water vapour over land and ocean	
CGTG-32	Temporal resolution (2.3)	Detected (1)	Absence of in a near real-time operational and timely manner a global coverage vegetation products	TBD (4)	Global coverage vegetation products	
CGTG-33	Temporal resolution (2.3)	Detected (1)	Absence of in a near real-time operational and timely manner a global coverage land ice/snow surface temperature product. %RED%Similar to gap 26 ??%ENDCOLOR%	TBD (4)	Global coverage land ice/snow surface temperature products	

Table 30 continued.

ID	GAPTYPE	STATUS	DESCRIPTION	OBSERVED	PURPOSE	REMEDY
CGTG-34	Geographical inconsistency (4.1)	Detected (1)	No back-calibration of data archives for coherent time series compounded by changing methodologies.	TBD (4)	Standardization in EO data and products	
CGTG-35	TBD (?.?)	Detected (1)	No overseeing authority ensuring EO-based biodiversity observations are in line with user needs	TBD (4)	Designating leadership and institutional oversight	
CGTG-36	TBD (?.?)	Detected (1)	Experts in EO data processing not trained in applied biodiversity concepts. EO data products are not fit for purpose.	TBD (4)	Providing more opportunities for interdisciplinary interdisciplinary collaboration	
CGTG-37	No measured (7.1)	Detected (1)	The missing of Genetic composition data	TBD (4)		
CGTG-38	No measured (7.1)	Detected (1)	There is the need to improve the availability of EO data to implement disaster risk reduction and resilience measures, during all disaster risk management phases	TBD (4)	To increase the availability and accuracy of risk related information, both satellite EO information combined with other sources of data (in-situ ground observations, socio-economic, model outputs)	
CGTG-39	Geographical extent (1.1)	Detected (1)	Lack of spatial coverage in Indic Ocean and in the south hemishere	TBD (4)	Contact indic companies if available	
CGTG-40	No quality (6.3)	Detected (1)	While the amount of information on biodiversity has increased greatly in recent years there are still major gaps in understanding which need to be filled, such as those related to taxonomy. Similarly much of the information which is currently available is often incomplete and/or in need of updating	TBD (4)		
CGTG-41	No open access (6.2)	Detected (1)	Information and technologies relating to biodiversity should be made more accessible and shared, subject to national legislation, so that it can be put to better use. Much of the information which is available is not effectively used as it is difficult to access.	TBD (4)	Accessibility could be improved through the further development of the clearing-house mechanism at national and global levels.	

Table 30 continued.

ID	GAPTYPE	STATUS	DESCRIPTION	OBSERVED	PURPOSE	REMEDY
CGTG-42	Uncertainty (3.1)	Detected (1)	Further efforts are also needed, at multiple scales, to improve biodiversity-related knowledge and reduce uncertainties around the relationship between biodiversity change, ecosystem services and impacts on human well-being	TBD (4)		
CGTG-43	Geographical extent (1.1)	Detected (1)	Scarcity of accurate in situ measurements in most of the world. Large networks measuring radiation, such as GAW, BSRN have a limited coverage. National meteo networks are by definition limited and in addition, many of them do not measure radiation, except sunshine duration.	In-Situ (2)	Various. Ranges from establishing a bankable report for investment seeking to validation / calibration of Copernicus products and others	Meta-Network: Opportunities exist to get access to in-situ measurements coming from numerous PV plant operators all over Europe. PV plant operators do hold in-situ measurements for their daily work. An extra effort is needed to identify, convince, access and connect their data. As a result one could create a Meta-Network of private providers using open, standard and interoperable technologies. This Meta-Network would complement existing well known meteo networks (GAW, BSRN).
CGTG-44	No open access (6.2)	Detected (1)	No easy access by SMEs to meteorological measurements because of costs	Both (3)	Various. Ranges from establishing a bankable report for investment seeking to validation / calibration of Copernicus products and others	It is likely a networking activity to demonstrate to governments supporting met-offices that providing easy access at very limited costs to companies will foster the development of renewable energy projects and will support their international commitments in climate and environment
CGTG-45	Geographical extent (1.1)	Detected (1)	Scarcity of accurate in situ measurements in coastal areas for marine renewable energies. Bathymetry, type of floor, tides, swell, currents.	Both (3)	Various. Ranges from establishing a bankable report for investment seeking to validation / calibration of Copernicus products and others	For bathymetry and type of floor, exploit SAR images or images in visible-NIR range together with computer models. For the other variables, see the gaps 64 to 72

Table 30 continued.

ID	GAPTYPE	STATUS	DESCRIPTION	OBSERVED	PURPOSE	REMEDY
CGTG-46	Temporal resolution (2.3)	Detected (1)	Satellite observations about Sea Surface Temperature do not cover the diurnal cycle	RS (1)	Determine and understanding ocean-atmosphere heat and gas exchanges. In situ measurements necessary to cal/val satellite signals and sensor drift.	To improve the combination of in-situ sensors with presently available infrared observations including geostationary and microwaves and model analysis to better describe the daily cycle. Increasing microwaves constellation would also help. Ocean operational models should be improved to include the dynamics associated with the processes involved (e.g. restratification, convective cooling, Langmuir turbulence, etc.).
CGTG-47	Geographical inconsistency (4.1)	Detected (1)	Differences among SST products near the coasts.	RS (1)	Determine and understanding ocean-atmosphere heat and gas exchanges. In situ measurements necessary to cal/val satellite signals and sensor drift.	Comprehensive review of procedures and dedicated intercomparisons/experiments against independent data should contribute to characterize and harmonize differences.
CGTG-48	Temporal inconsistency (4.2)	Detected (1)	Uncertainties in the adjutsments between different instruments along the time	RS (1)	Determine and understanding ocean-atmosphere heat and gas exchanges. In situ measurements necessary to cal/val satellite signals and sensor drift.	Careful adjustments procedures need to be designed in particular because cloud cover is seasonal and regional dependent and temporal continuity with global coverage can only be assured by conbining radiometers of different characteristics. Additionally to keep long time in situ series is a way to reduce uncertainties in the adjustment procedures.
CGTG-49	Geographical extent (1.1)	Detected (1)	Non-uniform distribution of in situ surface measurements. Argo floats tend to be clustered by topographically constraint areas (e.g. Caribbean Sea, South China Sea,etc.), lack at high latitudes and polar areas and in areas of higher variability (e.g. Falkands/Malvinas, gulf Stream, etc.)	In-Situ (2)	Determine and understand ocean-atmosphere heat and gas exchanges. In situ measurements necessary to cal/val satellite signals and sensor drift.	Coordination mechanisms between national agencies and the scientific community and needs could be used to have a better coverage either to be more uniform or based on reducing uncertainties. Specific research programs devoted to deal with undersampled regions or to allocate additional funds for a more intensive deployment could be promoted.

Table 30 continued.

ID	GAPTYPE	STATUS	DESCRIPTION	OBSERVED	PURPOSE	REMEDY
CGTG-50	No measured (7.1)	Detected (1)	Lack of in situ surface measurements from Argo buoys in marginal seas and shelf seas (i.e Baltic Sea, North Sea, Barents Sea etc.) ad polar areas	In-Situ (2)	Determine and understand ocean-atmosphere heat and gas exchanges. In situ measurements necessary to cal/val satellite signals and sensor drift.	Some technical solutions endowing Argo floats with inertial navigation systems via accelerometers may help to self-adjust the sampling to bathymetric changes provided bathymetric charts are also included . Adopting measures of hardware protection of antenna and instruments or alternatively using sensing ice algorithms and procedures would also be necessary in polar areas to avoid equipment dammages. For shelf seas complementary meaures can be adopted by extending actual coastal buoys networks or by collaboration with owners of offshore platforms (e.g. oil and gas rigs, aquaculture installation, etc.) to supply environmental data.
CGTG-51	Vertical resolution (2.2)	Detected (1)	Insufficient in situ surface measurements from Argo buoys. The number of measurements close to the surface (0 - 5 m) is around 20% of total profiles	In-Situ (2)	Determine and understand ocean-atmosphere heat and gas exchanges. In situ measurements necessary to cal/val satellite signals and sensor drift.	
CGTG-52	Temporal extent (1.2)	Detected (1)	Insufficient temporal coverage. Argo deployment started in 2000 and became fully operative in 2005 so less than the WMO 30 years definition of clima. Drop of the number of Argo float deployments benneath 3200 in 2018.	In-Situ (2)	Determine and understand ocean-atmosphere heat and gas exchanges. In situ measurements necessary to cal/val satellite signals and sensor drift.	Increase the investment on Argo floats at least to ensure the 30 years period according to the WMO definition of clima.
CGTG-53	TBD (?.?)	Detected (1)	This row should be dropped	In-Situ (2)	Determine and understand ocean-atmosphere heat and gas exchanges. In situ measurements necessary to cal/val satellite signals and sensor drift.	

Table 30 continued.

ID	GAPTYPE	STATUS	DESCRIPTION	OBSERVED	PURPOSE	REMEDY
CGTG-57	Temporal extent (1.3)	Detected (1)	Time series are short because SSS missions and relatively new. SMOS was a proof of concept (2010-present), Aquarius operated in 2011-2015 and SMAP was conceived for soil moisture and now is being exploited for ocean SSS (2015-present).	RS (1)	SSS is directly essential for climate, monitoring the water cycle changes and to evaluate Evaporation-Precipitation (E-P) fluxes over the ocean from basin to global scales. It is relevant to determine the sea surface density, freshwater transport and coastal ocean dynamics (river discharges). Further, in situ SSS measurements are essential for cal/val satellite signals and sensor drift of new missions.	To promote coordination among spatial agencies to ensure the continuity of present L-band missions (SMOS-Aquarius-SMAP). The Aquarius mission has prematurely ended, SMOS is still running beyond the nominal mission life-time and SMAP was launched in 2015.
CGTG-58	Geographical extent (1.1)	Detected (1)	Insufficient spatial coverage. SSS retrieval in marginal seas and cold waters is difficult to obtain due to RFI (Radio-Frequency interference) contamination. SSS is problematic for the land-sea transition. Retrieved signals are good up to several km near the continental coasts (50 km SMAP and 800 km, SMOS).	RS (1)	SSS is directly an essential for climate, monitoring the water cycle changes and to evaluate Evaporation-Precipitation (E-P) fluxes over the ocean from basin to global scales. It is relevant to determine the sea surface density, freshwater transport and coastal ocean dynamics (river discharges). Further, in situ SSS measurements are essential for cal/val satellite signals and sensor drift of new missions.	Three measures would help to improve the retrieval of SSS: a) To promote stronger commitments among countries to improve the applicability of present regulations related with the radiofrequency use in the bands of interest . b) To foster a new generation of instruments to reduce the limitations associated to land-sea transition areas and to promote a continuous series of missions in L-band similarly as the infrared and higher frequency microwaves missions (C-band and above), c) there is room to improve L2 products at the processing level, d)In line with the production of SST analysis to promote a roadmap of L4 products merging satellite and in situ measurements to increase the geographical extent of present products.

Table 30 continued.

ID	GAPTYPE	STATUS	DESCRIPTION	OBSERVED	PURPOSE	REMEDY
CGTG-59	Geographical inconsistency (4.1)	Detected (1)	Products differ due to differences of onboard instrument configurations (e.g. real aperture radiometers versus synthetic aperture radiometers). Also different processing strategies produce different high levels products (L3, L4). Biases and non-linear effects at the level of brightness temperature measurements exist between SSS derived from Aquarius and SMOS missions. A similar gap appears in terms of Temporal Inconsistency.	RS (1)	SSS is directly essential for climate, monitoring the water cycle changes and to evaluate Evaporation-Precipitation (E-P) fluxes over the ocean from basin to global scales. It is relevant to determine the sea surface density, freshwater transport and coastal ocean dynamics (river discharges). Further, in situ SSS measurements are essential for cal/val satellite signals and sensor drift of new missions.	To improve intercalibration algorithms.
CGTG-60	Uncertainty (3.1)	Detected (1)	In marginal and shelf seas and cold regions, inadequate accuracy with respect to the mission target requirements (cold waters, north Atlantic, north and western Pacific, Antartic Circumpolar). This is the result of both instrument properties and RFI contamination translating uncertainties and reducing the accuracy in such affected areas.	RS (1)	SSS is directly essential for climate, monitoring the water cycle changes and to evaluate Evaporation-Precipitation (E-P) fluxes over the ocean from basin to global scales. It is relevant to determine the sea surface density, freshwater transport and coastal ocean dynamics (river discharges). Further, in situ SSS measurements are essential for cal/val satellite signals and sensor drift of new missions.	To promote stronger commitments among countries to improve the applicability of present regulations related with the radiofrequency use in the bands of interest. To explore feasibility of new generation of instruments on other bands (e.g. P-band).

Table 30 continued.

ID	GAPTYPE	STATUS	DESCRIPTION	OBSERVED	PURPOSE	REMEDY
CGTG-61	No measured (7.1)	Detected (1)	Insufficient spatial coverage by design. Argo does not measure salinity close to the surface (¡ 5 m) to avoid biofouling. Around 1% of data within 1 m.	In-Situ (2)	SSS is directly essential for climate, monitoring the water cycle changes and to evaluate Evaporation-Precipitation (E-P) fluxes over the ocean from basin to global scales. It is relevant to determine the sea surface density, freshwater transport and coastal ocean dynamics (river discharges). Further, in situ SSS measurements are essential for cal/val satellite signals and sensor drift of new missions.	This is a technical gap with no satisfactory solution. There is a variety of acoustic, chemical, mechanical and energy methods (laser and ultraviolet irradiance) that partially could help but increase the energy consumption. Research should be needed to investigate different solutions while minimising the energy requirements.
CGTG-62	No measured (7.1)	Detected (1)	Insufficient spatial coverage related to marginal, shelf areas and shelf seas similar as for the SST	In-Situ (2)	In situ SSS measurement essential for cal/val satellite signals and sensor drift. SSS is essential for climate and water cycle changes derived from Evaporation-Precipitation (E-P) fluxes over the ocean from basin to global scales. It is relevant to determine the surface density, freshwater transport and coastal ocean dynamics (river discharges).	
CGTG-63	Temporal extent (1.3)	Detected (1)	Insuficient temporal coverage. Time series are short because SSS missions and relatively new. SMOS was a proof of concept (2010-present). Aquarius ceased in (2011-2015). SMAP was conceived for soil moisture and now is being exploited for ocean SSS (2015-present)	RS (1)	In situ SSS measurement essential for cal/val satellite signals and sensor drift .SSS is essential for climate and water cycle changes derived from Evaporation-Precipitation (E-P) fluxes over the ocean from basin to global scales. It is relevant to determine the surface density, freshwater transport and coastal ocean dynamics (river discharges).	
CGTG-64	Temporal resolution (2.3)	Detected (1)	Poor temporal coverage from altimeters for the involved scales.	RS (1)	Improve and validate sea state forecasts. Essential for marine security and marine trade.	
CGTG-65	Spatial resolution (2.1)	Detected (1)	Lack of enough horizontal resolution (100 km) from SAR spectral and wave energy capabilities	RS (1)	Improve and validate sea state forecasts. Essential for marine security and marine trade for regional applications.	

Table 30 continued.

ID	GAPTYPE	STATUS	DESCRIPTION	OBSERVED	PURPOSE	REMEDY
CGTG-66	Temporal resolution (2.3)	Detected (1)	Lack of enough temporal (6 h) from SAR spectra and wave energy capabilities	RS (1)	Improve and validate sea state forecasts for regional applications. Essential for marine security and marine trade.	
CGTG-67	No measured (7.1)	Detected (1)	No data on spectra and nor directional information from altimeters. Several parameters not measured by present meteo-ocean buoys (wave breaking, whitcapping, rogue waves, Stokes drift)	Both (3)	Improve and validate sea state forecasts. Essential for marine security and marine trade.	
CGTG-68	Geographical extent (1.1)	Detected (1)	Poor offshore coverage	In-Situ (2)	Improve and validate sea state forecasts. Essential for marine security and marine trade.	
CGTG-69	TBD (?.?)	Detected (1)	Capacity building ?. Not much meteo-ocean buoys with directional spectra capabilities	In-Situ (2)	Improve and validate sea state forecasts. Essential for marine security and marine trade.	
CGTG-70	Geographical inconsistency (4.1)	Detected (1)	Capacity building ?. Lack of standardization in data reports with biases between networks of buoys.	In-Situ (2)	Improve and validate sea state forecasts. Essential for marine security and marine trade.	
CGTG-71	Spatial resolution (2.1)	Detected (1)	Lack of enough resolution. Currents derived from SSH lacks of enough resolution to address ocean submesoscale processes.	RS (1)	Surface mesoscale features are adequately resolved with several altimeters working simulatenously. High resolution velocity fields are needed to resolve submesoscale variability with large impact on seaborne commerce, fishing, strom surge, marine ecossytems,..	
CGTG-72	Geographical extent (1.1)	Detected (1)	Insufficient spatial coverage of sea surface measurements. In coastal regions VHF radar measurements mainly cover USA coasts and few locations in Europe. In open ocean where coverage is mainly done with drifters (SVP program) fixed morings and ADCP onboard R/V the highest rate are approximately 1 data per 5 box from drifters.	Both (3)	To cover the range of space and time variability of coastal currents. Proved impact on forecasting products via data assimilation techniques at least for regional applications	

Table 30 continued.

ID	GAPTYPE	STATUS	DESCRIPTION	OBSERVED	PURPOSE	REMEDY
CGTG-73	Temporal extent (1.3)	Detected (1)	Recovery of times series of surface currents is affected by lack of at least 4 altimeters working simultaneously in several periods needed to accurately assess ocean mesoscale variability.	RS (1)	Resolving adequately the variability of sea surface mesoscale currents is fundamental to infer non-local mass, energy and momentum at planetary scales	
CGTG-74	Geographical extent (1.1)	Detected (1)	Lack of an international organism coordinating ocean surface currents.	Both (3)	To coordinate measurements and information from many heterogeneous ways and technologies to obtain sea surface currents.	
CGTG-75	Temporal extent (1.3)	Detected (1)	Insufficient data to cover the extent of variability that organisms observe.	In-Situ (2)	Understanding global acidification conditions and improving the understanding of the ecosystem impacts and response to ocean acidification for warn-water coral reefs.	
CGTG-76	Vertical extent (1.2)	Detected (1)	Insufficient spatial coverage in Artic, Southern Oceans, ”coral triangle” (south-east Asia) and off Peru.	In-Situ (2)	Understanding global acidification conditions and improving the understanding of the ecosystem impacts and response to ocean acidification for warn-water coral reefs.	
CGTG-77	No parameter (7.2)	Detected (1)	Integration of physical, chemical and biological sensing.	In-Situ (2)	Need of colocation of environmental data to solve the Ecosystem function characterized by primary and secondary production, orsganism interaction, nutrient cycling an material exchange.	
CGTG-78	No measured (7.1)	Detected (1)	Identification of hot spots in the sense of threatened ecosystems	In-Situ (2)	Understanding global acidification conditions and improving the understanding of the ecosystem impacts and response to ocean acidification for warn-water coral reefs.	
CGTG-79	No catalogue (5.1)	Detected (1)	Lack of development and sharing of in situ databases and derived products of sufficient quality to use in cal/val satellite products.	In-Situ (2)	Relevant to determine the marine albedo and assess the ocean ecosystem health and productivity and the role of the oceans in the global carbon cycle. Important to manage living marine resources and to quantify the impacts of climate variability and change.	

Table 30 continued.

ID	GAPTYPE	STATUS	DESCRIPTION	OBSERVED	PURPOSE	REMEDY
CGTG-80	Geographical inconsistency (4.1)	Detected (1)	Limited linkage between ocean colour and ecosystem variables	RS (1)	Relevant to determine the marine albedo and assess the ocean ecosystem health and productivity and the role of the oceans in the global carbon cycle. Important to manage living marine resources and to quantify the impacts of climate variability and change.	
CGTG-81	TBD (?.?)	Detected (1)	Risk of continuity of climate-research quality ocean colour radiance observations.	RS (1)	Relevant to determine the marine albedo and assess the ocean ecosystem health and productivity and the role of the oceans in the global carbon cycle. Important to manage living marine resources and to quantify the impacts of climate variability and change	
CGTG-82	TBD (?.?)	Detected (1)	Difficulty in sustaining projects for cross-calibrating and merging OCR data across satellite sensors to support global and regional products	RS (1)	Relevant to determine the marine albedo and assess the ocean ecosystem health and productivity and the role of the oceans in the global carbon cycle. Important to manage living marine resources and to quantify the impacts of climate variability and change	
CGTG-83	No processable (5.6)	Detected (1)	Need of continued R+T development (data streams, algorithms, products) for waters of type II where optical properties are not dominated by phytoplankton.	RS (1)	Relevant to determine the marine albedo and assess the ocean ecosystem health and productivity and the role of the oceans in the global carbon cycle. Important to manage living marine resources and to quantify the impacts of climate variability and change	

Table 30 continued.

ID	GAPTYPE	STATUS	DESCRIPTION	OBSERVED	PURPOSE	REMEDY
CGTG-84	Vertical extent (1.2)	Detected (1)	Insufficient vertical coverage of measurements down 2000 m (more of the 50% of the ocean volume is whithin the layer deeper than 2000 m). XBT regular sections are concentrated around the first 750 m and in general below 700 m data are too sparse.	In-Situ (2)	To characterize deep water masses, to monitor the ocen heat content and to determine the general structure of the ocean circulation and the conveyor belt. Necessary to determine the water cycle, heat and mass gesotrophic transports and the steric component of the sea level change, and indirectly to understand changes in the marine biology and biogeochemistry. Essential for data assimilation into ocean circulation models.	To deploy a fraction of Argo profilers with the ability to increase the vertical extent downwards.
CGTG-85	Geographical inconsistency (4.1)	Detected (1)	Sub-surface temperatures estimates from available products have variations at different times and for differents periods.	In-Situ (2)	To characterize deep water masses, to monitor the ocen heat content and to determine the general structure of the ocean circulation. Necessary to determine the geostrophic circulation, heat transport and steric sea level and indirectly to understand changes in the marine biology and biogeochemistry.	
CGTG-86	Bad metadata (6.5)	Detected (1)	XBT metadata not always available.	In-Situ (2)	To characterize deep water masses, to monitor the ocen heat content and to determine the general structure of the ocean circulation. Necessary to determine the geostrophic circulation, heat transport and steric sea level and indirectly to understand changes in the marine biology and biogeochemistry.	
CGTG-87	Geographical extent (1.1)	Detected (1)	Non-uniform distribution of in situ measurements. Argo profilers by design provide data up to 2000 m leaving inaccessible topographically constraint areas (Caribbean Sea, South China Sea,etc.) and for high latitudes if dedicated deployments are not scheduled.	In-Situ (2)	To characterize water masses, to monitor the ocen heat content and to determine the general structure of the ocean circulation. Necessary to determine the geostrophic circulation, heat transport and steric sea level and indirectly to understand changes in the marine biology and biogeochemistry.	

Table 30 continued.

ID	GAPTYPE	STATUS	DESCRIPTION	OBSERVED	PURPOSE	REMEDY
CGTG-88	Geographical extent (1.1)	Detected (1)	Lack of enough in situ surface and subsurface measurements in shelf seas, marginal seas (e.g. Baltic Sea, North Sea, Barents Sea, Mediterranean Sea, etc.)	In-Situ (2)	To characterize water masses, to monitor the ocen heat content and to determine the general structure of the ocean circulation. Necessary to determine the geostrophic circulation, heat transport and steric sea level and indirectly to understand changes in the marine biology and biogeochemistry.	To reinforce coordination mechanisms among national agencies, the scientific community to agree on plans to have a better and uniform coverage based on reducing uncertainties. To promote systematic detailed studies on the number of Argo floats needed to optimize Argo deployment in such regions. Specific research programs devoted to deal with undersampled regions or to allocate additional funds for a more intensive deployment could be promoted. To promote collaboration with already existing offshore installations in shelf areas, usually associated to energy production and aquaculture, to deploy fixed instruments and increase the infromation coverage.
CGTG-89	Temporal extent (1.3)	Detected (1)	Insufficient temporal coverage. Argo deployment started in 2000 and became fully operative in 2005-2006, so less than the WMO 30 years definition of clima. Note however that regular sections sections and measurements (bathythermographs, CTD and XBT sections) are available since 1980s and before.	In-Situ (2)	To characterize water masses, to monitor the ocen heat content and to determine the general structure of the ocean circulation. Necessary to determine the geostrophic circulation, heat transport and steric sea level and indirectly to understand changes in the marine biology and biogeochemistry.	To maintain, or even increase, the investment on Argo floats at least to ensure the 30 years period according to the WMO definition of clima.
CGTG-90	Temporal resolution (2.3)	Detected (1)	Lack of high temporal resolution of in situ observations to cover diurnal cycle.	In-Situ (2)	To characterize deep water masses, to monitor the ocen heat content and to determine the general structure of the ocean circulation. Necessary to determine the geostrophic circulation, heat transport and steric sea level and indirectly to understand changes in the marine biology and biogeochemistry.	
CGTG-91	TBD (?.?)	Detected (1)	Drop of the number of Argo float deployments benneath 3200 in 2018.	In-Situ (2)		

Table 30 continued.

ID	GAPTYPE	STATUS	DESCRIPTION	OBSERVED	PURPOSE	REMEDY
CGTG-92	Geographical extent (1.1)	Detected (1)	Lack of sufficient spatial coverage for many climatic applications, specially in the Southern hemisphere.	In-Situ (2)	Currents are essential to determine the transport of mass, energy and many other properties (nutrients, O2, sediments, etc.) from basin to global scales. They are necessary to determine absolute velocity fields complementing the geostrophic field from temperature and salinity measurements. Direct measurements of lateral and bottom boundary currents ara important to resolve Ekman transport of properties to constraint large-scale and basin ocean currents, from small to climate scales. Important for model validation.	To extent spatially the number of mooring sites with currentmeters at least for key areas relative a and to promote a sincrease the present ssystems efforts to at least maintin the present mooring
CGTG-93	Temporal extent (1.3)	Detected (1)	Lack of sufficient temporal coverage and extent for many climatic applications, in particular to monitor the meridional overturning circulation.	In-Situ (2)	Currents are essential to determine the transport of mass, energy and many other properties (nutrients, O2, sediments, etc.) from basin to global scales. They are necessary to determine absolute velocity fields complementing the geostrophic field from temperature and salinity measurements. Direct measurements of lateral and bottom boundary currents ara important to resolve Ekman transport of properties to constraint large-scale and basin ocean currents, from small to climate scales. Important for model validation.	

Table 30 continued.

ID	GAPTYPE	STATUS	DESCRIPTION	OBSERVED	PURPOSE	REMEDY
CGTG-94	No measured (7.1)	Detected (1)	Present observing system is inadequate to directly measure the vertical component of currents.	In-Situ (2)	Currents are essential to determine the transport of mass, energy and many other properties (nutrients, O2, sediments, etc.) from basin to global scales. They are necessary to determine absolute velocity fields complementing the geostrophic field from temperature and salinity measurements. Direct measurements of lateral and bottom boundary currents ara important to resolve Ekman transport of properties to constraint large-scale and basin ocean currents, from small to climate scales. Important for model validation.	
CGTG-95	No coordination of obs. sites (8.2)	Detected (1)	Lack of an international organism coordinating such kind of measurements at global scale.	In-Situ (2)	Currents are essential to determine the transport of mass, energy and many other properties (nutrients, O2, sediments, etc.) from basin to global scales. They are necessary to determine absolute velocity fields complementing the geostrophic field from temperature and salinity measurements. Direct measurements of lateral and bottom boundary currents ara important to resolve Ekman transport of properties to constraint large-scale and basin ocean currents, from small to climate scales. Important for model validation.	To promote international cooperation to stablish a coordination organism specific for ocean current measurements.
CGTG-96	Vertical extent (1.2)	Detected (1)	Insufficient vertical coverage of measurements down 2000 m (more of the 50% of the ocean volume is whithin the layer deeper than 2000 m). Historical classical Winkler method was based on discrete samples from ship cruises so measurements have long history but have limitations.	In-Situ (2)	Determine the evolution of O2 necessary to sustain the life in the ocean. To assess the risk of ocean deoxygenation and the impact on marine ecosystems eventually as a response to global warming but also to eutrophication. To identify ocean water masses related with ocean circulation patterns.	

Table 30 continued.

ID	GAPTYPE	STATUS	DESCRIPTION	OBSERVED	PURPOSE	REMEDY
CGTG-97	Geographical extent (1.1)	Detected (1)	Non-uniform distribution of in situ surface measurements. Argo profilers by design provide data up to 2000 m leaving inaccessible topographically constraint areas (Caribbean Sea, South China Sea,etc.) and for high latitudes if dedicated deployments are not scheduled.	In-Situ (2)	Determine the evolution of O2 necessary to sustain the life in the ocean. To assess the risk of ocean deoxygenation and the impact on marine ecosystems eventually as a response to global warming but also to eutrophication. To identify ocean water masses related with ocean circulation patterns.	
CGTG-98	No measured (7.1)	Detected (1)	Lack of in situ measurements from Argo buoys in shelf seas (i.e Baltic Sea, North Sea, Barents Sea etc.) and marginal seas	In-Situ (2)	Determine the evolution of O2 necessary to sustain the life in the ocean. To assess the risk of ocean deoxygenation and the impact on marine ecosystems eventually as a response to global warming but also to eutrophication. To identify ocean water masses related with ocean circulation patterns.	
CGTG-99	Temporal extent (1.3)	Detected (1)	Insufficient temporal coverage. Argo deployment started in 2000 and became fully operative in 2005 so half the WMO temporal definition of clima (30 years). Salinity observations is the third most-oft-observed water quality parameter after temperature and salinity.	In-Situ (2)	Determine the evolution of O2 necessary to sustain the life in the ocean. To assess the risk of ocean deoxygenation and the impact on marine ecosystems eventually as a response to global warming but also to eutrophication. To identify ocean water masses related with ocean circulation patterns.	

Table 30 continued.

ID	GAPTYPE	STATUS	DESCRIPTION	OBSERVED	PURPOSE	REMEDY
CGTG-100	Geographical extent (1.1)	Detected (1)	Spatial coverage. Insufficient number of stations.	In-Situ (2)	Impact on coastal and islands communities and settlements. Essential for coastal infrastructure dessign, protection and maintenance (risk assessment) and for marine security (storm surges, tsunamis, etc). Sea Level is presently a key variable in data assimilation systems into ocean models.	
CGTG-101	No metadata (6.6)	Detected (1)	Lack of metadata in the position of gauges affect uncertainties.	In-Situ (2)	Impact on coastal and islands communities and settlements. Essential for coastal infrastructure dessign, protection and maintenance (risk assessment) and for marine security (storm surges, tsunamis, etc). Sea Level is presently a key variable in data assimilation systems into ocean models.	
CGTG-102	Geographical inconsistency (4.1)	Detected (1)	Reconcile altimetry measurements (SSH) and in situ sea level gauges for intercalibration purposes and reconstruct long tme series of sea level.	Both (3)	Sea level signal helps to identify, detect, surface mesoscale features adequately resolved with several altimeters working simulatenously. High resolution velocity fields are needed to resolve submesoscale motions for many applications related with marine trade and security.	
CGTG-103	No parameter (7.2)	Detected (1)	Not always guarantee the operation of enough simulatenous of altimeters (capacity ?)	RS (1)	Sea level signal helps to identify, detect, surface mesoscale features adequately resolved with several altimeters working simulatenously. High resolution velocity fields are needed to resolve submesoscale motions for many applications related with marine trade and security.	
CGTG-104	Unknown semantics (5.7)	Detected (1)	Missing agreement on levels of data and associated names across domains	TBD (4)		
CGTG-105	Uncertainty (3.1)	Detected (1)	Unknown suitability of measurement maturity assessment	TBD (4)		

Table 30 continued.

ID	GAPTYPE	STATUS	DESCRIPTION	OBSERVED	PURPOSE	REMEDY
CGTG-106	Uncertainty (3.1)	Detected (1)	Missing evaluation criteria for assessing existing observing capabilities	TBD (4)		
CGTG-107	No quality (6.3)	Detected (1)	Lack of a comprehensive review of current sub-orbital observing capabilities for all the study of ECVs in atmospheric, ocean and land domains	TBD (4)		
CGTG-108	No catalogue (5.1)	Detected (1)	Lack of unified tools showing all the existing observing capabilities for measuring ECVs with respect to satellite spatial coverage	TBD (4)		
CGTG-109	Bad metadata (6.5)	Detected (1)	Lack of a common effort in metadata harmonization	TBD (4)		
CGTG-110	No quality (6.3)	Detected (1)	Need for a scientific approach for the assessment of gaps in the existing networks measuring ECVs	TBD (4)		
CGTG-111	Temporal extent (1.3)	Detected (1)	Evaluation of the effect of missing data or missing in temporal coverage of full traceability data provided by ground-based networks	TBD (4)		
CGTG-112	Vertical extent (1.2)	Detected (1)	CO limited availability of quantitative profiles; Insufficient verification of vertical information in satellite products	TBD (4)		
CGTG-113	Uncertainty (3.1)	Detected (1)	Insufficiently traceable uncertainty estimates	TBD (4)		
CGTG-114	Uncertainty (3.1)	Detected (1)	Traceable uncertainty estimates from baseline and comprehensive networks	TBD (4)		
CGTG-115	Uncertainty (3.1)	Detected (1)	Propagate uncertainty from well-characterized locations and parameters to other locations and parameters.	TBD (4)		
CGTG-116	Catalogue saturation (5.2)	Detected (1)	Water vapor measurements with the lidar and microwave radiometer are often provided in a sparse way and under an uncoordinated effort	TBD (4)		
CGTG-117	Geographical extent (1.1)	Detected (1)	There is currently limited aircraft data, for example in Eastern Europe.	TBD (4)		
CGTG-118	Catalogue saturation (5.2)	Detected (1)	Northern Hemisphere bias in NDACC and PANDORA network sites distribution	TBD (4)		

Table 30 continued.

ID	GAPTYPE	STATUS	DESCRIPTION	OBSERVED	PURPOSE	REMEDY
CGTG-119	Temporal extent (1.3)	Detected (1)	24/7 operation of lidar systems	TBD (4)		
CGTG-120	Vertical resolution (2.2)	Detected (1)	Lidar incomplete altitude coverage	TBD (4)		
CGTG-121	Temporal extent (1.3)	Detected (1)	Incomplete collocation of sun and moon photometers with day and night time aerosol lidars	TBD (4)		
CGTG-122	Temporal extent (1.3)	Detected (1)	Missing continued intercomparison with reference systems	TBD (4)		
CGTG-123	Uncertainty (3.1)	Detected (1)	Lack of rigorous aerosol lidar error budget availability	TBD (4)		
CGTG-124	Uncertainty (3.1)	Detected (1)	Need of Raman lidars or better multi-wavelength systems	TBD (4)		
CGTG-125	Uncertainty (3.1)	Detected (1)	Need for assimilation experiments of lidar measurements	TBD (4)		
CGTG-126	Uncertainty (3.1)	Detected (1)	Reducing calibration uncertainties using a common reference standard	TBD (4)		
CGTG-127	Temporal resolution (2.3)	Detected (1)	Continuous operation of water vapor Raman lidars limited during daytime	TBD (4)		
CGTG-128	Vertical resolution (2.2)	Detected (1)	Tropospheric O3 profile data is limited	TBD (4)		
CGTG-129	Uncertainty (3.1)	Detected (1)	Lack of rigorous tropospheric O3 lidar error budget availability	TBD (4)		
CGTG-130	Uncertainty (3.1)	Detected (1)	Lack of rigorous temperature lidar error budget availability	TBD (4)		
CGTG-131	Uncertainty (3.1)	Detected (1)	MWR Missing standards maintained by National/International Measurement Institutes	TBD (4)		
CGTG-132	Uncertainty (3.1)	Detected (1)	Uncertainty of the MW absorption spectrum used in MWR retrievals	TBD (4)		
CGTG-133	No quality (6.3)	Detected (1)	Automated MWR data quality control	TBD (4)		
CGTG-134	No quality (6.3)	Detected (1)	Calibration best practices and instrument error characterization	TBD (4)		
CGTG-135	Temporal extent (1.3)	Detected (1)	Homogenization of retrieval method	TBD (4)		
CGTG-136	Temporal extent (1.3)	Detected (1)	Agreement on systematic vs. random part of the uncertainty and how to evaluate each part (H20, O3, CH4)	TBD (4)		

Table 30 continued.

ID	GAPTYPE	STATUS	DESCRIPTION	OBSERVED	PURPOSE	REMEDY
CGTG-137	Temporal extent (1.3)	Detected (1)	Line of sight and vertical averaging kernel are only approximations of the real 3D averaging kernel of a retrieval (H20, O3, CH4)	TBD (4)		
CGTG-138	Temporal extent (1.3)	Detected (1)	Spectroscopic uncertainties (H20, O3, CH4)	TBD (4)		
CGTG-139	Temporal extent (1.3)	Detected (1)	Current spectroscopic databases contain uncertainties (CO2, CH4)	TBD (4)		
CGTG-140	Temporal extent (1.3)	Detected (1)	Cell measurements carried out to characterize ILS have their own uncertainties (H20, O3, CH4)	TBD (4)		
CGTG-141	Temporal extent (1.3)	Detected (1)	possible SZA dependence in the retrieval during polar vortex overpasse (CH4)	TBD (4)		
CGTG-142	Temporal extent (1.3)	Detected (1)	In-situ calibration can be verified by involving new data (CO2, CH4)	TBD (4)		
CGTG-143	Temporal extent (1.3)	Detected (1)	TCCON calibration w.r.t. standards (H20, CO2, CH4; column)	TBD (4)		
CGTG-144	Temporal extent (1.3)	Detected (1)	Uncertainty of the O3 cross section used in the spectral fit	TBD (4)		
CGTG-145	Temporal extent (1.3)	Detected (1)	Random uncertainty of the O3 section in spectral fit and AMF calculations	TBD (4)		
CGTG-146	Temporal extent (1.3)	Detected (1)	Uncertainty in a priori profile of O3 shape for AMF calculation	TBD (4)		
CGTG-147	Temporal extent (1.3)	Detected (1)	Uncertainty in vertical averaging kernels for O3	TBD (4)		
CGTG-148	Temporal extent (1.3)	Detected (1)	Uncertainty in PANDORA measurements for O3 columns	TBD (4)		
CGTG-149	Temporal extent (1.3)	Detected (1)	Information content of MAX-DOAS tropospheric O3 (tropospheric column) measurements	TBD (4)		
CGTG-150	Temporal extent (1.3)	Detected (1)	MAX-DOAS tropospheric O3 (tropospheric column) retrieval method	TBD (4)		
CGTG-151	Temporal extent (1.3)	Detected (1)	Random and systematic uncertainties of MAX-DOAS tropospheric O3 column measurements	TBD (4)		
CGTG-152	Temporal extent (1.3)	Detected (1)	Uncertainties of ZTD, given by a 3rd party (IGS) (H20 column)	TBD (4)		

Table 30 continued.

ID	GAPTYPE	STATUS	DESCRIPTION	OBSERVED	PURPOSE	REMEDY
CGTG-153	Uncertainty (3.1)	Detected (1)	Incomplete knowledge of spatiotemporal atmospheric variability at the scale of the intercomparisons (H2O, O3, T, CO2, CH4, aerosols)	TBD (4)		
CGTG-154	Uncertainty (3.1)	Detected (1)	Limited quantification of the impact of co-location criteria. (H2O, O3, T, CO2, CH4, aerosols)	TBD (4)		
CGTG-155	Uncertainty (3.1)	Detected (1)	Missing generic and specific standards for co-location criteria in validation work. (H2O, O3, T, CO2, CH4, aerosols)	TBD (4)		
CGTG-156	Uncertainty (3.1)	Detected (1)	Limited characterization of the multi-dimensional (spatiotemporal) smoothing and sampling properties of atmospheric remote sensing systems, and of the resulting uncertainties. (H2O, O3, T, CO2, CH4, aerosols)	TBD (4)		
CGTG-157	Uncertainty (3.1)	Detected (1)	Representativeness uncertainty assessment missing for higher-level data based on averaging of individual measurements. (H2O, O3, T, CO2, CH4, aerosols)	TBD (4)		
CGTG-158	Uncertainty (3.1)	Detected (1)	Missing comparison error budget decomposition including errors due to sampling and smoothing differences. (H2O, O3, T, CO2, CH4, aerosols)	TBD (4)		
CGTG-159	Uncertainty (3.1)	Detected (1)	Lack of traceable uncertainty estimates for NWP and reanalysis fields and equivalent TOA radiances. (H2O, O3, T, CO2, CH4, aerosols)	TBD (4)		
CGTG-160	Uncertainty (3.1)	Detected (1)	Lack of traceable uncertainty estimates for NWP and reanalysis fields and equivalent TOA radiances	TBD (4)		
CGTG-161	Uncertainty (3.1)	Detected (1)	Where traceable uncertainty estimates exist for a model or reanalysis quantity, it is often limited to a few locations and parameters where reference datasets are available. Comprehensiveness is lacking for extension to locations and parameters where reference datasets are not available	TBD (4)		

Table 30 continued.

ID	GAPTYPE	STATUS	DESCRIPTION	OBSERVED	PURPOSE	REMEDY
CGTG-162	Uncertainty (3.1)	Detected (1)	Datasets from baseline and comprehensive networks provide valuable spatiotemporal coverage, but often lack the characteristics needed to facilitate traceable uncertainty estimates	TBD (4)		
CGTG-163	Uncertainty (3.1)	Detected (1)	Limited knowledge about how to propagate uncertainty from well-characterized locations and parameters to other locations and parameters.	TBD (4)		
CGTG-164	Uncertainty (3.1)	Detected (1)	Difficulty to assess the importance of natural variability in the total model-observation error budget	TBD (4)		
CGTG-165	No easy access (5.4)	Detected (1)	Access to data in multiple locations with different data policies and accessibility (e.g. speed of retrieving and unpacking, passwords) (H2O, O3, T, CO2, CH4, aerosols)	TBD (4)		
CGTG-166	No easy access (5.4)	Detected (1)	Access to data in multiple data format and structure (e.g. granularity of data). Lack of standardized metadata (H2O, O3, T, CO2, CH4, aerosols)	TBD (4)		
CGTG-167	Cannot be viewed (5.3)	Detected (1)	Efficient data management to collocate observations needs to be improved (H2O, O3, T, CO2, CH4, aerosols)	TBD (4)		
CGTG-168	Catalogue saturation (5.2)	Detected (1)	Usability of reference database needs to be ascertained: subset definition (H2O, O3, T, CO2, CH4, aerosols)	TBD (4)		
CGTG-169	Non well known format (5.5)	Detected (1)	Usability of reference database needs to be ascertained: format (H2O, O3, T, CO2, CH4, aerosols)	TBD (4)		
CGTG-170	Cannot be viewed (5.3)	Detected (1)	Need for analysis tools to exploit reference database (visualization, intercomparison, statistics, etc.) (H2O, O3, T, CO2, CH4, aerosols)	TBD (4)		
CGTG-171	No provenance (6.4)	Detected (1)	Incomplete development and/or application and/or documentation of an unbroken traceability chain of Cal/Val data manipulations for atmospheric ECV validation systems.	TBD (4)		

Table 30 continued.

ID	GAPTYPE	STATUS	DESCRIPTION	OBSERVED	PURPOSE	REMEDY
CGTG-172	Temporal extent (1.3)	Detected (1)	Missing quantification of additional uncertainties introduced in the comparison results due to differences in (multi-dimensional) sampling and smoothing of atmospheric inhomogeneity	TBD (4)		
CGTG-173	No fast access to big data (5.8)	Solved (6)	Lack of broadband connectivity for big-data fast visualization and processing	RS (1)		Improve client software to transmit only the necessary data. Use cloud or High Processing Computing (HPC) data processing.
CGTG-174	Geographical extent (1.1)	Solved (6)	Lack of continuity and uniform temporal sampling in time series.	RS (1)		Implement data fussion techniques to generated regular interpolated samples.
CGTG-175	Temporal extent (1.3)	Solved (6)	Lack of tidal, ocean currents and water elevation prediction services	RS (1)		Implement a forecast system based on recent data
CGTG-176	Catalogue saturation (5.2)	Solved (6)	Lack of tools for Big Data analysis: merge time-series, proper map and statistics visual representation	RS (1)		Develope the right tools for big data analysis and visualization
CGTG-177	Geographical extent (1.1)	Detected (1)	Glacier, Accumulation - performed in situ on only a small fraction of glaciers globally. Component of mass balance	In-Situ (2)	Glacier mass balance is a climate indicator and also impacts water resources	the most accurate estimate of accumulation is in situ measurements but ranging by lidar and radar are increasingly being used. In situ will still be needed for validation. Networks in Alpine regions should be increased instead of being closed.
CGTG-178	Geographical extent (1.1)	Detected (1)	Glacier, Facies, snow-line - can be estimated from imagery, approximates equlibrium line	RS (1)	facies are the visible expression of the processes determining surface mass balance	facies can be determined from radar and visible imagery with adequate resolution
CGTG-179	Uncertainty (3.1)	Detected (1)	Glacier, Glacier area - global inventory of glaciers is mostly complete but quality and accuracy varies widely	RS (1)	short term contribution to runoff and sea level rise depends on area (volume is needed to estimate future flows)	glacier area is the simplest parameter to measure from satellite data and this has been done for most of the world's glaciers (Randolph inventory). However, quality varies greatly by source and region.
CGTG-180	Geographical extent (1.1)	Detected (1)	Glacier, Glacier dammed lakes - near continuous global mapping needed	Both (3)	due to accelerating melt rates of many mountain glaciers, glacier lakes are an increasing hazard since many are in remote locations and hard to monitor	traditionally accomplished with visible imagery, but possible also with high resolution SAR
CGTG-181	Geographical extent (1.1)	Detected (1)	Glacier, Glacier ice thickness - a limiting factor in ability to forecast glacier contribution to runoff	RS (1)	future runoff from glaciers having negative mass balance depends on remaining volume, for which thickness is needed	various remote sensing methods using radar and gravity measurements are available

Table 30 continued.

ID	GAPTYPE	STATUS	DESCRIPTION	OBSERVED	PURPOSE	REMEDY
CGTG-183	Geographical extent (1.1)	Detected (1)	Glacier, Glacier topography - inadequate resolution in most places	RS (1)	changes in mass balance are reflected in surface topography	various remote sensing methods using lidar, SAR and stereoscopy of visible imagery can be used.
CGTG-184	Geographical extent (1.1)	Detected (1)	Glacier, Glacier velocity - has been determined for only a fraction of glaciers globally	RS (1)	velocity is important measure of glacier dynamics	feature tracking in visible imagery or inSAR can supply necessary dat
CGTG-185	Geographical extent (1.1)	Detected (1)	Ice sheet, Ice sheet mass change - requires knowledge of basal melt, surface melt, accumulation, velocity, calving rate	RS (1)	ice sheets are continental-scale masses of glacier ice with outlets mostly terminating at the ocean, and thus loose mass by calving, and in the case of floating ice shelves, through basal melting	all of the measurements describe in gap 177-184
CGTG-186	Geographical extent (1.1)	Detected (1)	Permafrost, Active layer depth - in situ monitoring network is sparse	Both (3)	We need to increase in-situ networks or use in-SAR satellite data (with in-situ validation again)	Increase the in-situ network density
CGTG-188	Geographical extent (1.1)	Detected (1)	Permafrost, Soil temperature - in situ monitoring network is sparse	In-Situ (2)	We need to increase in-situ networks	Increase the in-situ network density
CGTG-189	Geographical extent (1.1)	Detected (1)	Permafrost, Subsea permafrost distribution	Both (3)	there is currently no program to monitor subsea permafrost	deploy monitoring network in hear-coastal regions
CGTG-193	Uncertainty (3.1)	Detected (1)	Land surface, Snow water equivalent	RS (1)	snow melt runoff is a major source of water in many regions and while the area covered by snow is mapped daily from satellite, this does not revveal the amount of water in the snow pack is unknown	existing in situ (e.g. snotel, GPS), airborne (gamma ray, lidar), and satellite (radar, lidar) methods each have limitations. new satellite mission dedicated to SWE is needed
CGTG-194	Temporal resolution (2.3)	Detected (1)	Sea surface, Sea-ice cover	RS (1)	done operationally, but temporal resolution is inadequate for many purposes	sea ice cover is critical part of climate system and important for shipping and sustenance harvesting by indigenous communities
CGTG-195	Temporal resolution (2.3)	Detected (1)	Sea surface, Sea-ice motion	RS (1)	done operationally, but temporal resolution is inadequate for many purposes	ice motion important for predicting ice concentration and ice pack evolution
CGTG-197	Uncertainty (3.1)	Detected (1)	Sea surface, Sea-ice thickness	RS (1)	estimated by measuring freeboard using remote sensing, but require also estimating ice density and snow cover	ice thickness important in forecasting ice pack evolution and energy fluxes
CGTG-198	Uncertainty (3.1)	Detected (1)	Sea surface, Sea-ice type - i.e. first year or multi-year	RS (1)	sea ice age an important determinant of its dynamical, chemical and thermodynamical properties	ice age important in forecasting ice pack evolution and energy fluxes

Table 30 continued.

ID	GAPTYPE	STATUS	DESCRIPTION	OBSERVED	PURPOSE	REMEDY
CGTG-199	Uncertainty (3.1)	Detected (1)	Sea surface, Snow on ice depth	RS (1)	essential for understanding sea ice surface energy balance and in determining sea ice thickness from surface elevation derived from satellite	snow on ice confounds ability to estimate ice thickness from radar or lidar measurements. It also strongly influences heat fluxes and albedo
CGTG-200	Non well known format (5.5)	Detected (1)	Lack of interoperability in mobile sensor data, regarding standards and data models (CO2, NOX)	In-Situ (2)	Harmonization of access to mobile sensor data (e.g. vessels, gliders, cars, drones, ...)	
CGTG-201	Non well known format (5.5)	Detected (1)	Lack of interoperability in crowd-sourced data (e.g. ground-truth data, sightings, etc.), regarding standards and data models	Both (3)	Harmonization of crowd-sourced / Citizen Science data models	
CGTG-202	No easy access (5.4)	Detected (1)	Heterogeneous drought data among European countries; access is not centralized	Both (3)	Climatic analysis of drought in the Europe	
CGTG-203	No open access (6.2)	Detected (1)	Missing River discharge data (historical, daily resolution) from all countries and regular updates of the time-series on annual or biennial frequency	Both (3)		
CGTG-204	Spatial resolution (2.1)	Detected (1)	Time series of small water bodies is not available for pastoral domain of Senegal due to spatial resolution	RS (1)	insufficient temporal resolution since the data are provided in 1 km and naturel water bodies do not exceed generally 100m length	
CGTG-205	Temporal resolution (2.3)	Detected (1)	Cloud coverage: Missing data, insufficient temporal resolution	RS (1)	energy balance modelling at field level in areas with moderate cloud cover; European Phenological analysis at high spatial resolution	
CGTG-206	No easy access (5.4)	Detected (1)	No automated download of satellite images for real-time classification, mosaicking, change detection analysis, etc.	RS (1)		
CGTG-207	No measured (7.1)	Detected (1)	Missing data on water vapor and cloud coverage for correlation	Both (3)	vertical profiles of water vapor in the lower troposphere are very poorly (actually not really at all) measured, and essential variables such as surface evaporation, or atmospheric winds are also not measured.	
CGTG-208	Spatial resolution (2.1)	Detected (1)	High resolution land cover/use data not available	RS (1)		
CGTG-209	No open access (6.2)	Detected (1)	Historical meteorological data not publicly available	Both (3)	Meteorological climate reanalysis	
CGTG-210	Temporal resolution (2.3)	Detected (1)	Incomplete or low quality data on historical urban fabrics data (both physical and social)	Both (3)		

Table 30 continued.

ID	GAPTYPE	STATUS	DESCRIPTION	OBSERVED	PURPOSE	REMEDY
CGTG-211	No easy access (5.4)	Detected (1)	Web-service based access to GEOSS data is not always possible	Both (3)		
CGTG-212	Temporal resolution (2.3)	Detected (1)	Historical water quality data not available	In-Situ (2)	Historic analysis of water quality for region north of Portugal	
CGTG-213	Uncertainty (3.1)	Detected (1)	Low quality of historical coastal data	RS (1)	Historic assessment of coastal change	
CGTG-214	Uncertainty (3.1)	Detected (1)	Low quality and scarcity of arctic sea ice thickness data	RS (1)	Analysis of Arctic sea ice mass trends.	
CGTG-215	Temporal resolution (2.3)	Detected (1)	Lacking temporal and spatial resolution of phytoplankton biodiversity data	RS (1)	interested in understanding how algal blooms develop and why harmful algae sometimes dominate blooms: combine data on phytoplankton biodiversity at the species level together with in situ data from automated sensors and satellite remote sensing.	
CGTG-216	Temporal resolution (2.3)	Detected (1)	Missing Near-/Quasi-Real-Time data on natural hazards	Both (3)		
CGTG-217	Temporal resolution (2.3)	Detected (1)	Low temporal resolution of vegetation index data (no seasonal analysis possible)	RS (1)	Temporal (various years) and seasonal evolution for vegetation index's and surface temperature (if no better, brightness surface temperature) for agricultural sparse woody crops.	
CGTG-218	No measured (7.1)	Detected (1)	Missing data about traffic pollutant emission	In-Situ (2)	Currently there is a lack in information to derive the air quality impact of traffic; especially data about pollutant emission of cars is necessary to augment the sparse stationary air pollution networks.	
CGTG-219	No interdisciplinary coord. (8.1)	Detected (1)	No European in-situ cross-domain coordination initiative	In-Situ (2)	Have a single initiative where network can discuss integration and translate their demands to funding agencies	The European Network of Earth Observation Networks
CGTG-220	No interdisciplinary coord. (8.1)	Detected (1)	No Global in-situ cross-domain coordination initiative	In-Situ (2)	Have a single initiative to ensure completeness and data sharing in GEOSS	A GEOSS fundational task
CGTG-221	No measured (7.1)	Detected (1)	No biogeochemistry measures of the deap occean	In-Situ (2)	Even if there argo floats are capturing information from deap see, they do not do biogeochemical measurements	Install biogeochemical sensors in Argo floats
CGTG-222	Spatial resolution (2.1)	Detected (1)	Missing high resolution data for terrestrial ecosystems structure and terrestrial ecosystems function	RS (1)	There are products are more corse resolution but not at this resolutions. Sentinel 2 based high level products can potentially deliver some EBV	Create services and methodologies to calculate high level products

Table 31. Remedies and other gap-related information.

ID	FEASIBILITY	IMPACT	COST	PRIORITY	TIMEFRAME
CGTG-1	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-2	Established in most European countries, however some do not operate with required time resolution or data quality//	Important to assess air pollution fluxes and impacts on ecosystems, health and climate//	inexpensive and easy to impleement//	1//	TBD (99)//
CGTG-3	Heavy metals is of less environmental concern than i the past, but still important to quantyfy regional deposition fluxes.//	Important to assess air pollution fluxes and impacts on ecosystems and health//	Inexpensive and easy to implement.//	2//	TBD (99)//
CGTG-4	Fairly good spatial coverage for suplur compounds, but more limited for nitrogen species and other components//	Air concentrations of major inorganic compounds needs to be monitored in order to understand the fluxes and impacts to ecosystems, health and climate)//	Inexpensive and easy to implement//	1//	TBD (99)//
CGTG-5	Very good coverage with respect to local scale air quality measurements, but few sites making measurement in prestine background areas//	Important to understand the nitrogen cycle, and impacts on air pollution and climate//	Difficult to measure, relatively expensive//	2//	TBD (99)//
CGTG-6	Many sites measure using filterpacks, a method which has liitations in deriving the true gas/particle disctribution, there is a wish to extend the number of sites which can offer data on actual distribution//	Supporting data to be combined with the filterpack monitoring//	inexpensive//	2//	TBD (99)//
CGTG-7	Well established and many existing sites. Data quality and site representatvity in background areas is still an issue//	important for assessin ecosystem effects, impacts on health and climate//	Inexpensive//	2//	TBD (99)//
CGTG-8	Very few sites measure aerosol chemistry in several size fractions.//	Important to assess air qualty and climate//	requires extensive effort, but can be done with low temporal resolution, making it realistic//	2//	TBD (99)//
CGTG-9	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-809	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-810	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-810	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-810	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//

Table 31 continued.

ID	FEASIBILITY	IMPACT	COST	PRIORITY	TIMEFRAME
CGTG-10	Many sites measure using filterpacks, a method which has liitations in deriving the true gas/particle disctribution, there is a wish to extend the number of sites which can offer data on actual distribution//	Supporting data to be combined with the filterpack monitoring//	TBD (9)//	2//	TBD (99)//
CGTG-11	To understand trends in oxidants, good data on so-called precursors are required. Very few sites measure VOCs today, and there are isses related to data quality//	Important to assess air pollution impacts on health, ecosystems and climate//	TBD (9)//	1//	Important to assess air pollution fluxes and impacts on ecosystems and health//
CGTG-12	Heavy metals is of less environmental concern than i the past, but still important to quantyfy regional deposition fluxes.//	Important to assess air pollution fluxes and impacts on ecosystems and health//	Inexpensive//	2//	TBD (99)//
CGTG-13	Only few countries operate active sampling networks for POPs//	POPs are strongly affecting ecosystems and human health. Most sites are in Northern lattitudes//	moderate effort//	1//	TBD (99)//
CGTG-14	A wide range of variables are listed, all consider important reseach foci, to develop atmospheric science//	Important to assess air pollution fluxes and impacts on ecosystems and health//	moderate effort//	1//	TBD (99)//
CGTG-15	Ozone depleting substanses, and climate forcers//	important to follow global traties on emission reductions//	Fairly good implementation through AGAGE and WMO-GAW//	1//	TBD (99)//
CGTG-16	A wide range of variables are listed, all consider important reseach foci, to develop atmospheric science//	Atmospheric processes are very complex, and research data allowing to understand inteactions etc is fundamental//	generally expensive, but pending on what measured//	1//	TBD (99)//
CGTG-17	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-18	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-19	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-20	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-21	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-22	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-23	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-24	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-25	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-26	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//

Table 31 continued.

ID	FEASIBILITY	IMPACT	COST	PRIORITY	TIMEFRAME
CGTG-27	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-28	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-29	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-30	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-31	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-32	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-33	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-34	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-35	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-36	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-37	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-38	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-39	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-40	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-41	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-42	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-43	Very high (4)//No instrument to develop, no specific installation. It is a matter of networking	Very high (4)//Such data are needed right from the start to develop projects in solar energy. Such data would be used routinely for the validation of Copernicus radiation products	Low (1)//It can be done with existing sensors. Costs are those for networking and operating a platform implementing the meta-network for interoperability of various small networks	Crucial (1)//Crucial for the development of projects in Africa or Asia where data may exist but are yet unknown and unavailable. Crucial also for the development of Copernicus products in solar energy as validation in areas outside Europe will help the uptake of these products by companies as it increases their confidence in products	TBD (99)//
CGTG-44	Very high (4)//No instrument to develop, no specific installation. It is a matter of networking	High (3)//Such data are really needed and their availability would help in developing renewable energy. However, it is not crucial as companies have found ways to cope with this gap.	TBD (9)//I cannot say. It is a balance at governmental level	High (3)//Such data are really needed and their availability would help in developing renewable energy. However, it is not crucial as companies have found ways to cope with this gap.	TBD (99)//
CGTG-45	Very high (4)//Images exist, models exist	Very high (4)//Such data are needed right from the start to develop projects in marine energy.	High (3)//Computer resources needed. Validation campaigns needed	Crucial (1)//Crucial for the development of projects in marine energy	TBD (99)//

Table 31 continued.

ID	FEASIBILITY	IMPACT	COST	PRIORITY	TIMEFRAME
CGTG-46	High (3)//While increasing the satellite capacity (e.g. AMSR) and optical recurrency at high spatial resolution are quite expensive, ocean models representing the physical processes are ready but not operational.	High (3)//Weather/ocean forecast uncertainties reduced. Improvements on the atmosphere-ocean feedbacks and parametrizations into climate models. Assessment improvements on fisheries operations (species associated to thermal fronts).	High (3)//Improvements can be done with combinations of sensors in place and analysis with models (e.g. GHRSST) however computational costs associated to make operational models resolving such scales are expensive with present computing resources. Benefits and reduction cost could benefit from more in situ observations.	TBD (0)//	TBD (99)//
CGTG-47	Very high (4)//As more high resolution infrared and microwave instruments are being launched data uncertainties will be reduced and differences among procedures as well. However processing methodologies can benefit from specifically dedicated experiment/exercises to validate products against independent data.	High (3)//Weather/ocean forecast uncertainties reduced. Improvements on the atmosphere-ocean feedbacks and parametrizations into climate models. Assessment improvements on fisheries operations (species associated to thermal fronts).	Medium (2)//The costs is between Low and Medium in the sense that intercomparison of procedures are ongoing (e.g. GHRSST) but detailed validation with experiments to obtain new high resolution independent data could be promoted.	TBD (0)//	TBD (99)//
CGTG-48	Very high (4))//As more high resolution infrared and microwave instruments are being launched data uncertainties will be reduced and differences among procedures as well. Methodologies can benefit from programs to maintain already available long time series of in situ SST observations, and in particular, set up a long time monitoring on those sites where cloud cover is more persistent in time.	High (3)//Improvements on the atmosphere-ocean feedbacks and parametrizations into climate models.	Medium (2)//The costs is medium in the sense that intercomparison of procedures are ongoing (e.g. GHRSST) but the maintenance of time series of in situ observations is necessary.	TBD (0)//	TBD (99)//

Table 31 continued.

ID	FEASIBILITY	IMPACT	COST	PRIORITY	TIMEFRAME
CGTG-49	Very high (4)//Near surface Argo measurements has been proved to provide a good estimate of foundation temperature (the remperature minus the diurnal cycle) so there is no technical concern and many floats provides SST while they stay at the surface to transmit data. So there are not technical reasons the feasibility is only a matter of coordination and cost to improve the number of floats.	High (3)//Reduce uncertainties and errors in SST analysis which therefore impacts the characterization of the atmosphere-ocean feedbacks in weather forecast models, parametrizations into climate models and the earth temperature evolution.	Medium (2)//According to Fiedler et al., 2015, to achieve an error sampling of 0.02 K across the global ocean, the Argo observations would need to be increased by up to 1300 observations/month. If we assume costs of about $200 per profile we have a rough estimation of near 3 M$ per year in addition to the already available array.	TBD (0)//	TBD (99)//
CGTG-50	High (3)//Some technical solutions endowing inertial navigation systems with accelerometers may help to self-adjust the sampling to bathymetric changes. In polar areas some changes in float design would allow to an efficient solution. However as it is usual a compromise between energy consumption and sampling strategy may constraint their performance, so the limiting element is the energy consumption. In polar areas, Argo floats would benefit of improvements in battery storage technologies. To promote collaboration with already existing offshore installations in shelf areas, usually associated to energy production and aquaculture, to deploy fixed instruments and increase the infromation coverage.	Very high (4)//To provide the most complete coverage of all kind of oceanic regions. Specific impact would be the information on polar regions as being in such areas where environmental changes are relevant footprints of the climate change.	High (3)//Specific hardware additions and changes in float design should be implemented increasing the costs. In polar regions maintenance, deployment operations and monitoring needs would increase costs.	TBD (0)//	TBD (99)//
CGTG-51	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//

Table 31 continued.

ID	FEASIBILITY	IMPACT	COST	PRIORITY	TIMEFRAME
CGTG-52	Very high (4)//There is almost no technological problems concerning the measurement of in situ SST from Argo. However, of a total of 3887 operational floats in October2016, the number of countries contributing to the Argo program falls to only 30 being a few national agencies from specific countries (e.g. USA, France, Australia,..) the main contributors. Probably much more efforts could be easily increased if more national agencies are involved. Outside the operational activities of national agencies, research plans and programs could be somehow incentivate the use of Argo floats as an indirect way to increase the number of floats.	Very high (4)//The impact of the Argo program as a multipurpose platform scanning the 3D structure of the ocean is beyond any doubt and affects a great number of communities.	Very high (4)//The approximate cost for deploying an array of 800 floats per year to maintain a level of around 3000 floats in operation is about 24 M$	TBD (0)//	TBD (99)//
CGTG-53	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-57	High (3)//SMOS, the first mission to retrieve SSS, was a proof of concept. After several years of operation, SMOS/Aquarius/SMAP missions have provided enough knowledge, expertise and maturity in terms of technologies, signal retrieval issues and operational capabilities to guarantee a successful continuation of remote sensing SSS measurements.	Very high (4)//SSS retrieval is as crucial as SST to gain knowledge on the water cycle, in particular to determine freshwater fluxes. A relevant collateral aspect to take into account is that L-band missions needed to retrieve SSS simultaneously serve to retrieve other ECV's. In particular soil moisture and complementary information for the cryosphere (Ice thickness, ice extent,..) and ocean acidification.	Very high (4)//Similar to many satellite missions.	TBD (0)//	TBD (99)//

Table 31 continued.

ID	FEASIBILITY	IMPACT	COST	PRIORITY	TIMEFRAME
CGTG-58	High (3)//SMOS, the first mission to retrieve SSS, was a proof of concept. After several years years of operation, SMOS/Aquarius/SMAP missions have provided enough knowledge, expertise and maturity in terms of technologies, SSS retrieval issues and operational capabilities to guarantee a successful continuation of remote sensing measurements. High level merging products are still under development and specific efforts to derive improved L4 products is a matter of continuity of research teams developing it.	Very high (4)//The impact of the SSS retrieval is as crucial as SST to gain knowledge on the water cycle. Generically speaking coastal areas are the places where freshwater discharges are produced. SSS at high latitudes can be essential to monitor ice and ice melting particularly in the Artic area. For some marginal and semi-enclosed seas (i.e. Mediterranean, Baltic) salinity and salinity gradients are key element of its dynamics. In marginal and shels seas, and shelf regions, remote sensing of SSS is complementary of the Argo monitoring and where climatological analysis (e.g. Levitus) present less data while they are necessary to constraint climate models.	High (3)//Cost depend on the mentioned remedies. Ensuring a continuity of any sattelite mission (a) is ranked ”Very High” according to the criteria here adopted. However the other two remedies can be considered as ”Low”. Policy actions (a) to reduce RFI’s is quite easy to implement and ensuring the continuity of the experts involved in the improvements and development of L2-L4 products is relatively low.	TBD (0)//	TBD (99)//
CGTG-59	High (3)//To promote joint synergies among mission teams. An increase of independent in situ measurements would benefit the validation and verification of intercalibrations.	Very high (4)//To improve the SSS analysis reducing the uncertainties in geographical analysis and obtain more coherent time series. Near real time SSS data may help to warn up on biofouling maintenance of open ocean moored arrays.	Medium (2)//The increase of in situ near-surface measurements can be ranked as ”High” while improvement the intercallibration can be considered as ”Low”	TBD (0)//	TBD (99)//
CGTG-60	Low (3)//Much more research is needed to both dessign new algorithms to mitigate RFI contamination decreasing uncertainties and explore new spectral bands to retrieve SSS.	Very high (4)//First missions were conceived to have acceptable resolution for climate purposes. Reducing uncertainties will improve the range of applications beyond climate as it could be improvements in predicatibility through data assimilation of SSS.	Medium (2)//Basic research is needed to make improvements at different levels that require moderate funds at least initially	TBD (0)//	TBD (99)//

Table 31 continued.

ID	FEASIBILITY	IMPACT	COST	PRIORITY	TIMEFRAME
CGTG-61	High (3)//Biofouling has been addressed in many areas and applications since long time. Efficiency and energy consumption are the key elements for a successful implementation into Argo and surface drfiters.	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-62	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-63	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-64	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-65	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-66	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-67	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-68	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-69	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-70	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-71	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-72	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-73	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-74	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-75	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-76	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-77	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-78	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-79	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-80	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-81	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-82	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-83	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-84	Very high (4)//Argo technology for CTD recording (conductivity, temperature and pressure) is not a problem. However some aspects concerning the need of pressure-ressistance equipment and energy storage may be problematic.	Very high (4)//The Argo program is a key oceanic observation system with considerable impact on the quality of forecasts and analysis of present ocean models. In 10 years (2006-2016) the Argo program has collected more data than in the previous century (1900-2000).	High (3)//Deployment of deep profilers implies a significant increase of costs. Already comercial deep floats increases a factor of 10 with respect the current Argo floats.	TBD (0)//	TBD (99)//
CGTG-85	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-86	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-87	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//

Table 31 continued.

ID	FEASIBILITY	IMPACT	COST	PRIORITY	TIMEFRAME
CGTG-88	High (3)//Argo technology for these variables is ready. For shelf and polar areas, some technical solutions endowing inertial navigation systems with accelerometers may help to self-adjust the sampling to bathymetric changes. In polar areas some changes in float design would allow to an efficient solution. However as it is usual a compromise between energy consumption and sampling strategy may constraint their performance, so the limiting element is the energy consumption. Argo floats would benefit of improvements in battery storage technologies. On the other hand for deep marginal seas (e.g. Mediterranean, Black Sea..) there is no need of such implementations and feasibility is "Very high"	Very high (4)//The Argo program is a key oceanic observation system with considerable impact on the quality of forecasts and analysis of present ocean models. In 10 years (2006-2016) the Argo program has collected more data than in the previous century (1900-2000). To increase measurements in shelf areas has a high impact because constitutes the boundaries of the open ocean and where anthropic pressures and impacts are more evident.	High (3)//Cost depends on the number of devices needed to have a satisfactory sampling. However promoting studies to evaluate the needs and the impact in order to optimize deployment strategis are relatively cheap.	TBD (0)//	TBD (99)//

Table 31 continued.

ID	FEASIBILITY	IMPACT	COST	PRIORITY	TIMEFRAME
CGTG-89	Very high (4)//There is almost no technological problems concerning the Argo measurements except for the salinity close to the surface (see gap XX). However, of a total of 3887 operational floats in October 2016, the number of countries contributing to the Argo program falls to only 30 being a few national agencies from specific countries (e.g. USA, France, Australia,..) the main contributors. Probably much more efforts could be easily increased if more national agencies are involved. Outside the commitments of national agencies, research plans and programs could be somehow incentivate the use of Argo floats as an indirect way to increase the number of floats.	Very high (4)//Generically speaking the impact of the Argo program as a multipurpose platform scanning the 3D structure of the ocean is beyond any doubt and affects a great number of communities. In particular for the temperature, extending the time series will provide a better description of subdecadal variability of the ocean heat content impacting the quatification of the contribution of the ocean warning to sea level rise.	Very high (4)//According to Argo program estimations, the cost of maintainning an array of 300 requires to deply 600 unities per year which is equivalent to $24m per year.(http://www.argo.ucsd.edu/FAQ.html#cost)	TBD (0)//	TBD (99)//
CGTG-90	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-91	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-92	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-93	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-94	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-95	Very high (4)//Quite feasible if promoted from already existing international organisms (GOOS, WMO, GEO, etc.) Alternatively an initial set-up could arise from specific R+I initiatives (e.g. national research plans or regional alliances) or reserach programs (SVP, GLOBCURRENT,etc)	Very high (4)//To coordinate procedures and best practices to archive, process and deliver such kind of data. It will help to recover much more historical records from field cruises and research experiments presently not much centralised.	Low(1)//To set up a coordination organism can be ranked as relatively low.	TBD (0)//	TBD (99)//
CGTG-96	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-97	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-98	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-99	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-100	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-101	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-102	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//

Table 31 continued.

ID	FEASIBILITY	IMPACT	COST	PRIORITY	TIMEFRAME
CGTG-103	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-104	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-105	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-106	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-107	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-108	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-109	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-110	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-111	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-112	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-113	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-114	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-115	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-116	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-117	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-118	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-119	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-120	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-121	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-122	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-123	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-124	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-125	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-126	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-127	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-128	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-129	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-130	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-131	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-132	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-133	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-134	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-135	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-136	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-137	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-138	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-139	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-140	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-141	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-142	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-143	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-144	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-145	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-146	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-147	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-148	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-149	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-150	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-151	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-152	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//

Table 31 continued.

ID	FEASIBILITY	IMPACT	COST	PRIORITY	TIMEFRAME
CGTG-153	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-154	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-155	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-156	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-157	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-158	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-159	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-160	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-161	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-162	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-163	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-164	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-165	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-166	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-167	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-168	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-169	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-170	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-171	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-172	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-173	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-174	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-175	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-176	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-177	High (3)//Long term In situ networks are funded through national hydromet services	High (3)//Most glaciers are losing mass which is impacting water resources and sea level rise	Medium (2)//In some regions the facilities are in place (huts, etc.) and only the personnel costs are needed to revive them.	High (3)//see impact rationale	Mid term (2)//(time frame to implement, or to maintain?)
CGTG-178	Very high (4)//only a matter scheduling acquisitions at end of ablation season for all the world's glaciers	High (3)//Most glaciers are losing mass which is impacting water resources and sea level rise	Medium (2)//depends on source, some data are free, some carry cost	High (3)//also requires people and/or algorithms to interpret the data	Short term (1)//
CGTG-179	Very high (4)//only a matter scheduling acquisitions for all the world's glaciers	Medium (2)//	Medium (2)//cost is mostly for personnel to run algorithms and quality check	Medium (4)//existing inventory needs to be updated as glacier areas are changing	Short term (1)//
CGTG-180	Very high (4)//only a matter scheduling acquisitions and implementing automated change detection algorithms	Very high (4)//recently entire villages in Nepal were wiped out by GLOFs	Medium (2)//depends on source, some data are free, some carry cost	Very high (2)//the number of dangerous lakes is growning and existing monitoring programs are inadequate	Short term (1)//
CGTG-181	Very high (4)//mostly a matter of cost. for global coverage need many aircraft hours	High (3)//Most glaciers are losing mass which is impacting water resources and sea level rise	High (3)//	TBD (0)//	Mid term (2)//

Table 31 continued.

ID	FEASIBILITY	IMPACT	COST	PRIORITY	TIMEFRAME
CGTG-183	Very high (4)//only a matter scheduling (and paying for in the case of TerraSAR -X) acquisitions	High (3)//Most glaciers are losing mass which is impacting water resources and sea level rise	Medium (2)//	High (3)//	Short term (1)//
CGTG-184	Very high (4)//only a matter scheduling acquisitions and applying algorithms	High (3)//mostly pertains to outlet glaciers of the Greenland and West Antarctic Ice Sheets which have the potential to raise sea levels by 6m or more	Medium (2)//	Very high (2)//the fate of the GIS and WAIS is of critical, global importance	Mid term (2)//
CGTG-185	High (3)//various satellite and aircraft missions needed to carry out the measureents	Very high (4)//potential for global scale human disaster of unimaginable proportions	High (3)//	Very high (2)//	Long term (3)//
CGTG-186	High (3)//We have the in-situ technology	High (3)//On Greenhouse liberation of gasses. Infrastructures maintenance. Hidrological balance. Even in disaster forcasting...	Medium (2)//Deploy in-situ in remote places in addition to established stations	Very high (2)//Indicators to Climate Change	Mid term (2)//
CGTG-188	High (3)//We have the in-situ technology	High (3)//On Greenhouse liberation of gasses. Infrastructures maintenance. Hidrological balance. Even in disaster forcasting...	Medium (2)//Deploy in-situ in remote places in addition to established stations	Very high (2)//	Mid term (2)//
CGTG-189	High (3)//ocean borehole drilling	Medium (2)//massive flux of CH4 would ensue if melted	High (3)//ocean drilling is costly	High (3)//	Mid term (2)//
CGTG-193	High (3)//both NASA and ESA have programs to develop spaceborne snow missions	Very high (4)//More than one-sixth of the world's population relies on seasonal snowpack and glaciers for water. Knowing amount and timing of runoff is of critical importance	Very high (4)//new mission	Very high (2)//	Short term (1)//the technologies are mostly ready
CGTG-194	Very high (4)//radar provides all-weather mapping of sea ice, but coverage and access to data an issue	High (3)//	Medium (2)//Sentinel-1 and other SAR mission data can fill gap, but	Medium (4)//the operational ice services should be queried to learn if current data is sufficient	Short term (1)//
CGTG-195	Very high (4)//radar provides all-weather mapping of sea ice, but coverage and access to data an issue	High (3)//	Medium (2)//Sentinel-1 and other SAR mission data can fill gap, but	Medium (4)//the operational ice services should be queried to learn if current data is sufficient	Short term (1)//
CGTG-197	Very high (4)//cryosat is already producing ice thickness maps, but better accuracy and resolution needed	High (3)//	Medium (2)//Sentinel-3 altimetry will advance	High (3)//disappearing Arctic ice pack a global concern	Mid term (2)//

Table 31 continued.

ID	FEASIBILITY	IMPACT	COST	PRIORITY	TIMEFRAME
CGTG-198	High (3)//tracking old ice from time of sea ice minimum can distinguish first year from multiyear ice. thickness and backscatter can also be used	High (3)//	Medium (2)//	High (3)//disappearing Arctic ice pack a global concern	Mid term (2)//
CGTG-199	High (3)//	High (3)//	Medium (2)//	High (3)//(I am less familiar with available methods for measuring this variable)	Mid term (2)//
CGTG-200	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-201	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-202	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-203	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-204	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-205	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-206	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-207	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-208	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-209	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-210	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-211	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-212	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-213	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-214	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-215	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-216	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-217	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-218	TBD (9)//	TBD (9)//	TBD (9)//	TBD (0)//	TBD (99)//
CGTG-219	High (3)//Already created	Very high (4)//	Low (1)//	Very high (2)//	Mid term (2)//
CGTG-220	High (3)//Already created	Very high (4)//	Low (1)//	Very high (2)//	Mid term (2)//
CGTG-221	High (3)//the thechnology and the argos are there	Medium (2)//	Medium (2)//	High (3)//	Mid term (2)//
CGTG-222	Medium (2)//Requires reserach and innovation to mature the algoritms	Medium (2)//	Medium (2)//	High (3)//	Short term (1)//

Table 32. Essential Variables extracted from the Gap Analysis Table.

ID	NAME	COMMUNITY
EV-CG-001	C_TAS	Climate (CL)
EV-CG-002	C_O3A	Climate (CL)
EV-CG-003	C_PRE	Climate (CL)
EV-CG-004	C_RAS	Climate (CL)
EV-CG-005	C_WAS	Climate (CL)
EV-CG-006	C_WVAS	Climate (CL)
EV-CG-007	C_PAS	Climate (CL)
EV-CG-008	N_APOL	Climate (CL)
EV-CG-009	E_LULC	Energy (EN)
EV-CG-010	EV	Energy (EN)
EV-CG-011	C_WVU	Water (WA)
EV-CG-012	C_CLD	Water (WA)
EV-CG-013	C_RIV	Water (WA)
EV-CG-014	C_LAK	Water (WA)
EV-CG-015	EBV	Biodiversity (BI)
EV-CG-016	C_AGB	Biodiversity (BI)
EV-CG-017	B_EFNP	Biodiversity (BI)
EV-CG-018	C_SL	Oceans (OC)
EV-CG-019	C_SICE	Oceans (OC)
EV-CG-020	C_SST	Oceans (OC)
EV-CG-021	C_OC	Oceans (OC)
EV-CG-022	C_LCV	Biodiversity (BI)
EV-CG-023	C_ICE	Climate (CL)
EV-CG-024	B_GCC	Biodiversity (BI)
EV-CG-025	B_GCA	Biodiversity (BI)
EV-CG-026	B_GCP	Biodiversity (BI)
EV-CG-027	B_GCB	Biodiversity (BI)
EV-CG-028	B_SPD	Biodiversity (BI)
EV-CG-029	B_SPA	Biodiversity (BI)
EV-CG-030	B_SPS	Biodiversity (BI)
EV-CG-031	EOV	Climate (CL)
EV-CG-032	B_CCT	Biodiversity (BI)
EV-CG-033	E-SSI	Energy (EN)
EV-CG-034	EREV	Energy (EN)
EV-CG-035	E-BAT	Energy (EN)
EV-CG-036	E-TDL	Energy (EN)
EV-CG-037	E-CUR	Energy (EN)
EV-CG-038	E-OFL	Energy (EN)
EV-CG-039	C_SSS	Multiple (10)
EV-CG-040	C_OAS	Multiple (10)
EV-CG-041	C_TD	Multiple (10)
EV-CG-042	C_SALD	Multiple (10)
EV-CG-043	Undefined	Multiple (10)
EV-CG-044	Undefined	Multiple (10)
EV-CG-045	Undefined	Multiple (10)
EV-CG-046	C_CD	Multiple (10)
EV-CG-047	C_OOD	Multiple (10)
EV-CG-048	C_CO2	Climate (CL)
EV-CG-049	C_GHG	Climate (CL)

Table 32 continued.

ID	NAME	COMMUNITY
EV-CG-050	C_TU	Climate (CL)
EV-CG-051	N_ACO	Climate (CL)
EV-CG-052	C_WNU	Climate (CL)
EV-CG-053	Undefined	Climate (CL)
EV-CG-054	Undefined	Climate (CL)
EV-CG-055	Undefined	Climate (CL)
EV-CG-056	ECVA	Climate (CL)
EV-CG-057	E-ELEV	Disaster resilience (DI)
EV-CG-058	C_GLA	Climate (CL)
EV-CG-059	C_PFR	Climate (CL)
EV-CG-060	C_SNC	Climate (CL)
EV-CG-061	N_NOI	Multiple (10)
EV-CG-062	C_WTS	Water (WA)
EV-CG-063	W_EVA	Climate (CL)
EV-CG-064	W_Q	Water (WA)
EV-CG-065	C_PLK	Oceans (OC)
EV-CG-066	O_NUT	Climate (CL)
EV-CG-067	O_CAR	Climate (CL)
EV-CG-068	O_TRTR	Climate (CL)

Table 33. References used in the CGT.

ID	DESCRIPTION
CG-Ref-001	Pieter De Frenne and Kris Verheyen "Weather stations lack forest data"
CG-Ref-002	http://emep.int/publ/reports/2016/EMEP_Status_Report_1_2016.pdf
CG-Ref-003	http://www.msceast.org/reports/2_2016.pdf
CG-Ref-004	EMEP PROGRESS IN ACTIVITIES IN 2009-2019 AND FUTURE WORK. Level 1
CG-Ref-005	http://www.msceast.org/reports/3_2016.pdf
CG-Ref-006	EMEP PROGRESS IN ACTIVITIES IN 2009-2019 AND FUTURE WORK. Level 2
CG-Ref-007	EMEP PROGRESS IN ACTIVITIES IN 2009-2019 AND FUTURE WORK. Level 3
CG-Ref-008	CA-01. GEO 2016 WORK PROGRAMME
CG-Ref-009	CA-06. GEO 2016 WORK PROGRAMME
CG-Ref-010	GEO 2016 WORK PROGRAMME. CA-027. Foster Utilization of Earth Observation Remote Sensing and In Situ Data for All Phases of Disaster Risk Management
CG-Ref-011	GEO 2016 WORK PROGRAMME. CA-028 Global Flood Risk Monitoring
CG-Ref-012	GEOBON- Global Biodiveristy Obvserbation
CG-Ref-013	ECOPotential WP2 meeting. Cited Herique Pereira
CG-Ref-014	Sentinel- 3 Mission Objectives
CG-Ref-015	O'Connor, B., Secades, C., Penner, J., Sonnenschein, R., Skidmore, A., Burgess, N. D., and Hutton, J. M. (2015). Earth observation as a tool for tracking progress towards the Aichi Biodiversity Targets. Remote Sensing in Ecology and Conservation, 1(1), 19-28.
CG-Ref-016	Geijzendorffer, I. R., Regan, E. C., Pereira, H. M., Brotons, L., Brummitt, N., Gavish, Y., ... and Schmeller, D. S. (2015). Bridging the gap between biodiversity data and policy reporting needs: An Essential Biodiversity Variables perspective. Journal of Applied Ecology.
CG-Ref-017	GI-16. GEO 2016 WORK PROGRAMME. GEO-DARMA = Data Access for Risk Managemen
CG-Ref-018	http://www.iagos.fr/web/images/map/map_iagos.png
CG-Ref-019	Aichi targets Compilation. Target 19
CG-Ref-020	IEA Solar Heating and Cooling Program, Tasks 36 and 46. GEO Task US-09-01a
CG-Ref-021	ConnectinGEO. Exchanges with companies in various occasions, including Copernicus events
CG-Ref-022	ConnectinGEO. Exchanges with companies in various occasions, including Copernicus events. IREMARE web site, EWTEC 2015, Island Energy Transitions: Pathways for Accelerated Uptake of Renewables 2015
CG-Ref-023	World Meteorological Organization (WMO), 2015: Status of the Global Observing System for Climate, October 2015, GCOS-195. Available at: http://www.wmo.int/pages/prog/gcos/Publications/GCOS-195_en.pdf
CG-Ref-024	World Meteorological Organization (WMO), 2015: Status of the Global Observing System for Climate, October 2015, GCOS-195. Available at: http://www.wmo.int/pages/prog/gcos/Publications/GCOS-195_en.pdfReynolds R. W., Chelton D. B., 2010: Comparisons of Daily Sea Surface Temperature Analyses for 2007-08, Journal of Climate, 23, 3545-3562
CG-Ref-025	World Meteorological Organization (WMO), 2015: Status of the Global Observing System for Climate, October 2015, GCOS-195. Available at: http://www.wmo.int/pages/prog/gcos/Publications/GCOS-195_en.pdfReal time status of ARGO deployments through JCOMMOPS API, (http://www.jcommops.org/board?t=Argo)Fiedler E, Mao Ch., Maclaren A. 2015: SST: results and recommendations. E-AIMS Deliverable D4.3.3. Availbale at http://www.euro-argo.eu/content/download/83965/1049581/version/1/file/E-AIMS_4.3_SeaSurfaceTemperature_V2.pdf
CG-Ref-026	World Meteorological Organization (WMO), 2015: Status of the Global Observing System for Climate, October 2015, GCOS-195. Available at: http://www.wmo.int/pages/prog/gcos/Publications/GCOS-195_en.pdfReal time status of ARGO deployments through JCOMMOPS API, (http://www.jcommops.org/board?t=Argo)W. Walczowski, I. Goszczko 2015: Arctic float final evaluation, E-AIMS Deliverable 2.5.2, available at http://www.euro-argo.eu/content/download/89388/1101132/file/E-AIMS_D2.252.pdf.
CG-Ref-027	Statistics from Coriolis Global Data Assembly Center (GDAC)
CG-Ref-028	Argo program description from the Argo website:http://www.argo.ucsd.edu/About_Argo.htmlDurack P.J., Lee T., Vinogradova N. T., D. Stammer, 2016: Keeping the lights on for global ocean salinity observation, NATURE CLIMATE CHANGE, vol 6. 228-231.
CG-Ref-029	This gap has been combined with gap 52. This row should be dropped
CG-Ref-030	World Meteorological Organization (WMO), 2015: Status of the Global Observing System for Climate, October 2015, GCOS-195. Available at: http://www.wmo.int/pages/prog/gcos/Publications/GCOS-195_en.pdfP. E. Land, J. D. Shutler, H.S. Findlay, F. Girard-Ardhuin, R. Sabia, N. Reul, J.-F. Piolle, B. Chapron, Y. Quilfen, J. Salisbury, D. Vandemark, R. Bellerby and P. Bhadury, 2015: Salinity from Space Unlocks Satellite-Based Assessment of Ocean Acidification, Environ. Sci. Technol., 2015, 49 (4), pp 19871994DOI: 10.1021/es504849s

Table 33 continued.

ID	DESCRIPTION
CG-Ref-031	Lagerloef G., Kao H.Y., Meissner T., Vazquez J., 2015: Aquarius Salinity Validation Analysis; Data Version 4.0, 30pp. Available at: ftp://podaac-ftp.jpl.nasa.gov/allData/aquarius/docs/v4/AQ-014-PS-0016_AquariusSalinityDataValidationAnalysis_DatasetVersion4.0and3.0.pdf)Ballabrera J., 2015: Sea Surface Salinity: Results and Recommendations D4.4.3, E-AIMS. Euro-Argo Improvements for the GMES Marine Service, E-AIMS: D4.443-v2. Available at: http://www.euro-argo.eu/content/download/91862/1123452/version/1/file/E-AIMS_D4.443-V2.pdf)
CG-Ref-032	Pablos M., Piles M., Gonzalez-Gambau V., Vall-llossera M., Camps A., Martinez J., 2014: IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, 7, 9, 3833-3844.W. Tang, A. Fore, S. Yueh, T. Lee, A. Hayashi, A. Sanchez-Franks, B, King, D, Baranowski, J, Martinez, submitted:Validating SMAP SSS with in situ measurements, Remote Sensing of Environment.
CG-Ref-033	Ballabrera J., 2015: Sea Surface Salinity: Results and Recommendations D4.4.3, E-AIMS. Euro-Argo Improvements for the GMES Marine Service, E-AIMS: D4.443-v2. Available at: http://www.euro-argo.eu/content/download/91862/1123452/version/1/file/E-AIMS_D4.443-V2.pdf)
CG-Ref-034	World Meteorological Organization (WMO), 2015: Status of the Global Observing System for Climate, October 2015, GCOS-195. Available at: http://www.wmo.int/pages/prog/gcos/Publications/GCOS-195_en.pdf P.-Y. Le Traon, D. Antoine, A. Bentamy, H. Bonekamp, L.A. Breivik, B.Chapron, G. Corlett, G. Dibarboure, P. DiGiacomo, C. Donlon, Y. Faugre, J. Font, F. Girard-Ardhuin, F. Gohin, J.A. Johannessen, M. Kamachi, G. Lagerloef, J. Lambin, G. Larnicol, P. Le Borgne, E. Leuliette, E. Lindstrom, M.J. Martin, E. Maturi, L. Miller, L. Mingsen, R. Morrow, N. Reul, M.H. Rio, H. Roquet, R. Santoleri and J. Wilkin (2015) Use of satellite observations for operational oceanography: recent achievements and future prospects, Journal of Operational Oceanography, 8:sup1, s12-s27, DOI: 10.1080/1755876X.2015.1022050A. Schiller, M. Bell, G. Brassington, P. Brasseur, R. Barciela, P. De Mey, E. Dombrowsky, M. Gehlen, F. Hernandez, V. Kourafalou, G. Larnicol, P.-Y. Le Traon, M. Martin, P. Oke, G. C. Smith, N. Smith, H. Tolman, K. Wilmer-Becker, 2015: Synthesis of new scientific challenges for GODAE OceanView, Journal of Operational Oceanography, 8:sup2, s259-s271, DOI:10.1080/1755876X.2015.1049901
CG-Ref-035	World Meteorological Organization (WMO), 2015: Status of the Global Observing System for Climate, October 2015, GCOS-195. Available at: http://www.wmo.int/pages/prog/gcos/Publications/GCOS-195_en.pdfP.R. Oke, G. Larnicol, E.M. Jones, V. Kourafalou, A.K. Sperrevik, F. Carse, C.A.S. Tanajura, B. Mourre, M. Tonani, G.B. Brassington, M. Le Henaff, G.R. Halliwell Jr., R. Atlas, A.M. Moore, C.A. Edwards, M.J. Martin, A.A. Sellar, A. Alvarez, P. De Mey and M. Iskandarani (2015) Assessing the impact of observations on ocean forecasts and reanalyses:Part 2, Regional applications, Journal of Operational Oceanography, 8:sup1, s63-s79, DOI:10.1080/1755876X.2015.1022080
CG-Ref-036	World Meteorological Organization (WMO), 2015: Status of the Global Observing System for Climate, October 2015, GCOS-195. Available at: http://www.wmo.int/pages/prog/gcos/Publications/GCOS-195_en.pdfPascual A., Faugere Y., Larnicol G., Le Traon P-Y., 2006: Geophysical Research Letters, vol. 33, L02611, doi:10.1029/2005GL024633
CG-Ref-037	World Meteorological Organization (WMO), 2015: Status of the Global Observing System for Climate, October 2015, GCOS-195. Available at: http://www.wmo.int/pages/prog/gcos/Publications/GCOS-195_en.pdfNewton J.A., Feely R.A., Jewett E.B., Williamson P., Mathis J., 2015: Global Ocean Acidification Observing Network: Requirements and Governance Plan.Second Edition, GOA-ON. Available at: http://www.goa-on.org/docs/GOA-ON_plan_print.pdf.
CG-Ref-038	World Meteorological Organization (WMO), 2015: Status of the Global Observing System for Climate, October 2015, GCOS-195. Available at: http://www.wmo.int/pages/prog/gcos/Publications/GCOS-195_en.pdfJCOMMOPS (http://www.jcommops.org/board?t=Argo),IPCC, 2013: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the IntergovernmentalPanel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley(eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp. Available at: http://www.climatechange2013.org/images/report/WG1AR5_ALL_FINAL.pdf
CG-Ref-039	IPCC, 2013: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the IntergovernmentalPanel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley(eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp. Available at: http://www.climatechange2013.org/images/report/WG1AR5_ALL_FINAL.pdf

Table 33 continued.

ID	DESCRIPTION
CG-Ref-040	World Meteorological Organization (WMO), 2015: Status of the Global Observing System for Climate, October 2015, GCOS-195. Available at: http://www.wmo.int/pages/prog/gcos/Publications/GCOS-195_en.pdfJCOMMOPS (http://www.jcommops.org/board?t=Argo) Ballabrera J., 2015: Sea Surface Salinity: Results and Recommendations D4.4.3, E-AIMS. Euro-Argo Improvements for the GMES Marine Service, E-AIMS: D4.443-v2. Available at: http://www.euro-argo.eu/content/download/91862/1123452/version/1/file/E-AIMS_D4.443-V2.pdf)Real time status of ARGO deployments through JCOMMOPS API, (http://www.jcommops.org/board?t=Argo)Fiedler E, Mao Ch., Maclaren A. 2015: SST: results and recommendations. E-AIMS Deliverable D4.3.3. Availbale at http://www.euro-argo.eu/content/download/83965/1049581/version/1/file/E-AIMS_4.3_SeaSurfaceTemperature_V2.pdf
CG-Ref-041	World Meteorological Organization (WMO), 2015: Status of the Global Observing System for Climate, October 2015, GCOS-195. Available at: http://www.wmo.int/pages/prog/gcos/Publications/GCOS-195_en.pdfArgo program description from the Argo website:http://www.argo.ucsd.edu/About_Argo.htmlDurack P.J., Lee T., Vinogradova N. T., D. Stammer, 2016: Keeping the lights on for global ocean salinity observation, NATURE CLIMATE CHANGE, vol 6. 228-231.
CG-Ref-042	Durack P.J., Lee T., Vinogradova N. T., D. Stammer, 2016: Keeping the lights on for global ocean salinity observation, NATURE CLIMATE CHANGE, vol 6. 228-231.
CG-Ref-043	World Meteorological Organization (WMO), 2015: Status of the Global Observing System for Climate, October 2015, GCOS-195. Available at: http://www.wmo.int/pages/prog/gcos/Publications/GCOS-195_en.pdfHolloway G., Nguyen A., Zeliang W., 2011: Oceans and ocean models as seen by current meters, Journal of Geophysical Research, VOL. 116, C00D08, doi:10.1029/2011JC007044IPCC, 2013: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the IntergovernmentalPanel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley(eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp. Available at: http://www.climatechange2013.org/images/report/WG1AR5_ALL_FINAL.pdf
CG-Ref-044	World Meteorological Organization (WMO), 2015: Status of the Global Observing System for Climate, October 2015, GCOS-195. Available at: http://www.wmo.int/pages/prog/gcos/Publications/GCOS-195_en.pdfGlobal Sea-Level Observing System (GLOSS) Implementation Plan - 2012, UNESCO/IOC, 41pp. 2012. IOC Technical Series No.100.
CG-Ref-045	GAIA-CLIM H2020- D1.3 GCOS AOPC Seidel et al., 2013
CG-Ref-046	GAIA-CLIM H2020- D1.1
CG-Ref-047	GAIA-CLIM H2020- D1.4, D1.6, D1.8
CG-Ref-048	GAIA-CLIM H2020- D1.9
CG-Ref-049	GAIA-CLIM H2020- D1.9 Whiteman et al., 2011
CG-Ref-050	GAIA-CLIM H2020- D1.2
CG-Ref-051	GAIA-CLIM H2020- D1.3 Immler et al., 2010
CG-Ref-052	GAIA-CLIM H2020- D1.1, D1.4 Immler et al., 2010
CG-Ref-053	GAIA-CLIM H2020- n/a
CG-Ref-054	GAIA-CLIM H2020- D1.1, D2.1
CG-Ref-055	GAIA-CLIM H2020- D2.2, D2.4
CG-Ref-056	GAIA-CLIM H2020- D2.2 Wandinger et al., 2015
CG-Ref-057	GAIA-CLIM H2020- D?.?; Earlinet
CG-Ref-058	GAIA-CLIM H2020- D2.2 Veselovskii et al., 2012
CG-Ref-059	GAIA-CLIM H2020- D2.2 EU project website ACTRIS2: www.actris.eu
CG-Ref-060	GAIA-CLIM H2020- D2.2 Leblanc et al., 2008 ?ISSI report? Is it also for aerosol?
CG-Ref-061	GAIA-CLIM H2020- Leblanc et al., 2008 ?ISSI report?
CG-Ref-062	GAIA-CLIM H2020- D2.1 Walker et al., 2011
CG-Ref-063	GAIA-CLIM H2020- D2.1 EU Cost action TOPROF
CG-Ref-064	GAIA-CLIM H2020- NORS_D4.3_UB.pdf
CG-Ref-065	GAIA-CLIM H2020- NORS_D4.2_DUG.pdf
CG-Ref-066	GAIA-CLIM H2020- Hase et al., 2012 Frankenberg et al., 2011
CG-Ref-067	GAIA-CLIM H2020- Wunsch et al., 2011
CG-Ref-068	GAIA-CLIM H2020- Hase et al, 2012 Hase et al., 2013
CG-Ref-069	GAIA-CLIM H2020- NORS_D4.3_UB.pdf NDACC_UVVIS-WG_O3settings_v2.pdf
CG-Ref-070	GAIA-CLIM H2020- Hendrick et al., 2011
CG-Ref-071	GAIA-CLIM H2020- Eskes and Boersma, 2003

Table 33 continued.

ID	DESCRIPTION
CG-Ref-072	GAIA-CLIM H2020- Herman et al., 2015
CG-Ref-073	GAIA-CLIM H2020- D2.1; Liu et al., 2006 Irie et al, 2011 Gomez et al., 2014
CG-Ref-074	GAIA-CLIM H2020- Same as for G2.31
CG-Ref-075	GAIA-CLIM H2020- Ning, 2012
CG-Ref-076	GAIA-CLIM H2020- D3-1 (incl. Annex 1, 2 and 3)
CG-Ref-077	GAIA-CLIM H2020- Bell et al., 2008 Bohrmann et al., 2013 Doherty et al., 2015 Geer et al., 2010 Lu et al., 2011
CG-Ref-078	GAIA-CLIM H2020- Same as for G4.01
CG-Ref-079	GAIA-CLIM H2020- WPs 1,2,3
CG-Ref-080	GAIA-CLIM H2020- WP4 (+ Task 1.4/1.5)
CG-Ref-081	GAIA-CLIM H2020- http://www.gruan.org http://tccon.ornl.gov/ http://www.ndsc.ncep.noaa.gov/data
CG-Ref-082	GAIA-CLIM H2020- http://www.ucar.edu/tools/applications_desc.jsp
CG-Ref-083	GAIA-CLIM H2020- CCI toolbox Giovanni GSICS
CG-Ref-084	GAIA-CLIM H2020- WP5
CG-Ref-085	GAIA-CLIM H2020- ICARE multibrowse and associated graphical modules? Felyx project NOAA NPROVS
CG-Ref-086	GAIA-CLIM H2020- D5.1 Keppens et al., 2015 (traceability chain) QA4ECV: http://www.qa4ecv.eu/ QA4EO: http://qa4eo.org/
CG-Ref-087	GAIA-CLIM H2020- D5.1, D3.1 Lambert et al., 2012 Verhoelst et al., 2015 Fasso et al., 2014 Ignaccolo et al., 2015 ?EU FP6 GEOmon Technical Notes D4.2.1 and D4.2.2 (2008-2011)?
CG-Ref-088	Presented at ConnectinGEO -product award WP.5.5.
CG-Ref-089	Presented at ConnectinGEO -product award WP.5.5. (Ocean. Tidal atlas)
CG-Ref-090	GCW = http://globalcryospherewatch.org/reference/obs_requirements.php
CG-Ref-091	OSCAR = http://www.wmo-sat.info/oscar/themes/view/5
CG-Ref-092	To be documented in ConnectinGEO deliverable (i.e. D6.x + D7.2)
CG-Ref-093	ConnectinGEO "User Needs and Gaps Survey" - http://twiki.eneon.net/foswiki/bin/view/ConnectinGEO-Intranet/UserNeedsAndGapsSurvey (Response #1)
CG-Ref-094	ConnectinGEO "User Needs and Gaps Survey" - http://twiki.eneon.net/foswiki/bin/view/ConnectinGEO-Intranet/UserNeedsAndGapsSurvey (Response #6, #23)
CG-Ref-095	ConnectinGEO "User Needs and Gaps Survey" - http://twiki.eneon.net/foswiki/bin/view/ConnectinGEO-Intranet/UserNeedsAndGapsSurvey (Response #9)
CG-Ref-096	ConnectinGEO "User Needs and Gaps Survey" - http://twiki.eneon.net/foswiki/bin/view/ConnectinGEO-Intranet/UserNeedsAndGapsSurvey (Response #12, #13)
CG-Ref-097	ConnectinGEO "User Needs and Gaps Survey" - http://twiki.eneon.net/foswiki/bin/view/ConnectinGEO-Intranet/UserNeedsAndGapsSurvey (Response #25)
CG-Ref-098	ConnectinGEO "User Needs and Gaps Survey" - http://twiki.eneon.net/foswiki/bin/view/ConnectinGEO-Intranet/UserNeedsAndGapsSurvey (Response #26)
CG-Ref-099	ConnectinGEO "User Needs and Gaps Survey" - http://twiki.eneon.net/foswiki/bin/view/ConnectinGEO-Intranet/UserNeedsAndGapsSurvey (Response #28, #50, #59, #62, #65, #80)
CG-Ref-100	ConnectinGEO "User Needs and Gaps Survey" - http://twiki.eneon.net/foswiki/bin/view/ConnectinGEO-Intranet/UserNeedsAndGapsSurvey (Response #30)
CG-Ref-101	ConnectinGEO "User Needs and Gaps Survey" - http://twiki.eneon.net/foswiki/bin/view/ConnectinGEO-Intranet/UserNeedsAndGapsSurvey (Response #42)
CG-Ref-102	ConnectinGEO "User Needs and Gaps Survey" - http://twiki.eneon.net/foswiki/bin/view/ConnectinGEO-Intranet/UserNeedsAndGapsSurvey (Response #43)
CG-Ref-103	ConnectinGEO "User Needs and Gaps Survey" - http://twiki.eneon.net/foswiki/bin/view/ConnectinGEO-Intranet/UserNeedsAndGapsSurvey (Response #47)
CG-Ref-104	ConnectinGEO "User Needs and Gaps Survey" - http://twiki.eneon.net/foswiki/bin/view/ConnectinGEO-Intranet/UserNeedsAndGapsSurvey (Response #51)
CG-Ref-105	ConnectinGEO "User Needs and Gaps Survey" - http://twiki.eneon.net/foswiki/bin/view/ConnectinGEO-Intranet/UserNeedsAndGapsSurvey (Response #52)
CG-Ref-106	ConnectinGEO "User Needs and Gaps Survey" - http://twiki.eneon.net/foswiki/bin/view/ConnectinGEO-Intranet/UserNeedsAndGapsSurvey (Response #55)
CG-Ref-107	ConnectinGEO "User Needs and Gaps Survey" - http://twiki.eneon.net/foswiki/bin/view/ConnectinGEO-Intranet/UserNeedsAndGapsSurvey (Response #68)

Table 33 continued.

ID	DESCRIPTION
CG-Ref-108	ConnectinGEO ”User Needs and Gaps Survey” - http://twiki.eneon.net/foswiki/bin/view/ConnectinGEO-Intranet/UserNeedsAndGapsSurvey (Response #77, #79)
CG-Ref-109	Horizon 2020 Work Programme 2014-2015 in the area of Climate action, environment, resource efficiency and raw materials. SC5-18-2014/2015
CG-Ref-110	GEOSS Work Programme 2017-2019
CG-Ref-111	In the ENVRIplus 3rt workshop verbally
CG-Ref-112	EOEP-4 Data User Element (DUE), GlobDiversity

Table 34. Reviews of gaps available so far.

ID	DESCRIPTION
CG-Rev-001	This gap is somehow represented in gaps 103-104 (EGL)
CG-Rev-002	According to the gap description, this gap affects the EOV: Sea level, not the EO: Sea Ice !In addition this gap is somehow represented in gaps 100-103. (EGL)
CG-Rev-003	According to the gap description, this gap affects the EOV: SST, not the EOV: Sea Ice and EOV: Sea levelAs far as i understand all the infrared radiometers (AVHRR, MODIS even in GEOSAT) are in real time, accessibleand global coverage is not possible unless some combination with T from microwaves is combined, at least for the SST. The GHRSST Multi-Product Ensemble (GMPE) delivered through CMEMS (Copernicus marine) offers a near real-time product at 0.25x 0.25 degrees. So the gap should perhaps more focused on the type spatial resolution. Thus, I believe that this gap should be more of type ”Spatial extent” than ”Temporal resolution” (EGL)
CG-Rev-004	According to the gap description, this gap affects the EOV: Ocean Color, not the EO: Sea State !This gap also should affect ”Climate ” theme because color is used as a aproxy of phytoplacnton that is a quite relevant C02 sink !I believe that MODIS and VIIRS on Suomi NPP are operating regularly on such bands. They are delivered in near real time but not at global coverage. In addition they are affected by the same problem as infrared radiometers, cloud cover, that in this case can not be solved by complementary radiometers as in the case of SST. The highest temporal resolution attainable is constraint by night/day conditions.I believe that this gap should be more of ”Spatial extent” type than ”Temporal resolution” ! (EGL)
CG-Rev-005	I believe that if this gap is associated to ECV:Wind speed at the surface, the it should also be associated also to [EOV :Sea State] because surface stress is derived/related with.On the other hand winds at the surface are obtained in near real time by already running scatterometers !.Perhaps the way they measure and the number of scatteropmeters are not enough to produce synoptic winds fields with global coverage. In such case the type of gap should be of ”Spatial extent” or ”Capacity” (EGL)
CG-Rev-006	I think that if this gap is also associated to [ECV:Sea State] (EGL)
CG-Rev-007	GEO BON network for facilitating inter-disciplinary dialogue and IPBES for achieving consensus on what biodiversity and ecosystem services need from EO
CG-Rev-008	Knowledge of established EO data providers must be matched with that of biodiversity conservation policy specialists to enable knowledge transfe
CG-Rev-009	Meteo data may originate from in situ measurements or from meteorological analyses
CG-Rev-010	This gap Is related mainly with gaps 64-70 and gap 28. In my humble opinion this gap could be partially merged with the others just by addding the ”Energy Theme”, merging together the gap description and/or the ”Purpose column” (EGL. LW: Yes, I agree that this gap is consistent with 64, 65, 66, 68, 70, 71 and 72. However, two caveats. 1) this gap includes bathymetry and type of floor; 2) it originates from industry challenge
CG-Rev-011	Infrared provides 2-4 measurements per day (or less with cloud covers). Geostacionary satellites (e.g. METEOSAT, GOES) recurrent every 3 hour (clouds affect). Microwave observations from (e.g. AMSR) complement cloud cover areas at lower resolution and far from coast-land areas.
CG-Rev-012	Resolution of infrared radiometers are reasonable for coastal areas (aprox 1-2 km). Differencies arise between the analyses and interpolation procedures to obtain high level products.
CG-Rev-013	For climate studies the only valuable analysis is based on AVHRR data because extends back to 1981. ATSR and AATSR microwaves on ENVISAT between 1991 and 2012 has contributed to complement infrared observations. To ensure a long time monitoring, a successful combination with new radiometers (e.g. MODIS, SENTINEL) and microwaves instruments is needed providing higher resolutions, global coverage and overcome cloud cover problems of infrared captors.
CG-Rev-014	Somehow national agencies through the Argo program coordinate the strategy to deploy the array of floats. However the scientific community and research projects may have their own objectives which can not be in line with the need of a uniform coverage.
CG-Rev-015	Lack of Argo in marginal seas is more related with the coordination and efforts of agencies in riparian countries while the lack in shelf seas and shelf areas (¡ 200 m depth) is more a consequence of Argo planning decissions. On shelf areas the topography may be highly variable and the probability of beaching can be high to interrupt the monitoring. Polar areas covered by ice capes introduces further complexity to make transmission available.
CG-Rev-016	This gap has been merged with gap 53
CG-Rev-017	This row should be dropped
CG-Rev-018	The gap type has been changed to better reflect the nature of the gap.
CG-Rev-019	Merged gap for both EV Temperature and Salinity (Subsurface)
CG-Rev-020	Merged for both EV Temperature and Salinity (Subsurface)

Table 34 continued.

ID	DESCRIPTION
CG-Rev-021	This gap affects many variables.Probably the main measure is to reinforce the Argo program as the most satisfactory way of solve this gap. Somehow national agencies through the Argo program coordinate the strategy to deploy the array of floats. However the scientific community and research projects may have their own interests which can not be in line with the need of a uniform coverage.
CG-Rev-022	This gap affects many variables.This gaps has been merged with gap 91Probably the main measure is to reinforce the Argo program as the most satisfactory way of solve this gap. Note however that for temperature ther exist complentary in situ sampling comming from regular XBT sectosn
CG-Rev-023	%RED%This gap has been merged with gap 89. It should be discarded.%ENDCOLOR%
CG-Rev-024	Ocean currents is probably the only variable that can be measured through many different direct and indirect methods and techniques (drifters, Doppler effect, dynamic topography, mechanical methods, etc).

Table 35. Recommendations of gaps available so far.

ID	DESCRIPTION
CG-Rec-001	Currently, companies must invest in very costly campaigns for collecting data on local bathymetry, type of floor, swell etc. These campaigns must last approx. 1 year and are very expensive, especailly outside Europe.

Table 36. Links of Gaps to EVs, References and Reviews.

ID	LEFT	RIGHT	DESCRIPTION
CGTG-1-EV-CG-001	CGTG-1	EV-CG-001	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-1-GAT-CG-BUT1	CGTG-1	GAT-CG-BUT1	Thread used for gap analysis
CGTG-1-THEM-CG-CL	CGTG-1	THEM-CG-CL	Main theme of the gap
CGTG-1-CG-Ref-001	CGTG-1	CG-Ref-001	Reference for gap determined in gap analysis
CGTG-2-EV-CG-002	CGTG-2	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-2-GAT-CG-TDT2	CGTG-2	GAT-CG-TDT2	Thread used for gap analysis
CGTG-2-THEM-CG-CL	CGTG-2	THEM-CG-CL	Main theme of the gap
CGTG-2-CG-Ref-002	CGTG-2	CG-Ref-002	Reference for gap determined in gap analysis
CGTG-3-EV-CG-002	CGTG-3	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-3-GAT-CG-TDT2	CGTG-3	GAT-CG-TDT2	Thread used for gap analysis
CGTG-3-THEM-CG-CL	CGTG-3	THEM-CG-CL	Main theme of the gap
CGTG-3-CG-Ref-003	CGTG-3	CG-Ref-003	Reference for gap determined in gap analysis
CGTG-4-EV-CG-002	CGTG-4	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-4-GAT-CG-TDT2	CGTG-4	GAT-CG-TDT2	Thread used for gap analysis
CGTG-4-THEM-CG-CL	CGTG-4	THEM-CG-CL	Main theme of the gap
CGTG-4-CG-Ref-002	CGTG-4	CG-Ref-002	Reference for gap determined in gap analysis
CGTG-5-EV-CG-003	CGTG-5	EV-CG-003	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-5-GAT-CG-TDT2	CGTG-5	GAT-CG-TDT2	Thread used for gap analysis
CGTG-5-THEM-CG-CL	CGTG-5	THEM-CG-CL	Main theme of the gap
CGTG-5-CG-Ref-002	CGTG-5	CG-Ref-002	Reference for gap determined in gap analysis
CGTG-6-EV-CG-003	CGTG-6	EV-CG-003	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-6-GAT-CG-TDT2	CGTG-6	GAT-CG-TDT2	Thread used for gap analysis
CGTG-6-THEM-CG-CL	CGTG-6	THEM-CG-CL	Main theme of the gap
CGTG-6-CG-Ref-002	CGTG-6	CG-Ref-002	Reference for gap determined in gap analysis
CGTG-7-EV-CG-002	CGTG-7	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-7-GAT-CG-TDT2	CGTG-7	GAT-CG-TDT2	Thread used for gap analysis
CGTG-7-THEM-CG-CL	CGTG-7	THEM-CG-CL	Main theme of the gap
CGTG-7-CG-Ref-002	CGTG-7	CG-Ref-002	Reference for gap determined in gap analysis
CGTG-8-EV-CG-002	CGTG-8	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-8-GAT-CG-TDT2	CGTG-8	GAT-CG-TDT2	Thread used for gap analysis
CGTG-8-THEM-CG-CL	CGTG-8	THEM-CG-CL	Main theme of the gap
CGTG-8-CG-Ref-004	CGTG-8	CG-Ref-004	Reference for gap determined in gap analysis
CGTG-9-EV-CG-004	CGTG-9	EV-CG-004	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-9-GAT-CG-TDT2	CGTG-9	GAT-CG-TDT2	Thread used for gap analysis
CGTG-9-THEM-CG-CL	CGTG-9	THEM-CG-CL	Main theme of the gap
CGTG-809-EV-CG-001	CGTG-809	EV-CG-001	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-809-GAT-CG-TDT2	CGTG-809	GAT-CG-TDT2	Thread used for gap analysis
CGTG-809-THEM-CG-CL	CGTG-809	THEM-CG-CL	Main theme of the gap
CGTG-810-EV-CG-005	CGTG-810	EV-CG-005	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-810-GAT-CG-TDT2	CGTG-810	GAT-CG-TDT2	Thread used for gap analysis
CGTG-810-THEM-CG-CL	CGTG-810	THEM-CG-CL	Main theme of the gap
CGTG-810-EV-CG-006	CGTG-810	EV-CG-006	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-810-GAT-CG-TDT2	CGTG-810	GAT-CG-TDT2	Thread used for gap analysis
CGTG-810-THEM-CG-CL	CGTG-810	THEM-CG-CL	Main theme of the gap

Table 36 continued.

ID	LEFT	RIGHT	DESCRIPTION
CGTG-810-EV-CG-007	CGTG-810	EV-CG-007	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-810-GAT-CG-TDT2	CGTG-810	GAT-CG-TDT2	Thread used for gap analysis
CGTG-810-THEM-CG-CL	CGTG-810	THEM-CG-CL	Main theme of the gap
CGTG-10-EV-CG-003	CGTG-10	EV-CG-003	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-10-GAT-CG-TDT2	CGTG-10	GAT-CG-TDT2	Thread used for gap analysis
CGTG-10-THEM-CG-CL	CGTG-10	THEM-CG-CL	Main theme of the gap
CGTG-10-CG-Ref-002	CGTG-10	CG-Ref-002	Reference for gap determined in gap analysis
CGTG-11-EV-CG-003	CGTG-11	EV-CG-003	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-11-GAT-CG-TDT2	CGTG-11	GAT-CG-TDT2	Thread used for gap analysis
CGTG-11-THEM-CG-CL	CGTG-11	THEM-CG-CL	Main theme of the gap
CGTG-11-CG-Ref-002	CGTG-11	CG-Ref-002	Reference for gap determined in gap analysis
CGTG-12-EV-CG-008	CGTG-12	EV-CG-008	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-12-GAT-CG-TDT2	CGTG-12	GAT-CG-TDT2	Thread used for gap analysis
CGTG-12-THEM-CG-CL	CGTG-12	THEM-CG-CL	Main theme of the gap
CGTG-12-CG-Ref-003	CGTG-12	CG-Ref-003	Reference for gap determined in gap analysis
CGTG-13-EV-CG-008	CGTG-13	EV-CG-008	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-13-GAT-CG-TDT2	CGTG-13	GAT-CG-TDT2	Thread used for gap analysis
CGTG-13-THEM-CG-CL	CGTG-13	THEM-CG-CL	Main theme of the gap
CGTG-13-CG-Ref-005	CGTG-13	CG-Ref-005	Reference for gap determined in gap analysis
CGTG-14-EV-CG-002	CGTG-14	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-14-GAT-CG-TDT2	CGTG-14	GAT-CG-TDT2	Thread used for gap analysis
CGTG-14-THEM-CG-CL	CGTG-14	THEM-CG-CL	Main theme of the gap
CGTG-14-CG-Ref-002	CGTG-14	CG-Ref-002	Reference for gap determined in gap analysis
CGTG-15-EV-CG-008	CGTG-15	EV-CG-008	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-15-GAT-CG-TDT2	CGTG-15	GAT-CG-TDT2	Thread used for gap analysis
CGTG-15-THEM-CG-CL	CGTG-15	THEM-CG-CL	Main theme of the gap
CGTG-15-CG-Ref-006	CGTG-15	CG-Ref-006	Reference for gap determined in gap analysis
CGTG-16-EV-CG-008	CGTG-16	EV-CG-008	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-16-GAT-CG-TDT2	CGTG-16	GAT-CG-TDT2	Thread used for gap analysis
CGTG-16-THEM-CG-CL	CGTG-16	THEM-CG-CL	Main theme of the gap
CGTG-16-CG-Ref-007	CGTG-16	CG-Ref-007	Reference for gap determined in gap analysis
CGTG-17-EV-CG-009	CGTG-17	EV-CG-009	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-17-GAT-CG-TDT2	CGTG-17	GAT-CG-TDT2	Thread used for gap analysis
CGTG-17-THEM-CG-EN	CGTG-17	THEM-CG-EN	Main theme of the gap
CGTG-17-CG-Ref-008	CGTG-17	CG-Ref-008	Reference for gap determined in gap analysis
CGTG-18-EV-CG-010	CGTG-18	EV-CG-010	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-18-GAT-CG-TDT2	CGTG-18	GAT-CG-TDT2	Thread used for gap analysis
CGTG-18-THEM-CG-EN	CGTG-18	THEM-CG-EN	Main theme of the gap
CGTG-18-CG-Ref-009	CGTG-18	CG-Ref-009	Reference for gap determined in gap analysis
CGTG-19-EV-CG-011	CGTG-19	EV-CG-011	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-19-EV-CG-012	CGTG-19	EV-CG-012	Other EV impacted by this gap. Result of a gap analysis.
CGTG-19-EV-CG-002	CGTG-19	EV-CG-002	Other EV impacted by this gap. Result of a gap analysis.
CGTG-19-EV-CG-004	CGTG-19	EV-CG-004	Other EV impacted by this gap. Result of a gap analysis.
CGTG-19-EV-CG-013	CGTG-19	EV-CG-013	Other EV impacted by this gap. Result of a gap analysis.
CGTG-19-EV-CG-014	CGTG-19	EV-CG-014	Other EV impacted by this gap. Result of a gap analysis.

Table 36 continued.

ID	LEFT	RIGHT	DESCRIPTION
CGTG-19-GAT-CG-TDT2	CGTG-19	GAT-CG-TDT2	Thread used for gap analysis
CGTG-19-THEM-CG-WA	CGTG-19	THEM-CG-WA	Main theme of the gap
CGTG-19-CG-Ref-009	CGTG-19	CG-Ref-009	Reference for gap determined in gap analysis
CGTG-20-EV-CG-010	CGTG-20	EV-CG-010	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-20-GAT-CG-TDT2	CGTG-20	GAT-CG-TDT2	Thread used for gap analysis
CGTG-20-THEM-CG-DI	CGTG-20	THEM-CG-DI	Main theme of the gap
CGTG-20-CG-Ref-010	CGTG-20	CG-Ref-010	Reference for gap determined in gap analysis
CGTG-21-EV-CG-004	CGTG-21	EV-CG-004	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-21-EV-CG-012	CGTG-21	EV-CG-012	Other EV impacted by this gap. Result of a gap analysis.
CGTG-21-EV-CG-002	CGTG-21	EV-CG-002	Other EV impacted by this gap. Result of a gap analysis.
CGTG-21-GAT-CG-TDT2	CGTG-21	GAT-CG-TDT2	Thread used for gap analysis
CGTG-21-THEM-CG-DI	CGTG-21	THEM-CG-DI	Main theme of the gap
CGTG-21-CG-Ref-011	CGTG-21	CG-Ref-011	Reference for gap determined in gap analysis
CGTG-22-EV-CG-015	CGTG-22	EV-CG-015	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-22-GAT-CG-TDT2	CGTG-22	GAT-CG-TDT2	Thread used for gap analysis
CGTG-22-THEM-CG-BI	CGTG-22	THEM-CG-BI	Main theme of the gap
CGTG-22-CG-Ref-012	CGTG-22	CG-Ref-012	Reference for gap determined in gap analysis
CGTG-23-EV-CG-016	CGTG-23	EV-CG-016	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-23-EV-CG-017	CGTG-23	EV-CG-017	Other EV impacted by this gap. Result of a gap analysis.
CGTG-23-GAT-CG-TDT2	CGTG-23	GAT-CG-TDT2	Thread used for gap analysis
CGTG-23-THEM-CG-BI	CGTG-23	THEM-CG-BI	Main theme of the gap
CGTG-23-CG-Ref-013	CGTG-23	CG-Ref-013	Reference for gap determined in gap analysis
CGTG-24-EV-CG-018	CGTG-24	EV-CG-018	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-24-GAT-CG-TDT2	CGTG-24	GAT-CG-TDT2	Thread used for gap analysis
CGTG-24-THEM-CG-OC	CGTG-24	THEM-CG-OC	Main theme of the gap
CGTG-24-CG-Ref-014	CGTG-24	CG-Ref-014	Reference for gap determined in gap analysis
CGTG-24-CG-Rev-001	CGTG-24	CG-Rev-001	Review of gap determined in gap analysis
CGTG-25-EV-CG-018	CGTG-25	EV-CG-018	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-25-EV-CG-019	CGTG-25	EV-CG-019	Other EV impacted by this gap. Result of a gap analysis.
CGTG-25-GAT-CG-TDT2	CGTG-25	GAT-CG-TDT2	Thread used for gap analysis
CGTG-25-THEM-CG-OC	CGTG-25	THEM-CG-OC	Main theme of the gap
CGTG-25-CG-Ref-014	CGTG-25	CG-Ref-014	Reference for gap determined in gap analysis
CGTG-25-CG-Rev-002	CGTG-25	CG-Rev-002	Review of gap determined in gap analysis
CGTG-26-EV-CG-020	CGTG-26	EV-CG-020	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-26-GAT-CG-TDT2	CGTG-26	GAT-CG-TDT2	Thread used for gap analysis
CGTG-26-THEM-CG-OC	CGTG-26	THEM-CG-OC	Main theme of the gap
CGTG-26-CG-Ref-014	CGTG-26	CG-Ref-014	Reference for gap determined in gap analysis
CGTG-26-CG-Rev-003	CGTG-26	CG-Rev-003	Review of gap determined in gap analysis
CGTG-27-EV-CG-021	CGTG-27	EV-CG-021	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-27-GAT-CG-TDT2	CGTG-27	GAT-CG-TDT2	Thread used for gap analysis
CGTG-27-THEM-CG-OC	CGTG-27	THEM-CG-OC	Main theme of the gap
CGTG-27-THEM-CG-BI	CGTG-27	THEM-CG-BI	Other theme of the gap
CGTG-27-CG-Ref-014	CGTG-27	CG-Ref-014	Reference for gap determined in gap analysis
CGTG-27-CG-Rev-004	CGTG-27	CG-Rev-004	Review of gap determined in gap analysis
CGTG-28-EV-CG-005	CGTG-28	EV-CG-005	Primary EV impacted by this gap. Result of a gap analysis.

Table 36 continued.

ID	LEFT	RIGHT	DESCRIPTION
CGTG-28-GAT-CG-TDT2	CGTG-28	GAT-CG-TDT2	Thread used for gap analysis
CGTG-28-THEM-CG-MU	CGTG-28	THEM-CG-MU	Main theme of the gap
CGTG-28-THEM-CG-CL	CGTG-28	THEM-CG-CL	Other theme of the gap
CGTG-28-THEM-CG-OC	CGTG-28	THEM-CG-OC	Other theme of the gap
CGTG-28-THEM-CG-DI	CGTG-28	THEM-CG-DI	Other theme of the gap
CGTG-28-THEM-CG-EN	CGTG-28	THEM-CG-EN	Other theme of the gap
CGTG-28-CG-Ref-014	CGTG-28	CG-Ref-014	Reference for gap determined in gap analysis
CGTG-28-CG-Rev-005	CGTG-28	CG-Rev-005	Review of gap determined in gap analysis
CGTG-29-EV-CG-020	CGTG-29	EV-CG-020	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-29-GAT-CG-TDT2	CGTG-29	GAT-CG-TDT2	Thread used for gap analysis
CGTG-29-THEM-CG-OC	CGTG-29	THEM-CG-OC	Main theme of the gap
CGTG-29-THEM-CG-DI	CGTG-29	THEM-CG-DI	Other theme of the gap
CGTG-29-CG-Ref-014	CGTG-29	CG-Ref-014	Reference for gap determined in gap analysis
CGTG-29-CG-Rev-006	CGTG-29	CG-Rev-006	Review of gap determined in gap analysis
CGTG-30-EV-CG-002	CGTG-30	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-30-GAT-CG-TDT2	CGTG-30	GAT-CG-TDT2	Thread used for gap analysis
CGTG-30-THEM-CG-CL	CGTG-30	THEM-CG-CL	Main theme of the gap
CGTG-30-CG-Ref-014	CGTG-30	CG-Ref-014	Reference for gap determined in gap analysis
CGTG-31-EV-CG-011	CGTG-31	EV-CG-011	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-31-EV-CG-006	CGTG-31	EV-CG-006	Other EV impacted by this gap. Result of a gap analysis.
CGTG-31-GAT-CG-TDT2	CGTG-31	GAT-CG-TDT2	Thread used for gap analysis
CGTG-31-THEM-CG-CL	CGTG-31	THEM-CG-CL	Main theme of the gap
CGTG-31-CG-Ref-014	CGTG-31	CG-Ref-014	Reference for gap determined in gap analysis
CGTG-32-EV-CG-022	CGTG-32	EV-CG-022	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-32-GAT-CG-TDT2	CGTG-32	GAT-CG-TDT2	Thread used for gap analysis
CGTG-32-THEM-CG-BI	CGTG-32	THEM-CG-BI	Main theme of the gap
CGTG-32-CG-Ref-014	CGTG-32	CG-Ref-014	Reference for gap determined in gap analysis
CGTG-33-EV-CG-023	CGTG-33	EV-CG-023	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-33-GAT-CG-TDT2	CGTG-33	GAT-CG-TDT2	Thread used for gap analysis
CGTG-33-THEM-CG-CL	CGTG-33	THEM-CG-CL	Main theme of the gap
CGTG-33-CG-Ref-014	CGTG-33	CG-Ref-014	Reference for gap determined in gap analysis
CGTG-34-EV-CG-015	CGTG-34	EV-CG-015	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-34-GAT-CG-TDT2	CGTG-34	GAT-CG-TDT2	Thread used for gap analysis
CGTG-34-THEM-CG-BI	CGTG-34	THEM-CG-BI	Main theme of the gap
CGTG-34-CG-Ref-015	CGTG-34	CG-Ref-015	Reference for gap determined in gap analysis
CGTG-35-EV-CG-015	CGTG-35	EV-CG-015	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-35-GAT-CG-TDT2	CGTG-35	GAT-CG-TDT2	Thread used for gap analysis
CGTG-35-THEM-CG-BI	CGTG-35	THEM-CG-BI	Main theme of the gap
CGTG-35-CG-Ref-015	CGTG-35	CG-Ref-015	Reference for gap determined in gap analysis
CGTG-35-CG-Rev-007	CGTG-35	CG-Rev-007	Review of gap determined in gap analysis
CGTG-36-EV-CG-015	CGTG-36	EV-CG-015	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-36-GAT-CG-TDT2	CGTG-36	GAT-CG-TDT2	Thread used for gap analysis
CGTG-36-THEM-CG-BI	CGTG-36	THEM-CG-BI	Main theme of the gap
CGTG-36-CG-Ref-015	CGTG-36	CG-Ref-015	Reference for gap determined in gap analysis
CGTG-36-CG-Rev-008	CGTG-36	CG-Rev-008	Review of gap determined in gap analysis

Table 36 continued.

ID	LEFT	RIGHT	DESCRIPTION
CGTG-37-EV-CG-024	CGTG-37	EV-CG-024	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-37-EV-CG-025	CGTG-37	EV-CG-025	Other EV impacted by this gap. Result of a gap analysis.
CGTG-37-EV-CG-026	CGTG-37	EV-CG-026	Other EV impacted by this gap. Result of a gap analysis.
CGTG-37-EV-CG-027	CGTG-37	EV-CG-027	Other EV impacted by this gap. Result of a gap analysis.
CGTG-37-EV-CG-028	CGTG-37	EV-CG-028	Other EV impacted by this gap. Result of a gap analysis.
CGTG-37-EV-CG-029	CGTG-37	EV-CG-029	Other EV impacted by this gap. Result of a gap analysis.
CGTG-37-EV-CG-030	CGTG-37	EV-CG-030	Other EV impacted by this gap. Result of a gap analysis.
CGTG-37-GAT-CG-TDT2	CGTG-37	GAT-CG-TDT2	Thread used for gap analysis
CGTG-37-THEM-CG-BI	CGTG-37	THEM-CG-BI	Main theme of the gap
CGTG-37-CG-Ref-016	CGTG-37	CG-Ref-016	Reference for gap determined in gap analysis
CGTG-38-EV-CG-010	CGTG-38	EV-CG-010	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-38-GAT-CG-TDT2	CGTG-38	GAT-CG-TDT2	Thread used for gap analysis
CGTG-38-THEM-CG-DI	CGTG-38	THEM-CG-DI	Main theme of the gap
CGTG-38-CG-Ref-017	CGTG-38	CG-Ref-017	Reference for gap determined in gap analysis
CGTG-39-EV-CG-031	CGTG-39	EV-CG-031	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-39-GAT-CG-TDT2	CGTG-39	GAT-CG-TDT2	Thread used for gap analysis
CGTG-39-THEM-CG-CL	CGTG-39	THEM-CG-CL	Main theme of the gap
CGTG-39-CG-Ref-018	CGTG-39	CG-Ref-018	Reference for gap determined in gap analysis
CGTG-40-EV-CG-032	CGTG-40	EV-CG-032	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-40-GAT-CG-TDT2	CGTG-40	GAT-CG-TDT2	Thread used for gap analysis
CGTG-40-THEM-CG-BI	CGTG-40	THEM-CG-BI	Main theme of the gap
CGTG-40-CG-Ref-019	CGTG-40	CG-Ref-019	Reference for gap determined in gap analysis
CGTG-41-EV-CG-015	CGTG-41	EV-CG-015	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-41-GAT-CG-TDT2	CGTG-41	GAT-CG-TDT2	Thread used for gap analysis
CGTG-41-THEM-CG-BI	CGTG-41	THEM-CG-BI	Main theme of the gap
CGTG-41-CG-Ref-019	CGTG-41	CG-Ref-019	Reference for gap determined in gap analysis
CGTG-42-EV-CG-015	CGTG-42	EV-CG-015	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-42-GAT-CG-TDT2	CGTG-42	GAT-CG-TDT2	Thread used for gap analysis
CGTG-42-THEM-CG-BI	CGTG-42	THEM-CG-BI	Main theme of the gap
CGTG-42-CG-Ref-019	CGTG-42	CG-Ref-019	Reference for gap determined in gap analysis
CGTG-43-EV-CG-033	CGTG-43	EV-CG-033	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-43-GAT-CG-TDT1	CGTG-43	GAT-CG-TDT1	Thread used for gap analysis
CGTG-43-THEM-CG-EN	CGTG-43	THEM-CG-EN	Main theme of the gap
CGTG-43-CG-Ref-020	CGTG-43	CG-Ref-020	Reference for gap determined in gap analysis
CGTG-44-EV-CG-034	CGTG-44	EV-CG-034	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-44-GAT-CG-BUT3	CGTG-44	GAT-CG-BUT3	Thread used for gap analysis
CGTG-44-THEM-CG-EN	CGTG-44	THEM-CG-EN	Main theme of the gap
CGTG-44-CG-Ref-021	CGTG-44	CG-Ref-021	Reference for gap determined in gap analysis
CGTG-44-CG-Rev-009	CGTG-44	CG-Rev-009	Review of gap determined in gap analysis
CGTG-45-EV-CG-035	CGTG-45	EV-CG-035	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-45-EV-CG-036	CGTG-45	EV-CG-036	Other EV impacted by this gap. Result of a gap analysis.
CGTG-45-EV-CG-037	CGTG-45	EV-CG-037	Other EV impacted by this gap. Result of a gap analysis.
CGTG-45-EV-CG-038	CGTG-45	EV-CG-038	Other EV impacted by this gap. Result of a gap analysis.
CGTG-45-GAT-CG-BUT3	CGTG-45	GAT-CG-BUT3	Thread used for gap analysis
CGTG-45-THEM-CG-EN	CGTG-45	THEM-CG-EN	Main theme of the gap

Table 36 continued.

ID	LEFT	RIGHT	DESCRIPTION
CGTG-45-CG-Ref-022	CGTG-45	CG-Ref-022	Reference for gap determined in gap analysis
CGTG-45-CG-Rev-010	CGTG-45	CG-Rev-010	Review of gap determined in gap analysis
CGTG-45-CG-Rec-001	CGTG-45	CG-Rec-001	Recommendation on handling gap determined in gap analysis
CGTG-46-EV-CG-020	CGTG-46	EV-CG-020	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-46-GAT-CG-BUT1	CGTG-46	GAT-CG-BUT1	Thread used for gap analysis
CGTG-46-THEM-CG-MU	CGTG-46	THEM-CG-MU	Main theme of the gap
CGTG-46-THEM-CG-CL	CGTG-46	THEM-CG-CL	Other theme of the gap
CGTG-46-THEM-CG-OC	CGTG-46	THEM-CG-OC	Other theme of the gap
CGTG-46-THEM-CG-WA	CGTG-46	THEM-CG-WA	Other theme of the gap
CGTG-46-THEM-CG-BI	CGTG-46	THEM-CG-BI	Other theme of the gap
CGTG-46-THEM-CG-DI	CGTG-46	THEM-CG-DI	Other theme of the gap
CGTG-46-CG-Ref-023	CGTG-46	CG-Ref-023	Reference for gap determined in gap analysis
CGTG-46-CG-Rev-011	CGTG-46	CG-Rev-011	Review of gap determined in gap analysis
CGTG-47-EV-CG-020	CGTG-47	EV-CG-020	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-47-GAT-CG-BUT1	CGTG-47	GAT-CG-BUT1	Thread used for gap analysis
CGTG-47-THEM-CG-MU	CGTG-47	THEM-CG-MU	Main theme of the gap
CGTG-47-THEM-CG-CL	CGTG-47	THEM-CG-CL	Other theme of the gap
CGTG-47-THEM-CG-OC	CGTG-47	THEM-CG-OC	Other theme of the gap
CGTG-47-THEM-CG-WA	CGTG-47	THEM-CG-WA	Other theme of the gap
CGTG-47-THEM-CG-BI	CGTG-47	THEM-CG-BI	Other theme of the gap
CGTG-47-THEM-CG-DI	CGTG-47	THEM-CG-DI	Other theme of the gap
CGTG-47-CG-Ref-024	CGTG-47	CG-Ref-024	Reference for gap determined in gap analysis
CGTG-47-CG-Rev-012	CGTG-47	CG-Rev-012	Review of gap determined in gap analysis
CGTG-48-EV-CG-020	CGTG-48	EV-CG-020	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-48-GAT-CG-BUT1	CGTG-48	GAT-CG-BUT1	Thread used for gap analysis
CGTG-48-THEM-CG-MU	CGTG-48	THEM-CG-MU	Main theme of the gap
CGTG-48-THEM-CG-CL	CGTG-48	THEM-CG-CL	Other theme of the gap
CGTG-48-THEM-CG-OC	CGTG-48	THEM-CG-OC	Other theme of the gap
CGTG-48-THEM-CG-WA	CGTG-48	THEM-CG-WA	Other theme of the gap
CGTG-48-THEM-CG-BI	CGTG-48	THEM-CG-BI	Other theme of the gap
CGTG-48-THEM-CG-DI	CGTG-48	THEM-CG-DI	Other theme of the gap
CGTG-48-CG-Ref-024	CGTG-48	CG-Ref-024	Reference for gap determined in gap analysis
CGTG-48-CG-Rev-013	CGTG-48	CG-Rev-013	Review of gap determined in gap analysis
CGTG-49-EV-CG-020	CGTG-49	EV-CG-020	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-49-GAT-CG-BUT1	CGTG-49	GAT-CG-BUT1	Thread used for gap analysis
CGTG-49-THEM-CG-MU	CGTG-49	THEM-CG-MU	Main theme of the gap
CGTG-49-THEM-CG-CL	CGTG-49	THEM-CG-CL	Other theme of the gap
CGTG-49-THEM-CG-OC	CGTG-49	THEM-CG-OC	Other theme of the gap
CGTG-49-THEM-CG-WA	CGTG-49	THEM-CG-WA	Other theme of the gap
CGTG-49-THEM-CG-BI	CGTG-49	THEM-CG-BI	Other theme of the gap
CGTG-49-THEM-CG-DI	CGTG-49	THEM-CG-DI	Other theme of the gap
CGTG-49-CG-Ref-025	CGTG-49	CG-Ref-025	Reference for gap determined in gap analysis
CGTG-49-CG-Rev-014	CGTG-49	CG-Rev-014	Review of gap determined in gap analysis
CGTG-50-EV-CG-020	CGTG-50	EV-CG-020	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-50-GAT-CG-BUT1	CGTG-50	GAT-CG-BUT1	Thread used for gap analysis

Table 36 continued.

ID	LEFT	RIGHT	DESCRIPTION
CGTG-50-THEM-CG-MU	CGTG-50	THEM-CG-MU	Main theme of the gap
CGTG-50-THEM-CG-CL	CGTG-50	THEM-CG-CL	Other theme of the gap
CGTG-50-THEM-CG-OC	CGTG-50	THEM-CG-OC	Other theme of the gap
CGTG-50-THEM-CG-WA	CGTG-50	THEM-CG-WA	Other theme of the gap
CGTG-50-THEM-CG-BI	CGTG-50	THEM-CG-BI	Other theme of the gap
CGTG-50-THEM-CG-DI	CGTG-50	THEM-CG-DI	Other theme of the gap
CGTG-50-CG-Ref-026	CGTG-50	CG-Ref-026	Reference for gap determined in gap analysis
CGTG-50-CG-Rev-015	CGTG-50	CG-Rev-015	Review of gap determined in gap analysis
CGTG-51-EV-CG-020	CGTG-51	EV-CG-020	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-51-GAT-CG-BUT1	CGTG-51	GAT-CG-BUT1	Thread used for gap analysis
CGTG-51-THEM-CG-MU	CGTG-51	THEM-CG-MU	Main theme of the gap
CGTG-51-THEM-CG-CL	CGTG-51	THEM-CG-CL	Other theme of the gap
CGTG-51-THEM-CG-OC	CGTG-51	THEM-CG-OC	Other theme of the gap
CGTG-51-THEM-CG-WA	CGTG-51	THEM-CG-WA	Other theme of the gap
CGTG-51-THEM-CG-BI	CGTG-51	THEM-CG-BI	Other theme of the gap
CGTG-51-THEM-CG-DI	CGTG-51	THEM-CG-DI	Other theme of the gap
CGTG-51-CG-Ref-027	CGTG-51	CG-Ref-027	Reference for gap determined in gap analysis
CGTG-52-EV-CG-020	CGTG-52	EV-CG-020	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-52-GAT-CG-BUT1	CGTG-52	GAT-CG-BUT1	Thread used for gap analysis
CGTG-52-THEM-CG-MU	CGTG-52	THEM-CG-MU	Main theme of the gap
CGTG-52-THEM-CG-CL	CGTG-52	THEM-CG-CL	Other theme of the gap
CGTG-52-THEM-CG-OC	CGTG-52	THEM-CG-OC	Other theme of the gap
CGTG-52-THEM-CG-WA	CGTG-52	THEM-CG-WA	Other theme of the gap
CGTG-52-THEM-CG-BI	CGTG-52	THEM-CG-BI	Other theme of the gap
CGTG-52-THEM-CG-DI	CGTG-52	THEM-CG-DI	Other theme of the gap
CGTG-52-CG-Ref-028	CGTG-52	CG-Ref-028	Reference for gap determined in gap analysis
CGTG-52-CG-Rev-016	CGTG-52	CG-Rev-016	Review of gap determined in gap analysis
CGTG-53-EV-CG-020	CGTG-53	EV-CG-020	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-53-GAT-CG-BUT1	CGTG-53	GAT-CG-BUT1	Thread used for gap analysis
CGTG-53-THEM-CG-MU	CGTG-53	THEM-CG-MU	Main theme of the gap
CGTG-53-THEM-CG-CL	CGTG-53	THEM-CG-CL	Other theme of the gap
CGTG-53-THEM-CG-OC	CGTG-53	THEM-CG-OC	Other theme of the gap
CGTG-53-THEM-CG-WA	CGTG-53	THEM-CG-WA	Other theme of the gap
CGTG-53-THEM-CG-BI	CGTG-53	THEM-CG-BI	Other theme of the gap
CGTG-53-THEM-CG-DI	CGTG-53	THEM-CG-DI	Other theme of the gap
CGTG-53-CG-Ref-029	CGTG-53	CG-Ref-029	Reference for gap determined in gap analysis
CGTG-53-CG-Rev-017	CGTG-53	CG-Rev-017	Review of gap determined in gap analysis
CGTG-57-EV-CG-039	CGTG-57	EV-CG-039	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-57-EV-CG-040	CGTG-57	EV-CG-040	Other EV impacted by this gap. Result of a gap analysis.
CGTG-57-GAT-CG-BUT1	CGTG-57	GAT-CG-BUT1	Thread used for gap analysis
CGTG-57-THEM-CG-MU	CGTG-57	THEM-CG-MU	Main theme of the gap
CGTG-57-THEM-CG-CL	CGTG-57	THEM-CG-CL	Other theme of the gap
CGTG-57-THEM-CG-OC	CGTG-57	THEM-CG-OC	Other theme of the gap
CGTG-57-THEM-CG-WA	CGTG-57	THEM-CG-WA	Other theme of the gap
CGTG-57-THEM-CG-BI	CGTG-57	THEM-CG-BI	Other theme of the gap

Table 36 continued.

ID	LEFT	RIGHT	DESCRIPTION
CGTG-57-CG-Ref-030	CGTG-57	CG-Ref-030	Reference for gap determined in gap analysis
CGTG-58-EV-CG-039	CGTG-58	EV-CG-039	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-58-GAT-CG-BUT1	CGTG-58	GAT-CG-BUT1	Thread used for gap analysis
CGTG-58-THEM-CG-MU	CGTG-58	THEM-CG-MU	Main theme of the gap
CGTG-58-THEM-CG-CL	CGTG-58	THEM-CG-CL	Other theme of the gap
CGTG-58-THEM-CG-OC	CGTG-58	THEM-CG-OC	Other theme of the gap
CGTG-58-THEM-CG-WA	CGTG-58	THEM-CG-WA	Other theme of the gap
CGTG-58-THEM-CG-BI	CGTG-58	THEM-CG-BI	Other theme of the gap
CGTG-58-CG-Ref-031	CGTG-58	CG-Ref-031	Reference for gap determined in gap analysis
CGTG-59-EV-CG-039	CGTG-59	EV-CG-039	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-59-GAT-CG-BUT1	CGTG-59	GAT-CG-BUT1	Thread used for gap analysis
CGTG-59-THEM-CG-MU	CGTG-59	THEM-CG-MU	Main theme of the gap
CGTG-59-THEM-CG-CL	CGTG-59	THEM-CG-CL	Other theme of the gap
CGTG-59-THEM-CG-OC	CGTG-59	THEM-CG-OC	Other theme of the gap
CGTG-59-THEM-CG-WA	CGTG-59	THEM-CG-WA	Other theme of the gap
CGTG-59-THEM-CG-BI	CGTG-59	THEM-CG-BI	Other theme of the gap
CGTG-59-CG-Ref-032	CGTG-59	CG-Ref-032	Reference for gap determined in gap analysis
CGTG-60-EV-CG-039	CGTG-60	EV-CG-039	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-60-GAT-CG-BUT1	CGTG-60	GAT-CG-BUT1	Thread used for gap analysis
CGTG-60-THEM-CG-MU	CGTG-60	THEM-CG-MU	Main theme of the gap
CGTG-60-THEM-CG-CL	CGTG-60	THEM-CG-CL	Other theme of the gap
CGTG-60-THEM-CG-OC	CGTG-60	THEM-CG-OC	Other theme of the gap
CGTG-60-THEM-CG-WA	CGTG-60	THEM-CG-WA	Other theme of the gap
CGTG-60-THEM-CG-BI	CGTG-60	THEM-CG-BI	Other theme of the gap
CGTG-60-CG-Ref-031	CGTG-60	CG-Ref-031	Reference for gap determined in gap analysis
CGTG-61-EV-CG-039	CGTG-61	EV-CG-039	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-61-GAT-CG-BUT1	CGTG-61	GAT-CG-BUT1	Thread used for gap analysis
CGTG-61-THEM-CG-MU	CGTG-61	THEM-CG-MU	Main theme of the gap
CGTG-61-THEM-CG-CL	CGTG-61	THEM-CG-CL	Other theme of the gap
CGTG-61-THEM-CG-OC	CGTG-61	THEM-CG-OC	Other theme of the gap
CGTG-61-THEM-CG-WA	CGTG-61	THEM-CG-WA	Other theme of the gap
CGTG-61-THEM-CG-BI	CGTG-61	THEM-CG-BI	Other theme of the gap
CGTG-61-CG-Ref-033	CGTG-61	CG-Ref-033	Reference for gap determined in gap analysis
CGTG-61-CG-Rev-018	CGTG-61	CG-Rev-018	Review of gap determined in gap analysis
CGTG-62-EV-CG-039	CGTG-62	EV-CG-039	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-62-GAT-CG-BUT1	CGTG-62	GAT-CG-BUT1	Thread used for gap analysis
CGTG-62-THEM-CG-MU	CGTG-62	THEM-CG-MU	Main theme of the gap
CGTG-62-THEM-CG-CL	CGTG-62	THEM-CG-CL	Other theme of the gap
CGTG-62-THEM-CG-OC	CGTG-62	THEM-CG-OC	Other theme of the gap
CGTG-62-THEM-CG-WA	CGTG-62	THEM-CG-WA	Other theme of the gap
CGTG-62-THEM-CG-BI	CGTG-62	THEM-CG-BI	Other theme of the gap
CGTG-62-CG-Ref-033	CGTG-62	CG-Ref-033	Reference for gap determined in gap analysis
CGTG-63-EV-CG-039	CGTG-63	EV-CG-039	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-63-GAT-CG-BUT1	CGTG-63	GAT-CG-BUT1	Thread used for gap analysis
CGTG-63-THEM-CG-MU	CGTG-63	THEM-CG-MU	Main theme of the gap

Table 36 continued.

ID	LEFT	RIGHT	DESCRIPTION
CGTG-63-THEM-CG-CL	CGTG-63	THEM-CG-CL	Other theme of the gap
CGTG-63-THEM-CG-OC	CGTG-63	THEM-CG-OC	Other theme of the gap
CGTG-63-THEM-CG-WA	CGTG-63	THEM-CG-WA	Other theme of the gap
CGTG-63-THEM-CG-BI	CGTG-63	THEM-CG-BI	Other theme of the gap
CGTG-63-CG-Ref-030	CGTG-63	CG-Ref-030	Reference for gap determined in gap analysis
CGTG-64-EV-CG-039	CGTG-64	EV-CG-039	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-64-GAT-CG-BUT1	CGTG-64	GAT-CG-BUT1	Thread used for gap analysis
CGTG-64-THEM-CG-MU	CGTG-64	THEM-CG-MU	Main theme of the gap
CGTG-64-THEM-CG-CL	CGTG-64	THEM-CG-CL	Other theme of the gap
CGTG-64-THEM-CG-OC	CGTG-64	THEM-CG-OC	Other theme of the gap
CGTG-64-THEM-CG-DI	CGTG-64	THEM-CG-DI	Other theme of the gap
CGTG-64-THEM-CG-EN	CGTG-64	THEM-CG-EN	Other theme of the gap
CGTG-64-THEM-CG-HS	CGTG-64	THEM-CG-HS	Other theme of the gap
CGTG-64-CG-Ref-030	CGTG-64	CG-Ref-030	Reference for gap determined in gap analysis
CGTG-65-EV-CG-039	CGTG-65	EV-CG-039	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-65-GAT-CG-BUT1	CGTG-65	GAT-CG-BUT1	Thread used for gap analysis
CGTG-65-THEM-CG-MU	CGTG-65	THEM-CG-MU	Main theme of the gap
CGTG-65-THEM-CG-CL	CGTG-65	THEM-CG-CL	Other theme of the gap
CGTG-65-THEM-CG-OC	CGTG-65	THEM-CG-OC	Other theme of the gap
CGTG-65-THEM-CG-DI	CGTG-65	THEM-CG-DI	Other theme of the gap
CGTG-65-THEM-CG-EN	CGTG-65	THEM-CG-EN	Other theme of the gap
CGTG-65-THEM-CG-HS	CGTG-65	THEM-CG-HS	Other theme of the gap
CGTG-65-CG-Ref-030	CGTG-65	CG-Ref-030	Reference for gap determined in gap analysis
CGTG-66-EV-CG-039	CGTG-66	EV-CG-039	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-66-GAT-CG-BUT1	CGTG-66	GAT-CG-BUT1	Thread used for gap analysis
CGTG-66-THEM-CG-MU	CGTG-66	THEM-CG-MU	Main theme of the gap
CGTG-66-THEM-CG-CL	CGTG-66	THEM-CG-CL	Other theme of the gap
CGTG-66-THEM-CG-OC	CGTG-66	THEM-CG-OC	Other theme of the gap
CGTG-66-THEM-CG-DI	CGTG-66	THEM-CG-DI	Other theme of the gap
CGTG-66-THEM-CG-EN	CGTG-66	THEM-CG-EN	Other theme of the gap
CGTG-66-THEM-CG-HS	CGTG-66	THEM-CG-HS	Other theme of the gap
CGTG-66-CG-Ref-030	CGTG-66	CG-Ref-030	Reference for gap determined in gap analysis
CGTG-67-EV-CG-039	CGTG-67	EV-CG-039	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-67-GAT-CG-BUT1	CGTG-67	GAT-CG-BUT1	Thread used for gap analysis
CGTG-67-THEM-CG-MU	CGTG-67	THEM-CG-MU	Main theme of the gap
CGTG-67-THEM-CG-CL	CGTG-67	THEM-CG-CL	Other theme of the gap
CGTG-67-THEM-CG-OC	CGTG-67	THEM-CG-OC	Other theme of the gap
CGTG-67-THEM-CG-DI	CGTG-67	THEM-CG-DI	Other theme of the gap
CGTG-67-THEM-CG-HS	CGTG-67	THEM-CG-HS	Other theme of the gap
CGTG-67-CG-Ref-030	CGTG-67	CG-Ref-030	Reference for gap determined in gap analysis
CGTG-68-EV-CG-039	CGTG-68	EV-CG-039	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-68-GAT-CG-BUT1	CGTG-68	GAT-CG-BUT1	Thread used for gap analysis
CGTG-68-THEM-CG-MU	CGTG-68	THEM-CG-MU	Main theme of the gap
CGTG-68-THEM-CG-CL	CGTG-68	THEM-CG-CL	Other theme of the gap
CGTG-68-THEM-CG-OC	CGTG-68	THEM-CG-OC	Other theme of the gap

Table 36 continued.

ID	LEFT	RIGHT	DESCRIPTION
CGTG-68-THEM-CG-DI	CGTG-68	THEM-CG-DI	Other theme of the gap
CGTG-68-THEM-CG-EN	CGTG-68	THEM-CG-EN	Other theme of the gap
CGTG-68-THEM-CG-HS	CGTG-68	THEM-CG-HS	Other theme of the gap
CGTG-68-CG-Ref-030	CGTG-68	CG-Ref-030	Reference for gap determined in gap analysis
CGTG-69-EV-CG-039	CGTG-69	EV-CG-039	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-69-GAT-CG-BUT1	CGTG-69	GAT-CG-BUT1	Thread used for gap analysis
CGTG-69-THEM-CG-MU	CGTG-69	THEM-CG-MU	Main theme of the gap
CGTG-69-THEM-CG-CL	CGTG-69	THEM-CG-CL	Other theme of the gap
CGTG-69-THEM-CG-OC	CGTG-69	THEM-CG-OC	Other theme of the gap
CGTG-69-THEM-CG-DI	CGTG-69	THEM-CG-DI	Other theme of the gap
CGTG-69-THEM-CG-HS	CGTG-69	THEM-CG-HS	Other theme of the gap
CGTG-69-CG-Ref-030	CGTG-69	CG-Ref-030	Reference for gap determined in gap analysis
CGTG-70-EV-CG-039	CGTG-70	EV-CG-039	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-70-GAT-CG-BUT1	CGTG-70	GAT-CG-BUT1	Thread used for gap analysis
CGTG-70-THEM-CG-MU	CGTG-70	THEM-CG-MU	Main theme of the gap
CGTG-70-THEM-CG-CL	CGTG-70	THEM-CG-CL	Other theme of the gap
CGTG-70-THEM-CG-OC	CGTG-70	THEM-CG-OC	Other theme of the gap
CGTG-70-THEM-CG-DI	CGTG-70	THEM-CG-DI	Other theme of the gap
CGTG-70-THEM-CG-EN	CGTG-70	THEM-CG-EN	Other theme of the gap
CGTG-70-THEM-CG-HS	CGTG-70	THEM-CG-HS	Other theme of the gap
CGTG-70-CG-Ref-030	CGTG-70	CG-Ref-030	Reference for gap determined in gap analysis
CGTG-71-EV-CG-021	CGTG-71	EV-CG-021	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-71-GAT-CG-BUT1	CGTG-71	GAT-CG-BUT1	Thread used for gap analysis
CGTG-71-THEM-CG-MU	CGTG-71	THEM-CG-MU	Main theme of the gap
CGTG-71-THEM-CG-OC	CGTG-71	THEM-CG-OC	Other theme of the gap
CGTG-71-THEM-CG-WA	CGTG-71	THEM-CG-WA	Other theme of the gap
CGTG-71-THEM-CG-BI	CGTG-71	THEM-CG-BI	Other theme of the gap
CGTG-71-THEM-CG-DI	CGTG-71	THEM-CG-DI	Other theme of the gap
CGTG-71-THEM-CG-EN	CGTG-71	THEM-CG-EN	Other theme of the gap
CGTG-71-THEM-CG-HS	CGTG-71	THEM-CG-HS	Other theme of the gap
CGTG-71-CG-Ref-034	CGTG-71	CG-Ref-034	Reference for gap determined in gap analysis
CGTG-72-EV-CG-021	CGTG-72	EV-CG-021	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-72-GAT-CG-BUT1	CGTG-72	GAT-CG-BUT1	Thread used for gap analysis
CGTG-72-THEM-CG-MU	CGTG-72	THEM-CG-MU	Main theme of the gap
CGTG-72-THEM-CG-OC	CGTG-72	THEM-CG-OC	Other theme of the gap
CGTG-72-THEM-CG-WA	CGTG-72	THEM-CG-WA	Other theme of the gap
CGTG-72-THEM-CG-BI	CGTG-72	THEM-CG-BI	Other theme of the gap
CGTG-72-THEM-CG-DI	CGTG-72	THEM-CG-DI	Other theme of the gap
CGTG-72-THEM-CG-EN	CGTG-72	THEM-CG-EN	Other theme of the gap
CGTG-72-THEM-CG-HS	CGTG-72	THEM-CG-HS	Other theme of the gap
CGTG-72-CG-Ref-035	CGTG-72	CG-Ref-035	Reference for gap determined in gap analysis
CGTG-73-EV-CG-021	CGTG-73	EV-CG-021	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-73-GAT-CG-BUT1	CGTG-73	GAT-CG-BUT1	Thread used for gap analysis
CGTG-73-THEM-CG-MU	CGTG-73	THEM-CG-MU	Main theme of the gap
CGTG-73-THEM-CG-OC	CGTG-73	THEM-CG-OC	Other theme of the gap

Table 36 continued.

ID	LEFT	RIGHT	DESCRIPTION
CGTG-73-THEM-CG-WA	CGTG-73	THEM-CG-WA	Other theme of the gap
CGTG-73-THEM-CG-DI	CGTG-73	THEM-CG-DI	Other theme of the gap
CGTG-73-THEM-CG-BI	CGTG-73	THEM-CG-BI	Other theme of the gap
CGTG-73-THEM-CG-HS	CGTG-73	THEM-CG-HS	Other theme of the gap
CGTG-73-CG-Ref-036	CGTG-73	CG-Ref-036	Reference for gap determined in gap analysis
CGTG-74-EV-CG-021	CGTG-74	EV-CG-021	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-74-GAT-CG-BUT1	CGTG-74	GAT-CG-BUT1	Thread used for gap analysis
CGTG-74-THEM-CG-MU	CGTG-74	THEM-CG-MU	Main theme of the gap
CGTG-74-THEM-CG-OC	CGTG-74	THEM-CG-OC	Other theme of the gap
CGTG-74-THEM-CG-WA	CGTG-74	THEM-CG-WA	Other theme of the gap
CGTG-74-THEM-CG-DI	CGTG-74	THEM-CG-DI	Other theme of the gap
CGTG-74-THEM-CG-BI	CGTG-74	THEM-CG-BI	Other theme of the gap
CGTG-74-THEM-CG-HS	CGTG-74	THEM-CG-HS	Other theme of the gap
CGTG-74-CG-Ref-036	CGTG-74	CG-Ref-036	Reference for gap determined in gap analysis
CGTG-75-EV-CG-040	CGTG-75	EV-CG-040	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-75-GAT-CG-TDT2	CGTG-75	GAT-CG-TDT2	Thread used for gap analysis
CGTG-75-THEM-CG-MU	CGTG-75	THEM-CG-MU	Main theme of the gap
CGTG-75-THEM-CG-CL	CGTG-75	THEM-CG-CL	Other theme of the gap
CGTG-75-THEM-CG-OC	CGTG-75	THEM-CG-OC	Other theme of the gap
CGTG-75-THEM-CG-WA	CGTG-75	THEM-CG-WA	Other theme of the gap
CGTG-75-THEM-CG-HE	CGTG-75	THEM-CG-HE	Other theme of the gap
CGTG-75-CG-Ref-037	CGTG-75	CG-Ref-037	Reference for gap determined in gap analysis
CGTG-76-EV-CG-040	CGTG-76	EV-CG-040	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-76-GAT-CG-TDT2	CGTG-76	GAT-CG-TDT2	Thread used for gap analysis
CGTG-76-THEM-CG-MU	CGTG-76	THEM-CG-MU	Main theme of the gap
CGTG-76-THEM-CG-CL	CGTG-76	THEM-CG-CL	Other theme of the gap
CGTG-76-THEM-CG-OC	CGTG-76	THEM-CG-OC	Other theme of the gap
CGTG-76-THEM-CG-WA	CGTG-76	THEM-CG-WA	Other theme of the gap
CGTG-76-THEM-CG-HE	CGTG-76	THEM-CG-HE	Other theme of the gap
CGTG-76-CG-Ref-037	CGTG-76	CG-Ref-037	Reference for gap determined in gap analysis
CGTG-77-EV-CG-040	CGTG-77	EV-CG-040	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-77-GAT-CG-TDT2	CGTG-77	GAT-CG-TDT2	Thread used for gap analysis
CGTG-77-THEM-CG-MU	CGTG-77	THEM-CG-MU	Main theme of the gap
CGTG-77-THEM-CG-CL	CGTG-77	THEM-CG-CL	Other theme of the gap
CGTG-77-THEM-CG-OC	CGTG-77	THEM-CG-OC	Other theme of the gap
CGTG-77-THEM-CG-WA	CGTG-77	THEM-CG-WA	Other theme of the gap
CGTG-77-THEM-CG-HE	CGTG-77	THEM-CG-HE	Other theme of the gap
CGTG-77-CG-Ref-037	CGTG-77	CG-Ref-037	Reference for gap determined in gap analysis
CGTG-78-EV-CG-040	CGTG-78	EV-CG-040	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-78-GAT-CG-TDT2	CGTG-78	GAT-CG-TDT2	Thread used for gap analysis
CGTG-78-THEM-CG-MU	CGTG-78	THEM-CG-MU	Main theme of the gap
CGTG-78-THEM-CG-CL	CGTG-78	THEM-CG-CL	Other theme of the gap
CGTG-78-THEM-CG-OC	CGTG-78	THEM-CG-OC	Other theme of the gap
CGTG-78-THEM-CG-WA	CGTG-78	THEM-CG-WA	Other theme of the gap
CGTG-78-THEM-CG-HE	CGTG-78	THEM-CG-HE	Other theme of the gap

Table 36 continued.

ID	LEFT	RIGHT	DESCRIPTION
CGTG-78-CG-Ref-037	CGTG-78	CG-Ref-037	Reference for gap determined in gap analysis
CGTG-79-EV-CG-021	CGTG-79	EV-CG-021	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-79-GAT-CG-TDT2	CGTG-79	GAT-CG-TDT2	Thread used for gap analysis
CGTG-79-THEM-CG-MU	CGTG-79	THEM-CG-MU	Main theme of the gap
CGTG-79-THEM-CG-CL	CGTG-79	THEM-CG-CL	Other theme of the gap
CGTG-79-THEM-CG-OC	CGTG-79	THEM-CG-OC	Other theme of the gap
CGTG-79-THEM-CG-WA	CGTG-79	THEM-CG-WA	Other theme of the gap
CGTG-79-THEM-CG-HE	CGTG-79	THEM-CG-HE	Other theme of the gap
CGTG-79-CG-Ref-037	CGTG-79	CG-Ref-037	Reference for gap determined in gap analysis
CGTG-80-EV-CG-021	CGTG-80	EV-CG-021	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-80-GAT-CG-TDT2	CGTG-80	GAT-CG-TDT2	Thread used for gap analysis
CGTG-80-THEM-CG-MU	CGTG-80	THEM-CG-MU	Main theme of the gap
CGTG-80-THEM-CG-CL	CGTG-80	THEM-CG-CL	Other theme of the gap
CGTG-80-THEM-CG-OC	CGTG-80	THEM-CG-OC	Other theme of the gap
CGTG-80-THEM-CG-WA	CGTG-80	THEM-CG-WA	Other theme of the gap
CGTG-80-THEM-CG-HE	CGTG-80	THEM-CG-HE	Other theme of the gap
CGTG-80-CG-Ref-037	CGTG-80	CG-Ref-037	Reference for gap determined in gap analysis
CGTG-81-EV-CG-021	CGTG-81	EV-CG-021	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-81-GAT-CG-TDT2	CGTG-81	GAT-CG-TDT2	Thread used for gap analysis
CGTG-81-THEM-CG-MU	CGTG-81	THEM-CG-MU	Main theme of the gap
CGTG-81-THEM-CG-CL	CGTG-81	THEM-CG-CL	Other theme of the gap
CGTG-81-THEM-CG-OC	CGTG-81	THEM-CG-OC	Other theme of the gap
CGTG-81-THEM-CG-WA	CGTG-81	THEM-CG-WA	Other theme of the gap
CGTG-81-THEM-CG-HE	CGTG-81	THEM-CG-HE	Other theme of the gap
CGTG-81-CG-Ref-037	CGTG-81	CG-Ref-037	Reference for gap determined in gap analysis
CGTG-82-EV-CG-021	CGTG-82	EV-CG-021	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-82-GAT-CG-TDT2	CGTG-82	GAT-CG-TDT2	Thread used for gap analysis
CGTG-82-THEM-CG-MU	CGTG-82	THEM-CG-MU	Main theme of the gap
CGTG-82-THEM-CG-CL	CGTG-82	THEM-CG-CL	Other theme of the gap
CGTG-82-THEM-CG-OC	CGTG-82	THEM-CG-OC	Other theme of the gap
CGTG-82-THEM-CG-WA	CGTG-82	THEM-CG-WA	Other theme of the gap
CGTG-82-THEM-CG-HE	CGTG-82	THEM-CG-HE	Other theme of the gap
CGTG-82-CG-Ref-037	CGTG-82	CG-Ref-037	Reference for gap determined in gap analysis
CGTG-83-EV-CG-021	CGTG-83	EV-CG-021	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-83-GAT-CG-TDT2	CGTG-83	GAT-CG-TDT2	Thread used for gap analysis
CGTG-83-THEM-CG-MU	CGTG-83	THEM-CG-MU	Main theme of the gap
CGTG-83-THEM-CG-CL	CGTG-83	THEM-CG-CL	Other theme of the gap
CGTG-83-THEM-CG-OC	CGTG-83	THEM-CG-OC	Other theme of the gap
CGTG-83-THEM-CG-WA	CGTG-83	THEM-CG-WA	Other theme of the gap
CGTG-83-THEM-CG-HE	CGTG-83	THEM-CG-HE	Other theme of the gap
CGTG-83-CG-Ref-037	CGTG-83	CG-Ref-037	Reference for gap determined in gap analysis
CGTG-84-EV-CG-041	CGTG-84	EV-CG-041	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-84-EV-CG-042	CGTG-84	EV-CG-042	Other EV impacted by this gap. Result of a gap analysis.
CGTG-84-GAT-CG-TDT2	CGTG-84	GAT-CG-TDT2	Thread used for gap analysis
CGTG-84-THEM-CG-MU	CGTG-84	THEM-CG-MU	Main theme of the gap

Table 36 continued.

ID	LEFT	RIGHT	DESCRIPTION
CGTG-84-THEM-CG-CL	CGTG-84	THEM-CG-CL	Other theme of the gap
CGTG-84-THEM-CG-OC	CGTG-84	THEM-CG-OC	Other theme of the gap
CGTG-84-THEM-CG-WA	CGTG-84	THEM-CG-WA	Other theme of the gap
CGTG-84-THEM-CG-BI	CGTG-84	THEM-CG-BI	Other theme of the gap
CGTG-84-THEM-CG-EN	CGTG-84	THEM-CG-EN	Other theme of the gap
CGTG-84-THEM-CG-HS	CGTG-84	THEM-CG-HS	Other theme of the gap
CGTG-84-CG-Ref-038	CGTG-84	CG-Ref-038	Reference for gap determined in gap analysis
CGTG-84-CG-Rev-019	CGTG-84	CG-Rev-019	Review of gap determined in gap analysis
CGTG-85-EV-CG-041	CGTG-85	EV-CG-041	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-85-GAT-CG-TDT2	CGTG-85	GAT-CG-TDT2	Thread used for gap analysis
CGTG-85-THEM-CG-MU	CGTG-85	THEM-CG-MU	Main theme of the gap
CGTG-85-THEM-CG-CL	CGTG-85	THEM-CG-CL	Other theme of the gap
CGTG-85-THEM-CG-OC	CGTG-85	THEM-CG-OC	Other theme of the gap
CGTG-85-THEM-CG-WA	CGTG-85	THEM-CG-WA	Other theme of the gap
CGTG-85-THEM-CG-BI	CGTG-85	THEM-CG-BI	Other theme of the gap
CGTG-85-THEM-CG-EN	CGTG-85	THEM-CG-EN	Other theme of the gap
CGTG-85-THEM-CG-HS	CGTG-85	THEM-CG-HS	Other theme of the gap
CGTG-85-CG-Ref-039	CGTG-85	CG-Ref-039	Reference for gap determined in gap analysis
CGTG-86-EV-CG-041	CGTG-86	EV-CG-041	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-86-GAT-CG-TDT2	CGTG-86	GAT-CG-TDT2	Thread used for gap analysis
CGTG-86-THEM-CG-MU	CGTG-86	THEM-CG-MU	Main theme of the gap
CGTG-86-THEM-CG-CL	CGTG-86	THEM-CG-CL	Other theme of the gap
CGTG-86-THEM-CG-OC	CGTG-86	THEM-CG-OC	Other theme of the gap
CGTG-86-THEM-CG-WA	CGTG-86	THEM-CG-WA	Other theme of the gap
CGTG-86-THEM-CG-BI	CGTG-86	THEM-CG-BI	Other theme of the gap
CGTG-86-THEM-CG-EN	CGTG-86	THEM-CG-EN	Other theme of the gap
CGTG-86-THEM-CG-HS	CGTG-86	THEM-CG-HS	Other theme of the gap
CGTG-86-CG-Ref-038	CGTG-86	CG-Ref-038	Reference for gap determined in gap analysis
CGTG-87-EV-CG-041	CGTG-87	EV-CG-041	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-87-EV-CG-043	CGTG-87	EV-CG-043	Other EV impacted by this gap. Result of a gap analysis.
CGTG-87-EV-CG-039	CGTG-87	EV-CG-039	Other EV impacted by this gap. Result of a gap analysis.
CGTG-87-GAT-CG-TDT2	CGTG-87	GAT-CG-TDT2	Thread used for gap analysis
CGTG-87-THEM-CG-MU	CGTG-87	THEM-CG-MU	Main theme of the gap
CGTG-87-THEM-CG-CL	CGTG-87	THEM-CG-CL	Other theme of the gap
CGTG-87-THEM-CG-OC	CGTG-87	THEM-CG-OC	Other theme of the gap
CGTG-87-THEM-CG-WA	CGTG-87	THEM-CG-WA	Other theme of the gap
CGTG-87-THEM-CG-BI	CGTG-87	THEM-CG-BI	Other theme of the gap
CGTG-87-THEM-CG-EN	CGTG-87	THEM-CG-EN	Other theme of the gap
CGTG-87-THEM-CG-HS	CGTG-87	THEM-CG-HS	Other theme of the gap
CGTG-87-CG-Ref-038	CGTG-87	CG-Ref-038	Reference for gap determined in gap analysis
CGTG-87-CG-Rev-020	CGTG-87	CG-Rev-020	Review of gap determined in gap analysis
CGTG-88-EV-CG-041	CGTG-88	EV-CG-041	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-88-EV-CG-043	CGTG-88	EV-CG-043	Other EV impacted by this gap. Result of a gap analysis.
CGTG-88-EV-CG-044	CGTG-88	EV-CG-044	Other EV impacted by this gap. Result of a gap analysis.
CGTG-88-EV-CG-039	CGTG-88	EV-CG-039	Other EV impacted by this gap. Result of a gap analysis.

Table 36 continued.

ID	LEFT	RIGHT	DESCRIPTION
CGTG-88-GAT-CG-TDT2	CGTG-88	GAT-CG-TDT2	Thread used for gap analysis
CGTG-88-THEM-CG-MU	CGTG-88	THEM-CG-MU	Main theme of the gap
CGTG-88-THEM-CG-CL	CGTG-88	THEM-CG-CL	Other theme of the gap
CGTG-88-THEM-CG-OC	CGTG-88	THEM-CG-OC	Other theme of the gap
CGTG-88-THEM-CG-WA	CGTG-88	THEM-CG-WA	Other theme of the gap
CGTG-88-THEM-CG-BI	CGTG-88	THEM-CG-BI	Other theme of the gap
CGTG-88-THEM-CG-EN	CGTG-88	THEM-CG-EN	Other theme of the gap
CGTG-88-THEM-CG-HS	CGTG-88	THEM-CG-HS	Other theme of the gap
CGTG-88-CG-Ref-040	CGTG-88	CG-Ref-040	Reference for gap determined in gap analysis
CGTG-88-CG-Rev-021	CGTG-88	CG-Rev-021	Review of gap determined in gap analysis
CGTG-89-EV-CG-041	CGTG-89	EV-CG-041	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-89-EV-CG-043	CGTG-89	EV-CG-043	Other EV impacted by this gap. Result of a gap analysis.
CGTG-89-EV-CG-039	CGTG-89	EV-CG-039	Other EV impacted by this gap. Result of a gap analysis.
CGTG-89-GAT-CG-TDT2	CGTG-89	GAT-CG-TDT2	Thread used for gap analysis
CGTG-89-THEM-CG-MU	CGTG-89	THEM-CG-MU	Main theme of the gap
CGTG-89-THEM-CG-CL	CGTG-89	THEM-CG-CL	Other theme of the gap
CGTG-89-THEM-CG-OC	CGTG-89	THEM-CG-OC	Other theme of the gap
CGTG-89-THEM-CG-WA	CGTG-89	THEM-CG-WA	Other theme of the gap
CGTG-89-THEM-CG-BI	CGTG-89	THEM-CG-BI	Other theme of the gap
CGTG-89-THEM-CG-EN	CGTG-89	THEM-CG-EN	Other theme of the gap
CGTG-89-THEM-CG-HS	CGTG-89	THEM-CG-HS	Other theme of the gap
CGTG-89-CG-Ref-041	CGTG-89	CG-Ref-041	Reference for gap determined in gap analysis
CGTG-89-CG-Rev-022	CGTG-89	CG-Rev-022	Review of gap determined in gap analysis
CGTG-90-EV-CG-041	CGTG-90	EV-CG-041	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-90-EV-CG-043	CGTG-90	EV-CG-043	Other EV impacted by this gap. Result of a gap analysis.
CGTG-90-EV-CG-045	CGTG-90	EV-CG-045	Other EV impacted by this gap. Result of a gap analysis.
CGTG-90-EV-CG-020	CGTG-90	EV-CG-020	Other EV impacted by this gap. Result of a gap analysis.
CGTG-90-GAT-CG-TDT2	CGTG-90	GAT-CG-TDT2	Thread used for gap analysis
CGTG-90-THEM-CG-MU	CGTG-90	THEM-CG-MU	Main theme of the gap
CGTG-90-THEM-CG-CL	CGTG-90	THEM-CG-CL	Other theme of the gap
CGTG-90-THEM-CG-OC	CGTG-90	THEM-CG-OC	Other theme of the gap
CGTG-90-THEM-CG-WA	CGTG-90	THEM-CG-WA	Other theme of the gap
CGTG-90-THEM-CG-BI	CGTG-90	THEM-CG-BI	Other theme of the gap
CGTG-90-THEM-CG-EN	CGTG-90	THEM-CG-EN	Other theme of the gap
CGTG-90-THEM-CG-HS	CGTG-90	THEM-CG-HS	Other theme of the gap
CGTG-90-CG-Ref-041	CGTG-90	CG-Ref-041	Reference for gap determined in gap analysis
CGTG-91-EV-CG-041	CGTG-91	EV-CG-041	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-91-GAT-CG-TDT2	CGTG-91	GAT-CG-TDT2	Thread used for gap analysis
CGTG-91-THEM-CG-MU	CGTG-91	THEM-CG-MU	Main theme of the gap
CGTG-91-THEM-CG-CL	CGTG-91	THEM-CG-CL	Other theme of the gap
CGTG-91-THEM-CG-OC	CGTG-91	THEM-CG-OC	Other theme of the gap
CGTG-91-THEM-CG-WA	CGTG-91	THEM-CG-WA	Other theme of the gap
CGTG-91-THEM-CG-BI	CGTG-91	THEM-CG-BI	Other theme of the gap
CGTG-91-THEM-CG-EN	CGTG-91	THEM-CG-EN	Other theme of the gap
CGTG-91-THEM-CG-HS	CGTG-91	THEM-CG-HS	Other theme of the gap

Table 36 continued.

ID	LEFT	RIGHT	DESCRIPTION
CGTG-91-CG-Ref-042	CGTG-91	CG-Ref-042	Reference for gap determined in gap analysis
CGTG-91-CG-Rev-023	CGTG-91	CG-Rev-023	Review of gap determined in gap analysis
CGTG-92-EV-CG-046	CGTG-92	EV-CG-046	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-92-EV-CG-046	CGTG-92	EV-CG-046	Other EV impacted by this gap. Result of a gap analysis.
CGTG-92-GAT-CG-TDT2	CGTG-92	GAT-CG-TDT2	Thread used for gap analysis
CGTG-92-THEM-CG-MU	CGTG-92	THEM-CG-MU	Main theme of the gap
CGTG-92-THEM-CG-CL	CGTG-92	THEM-CG-CL	Other theme of the gap
CGTG-92-THEM-CG-OC	CGTG-92	THEM-CG-OC	Other theme of the gap
CGTG-92-THEM-CG-WA	CGTG-92	THEM-CG-WA	Other theme of the gap
CGTG-92-THEM-CG-DI	CGTG-92	THEM-CG-DI	Other theme of the gap
CGTG-92-THEM-CG-EN	CGTG-92	THEM-CG-EN	Other theme of the gap
CGTG-92-THEM-CG-HS	CGTG-92	THEM-CG-HS	Other theme of the gap
CGTG-92-CG-Ref-043	CGTG-92	CG-Ref-043	Reference for gap determined in gap analysis
CGTG-93-EV-CG-046	CGTG-93	EV-CG-046	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-93-EV-CG-046	CGTG-93	EV-CG-046	Other EV impacted by this gap. Result of a gap analysis.
CGTG-93-GAT-CG-TDT2	CGTG-93	GAT-CG-TDT2	Thread used for gap analysis
CGTG-93-THEM-CG-MU	CGTG-93	THEM-CG-MU	Main theme of the gap
CGTG-93-THEM-CG-CL	CGTG-93	THEM-CG-CL	Other theme of the gap
CGTG-93-THEM-CG-OC	CGTG-93	THEM-CG-OC	Other theme of the gap
CGTG-93-THEM-CG-WA	CGTG-93	THEM-CG-WA	Other theme of the gap
CGTG-93-THEM-CG-DI	CGTG-93	THEM-CG-DI	Other theme of the gap
CGTG-93-THEM-CG-EN	CGTG-93	THEM-CG-EN	Other theme of the gap
CGTG-93-THEM-CG-HS	CGTG-93	THEM-CG-HS	Other theme of the gap
CGTG-93-CG-Ref-043	CGTG-93	CG-Ref-043	Reference for gap determined in gap analysis
CGTG-94-EV-CG-046	CGTG-94	EV-CG-046	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-94-EV-CG-046	CGTG-94	EV-CG-046	Other EV impacted by this gap. Result of a gap analysis.
CGTG-94-GAT-CG-TDT2	CGTG-94	GAT-CG-TDT2	Thread used for gap analysis
CGTG-94-THEM-CG-MU	CGTG-94	THEM-CG-MU	Main theme of the gap
CGTG-94-THEM-CG-CL	CGTG-94	THEM-CG-CL	Other theme of the gap
CGTG-94-THEM-CG-OC	CGTG-94	THEM-CG-OC	Other theme of the gap
CGTG-94-THEM-CG-WA	CGTG-94	THEM-CG-WA	Other theme of the gap
CGTG-94-THEM-CG-DI	CGTG-94	THEM-CG-DI	Other theme of the gap
CGTG-94-THEM-CG-EN	CGTG-94	THEM-CG-EN	Other theme of the gap
CGTG-94-THEM-CG-HS	CGTG-94	THEM-CG-HS	Other theme of the gap
CGTG-94-CG-Ref-043	CGTG-94	CG-Ref-043	Reference for gap determined in gap analysis
CGTG-95-EV-CG-046	CGTG-95	EV-CG-046	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-95-EV-CG-046	CGTG-95	EV-CG-046	Other EV impacted by this gap. Result of a gap analysis.
CGTG-95-GAT-CG-TDT2	CGTG-95	GAT-CG-TDT2	Thread used for gap analysis
CGTG-95-THEM-CG-MU	CGTG-95	THEM-CG-MU	Main theme of the gap
CGTG-95-THEM-CG-CL	CGTG-95	THEM-CG-CL	Other theme of the gap
CGTG-95-THEM-CG-OC	CGTG-95	THEM-CG-OC	Other theme of the gap
CGTG-95-THEM-CG-WA	CGTG-95	THEM-CG-WA	Other theme of the gap
CGTG-95-THEM-CG-DI	CGTG-95	THEM-CG-DI	Other theme of the gap
CGTG-95-THEM-CG-EN	CGTG-95	THEM-CG-EN	Other theme of the gap
CGTG-95-THEM-CG-HS	CGTG-95	THEM-CG-HS	Other theme of the gap

Table 36 continued.

ID	LEFT	RIGHT	DESCRIPTION
CGTG-95-CG-Ref-043	CGTG-95	CG-Ref-043	Reference for gap determined in gap analysis
CGTG-95-CG-Rev-024	CGTG-95	CG-Rev-024	Review of gap determined in gap analysis
CGTG-96-EV-CG-047	CGTG-96	EV-CG-047	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-96-GAT-CG-TDT2	CGTG-96	GAT-CG-TDT2	Thread used for gap analysis
CGTG-96-THEM-CG-MU	CGTG-96	THEM-CG-MU	Main theme of the gap
CGTG-96-THEM-CG-CL	CGTG-96	THEM-CG-CL	Other theme of the gap
CGTG-96-THEM-CG-OC	CGTG-96	THEM-CG-OC	Other theme of the gap
CGTG-96-THEM-CG-WA	CGTG-96	THEM-CG-WA	Other theme of the gap
CGTG-96-THEM-CG-HE	CGTG-96	THEM-CG-HE	Other theme of the gap
CGTG-96-CG-Ref-040	CGTG-96	CG-Ref-040	Reference for gap determined in gap analysis
CGTG-97-EV-CG-047	CGTG-97	EV-CG-047	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-97-GAT-CG-TDT2	CGTG-97	GAT-CG-TDT2	Thread used for gap analysis
CGTG-97-THEM-CG-MU	CGTG-97	THEM-CG-MU	Main theme of the gap
CGTG-97-THEM-CG-CL	CGTG-97	THEM-CG-CL	Other theme of the gap
CGTG-97-THEM-CG-OC	CGTG-97	THEM-CG-OC	Other theme of the gap
CGTG-97-THEM-CG-WA	CGTG-97	THEM-CG-WA	Other theme of the gap
CGTG-97-THEM-CG-HE	CGTG-97	THEM-CG-HE	Other theme of the gap
CGTG-97-CG-Ref-040	CGTG-97	CG-Ref-040	Reference for gap determined in gap analysis
CGTG-98-EV-CG-047	CGTG-98	EV-CG-047	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-98-GAT-CG-TDT2	CGTG-98	GAT-CG-TDT2	Thread used for gap analysis
CGTG-98-THEM-CG-MU	CGTG-98	THEM-CG-MU	Main theme of the gap
CGTG-98-THEM-CG-CL	CGTG-98	THEM-CG-CL	Other theme of the gap
CGTG-98-THEM-CG-OC	CGTG-98	THEM-CG-OC	Other theme of the gap
CGTG-98-THEM-CG-WA	CGTG-98	THEM-CG-WA	Other theme of the gap
CGTG-98-THEM-CG-HE	CGTG-98	THEM-CG-HE	Other theme of the gap
CGTG-98-CG-Ref-040	CGTG-98	CG-Ref-040	Reference for gap determined in gap analysis
CGTG-99-EV-CG-047	CGTG-99	EV-CG-047	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-99-GAT-CG-TDT2	CGTG-99	GAT-CG-TDT2	Thread used for gap analysis
CGTG-99-THEM-CG-MU	CGTG-99	THEM-CG-MU	Main theme of the gap
CGTG-99-THEM-CG-CL	CGTG-99	THEM-CG-CL	Other theme of the gap
CGTG-99-THEM-CG-OC	CGTG-99	THEM-CG-OC	Other theme of the gap
CGTG-99-THEM-CG-WA	CGTG-99	THEM-CG-WA	Other theme of the gap
CGTG-99-THEM-CG-HE	CGTG-99	THEM-CG-HE	Other theme of the gap
CGTG-99-CG-Ref-040	CGTG-99	CG-Ref-040	Reference for gap determined in gap analysis
CGTG-100-EV-CG-018	CGTG-100	EV-CG-018	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-100-GAT-CG-TDT2	CGTG-100	GAT-CG-TDT2	Thread used for gap analysis
CGTG-100-THEM-CG-MU	CGTG-100	THEM-CG-MU	Main theme of the gap
CGTG-100-THEM-CG-CL	CGTG-100	THEM-CG-CL	Other theme of the gap
CGTG-100-THEM-CG-OC	CGTG-100	THEM-CG-OC	Other theme of the gap
CGTG-100-THEM-CG-DI	CGTG-100	THEM-CG-DI	Other theme of the gap
CGTG-100-THEM-CG-EN	CGTG-100	THEM-CG-EN	Other theme of the gap
CGTG-100-THEM-CG-HS	CGTG-100	THEM-CG-HS	Other theme of the gap
CGTG-100-CG-Ref-044	CGTG-100	CG-Ref-044	Reference for gap determined in gap analysis
CGTG-101-EV-CG-018	CGTG-101	EV-CG-018	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-101-GAT-CG-TDT2	CGTG-101	GAT-CG-TDT2	Thread used for gap analysis

Table 36 continued.

ID	LEFT	RIGHT	DESCRIPTION
CGTG-101-THEM-CG-MU	CGTG-101	THEM-CG-MU	Main theme of the gap
CGTG-101-THEM-CG-CL	CGTG-101	THEM-CG-CL	Other theme of the gap
CGTG-101-THEM-CG-OC	CGTG-101	THEM-CG-OC	Other theme of the gap
CGTG-101-THEM-CG-DI	CGTG-101	THEM-CG-DI	Other theme of the gap
CGTG-101-THEM-CG-EN	CGTG-101	THEM-CG-EN	Other theme of the gap
CGTG-101-THEM-CG-HS	CGTG-101	THEM-CG-HS	Other theme of the gap
CGTG-101-CG-Ref-044	CGTG-101	CG-Ref-044	Reference for gap determined in gap analysis
CGTG-102-EV-CG-018	CGTG-102	EV-CG-018	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-102-GAT-CG-TDT2	CGTG-102	GAT-CG-TDT2	Thread used for gap analysis
CGTG-102-THEM-CG-MU	CGTG-102	THEM-CG-MU	Main theme of the gap
CGTG-102-THEM-CG-CL	CGTG-102	THEM-CG-CL	Other theme of the gap
CGTG-102-THEM-CG-OC	CGTG-102	THEM-CG-OC	Other theme of the gap
CGTG-102-THEM-CG-DI	CGTG-102	THEM-CG-DI	Other theme of the gap
CGTG-102-THEM-CG-EN	CGTG-102	THEM-CG-EN	Other theme of the gap
CGTG-102-THEM-CG-HS	CGTG-102	THEM-CG-HS	Other theme of the gap
CGTG-102-CG-Ref-044	CGTG-102	CG-Ref-044	Reference for gap determined in gap analysis
CGTG-103-EV-CG-018	CGTG-103	EV-CG-018	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-103-GAT-CG-TDT2	CGTG-103	GAT-CG-TDT2	Thread used for gap analysis
CGTG-103-THEM-CG-MU	CGTG-103	THEM-CG-MU	Main theme of the gap
CGTG-103-THEM-CG-CL	CGTG-103	THEM-CG-CL	Other theme of the gap
CGTG-103-THEM-CG-OC	CGTG-103	THEM-CG-OC	Other theme of the gap
CGTG-103-THEM-CG-DI	CGTG-103	THEM-CG-DI	Other theme of the gap
CGTG-103-THEM-CG-EN	CGTG-103	THEM-CG-EN	Other theme of the gap
CGTG-103-THEM-CG-HS	CGTG-103	THEM-CG-HS	Other theme of the gap
CGTG-103-CG-Ref-044	CGTG-103	CG-Ref-044	Reference for gap determined in gap analysis
CGTG-104-EV-CG-002	CGTG-104	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-104-EV-CG-011	CGTG-104	EV-CG-011	Other EV impacted by this gap. Result of a gap analysis.
CGTG-104-EV-CG-048	CGTG-104	EV-CG-048	Other EV impacted by this gap. Result of a gap analysis.
CGTG-104-EV-CG-049	CGTG-104	EV-CG-049	Other EV impacted by this gap. Result of a gap analysis.
CGTG-104-EV-CG-050	CGTG-104	EV-CG-050	Other EV impacted by this gap. Result of a gap analysis.
CGTG-104-GAT-CG-TDT2	CGTG-104	GAT-CG-TDT2	Thread used for gap analysis
CGTG-104-THEM-CG-CL	CGTG-104	THEM-CG-CL	Main theme of the gap
CGTG-104-CG-Ref-045	CGTG-104	CG-Ref-045	Reference for gap determined in gap analysis
CGTG-105-EV-CG-002	CGTG-105	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-105-EV-CG-011	CGTG-105	EV-CG-011	Other EV impacted by this gap. Result of a gap analysis.
CGTG-105-EV-CG-048	CGTG-105	EV-CG-048	Other EV impacted by this gap. Result of a gap analysis.
CGTG-105-EV-CG-049	CGTG-105	EV-CG-049	Other EV impacted by this gap. Result of a gap analysis.
CGTG-105-EV-CG-050	CGTG-105	EV-CG-050	Other EV impacted by this gap. Result of a gap analysis.
CGTG-105-GAT-CG-TDT2	CGTG-105	GAT-CG-TDT2	Thread used for gap analysis
CGTG-105-THEM-CG-CL	CGTG-105	THEM-CG-CL	Main theme of the gap
CGTG-105-CG-Ref-045	CGTG-105	CG-Ref-045	Reference for gap determined in gap analysis
CGTG-106-EV-CG-002	CGTG-106	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-106-EV-CG-011	CGTG-106	EV-CG-011	Other EV impacted by this gap. Result of a gap analysis.
CGTG-106-EV-CG-048	CGTG-106	EV-CG-048	Other EV impacted by this gap. Result of a gap analysis.
CGTG-106-EV-CG-049	CGTG-106	EV-CG-049	Other EV impacted by this gap. Result of a gap analysis.

Table 36 continued.

ID	LEFT	RIGHT	DESCRIPTION
CGTG-106-EV-CG-050	CGTG-106	EV-CG-050	Other EV impacted by this gap. Result of a gap analysis.
CGTG-106-GAT-CG-TDT2	CGTG-106	GAT-CG-TDT2	Thread used for gap analysis
CGTG-106-THEM-CG-CL	CGTG-106	THEM-CG-CL	Main theme of the gap
CGTG-106-CG-Ref-046	CGTG-106	CG-Ref-046	Reference for gap determined in gap analysis
CGTG-107-EV-CG-002	CGTG-107	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-107-EV-CG-011	CGTG-107	EV-CG-011	Other EV impacted by this gap. Result of a gap analysis.
CGTG-107-EV-CG-048	CGTG-107	EV-CG-048	Other EV impacted by this gap. Result of a gap analysis.
CGTG-107-EV-CG-049	CGTG-107	EV-CG-049	Other EV impacted by this gap. Result of a gap analysis.
CGTG-107-EV-CG-050	CGTG-107	EV-CG-050	Other EV impacted by this gap. Result of a gap analysis.
CGTG-107-GAT-CG-TDT2	CGTG-107	GAT-CG-TDT2	Thread used for gap analysis
CGTG-107-THEM-CG-CL	CGTG-107	THEM-CG-CL	Main theme of the gap
CGTG-107-CG-Ref-047	CGTG-107	CG-Ref-047	Reference for gap determined in gap analysis
CGTG-108-EV-CG-002	CGTG-108	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-108-EV-CG-011	CGTG-108	EV-CG-011	Other EV impacted by this gap. Result of a gap analysis.
CGTG-108-EV-CG-048	CGTG-108	EV-CG-048	Other EV impacted by this gap. Result of a gap analysis.
CGTG-108-EV-CG-049	CGTG-108	EV-CG-049	Other EV impacted by this gap. Result of a gap analysis.
CGTG-108-EV-CG-050	CGTG-108	EV-CG-050	Other EV impacted by this gap. Result of a gap analysis.
CGTG-108-GAT-CG-TDT2	CGTG-108	GAT-CG-TDT2	Thread used for gap analysis
CGTG-108-THEM-CG-CL	CGTG-108	THEM-CG-CL	Main theme of the gap
CGTG-108-CG-Ref-047	CGTG-108	CG-Ref-047	Reference for gap determined in gap analysis
CGTG-109-EV-CG-002	CGTG-109	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-109-EV-CG-011	CGTG-109	EV-CG-011	Other EV impacted by this gap. Result of a gap analysis.
CGTG-109-EV-CG-048	CGTG-109	EV-CG-048	Other EV impacted by this gap. Result of a gap analysis.
CGTG-109-EV-CG-049	CGTG-109	EV-CG-049	Other EV impacted by this gap. Result of a gap analysis.
CGTG-109-EV-CG-050	CGTG-109	EV-CG-050	Other EV impacted by this gap. Result of a gap analysis.
CGTG-109-GAT-CG-TDT2	CGTG-109	GAT-CG-TDT2	Thread used for gap analysis
CGTG-109-THEM-CG-CL	CGTG-109	THEM-CG-CL	Main theme of the gap
CGTG-109-CG-Ref-047	CGTG-109	CG-Ref-047	Reference for gap determined in gap analysis
CGTG-110-EV-CG-002	CGTG-110	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-110-EV-CG-011	CGTG-110	EV-CG-011	Other EV impacted by this gap. Result of a gap analysis.
CGTG-110-EV-CG-048	CGTG-110	EV-CG-048	Other EV impacted by this gap. Result of a gap analysis.
CGTG-110-EV-CG-049	CGTG-110	EV-CG-049	Other EV impacted by this gap. Result of a gap analysis.
CGTG-110-EV-CG-050	CGTG-110	EV-CG-050	Other EV impacted by this gap. Result of a gap analysis.
CGTG-110-GAT-CG-TDT2	CGTG-110	GAT-CG-TDT2	Thread used for gap analysis
CGTG-110-THEM-CG-CL	CGTG-110	THEM-CG-CL	Main theme of the gap
CGTG-110-CG-Ref-048	CGTG-110	CG-Ref-048	Reference for gap determined in gap analysis
CGTG-111-EV-CG-002	CGTG-111	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-111-EV-CG-011	CGTG-111	EV-CG-011	Other EV impacted by this gap. Result of a gap analysis.
CGTG-111-EV-CG-048	CGTG-111	EV-CG-048	Other EV impacted by this gap. Result of a gap analysis.
CGTG-111-EV-CG-049	CGTG-111	EV-CG-049	Other EV impacted by this gap. Result of a gap analysis.
CGTG-111-EV-CG-050	CGTG-111	EV-CG-050	Other EV impacted by this gap. Result of a gap analysis.
CGTG-111-GAT-CG-TDT2	CGTG-111	GAT-CG-TDT2	Thread used for gap analysis
CGTG-111-THEM-CG-CL	CGTG-111	THEM-CG-CL	Main theme of the gap
CGTG-111-CG-Ref-049	CGTG-111	CG-Ref-049	Reference for gap determined in gap analysis
CGTG-112-EV-CG-051	CGTG-112	EV-CG-051	Primary EV impacted by this gap. Result of a gap analysis.

Table 36 continued.

ID	LEFT	RIGHT	DESCRIPTION
CGTG-112-GAT-CG-TDT2	CGTG-112	GAT-CG-TDT2	Thread used for gap analysis
CGTG-112-THEM-CG-CL	CGTG-112	THEM-CG-CL	Main theme of the gap
CGTG-112-CG-Ref-050	CGTG-112	CG-Ref-050	Reference for gap determined in gap analysis
CGTG-113-EV-CG-002	CGTG-113	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-113-EV-CG-011	CGTG-113	EV-CG-011	Other EV impacted by this gap. Result of a gap analysis.
CGTG-113-EV-CG-048	CGTG-113	EV-CG-048	Other EV impacted by this gap. Result of a gap analysis.
CGTG-113-EV-CG-049	CGTG-113	EV-CG-049	Other EV impacted by this gap. Result of a gap analysis.
CGTG-113-EV-CG-050	CGTG-113	EV-CG-050	Other EV impacted by this gap. Result of a gap analysis.
CGTG-113-GAT-CG-TDT2	CGTG-113	GAT-CG-TDT2	Thread used for gap analysis
CGTG-113-THEM-CG-CL	CGTG-113	THEM-CG-CL	Main theme of the gap
CGTG-113-CG-Ref-051	CGTG-113	CG-Ref-051	Reference for gap determined in gap analysis
CGTG-114-EV-CG-002	CGTG-114	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-114-EV-CG-011	CGTG-114	EV-CG-011	Other EV impacted by this gap. Result of a gap analysis.
CGTG-114-EV-CG-048	CGTG-114	EV-CG-048	Other EV impacted by this gap. Result of a gap analysis.
CGTG-114-EV-CG-049	CGTG-114	EV-CG-049	Other EV impacted by this gap. Result of a gap analysis.
CGTG-114-EV-CG-050	CGTG-114	EV-CG-050	Other EV impacted by this gap. Result of a gap analysis.
CGTG-114-GAT-CG-TDT2	CGTG-114	GAT-CG-TDT2	Thread used for gap analysis
CGTG-114-THEM-CG-CL	CGTG-114	THEM-CG-CL	Main theme of the gap
CGTG-114-CG-Ref-052	CGTG-114	CG-Ref-052	Reference for gap determined in gap analysis
CGTG-115-EV-CG-002	CGTG-115	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-115-EV-CG-011	CGTG-115	EV-CG-011	Other EV impacted by this gap. Result of a gap analysis.
CGTG-115-EV-CG-048	CGTG-115	EV-CG-048	Other EV impacted by this gap. Result of a gap analysis.
CGTG-115-EV-CG-049	CGTG-115	EV-CG-049	Other EV impacted by this gap. Result of a gap analysis.
CGTG-115-EV-CG-050	CGTG-115	EV-CG-050	Other EV impacted by this gap. Result of a gap analysis.
CGTG-115-GAT-CG-TDT2	CGTG-115	GAT-CG-TDT2	Thread used for gap analysis
CGTG-115-THEM-CG-CL	CGTG-115	THEM-CG-CL	Main theme of the gap
CGTG-115-CG-Ref-053	CGTG-115	CG-Ref-053	Reference for gap determined in gap analysis
CGTG-116-EV-CG-011	CGTG-116	EV-CG-011	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-116-GAT-CG-TDT2	CGTG-116	GAT-CG-TDT2	Thread used for gap analysis
CGTG-116-THEM-CG-CL	CGTG-116	THEM-CG-CL	Main theme of the gap
CGTG-116-CG-Ref-054	CGTG-116	CG-Ref-054	Reference for gap determined in gap analysis
CGTG-117-EV-CG-002	CGTG-117	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-117-EV-CG-011	CGTG-117	EV-CG-011	Other EV impacted by this gap. Result of a gap analysis.
CGTG-117-EV-CG-052	CGTG-117	EV-CG-052	Other EV impacted by this gap. Result of a gap analysis.
CGTG-117-EV-CG-050	CGTG-117	EV-CG-050	Other EV impacted by this gap. Result of a gap analysis.
CGTG-117-GAT-CG-TDT2	CGTG-117	GAT-CG-TDT2	Thread used for gap analysis
CGTG-117-THEM-CG-CL	CGTG-117	THEM-CG-CL	Main theme of the gap
CGTG-117-CG-Ref-053	CGTG-117	CG-Ref-053	Reference for gap determined in gap analysis
CGTG-118-EV-CG-002	CGTG-118	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-118-GAT-CG-TDT1	CGTG-118	GAT-CG-TDT1	Thread used for gap analysis
CGTG-118-THEM-CG-CL	CGTG-118	THEM-CG-CL	Main theme of the gap
CGTG-118-CG-Ref-054	CGTG-118	CG-Ref-054	Reference for gap determined in gap analysis
CGTG-119-EV-CG-002	CGTG-119	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-119-GAT-CG-TDT2	CGTG-119	GAT-CG-TDT2	Thread used for gap analysis
CGTG-119-THEM-CG-CL	CGTG-119	THEM-CG-CL	Main theme of the gap

Table 36 continued.

ID	LEFT	RIGHT	DESCRIPTION
CGTG-119-CG-Ref-053	CGTG-119	CG-Ref-053	Reference for gap determined in gap analysis
CGTG-120-EV-CG-002	CGTG-120	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-120-GAT-CG-TDT2	CGTG-120	GAT-CG-TDT2	Thread used for gap analysis
CGTG-120-THEM-CG-CL	CGTG-120	THEM-CG-CL	Main theme of the gap
CGTG-120-CG-Ref-055	CGTG-120	CG-Ref-055	Reference for gap determined in gap analysis
CGTG-121-EV-CG-002	CGTG-121	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-121-GAT-CG-TDT2	CGTG-121	GAT-CG-TDT2	Thread used for gap analysis
CGTG-121-THEM-CG-CL	CGTG-121	THEM-CG-CL	Main theme of the gap
CGTG-121-CG-Ref-053	CGTG-121	CG-Ref-053	Reference for gap determined in gap analysis
CGTG-122-EV-CG-002	CGTG-122	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-122-GAT-CG-TDT2	CGTG-122	GAT-CG-TDT2	Thread used for gap analysis
CGTG-122-THEM-CG-CL	CGTG-122	THEM-CG-CL	Main theme of the gap
CGTG-122-CG-Ref-056	CGTG-122	CG-Ref-056	Reference for gap determined in gap analysis
CGTG-123-EV-CG-002	CGTG-123	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-123-GAT-CG-TDT2	CGTG-123	GAT-CG-TDT2	Thread used for gap analysis
CGTG-123-THEM-CG-CL	CGTG-123	THEM-CG-CL	Main theme of the gap
CGTG-123-CG-Ref-057	CGTG-123	CG-Ref-057	Reference for gap determined in gap analysis
CGTG-124-EV-CG-002	CGTG-124	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-124-GAT-CG-TDT2	CGTG-124	GAT-CG-TDT2	Thread used for gap analysis
CGTG-124-THEM-CG-CL	CGTG-124	THEM-CG-CL	Main theme of the gap
CGTG-124-CG-Ref-058	CGTG-124	CG-Ref-058	Reference for gap determined in gap analysis
CGTG-125-EV-CG-002	CGTG-125	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-125-GAT-CG-TDT2	CGTG-125	GAT-CG-TDT2	Thread used for gap analysis
CGTG-125-THEM-CG-CL	CGTG-125	THEM-CG-CL	Main theme of the gap
CGTG-125-CG-Ref-059	CGTG-125	CG-Ref-059	Reference for gap determined in gap analysis
CGTG-126-EV-CG-002	CGTG-126	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-126-GAT-CG-TDT2	CGTG-126	GAT-CG-TDT2	Thread used for gap analysis
CGTG-126-THEM-CG-CL	CGTG-126	THEM-CG-CL	Main theme of the gap
CGTG-126-CG-Ref-060	CGTG-126	CG-Ref-060	Reference for gap determined in gap analysis
CGTG-127-EV-CG-011	CGTG-127	EV-CG-011	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-127-GAT-CG-TDT2	CGTG-127	GAT-CG-TDT2	Thread used for gap analysis
CGTG-127-THEM-CG-CL	CGTG-127	THEM-CG-CL	Main theme of the gap
CGTG-127-CG-Ref-053	CGTG-127	CG-Ref-053	Reference for gap determined in gap analysis
CGTG-128-EV-CG-002	CGTG-128	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-128-GAT-CG-TDT2	CGTG-128	GAT-CG-TDT2	Thread used for gap analysis
CGTG-128-THEM-CG-CL	CGTG-128	THEM-CG-CL	Main theme of the gap
CGTG-128-CG-Ref-053	CGTG-128	CG-Ref-053	Reference for gap determined in gap analysis
CGTG-129-EV-CG-002	CGTG-129	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-129-GAT-CG-TDT2	CGTG-129	GAT-CG-TDT2	Thread used for gap analysis
CGTG-129-THEM-CG-CL	CGTG-129	THEM-CG-CL	Main theme of the gap
CGTG-129-CG-Ref-061	CGTG-129	CG-Ref-061	Reference for gap determined in gap analysis
CGTG-130-EV-CG-050	CGTG-130	EV-CG-050	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-130-GAT-CG-TDT2	CGTG-130	GAT-CG-TDT2	Thread used for gap analysis
CGTG-130-THEM-CG-CL	CGTG-130	THEM-CG-CL	Main theme of the gap
CGTG-130-CG-Ref-061	CGTG-130	CG-Ref-061	Reference for gap determined in gap analysis

Table 36 continued.

ID	LEFT	RIGHT	DESCRIPTION
CGTG-131-EV-CG-050	CGTG-131	EV-CG-050	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-131-EV-CG-053	CGTG-131	EV-CG-053	Other EV impacted by this gap. Result of a gap analysis.
CGTG-131-EV-CG-012	CGTG-131	EV-CG-012	Other EV impacted by this gap. Result of a gap analysis.
CGTG-131-GAT-CG-TDT2	CGTG-131	GAT-CG-TDT2	Thread used for gap analysis
CGTG-131-THEM-CG-CL	CGTG-131	THEM-CG-CL	Main theme of the gap
CGTG-131-CG-Ref-062	CGTG-131	CG-Ref-062	Reference for gap determined in gap analysis
CGTG-132-EV-CG-050	CGTG-132	EV-CG-050	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-132-EV-CG-053	CGTG-132	EV-CG-053	Other EV impacted by this gap. Result of a gap analysis.
CGTG-132-EV-CG-012	CGTG-132	EV-CG-012	Other EV impacted by this gap. Result of a gap analysis.
CGTG-132-GAT-CG-TDT2	CGTG-132	GAT-CG-TDT2	Thread used for gap analysis
CGTG-132-THEM-CG-CL	CGTG-132	THEM-CG-CL	Main theme of the gap
CGTG-132-CG-Ref-062	CGTG-132	CG-Ref-062	Reference for gap determined in gap analysis
CGTG-133-EV-CG-050	CGTG-133	EV-CG-050	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-133-EV-CG-053	CGTG-133	EV-CG-053	Other EV impacted by this gap. Result of a gap analysis.
CGTG-133-EV-CG-012	CGTG-133	EV-CG-012	Other EV impacted by this gap. Result of a gap analysis.
CGTG-133-GAT-CG-TDT2	CGTG-133	GAT-CG-TDT2	Thread used for gap analysis
CGTG-133-THEM-CG-CL	CGTG-133	THEM-CG-CL	Main theme of the gap
CGTG-133-CG-Ref-063	CGTG-133	CG-Ref-063	Reference for gap determined in gap analysis
CGTG-134-EV-CG-050	CGTG-134	EV-CG-050	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-134-EV-CG-053	CGTG-134	EV-CG-053	Other EV impacted by this gap. Result of a gap analysis.
CGTG-134-EV-CG-012	CGTG-134	EV-CG-012	Other EV impacted by this gap. Result of a gap analysis.
CGTG-134-GAT-CG-TDT2	CGTG-134	GAT-CG-TDT2	Thread used for gap analysis
CGTG-134-THEM-CG-CL	CGTG-134	THEM-CG-CL	Main theme of the gap
CGTG-134-CG-Ref-063	CGTG-134	CG-Ref-063	Reference for gap determined in gap analysis
CGTG-135-EV-CG-050	CGTG-135	EV-CG-050	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-135-EV-CG-053	CGTG-135	EV-CG-053	Other EV impacted by this gap. Result of a gap analysis.
CGTG-135-EV-CG-012	CGTG-135	EV-CG-012	Other EV impacted by this gap. Result of a gap analysis.
CGTG-135-GAT-CG-TDT2	CGTG-135	GAT-CG-TDT2	Thread used for gap analysis
CGTG-135-THEM-CG-CL	CGTG-135	THEM-CG-CL	Main theme of the gap
CGTG-135-CG-Ref-063	CGTG-135	CG-Ref-063	Reference for gap determined in gap analysis
CGTG-136-EV-CG-011	CGTG-136	EV-CG-011	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-136-EV-CG-054	CGTG-136	EV-CG-054	Other EV impacted by this gap. Result of a gap analysis.
CGTG-136-EV-CG-049	CGTG-136	EV-CG-049	Other EV impacted by this gap. Result of a gap analysis.
CGTG-136-GAT-CG-TDT2	CGTG-136	GAT-CG-TDT2	Thread used for gap analysis
CGTG-136-THEM-CG-CL	CGTG-136	THEM-CG-CL	Main theme of the gap
CGTG-136-CG-Ref-064	CGTG-136	CG-Ref-064	Reference for gap determined in gap analysis
CGTG-137-EV-CG-011	CGTG-137	EV-CG-011	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-137-EV-CG-054	CGTG-137	EV-CG-054	Other EV impacted by this gap. Result of a gap analysis.
CGTG-137-EV-CG-049	CGTG-137	EV-CG-049	Other EV impacted by this gap. Result of a gap analysis.
CGTG-137-GAT-CG-TDT2	CGTG-137	GAT-CG-TDT2	Thread used for gap analysis
CGTG-137-THEM-CG-CL	CGTG-137	THEM-CG-CL	Main theme of the gap
CGTG-137-CG-Ref-065	CGTG-137	CG-Ref-065	Reference for gap determined in gap analysis
CGTG-138-EV-CG-011	CGTG-138	EV-CG-011	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-138-EV-CG-054	CGTG-138	EV-CG-054	Other EV impacted by this gap. Result of a gap analysis.
CGTG-138-EV-CG-049	CGTG-138	EV-CG-049	Other EV impacted by this gap. Result of a gap analysis.

Table 36 continued.

ID	LEFT	RIGHT	DESCRIPTION
CGTG-138-GAT-CG-TDT2	CGTG-138	GAT-CG-TDT2	Thread used for gap analysis
CGTG-138-THEM-CG-CL	CGTG-138	THEM-CG-CL	Main theme of the gap
CGTG-138-CG-Ref-066	CGTG-138	CG-Ref-066	Reference for gap determined in gap analysis
CGTG-139-EV-CG-048	CGTG-139	EV-CG-048	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-139-EV-CG-049	CGTG-139	EV-CG-049	Other EV impacted by this gap. Result of a gap analysis.
CGTG-139-GAT-CG-TDT2	CGTG-139	GAT-CG-TDT2	Thread used for gap analysis
CGTG-139-THEM-CG-CL	CGTG-139	THEM-CG-CL	Main theme of the gap
CGTG-139-CG-Ref-067	CGTG-139	CG-Ref-067	Reference for gap determined in gap analysis
CGTG-140-EV-CG-002	CGTG-140	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-140-EV-CG-055	CGTG-140	EV-CG-055	Other EV impacted by this gap. Result of a gap analysis.
CGTG-140-EV-CG-049	CGTG-140	EV-CG-049	Other EV impacted by this gap. Result of a gap analysis.
CGTG-140-GAT-CG-TDT2	CGTG-140	GAT-CG-TDT2	Thread used for gap analysis
CGTG-140-THEM-CG-CL	CGTG-140	THEM-CG-CL	Main theme of the gap
CGTG-140-CG-Ref-068	CGTG-140	CG-Ref-068	Reference for gap determined in gap analysis
CGTG-141-EV-CG-049	CGTG-141	EV-CG-049	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-141-GAT-CG-TDT2	CGTG-141	GAT-CG-TDT2	Thread used for gap analysis
CGTG-141-THEM-CG-CL	CGTG-141	THEM-CG-CL	Main theme of the gap
CGTG-141-CG-Ref-053	CGTG-141	CG-Ref-053	Reference for gap determined in gap analysis
CGTG-142-EV-CG-048	CGTG-142	EV-CG-048	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-142-EV-CG-049	CGTG-142	EV-CG-049	Other EV impacted by this gap. Result of a gap analysis.
CGTG-142-GAT-CG-TDT2	CGTG-142	GAT-CG-TDT2	Thread used for gap analysis
CGTG-142-THEM-CG-CL	CGTG-142	THEM-CG-CL	Main theme of the gap
CGTG-142-CG-Ref-067	CGTG-142	CG-Ref-067	Reference for gap determined in gap analysis
CGTG-143-EV-CG-011	CGTG-143	EV-CG-011	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-143-EV-CG-055	CGTG-143	EV-CG-055	Other EV impacted by this gap. Result of a gap analysis.
CGTG-143-EV-CG-049	CGTG-143	EV-CG-049	Other EV impacted by this gap. Result of a gap analysis.
CGTG-143-GAT-CG-TDT2	CGTG-143	GAT-CG-TDT2	Thread used for gap analysis
CGTG-143-THEM-CG-CL	CGTG-143	THEM-CG-CL	Main theme of the gap
CGTG-143-CG-Ref-053	CGTG-143	CG-Ref-053	Reference for gap determined in gap analysis
CGTG-144-EV-CG-002	CGTG-144	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-144-GAT-CG-TDT2	CGTG-144	GAT-CG-TDT2	Thread used for gap analysis
CGTG-144-THEM-CG-CL	CGTG-144	THEM-CG-CL	Main theme of the gap
CGTG-144-CG-Ref-069	CGTG-144	CG-Ref-069	Reference for gap determined in gap analysis
CGTG-145-EV-CG-002	CGTG-145	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-145-GAT-CG-TDT2	CGTG-145	GAT-CG-TDT2	Thread used for gap analysis
CGTG-145-THEM-CG-CL	CGTG-145	THEM-CG-CL	Main theme of the gap
CGTG-145-CG-Ref-069	CGTG-145	CG-Ref-069	Reference for gap determined in gap analysis
CGTG-146-EV-CG-002	CGTG-146	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-146-GAT-CG-TDT2	CGTG-146	GAT-CG-TDT2	Thread used for gap analysis
CGTG-146-THEM-CG-CL	CGTG-146	THEM-CG-CL	Main theme of the gap
CGTG-146-CG-Ref-070	CGTG-146	CG-Ref-070	Reference for gap determined in gap analysis
CGTG-147-EV-CG-002	CGTG-147	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-147-GAT-CG-TDT2	CGTG-147	GAT-CG-TDT2	Thread used for gap analysis
CGTG-147-THEM-CG-CL	CGTG-147	THEM-CG-CL	Main theme of the gap
CGTG-147-CG-Ref-071	CGTG-147	CG-Ref-071	Reference for gap determined in gap analysis

Table 36 continued.

ID	LEFT	RIGHT	DESCRIPTION
CGTG-148-EV-CG-002	CGTG-148	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-148-GAT-CG-TDT2	CGTG-148	GAT-CG-TDT2	Thread used for gap analysis
CGTG-148-THEM-CG-CL	CGTG-148	THEM-CG-CL	Main theme of the gap
CGTG-148-CG-Ref-072	CGTG-148	CG-Ref-072	Reference for gap determined in gap analysis
CGTG-149-EV-CG-002	CGTG-149	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-149-GAT-CG-TDT2	CGTG-149	GAT-CG-TDT2	Thread used for gap analysis
CGTG-149-THEM-CG-CL	CGTG-149	THEM-CG-CL	Main theme of the gap
CGTG-149-CG-Ref-073	CGTG-149	CG-Ref-073	Reference for gap determined in gap analysis
CGTG-150-EV-CG-002	CGTG-150	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-150-GAT-CG-TDT2	CGTG-150	GAT-CG-TDT2	Thread used for gap analysis
CGTG-150-THEM-CG-CL	CGTG-150	THEM-CG-CL	Main theme of the gap
CGTG-150-CG-Ref-074	CGTG-150	CG-Ref-074	Reference for gap determined in gap analysis
CGTG-151-EV-CG-002	CGTG-151	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-151-GAT-CG-TDT2	CGTG-151	GAT-CG-TDT2	Thread used for gap analysis
CGTG-151-THEM-CG-CL	CGTG-151	THEM-CG-CL	Main theme of the gap
CGTG-151-CG-Ref-073	CGTG-151	CG-Ref-073	Reference for gap determined in gap analysis
CGTG-152-EV-CG-011	CGTG-152	EV-CG-011	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-152-GAT-CG-TDT2	CGTG-152	GAT-CG-TDT2	Thread used for gap analysis
CGTG-152-THEM-CG-CL	CGTG-152	THEM-CG-CL	Main theme of the gap
CGTG-152-CG-Ref-075	CGTG-152	CG-Ref-075	Reference for gap determined in gap analysis
CGTG-153-EV-CG-002	CGTG-153	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-153-EV-CG-011	CGTG-153	EV-CG-011	Other EV impacted by this gap. Result of a gap analysis.
CGTG-153-EV-CG-048	CGTG-153	EV-CG-048	Other EV impacted by this gap. Result of a gap analysis.
CGTG-153-EV-CG-049	CGTG-153	EV-CG-049	Other EV impacted by this gap. Result of a gap analysis.
CGTG-153-EV-CG-050	CGTG-153	EV-CG-050	Other EV impacted by this gap. Result of a gap analysis.
CGTG-153-GAT-CG-TDT2	CGTG-153	GAT-CG-TDT2	Thread used for gap analysis
CGTG-153-THEM-CG-CL	CGTG-153	THEM-CG-CL	Main theme of the gap
CGTG-153-CG-Ref-076	CGTG-153	CG-Ref-076	Reference for gap determined in gap analysis
CGTG-154-EV-CG-002	CGTG-154	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-154-EV-CG-011	CGTG-154	EV-CG-011	Other EV impacted by this gap. Result of a gap analysis.
CGTG-154-EV-CG-048	CGTG-154	EV-CG-048	Other EV impacted by this gap. Result of a gap analysis.
CGTG-154-EV-CG-049	CGTG-154	EV-CG-049	Other EV impacted by this gap. Result of a gap analysis.
CGTG-154-EV-CG-050	CGTG-154	EV-CG-050	Other EV impacted by this gap. Result of a gap analysis.
CGTG-154-GAT-CG-TDT2	CGTG-154	GAT-CG-TDT2	Thread used for gap analysis
CGTG-154-THEM-CG-CL	CGTG-154	THEM-CG-CL	Main theme of the gap
CGTG-154-CG-Ref-076	CGTG-154	CG-Ref-076	Reference for gap determined in gap analysis
CGTG-155-EV-CG-002	CGTG-155	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-155-EV-CG-011	CGTG-155	EV-CG-011	Other EV impacted by this gap. Result of a gap analysis.
CGTG-155-EV-CG-048	CGTG-155	EV-CG-048	Other EV impacted by this gap. Result of a gap analysis.
CGTG-155-EV-CG-049	CGTG-155	EV-CG-049	Other EV impacted by this gap. Result of a gap analysis.
CGTG-155-EV-CG-050	CGTG-155	EV-CG-050	Other EV impacted by this gap. Result of a gap analysis.
CGTG-155-GAT-CG-TDT2	CGTG-155	GAT-CG-TDT2	Thread used for gap analysis
CGTG-155-THEM-CG-CL	CGTG-155	THEM-CG-CL	Main theme of the gap
CGTG-155-CG-Ref-076	CGTG-155	CG-Ref-076	Reference for gap determined in gap analysis
CGTG-156-EV-CG-002	CGTG-156	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.

Table 36 continued.

ID	LEFT	RIGHT	DESCRIPTION
CGTG-156-EV-CG-011	CGTG-156	EV-CG-011	Other EV impacted by this gap. Result of a gap analysis.
CGTG-156-EV-CG-048	CGTG-156	EV-CG-048	Other EV impacted by this gap. Result of a gap analysis.
CGTG-156-EV-CG-049	CGTG-156	EV-CG-049	Other EV impacted by this gap. Result of a gap analysis.
CGTG-156-EV-CG-050	CGTG-156	EV-CG-050	Other EV impacted by this gap. Result of a gap analysis.
CGTG-156-GAT-CG-TDT2	CGTG-156	GAT-CG-TDT2	Thread used for gap analysis
CGTG-156-THEM-CG-CL	CGTG-156	THEM-CG-CL	Main theme of the gap
CGTG-156-CG-Ref-076	CGTG-156	CG-Ref-076	Reference for gap determined in gap analysis
CGTG-157-EV-CG-002	CGTG-157	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-157-EV-CG-011	CGTG-157	EV-CG-011	Other EV impacted by this gap. Result of a gap analysis.
CGTG-157-EV-CG-048	CGTG-157	EV-CG-048	Other EV impacted by this gap. Result of a gap analysis.
CGTG-157-EV-CG-049	CGTG-157	EV-CG-049	Other EV impacted by this gap. Result of a gap analysis.
CGTG-157-EV-CG-050	CGTG-157	EV-CG-050	Other EV impacted by this gap. Result of a gap analysis.
CGTG-157-GAT-CG-TDT2	CGTG-157	GAT-CG-TDT2	Thread used for gap analysis
CGTG-157-THEM-CG-CL	CGTG-157	THEM-CG-CL	Main theme of the gap
CGTG-157-CG-Ref-076	CGTG-157	CG-Ref-076	Reference for gap determined in gap analysis
CGTG-158-EV-CG-002	CGTG-158	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-158-EV-CG-011	CGTG-158	EV-CG-011	Other EV impacted by this gap. Result of a gap analysis.
CGTG-158-EV-CG-048	CGTG-158	EV-CG-048	Other EV impacted by this gap. Result of a gap analysis.
CGTG-158-EV-CG-049	CGTG-158	EV-CG-049	Other EV impacted by this gap. Result of a gap analysis.
CGTG-158-EV-CG-050	CGTG-158	EV-CG-050	Other EV impacted by this gap. Result of a gap analysis.
CGTG-158-GAT-CG-TDT2	CGTG-158	GAT-CG-TDT2	Thread used for gap analysis
CGTG-158-THEM-CG-CL	CGTG-158	THEM-CG-CL	Main theme of the gap
CGTG-158-CG-Ref-076	CGTG-158	CG-Ref-076	Reference for gap determined in gap analysis
CGTG-159-EV-CG-050	CGTG-159	EV-CG-050	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-159-GAT-CG-TDT2	CGTG-159	GAT-CG-TDT2	Thread used for gap analysis
CGTG-159-THEM-CG-CL	CGTG-159	THEM-CG-CL	Main theme of the gap
CGTG-159-CG-Ref-077	CGTG-159	CG-Ref-077	Reference for gap determined in gap analysis
CGTG-160-EV-CG-011	CGTG-160	EV-CG-011	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-160-GAT-CG-TDT2	CGTG-160	GAT-CG-TDT2	Thread used for gap analysis
CGTG-160-THEM-CG-CL	CGTG-160	THEM-CG-CL	Main theme of the gap
CGTG-160-CG-Ref-078	CGTG-160	CG-Ref-078	Reference for gap determined in gap analysis
CGTG-161-EV-CG-050	CGTG-161	EV-CG-050	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-161-EV-CG-011	CGTG-161	EV-CG-011	Other EV impacted by this gap. Result of a gap analysis.
CGTG-161-GAT-CG-TDT2	CGTG-161	GAT-CG-TDT2	Thread used for gap analysis
CGTG-161-THEM-CG-CL	CGTG-161	THEM-CG-CL	Main theme of the gap
CGTG-161-CG-Ref-053	CGTG-161	CG-Ref-053	Reference for gap determined in gap analysis
CGTG-162-EV-CG-050	CGTG-162	EV-CG-050	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-162-EV-CG-011	CGTG-162	EV-CG-011	Other EV impacted by this gap. Result of a gap analysis.
CGTG-162-GAT-CG-TDT2	CGTG-162	GAT-CG-TDT2	Thread used for gap analysis
CGTG-162-THEM-CG-CL	CGTG-162	THEM-CG-CL	Main theme of the gap
CGTG-162-CG-Ref-079	CGTG-162	CG-Ref-079	Reference for gap determined in gap analysis
CGTG-163-EV-CG-050	CGTG-163	EV-CG-050	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-163-EV-CG-011	CGTG-163	EV-CG-011	Other EV impacted by this gap. Result of a gap analysis.
CGTG-163-GAT-CG-TDT2	CGTG-163	GAT-CG-TDT2	Thread used for gap analysis
CGTG-163-THEM-CG-CL	CGTG-163	THEM-CG-CL	Main theme of the gap

Table 36 continued.

ID	LEFT	RIGHT	DESCRIPTION
CGTG-163-CG-Ref-080	CGTG-163	CG-Ref-080	Reference for gap determined in gap analysis
CGTG-164-EV-CG-050	CGTG-164	EV-CG-050	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-164-EV-CG-011	CGTG-164	EV-CG-011	Other EV impacted by this gap. Result of a gap analysis.
CGTG-164-GAT-CG-TDT2	CGTG-164	GAT-CG-TDT2	Thread used for gap analysis
CGTG-164-THEM-CG-CL	CGTG-164	THEM-CG-CL	Main theme of the gap
CGTG-164-CG-Ref-080	CGTG-164	CG-Ref-080	Reference for gap determined in gap analysis
CGTG-165-EV-CG-002	CGTG-165	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-165-EV-CG-011	CGTG-165	EV-CG-011	Other EV impacted by this gap. Result of a gap analysis.
CGTG-165-EV-CG-048	CGTG-165	EV-CG-048	Other EV impacted by this gap. Result of a gap analysis.
CGTG-165-EV-CG-049	CGTG-165	EV-CG-049	Other EV impacted by this gap. Result of a gap analysis.
CGTG-165-EV-CG-050	CGTG-165	EV-CG-050	Other EV impacted by this gap. Result of a gap analysis.
CGTG-165-GAT-CG-TDT2	CGTG-165	GAT-CG-TDT2	Thread used for gap analysis
CGTG-165-THEM-CG-CL	CGTG-165	THEM-CG-CL	Main theme of the gap
CGTG-165-CG-Ref-081	CGTG-165	CG-Ref-081	Reference for gap determined in gap analysis
CGTG-166-EV-CG-002	CGTG-166	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-166-EV-CG-011	CGTG-166	EV-CG-011	Other EV impacted by this gap. Result of a gap analysis.
CGTG-166-EV-CG-048	CGTG-166	EV-CG-048	Other EV impacted by this gap. Result of a gap analysis.
CGTG-166-EV-CG-049	CGTG-166	EV-CG-049	Other EV impacted by this gap. Result of a gap analysis.
CGTG-166-EV-CG-050	CGTG-166	EV-CG-050	Other EV impacted by this gap. Result of a gap analysis.
CGTG-166-GAT-CG-TDT2	CGTG-166	GAT-CG-TDT2	Thread used for gap analysis
CGTG-166-THEM-CG-CL	CGTG-166	THEM-CG-CL	Main theme of the gap
CGTG-166-CG-Ref-082	CGTG-166	CG-Ref-082	Reference for gap determined in gap analysis
CGTG-167-EV-CG-002	CGTG-167	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-167-EV-CG-011	CGTG-167	EV-CG-011	Other EV impacted by this gap. Result of a gap analysis.
CGTG-167-EV-CG-048	CGTG-167	EV-CG-048	Other EV impacted by this gap. Result of a gap analysis.
CGTG-167-EV-CG-049	CGTG-167	EV-CG-049	Other EV impacted by this gap. Result of a gap analysis.
CGTG-167-EV-CG-050	CGTG-167	EV-CG-050	Other EV impacted by this gap. Result of a gap analysis.
CGTG-167-GAT-CG-TDT2	CGTG-167	GAT-CG-TDT2	Thread used for gap analysis
CGTG-167-THEM-CG-CL	CGTG-167	THEM-CG-CL	Main theme of the gap
CGTG-167-CG-Ref-083	CGTG-167	CG-Ref-083	Reference for gap determined in gap analysis
CGTG-168-EV-CG-002	CGTG-168	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-168-EV-CG-011	CGTG-168	EV-CG-011	Other EV impacted by this gap. Result of a gap analysis.
CGTG-168-EV-CG-048	CGTG-168	EV-CG-048	Other EV impacted by this gap. Result of a gap analysis.
CGTG-168-EV-CG-049	CGTG-168	EV-CG-049	Other EV impacted by this gap. Result of a gap analysis.
CGTG-168-EV-CG-050	CGTG-168	EV-CG-050	Other EV impacted by this gap. Result of a gap analysis.
CGTG-168-GAT-CG-TDT2	CGTG-168	GAT-CG-TDT2	Thread used for gap analysis
CGTG-168-THEM-CG-CL	CGTG-168	THEM-CG-CL	Main theme of the gap
CGTG-168-CG-Ref-084	CGTG-168	CG-Ref-084	Reference for gap determined in gap analysis
CGTG-169-EV-CG-002	CGTG-169	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-169-EV-CG-011	CGTG-169	EV-CG-011	Other EV impacted by this gap. Result of a gap analysis.
CGTG-169-EV-CG-048	CGTG-169	EV-CG-048	Other EV impacted by this gap. Result of a gap analysis.
CGTG-169-EV-CG-049	CGTG-169	EV-CG-049	Other EV impacted by this gap. Result of a gap analysis.
CGTG-169-EV-CG-050	CGTG-169	EV-CG-050	Other EV impacted by this gap. Result of a gap analysis.
CGTG-169-GAT-CG-TDT2	CGTG-169	GAT-CG-TDT2	Thread used for gap analysis
CGTG-169-THEM-CG-CL	CGTG-169	THEM-CG-CL	Main theme of the gap

Table 36 continued.

ID	LEFT	RIGHT	DESCRIPTION
CGTG-169-CG-Ref-084	CGTG-169	CG-Ref-084	Reference for gap determined in gap analysis
CGTG-170-EV-CG-002	CGTG-170	EV-CG-002	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-170-EV-CG-011	CGTG-170	EV-CG-011	Other EV impacted by this gap. Result of a gap analysis.
CGTG-170-EV-CG-048	CGTG-170	EV-CG-048	Other EV impacted by this gap. Result of a gap analysis.
CGTG-170-EV-CG-049	CGTG-170	EV-CG-049	Other EV impacted by this gap. Result of a gap analysis.
CGTG-170-EV-CG-050	CGTG-170	EV-CG-050	Other EV impacted by this gap. Result of a gap analysis.
CGTG-170-GAT-CG-TDT2	CGTG-170	GAT-CG-TDT2	Thread used for gap analysis
CGTG-170-THEM-CG-CL	CGTG-170	THEM-CG-CL	Main theme of the gap
CGTG-170-CG-Ref-085	CGTG-170	CG-Ref-085	Reference for gap determined in gap analysis
CGTG-171-EV-CG-056	CGTG-171	EV-CG-056	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-171-GAT-CG-TDT2	CGTG-171	GAT-CG-TDT2	Thread used for gap analysis
CGTG-171-THEM-CG-CL	CGTG-171	THEM-CG-CL	Main theme of the gap
CGTG-171-CG-Ref-086	CGTG-171	CG-Ref-086	Reference for gap determined in gap analysis
CGTG-172-EV-CG-056	CGTG-172	EV-CG-056	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-172-GAT-CG-TDT2	CGTG-172	GAT-CG-TDT2	Thread used for gap analysis
CGTG-172-THEM-CG-CL	CGTG-172	THEM-CG-CL	Main theme of the gap
CGTG-172-CG-Ref-087	CGTG-172	CG-Ref-087	Reference for gap determined in gap analysis
CGTG-173-EV-CG-056	CGTG-173	EV-CG-056	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-173-GAT-CG-BUT3	CGTG-173	GAT-CG-BUT3	Thread used for gap analysis
CGTG-173-THEM-CG-All	CGTG-173	THEM-CG-All	Main theme of the gap
CGTG-173-CG-Ref-088	CGTG-173	CG-Ref-088	Reference for gap determined in gap analysis
CGTG-174-EV-CG-057	CGTG-174	EV-CG-057	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-174-GAT-CG-BUT3	CGTG-174	GAT-CG-BUT3	Thread used for gap analysis
CGTG-174-THEM-CG-DI	CGTG-174	THEM-CG-DI	Main theme of the gap
CGTG-174-THEM-CG-HS	CGTG-174	THEM-CG-HS	Other theme of the gap
CGTG-174-CG-Ref-088	CGTG-174	CG-Ref-088	Reference for gap determined in gap analysis
CGTG-175-EV-CG-018	CGTG-175	EV-CG-018	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-175-GAT-CG-BUT3	CGTG-175	GAT-CG-BUT3	Thread used for gap analysis
CGTG-175-THEM-CG-OC	CGTG-175	THEM-CG-OC	Main theme of the gap
CGTG-175-CG-Ref-089	CGTG-175	CG-Ref-089	Reference for gap determined in gap analysis
CGTG-176-EV-CG-057	CGTG-176	EV-CG-057	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-176-GAT-CG-BUT3	CGTG-176	GAT-CG-BUT3	Thread used for gap analysis
CGTG-176-THEM-CG-All	CGTG-176	THEM-CG-All	Main theme of the gap
CGTG-176-CG-Ref-089	CGTG-176	CG-Ref-089	Reference for gap determined in gap analysis
CGTG-177-EV-CG-058	CGTG-177	EV-CG-058	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-177-GAT-CG-TDT1	CGTG-177	GAT-CG-TDT1	Thread used for gap analysis
CGTG-177-THEM-CG-CL	CGTG-177	THEM-CG-CL	Main theme of the gap
CGTG-177-CG-Ref-090	CGTG-177	CG-Ref-090	Reference for gap determined in gap analysis
CGTG-178-EV-CG-058	CGTG-178	EV-CG-058	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-178-GAT-CG-TDT1	CGTG-178	GAT-CG-TDT1	Thread used for gap analysis
CGTG-178-THEM-CG-CL	CGTG-178	THEM-CG-CL	Main theme of the gap
CGTG-178-CG-Ref-090	CGTG-178	CG-Ref-090	Reference for gap determined in gap analysis
CGTG-179-EV-CG-058	CGTG-179	EV-CG-058	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-179-GAT-CG-TDT1	CGTG-179	GAT-CG-TDT1	Thread used for gap analysis
CGTG-179-THEM-CG-CL	CGTG-179	THEM-CG-CL	Main theme of the gap

Table 36 continued.

ID	LEFT	RIGHT	DESCRIPTION
CGTG-179-CG-Ref-090	CGTG-179	CG-Ref-090	Reference for gap determined in gap analysis
CGTG-180-EV-CG-058	CGTG-180	EV-CG-058	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-180-GAT-CG-TDT1	CGTG-180	GAT-CG-TDT1	Thread used for gap analysis
CGTG-180-THEM-CG-DI	CGTG-180	THEM-CG-DI	Main theme of the gap
CGTG-180-CG-Ref-090	CGTG-180	CG-Ref-090	Reference for gap determined in gap analysis
CGTG-181-EV-CG-058	CGTG-181	EV-CG-058	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-181-GAT-CG-TDT1	CGTG-181	GAT-CG-TDT1	Thread used for gap analysis
CGTG-181-THEM-CG-CL	CGTG-181	THEM-CG-CL	Main theme of the gap
CGTG-181-CG-Ref-090	CGTG-181	CG-Ref-090	Reference for gap determined in gap analysis
CGTG-183-EV-CG-058	CGTG-183	EV-CG-058	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-183-GAT-CG-TDT1	CGTG-183	GAT-CG-TDT1	Thread used for gap analysis
CGTG-183-THEM-CG-CL	CGTG-183	THEM-CG-CL	Main theme of the gap
CGTG-183-CG-Ref-090	CGTG-183	CG-Ref-090	Reference for gap determined in gap analysis
CGTG-184-EV-CG-058	CGTG-184	EV-CG-058	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-184-GAT-CG-TDT1	CGTG-184	GAT-CG-TDT1	Thread used for gap analysis
CGTG-184-THEM-CG-CL	CGTG-184	THEM-CG-CL	Main theme of the gap
CGTG-184-CG-Ref-090	CGTG-184	CG-Ref-090	Reference for gap determined in gap analysis
CGTG-185-EV-CG-023	CGTG-185	EV-CG-023	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-185-GAT-CG-TDT1	CGTG-185	GAT-CG-TDT1	Thread used for gap analysis
CGTG-185-THEM-CG-CL	CGTG-185	THEM-CG-CL	Main theme of the gap
CGTG-185-CG-Ref-090	CGTG-185	CG-Ref-090	Reference for gap determined in gap analysis
CGTG-186-EV-CG-059	CGTG-186	EV-CG-059	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-186-GAT-CG-TDT1	CGTG-186	GAT-CG-TDT1	Thread used for gap analysis
CGTG-186-THEM-CG-CL	CGTG-186	THEM-CG-CL	Main theme of the gap
CGTG-186-CG-Ref-090	CGTG-186	CG-Ref-090	Reference for gap determined in gap analysis
CGTG-188-EV-CG-059	CGTG-188	EV-CG-059	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-188-GAT-CG-TDT1	CGTG-188	GAT-CG-TDT1	Thread used for gap analysis
CGTG-188-THEM-CG-CL	CGTG-188	THEM-CG-CL	Main theme of the gap
CGTG-188-CG-Ref-090	CGTG-188	CG-Ref-090	Reference for gap determined in gap analysis
CGTG-189-EV-CG-059	CGTG-189	EV-CG-059	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-189-GAT-CG-TDT1	CGTG-189	GAT-CG-TDT1	Thread used for gap analysis
CGTG-189-THEM-CG-CL	CGTG-189	THEM-CG-CL	Main theme of the gap
CGTG-189-CG-Ref-090	CGTG-189	CG-Ref-090	Reference for gap determined in gap analysis
CGTG-193-EV-CG-060	CGTG-193	EV-CG-060	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-193-GAT-CG-TDT1	CGTG-193	GAT-CG-TDT1	Thread used for gap analysis
CGTG-193-THEM-CG-CL	CGTG-193	THEM-CG-CL	Main theme of the gap
CGTG-193-CG-Ref-091	CGTG-193	CG-Ref-091	Reference for gap determined in gap analysis
CGTG-194-EV-CG-019	CGTG-194	EV-CG-019	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-194-GAT-CG-TDT1	CGTG-194	GAT-CG-TDT1	Thread used for gap analysis
CGTG-194-THEM-CG-OC	CGTG-194	THEM-CG-OC	Main theme of the gap
CGTG-194-CG-Ref-091	CGTG-194	CG-Ref-091	Reference for gap determined in gap analysis
CGTG-195-EV-CG-019	CGTG-195	EV-CG-019	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-195-GAT-CG-TDT1	CGTG-195	GAT-CG-TDT1	Thread used for gap analysis
CGTG-195-THEM-CG-OC	CGTG-195	THEM-CG-OC	Main theme of the gap
CGTG-195-CG-Ref-091	CGTG-195	CG-Ref-091	Reference for gap determined in gap analysis

Table 36 continued.

ID	LEFT	RIGHT	DESCRIPTION
CGTG-197-EV-CG-019	CGTG-197	EV-CG-019	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-197-GAT-CG-TDT1	CGTG-197	GAT-CG-TDT1	Thread used for gap analysis
CGTG-197-THEM-CG-OC	CGTG-197	THEM-CG-OC	Main theme of the gap
CGTG-197-CG-Ref-091	CGTG-197	CG-Ref-091	Reference for gap determined in gap analysis
CGTG-198-EV-CG-019	CGTG-198	EV-CG-019	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-198-GAT-CG-TDT1	CGTG-198	GAT-CG-TDT1	Thread used for gap analysis
CGTG-198-THEM-CG-OC	CGTG-198	THEM-CG-OC	Main theme of the gap
CGTG-198-CG-Ref-091	CGTG-198	CG-Ref-091	Reference for gap determined in gap analysis
CGTG-199-EV-CG-019	CGTG-199	EV-CG-019	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-199-GAT-CG-TDT1	CGTG-199	GAT-CG-TDT1	Thread used for gap analysis
CGTG-199-THEM-CG-OC	CGTG-199	THEM-CG-OC	Main theme of the gap
CGTG-199-CG-Ref-091	CGTG-199	CG-Ref-091	Reference for gap determined in gap analysis
CGTG-200-EV-CG-048	CGTG-200	EV-CG-048	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-200-EV-CG-003	CGTG-200	EV-CG-003	Other EV impacted by this gap. Result of a gap analysis.
CGTG-200-EV-CG-061	CGTG-200	EV-CG-061	Other EV impacted by this gap. Result of a gap analysis.
CGTG-200-GAT-CG-BUT3	CGTG-200	GAT-CG-BUT3	Thread used for gap analysis
CGTG-200-THEM-CG-MU	CGTG-200	THEM-CG-MU	Main theme of the gap
CGTG-200-CG-Ref-092	CGTG-200	CG-Ref-092	Reference for gap determined in gap analysis
CGTG-201-EV-CG-010	CGTG-201	EV-CG-010	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-201-GAT-CG-BUT3	CGTG-201	GAT-CG-BUT3	Thread used for gap analysis
CGTG-201-THEM-CG-MU	CGTG-201	THEM-CG-MU	Main theme of the gap
CGTG-201-CG-Ref-092	CGTG-201	CG-Ref-092	Reference for gap determined in gap analysis
CGTG-202-EV-CG-022	CGTG-202	EV-CG-022	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-202-GAT-CG-BUT1	CGTG-202	GAT-CG-BUT1	Thread used for gap analysis
CGTG-202-THEM-CG-CL	CGTG-202	THEM-CG-CL	Main theme of the gap
CGTG-202-CG-Ref-093	CGTG-202	CG-Ref-093	Reference for gap determined in gap analysis
CGTG-203-EV-CG-013	CGTG-203	EV-CG-013	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-203-GAT-CG-BUT1	CGTG-203	GAT-CG-BUT1	Thread used for gap analysis
CGTG-203-THEM-CG-WA	CGTG-203	THEM-CG-WA	Main theme of the gap
CGTG-203-CG-Ref-094	CGTG-203	CG-Ref-094	Reference for gap determined in gap analysis
CGTG-204-EV-CG-062	CGTG-204	EV-CG-062	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-204-EV-CG-014	CGTG-204	EV-CG-014	Other EV impacted by this gap. Result of a gap analysis.
CGTG-204-GAT-CG-BUT1	CGTG-204	GAT-CG-BUT1	Thread used for gap analysis
CGTG-204-THEM-CG-WA	CGTG-204	THEM-CG-WA	Main theme of the gap
CGTG-204-CG-Ref-095	CGTG-204	CG-Ref-095	Reference for gap determined in gap analysis
CGTG-205-EV-CG-012	CGTG-205	EV-CG-012	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-205-GAT-CG-BUT1	CGTG-205	GAT-CG-BUT1	Thread used for gap analysis
CGTG-205-THEM-CG-CL	CGTG-205	THEM-CG-CL	Main theme of the gap
CGTG-205-CG-Ref-096	CGTG-205	CG-Ref-096	Reference for gap determined in gap analysis
CGTG-206-EV-CG-062	CGTG-206	EV-CG-062	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-206-GAT-CG-BUT1	CGTG-206	GAT-CG-BUT1	Thread used for gap analysis
CGTG-206-THEM-CG-All	CGTG-206	THEM-CG-All	Main theme of the gap
CGTG-206-CG-Ref-097	CGTG-206	CG-Ref-097	Reference for gap determined in gap analysis
CGTG-207-EV-CG-006	CGTG-207	EV-CG-006	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-207-EV-CG-005	CGTG-207	EV-CG-005	Other EV impacted by this gap. Result of a gap analysis.

Table 36 continued.

ID	LEFT	RIGHT	DESCRIPTION
CGTG-207-EV-CG-063	CGTG-207	EV-CG-063	Other EV impacted by this gap. Result of a gap analysis.
CGTG-207-GAT-CG-BUT1	CGTG-207	GAT-CG-BUT1	Thread used for gap analysis
CGTG-207-THEM-CG-CL	CGTG-207	THEM-CG-CL	Main theme of the gap
CGTG-207-CG-Ref-098	CGTG-207	CG-Ref-098	Reference for gap determined in gap analysis
CGTG-208-EV-CG-022	CGTG-208	EV-CG-022	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-208-GAT-CG-BUT1	CGTG-208	GAT-CG-BUT1	Thread used for gap analysis
CGTG-208-THEM-CG-MU	CGTG-208	THEM-CG-MU	Main theme of the gap
CGTG-208-CG-Ref-099	CGTG-208	CG-Ref-099	Reference for gap determined in gap analysis
CGTG-209-EV-CG-056	CGTG-209	EV-CG-056	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-209-GAT-CG-BUT1	CGTG-209	GAT-CG-BUT1	Thread used for gap analysis
CGTG-209-THEM-CG-CL	CGTG-209	THEM-CG-CL	Main theme of the gap
CGTG-209-CG-Ref-100	CGTG-209	CG-Ref-100	Reference for gap determined in gap analysis
CGTG-210-EV-CG-009	CGTG-210	EV-CG-009	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-210-GAT-CG-BUT1	CGTG-210	GAT-CG-BUT1	Thread used for gap analysis
CGTG-210-THEM-CG-MU	CGTG-210	THEM-CG-MU	Main theme of the gap
CGTG-210-CG-Ref-101	CGTG-210	CG-Ref-101	Reference for gap determined in gap analysis
CGTG-211-EV-CG-063	CGTG-211	EV-CG-063	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-211-GAT-CG-BUT1	CGTG-211	GAT-CG-BUT1	Thread used for gap analysis
CGTG-211-THEM-CG-All	CGTG-211	THEM-CG-All	Main theme of the gap
CGTG-211-CG-Ref-102	CGTG-211	CG-Ref-102	Reference for gap determined in gap analysis
CGTG-212-EV-CG-064	CGTG-212	EV-CG-064	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-212-GAT-CG-BUT1	CGTG-212	GAT-CG-BUT1	Thread used for gap analysis
CGTG-212-THEM-CG-WA	CGTG-212	THEM-CG-WA	Main theme of the gap
CGTG-212-CG-Ref-103	CGTG-212	CG-Ref-103	Reference for gap determined in gap analysis
CGTG-213-EV-CG-064	CGTG-213	EV-CG-064	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-213-GAT-CG-BUT1	CGTG-213	GAT-CG-BUT1	Thread used for gap analysis
CGTG-213-THEM-CG-MU	CGTG-213	THEM-CG-MU	Main theme of the gap
CGTG-213-CG-Ref-104	CGTG-213	CG-Ref-104	Reference for gap determined in gap analysis
CGTG-214-EV-CG-019	CGTG-214	EV-CG-019	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-214-EV-CG-058	CGTG-214	EV-CG-058	Other EV impacted by this gap. Result of a gap analysis.
CGTG-214-GAT-CG-BUT1	CGTG-214	GAT-CG-BUT1	Thread used for gap analysis
CGTG-214-THEM-CG-CL	CGTG-214	THEM-CG-CL	Main theme of the gap
CGTG-214-CG-Ref-105	CGTG-214	CG-Ref-105	Reference for gap determined in gap analysis
CGTG-215-EV-CG-065	CGTG-215	EV-CG-065	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-215-GAT-CG-BUT1	CGTG-215	GAT-CG-BUT1	Thread used for gap analysis
CGTG-215-THEM-CG-OC	CGTG-215	THEM-CG-OC	Main theme of the gap
CGTG-215-CG-Ref-106	CGTG-215	CG-Ref-106	Reference for gap determined in gap analysis
CGTG-216-EV-CG-010	CGTG-216	EV-CG-010	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-216-GAT-CG-BUT1	CGTG-216	GAT-CG-BUT1	Thread used for gap analysis
CGTG-216-THEM-CG-DI	CGTG-216	THEM-CG-DI	Main theme of the gap
CGTG-216-CG-Ref-107	CGTG-216	CG-Ref-107	Reference for gap determined in gap analysis
CGTG-217-EV-CG-022	CGTG-217	EV-CG-022	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-217-GAT-CG-BUT1	CGTG-217	GAT-CG-BUT1	Thread used for gap analysis
CGTG-217-THEM-CG-MU	CGTG-217	THEM-CG-MU	Main theme of the gap
CGTG-217-CG-Ref-108	CGTG-217	CG-Ref-108	Reference for gap determined in gap analysis

Table 36 continued.

ID	LEFT	RIGHT	DESCRIPTION
CGTG-218-EV-CG-008	CGTG-218	EV-CG-008	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-218-EV-CG-051	CGTG-218	EV-CG-051	Other EV impacted by this gap. Result of a gap analysis.
CGTG-218-EV-CG-002	CGTG-218	EV-CG-002	Other EV impacted by this gap. Result of a gap analysis.
CGTG-218-EV-CG-003	CGTG-218	EV-CG-003	Other EV impacted by this gap. Result of a gap analysis.
CGTG-218-GAT-CG-BUT3	CGTG-218	GAT-CG-BUT3	Thread used for gap analysis
CGTG-218-THEM-CG-MU	CGTG-218	THEM-CG-MU	Main theme of the gap
CGTG-218-CG-Ref-092	CGTG-218	CG-Ref-092	Reference for gap determined in gap analysis
CGTG-219-EV-CG-010	CGTG-219	EV-CG-010	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-219-GAT-CG-TDT2	CGTG-219	GAT-CG-TDT2	Thread used for gap analysis
CGTG-219-THEM-CG-All	CGTG-219	THEM-CG-All	Main theme of the gap
CGTG-219-CG-Ref-109	CGTG-219	CG-Ref-109	Reference for gap determined in gap analysis
CGTG-220-EV-CG-010	CGTG-220	EV-CG-010	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-220-GAT-CG-TDT2	CGTG-220	GAT-CG-TDT2	Thread used for gap analysis
CGTG-220-THEM-CG-All	CGTG-220	THEM-CG-All	Main theme of the gap
CGTG-220-CG-Ref-110	CGTG-220	CG-Ref-110	Reference for gap determined in gap analysis
CGTG-221-EV-CG-066	CGTG-221	EV-CG-066	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-221-EV-CG-067	CGTG-221	EV-CG-067	Other EV impacted by this gap. Result of a gap analysis.
CGTG-221-EV-CG-068	CGTG-221	EV-CG-068	Other EV impacted by this gap. Result of a gap analysis.
CGTG-221-GAT-CG-BUT1	CGTG-221	GAT-CG-BUT1	Thread used for gap analysis
CGTG-221-THEM-CG-CL	CGTG-221	THEM-CG-CL	Main theme of the gap
CGTG-221-CG-Ref-111	CGTG-221	CG-Ref-111	Reference for gap determined in gap analysis
CGTG-222-EV-CG-015	CGTG-222	EV-CG-015	Primary EV impacted by this gap. Result of a gap analysis.
CGTG-222-GAT-CG-TDT2	CGTG-222	GAT-CG-TDT2	Thread used for gap analysis
CGTG-222-THEM-CG-CL	CGTG-222	THEM-CG-CL	Main theme of the gap
CGTG-222-CG-Ref-112	CGTG-222	CG-Ref-112	Reference for gap determined in gap analysis