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Institution	Contributors
ASTON_VL	Aston University: Victoria Lush
ASTON_JL	Aston University: Joanna Lumsden

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Executive Summary

This document presents research conducted to establish and evaluate the concept of a GEO label which will act as a decision-support mechanism for geospatial dataset selection. Our research is adopting a multi-phased user-centred design (UCD) approach in order to develop a GEO label that is likely to garner user acceptance once deployed. To this end, we have thus far conducted 3 user studies to (1) identify the informational aspects of geospatial datasets upon which users rely when assessing dataset quality and trustworthiness, (2) elicit initial user views on the concept of a GEO label and its potential role in supporting dataset comparison and selection, and (3), evaluate prototype label visualizations.

The *Introduction* section of this report discusses the challenges associated with geospatial dataset selection and comparative data quality and trustworthiness evaluation. It highlights the need for developing better geospatial data quality and trustworthiness interrogation tools to support users in the process of dataset selection. This section also provides an insight into our proposed GEO label concept and its potential role in supporting dataset selection and decision making.

Preparatory Phase: Initial User Interviews presents the results of an initial investigation into how geospatial data experts and users of geospatial datasets evaluate the comparative quality and trustworthiness of geospatial datasets. The results of this initial investigation revealed eight informational facets that could potentially be included as part of the GEO label function, namely: the reputation of the data producer; producer comments on dataset quality; dataset compliance with international standards; community advice; dataset ratings; links to dataset citations; expert value judgments; and side-by-side metadata records comparison.

In *Phase I: Identifying* a *Role the GEO Label Should Serve*, we report on the design and findings of the first main phase of our GEO label investigation in which we used the insight derived from the initial user interviews as the basis on which to investigate geospatial data producers' and users' views on the concept of a GEO label and the role it should serve. Our results indicate that users and producers support the concept of a GEO label providing an all-in-one drill-down interrogation facility that would combine all eight of the geospatial data informational aspects identified in the initial investigation.

On the basis of our findings from Phase I, we developed three prototype GEO label visualisations which we then evaluated in the *Phase II: Evaluation of Proposed GEO Label Designs* stage of our research. The three visualisations comprised a circular GEO label and a rectangular GEO label, both utilising icons to represent the informational facets and the availability of related data for each, as well as a star-shaped GEO label which adopted graded pointers to textual labels representing each of the facets. Our study results revealed that iconic representations of informational aspects are essential for facilitating facet recognition. The two GEO label designs that comprised icons were perceived by respondents as more informative and supported better recognition of the specific informational aspects than the star-based design which adopted text-only representation of facets. In contrast however, although unsuccessful in terms of representing individual facets of information, the latter design (based on a star visualisation) was perceived as more effective in terms of conveying 'at a glance' the global *availability* of quality information for a given dataset. Study respondents proposed to combine elements of both the circular iconic design and the star-based design to arrive at a final GEO label visualisation. The rectangular GEO label design was also very positively accepted by study respondents who agreed that this design most efficiently utilised available label space and was the easiest to use for dataset selection. Although the results of this

phase are highly illuminating in terms of what works and doesn't work from users' perspectives for a GEO label visualisation, the study did not return clear consensus for a single one of the prototypes as presented. Instead, from the results (which include user suggestions), we can conclude that the final user-dictated graphical GEO label representation should *either* be a hybrid of two of the tested prototype designs (circular and star designs) *or* should adopt a rectangular design, and comprise eight informational aspects which need further work to better represent the nature and availability level of the associated information. At time of writing this report, 2 modified GEO label designs are being developed in light of the Phase II feedback, and will be evaluated in a third phase of our research – that is, a human subject study to validate and finalise the GEO label specification. The outcome of this remaining phase will be published as an addendum to this report.

This report concludes with a summary of the research conducted to define the notion of a GEO label and the role it should serve and a set of GEO label requirements elicited from our 3 user studies. Further work that will be conducted to implement and provide the GEO label service is outlined.

1. Introduction

This report describes research conducted by the GeoViQua consortium to establish the concept of a GEO label and identify the role it should serve in visualisation of geospatial data quality. It presents the results of phased user studies that have been carried out as part of the GEO label development process. In this introductory section we describe the importance of geospatial data quality and trustworthiness, highlighting the escalating need for practical, novel tools to support effective data quality and trustworthiness visualisation.

1.1 Geospatial Data Quality, Trust, and a GEO Label

During the last decade, the production and availability of geospatial data has significantly increased. With advances in satellite technologies and GIS software, the creation and processing of geospatial data has become simpler, leading to large volumes of data being generated and therefore accumulated. Technological advances have also facilitated increased availability of geospatial datasets to both professional and non-expert users (Devillers *et al*., 2002). Together, these advances mean that dataset users face much greater choice when selecting a dataset for a given purpose, lending increased importance to the issue of quality and users' ability to comparatively assess the quality of candidate datasets (Delavar & Devillers, 2010).

Almost all geospatial data has limited accuracy and is inevitably uncertain (Goodchild, 1995). Having to go through processes of generalisation, abstraction, and aggregation, geospatial data can only provide an approximation of the real world and therefore almost always suffers from imperfect quality. As a result, the quality of available geospatial data varies considerably and is sometimes hard to assess for a given dataset due to incomplete metadata records or users' lack of expertise in the GIS field. Unsurprisingly, geospatial data quality and uncertainty has been an area of active research within the Geographic Information (GI) community during the past three decades (Devillers *et al*., 2002). There exist various definitions of the concept of quality in relevant literature; an extensively accepted definition, however, of spatial data quality is 'fitness for use' which implies that, in order to assess the quality of data, we need to have information about the data to be used as well as actual user needs (Devillers *et al*., 2002; Wang & Huang, 2007). Although the importance of 'fitness for use' assessment is widely recognised within the geospatial community (e.g., Comber *et al.*, 2007), to date practical tools to support appropriate data quality interrogation and intercomparison based on the concept of fitness for use have been given relatively little research attention (Oort, 2005). Via qualitative user studies, Boin and Hunter (2008) demonstrated that geospatial data quality information is not currently communicated to data consumers effectively. Their findings showed that data consumers, when selecting a dataset to use, heavily rely on subjective quality information (e.g., data source, provider's reputation, intercomparison with other data, cost, etc.) and not just objective, numerical assessments of quality. Unfortunately, little *practical* work has been done to address the issue of *conveying* or *presenting* subjective quality information to data users in a manner which allows the users to consume and interrogate the information for the benefit of making informed dataset selections. Consequently, geospatial data users still require accessible mechanisms for data quality discovery that recognise the subjective and use-case-dependent nature of geospatial data quality.

With the significant growth of availability of geospatial data, geospatial datasets can, in many respects, be considered commercial products that are available for purchase or access online. Considering that trust has a significant influence on consumer behaviour within e-Commerce (Jarvenpaa *et al*., 2000), it is also likely to be a key element in data quality evaluation in the selection of one from *n* datasets based on fitness for purpose within the GIS domain. Trust – which is largely a combined measure of willingness to assume risk (Luhmann, 1979), the perceived

goodwill of others (Yamamoto, 1990), and the perceived quality of a product/service (Jarvenpaa *et al*., 2000) – is a critical determinant in a consumer's willingness to engage in a transaction, for example with an electronic vendor or when using/relying on an electronic service. Unsurprisingly, therefore, research into mechanisms for representing the trustworthiness of electronic systems has thus far been led by the domain of electronic commerce (Jarvenpaa *et al*., 2000; Yang & Chen, 2005). Trust indicators (also known as trust triggers) are used extensively in business-to-consumer (B2C) e-Commerce to engender consumer trust and increase user willingness to engage in online transactions (Head & Hassanein, 2002; Lumsden, 2009). For instance, trust labels and third-party assurance seals (e.g., TRUSTe, VISA, MasterCard, etc.) are widely integrated in B2C websites to visually convey trust information to consumers (e.g., Head & Hassanein, 2002) in the hope of encouraging users to engage in a transaction with vendor.

Despite the potential for trust to have a major impact on users' geospatial dataset selection and quality evaluation processes, representation of the trustworthiness of geospatial data and trust-based labelling has not yet received the necessary level of attention in the GIS domain. Knowledge on trust and trust representation gathered in the domain of e-Commerce could usefully, therefore, be transferred and applied to the GIS domain to engender user trust in geospatial data and its providers. Users will always be interested in using good quality data (Wang & Huang, 2007), but the process of selecting the best quality dataset can often be complex and time consuming. The presence of trust-engendering features (trust indicators) could simplify the user's task of data selection, significantly reduce disadvantages associated with the apparent impersonality of websites or online systems in terms of making trustworthiness decisions, and decrease the risks perceived by users in terms of electing to utilise a given dataset (Jarvenpaa *et al*., 2000). The importance of geospatial data quality indicators in support of effective geospatial dataset evaluation and selection has been widely recognised in GIS literature (Devillers *et al*., 2002; Wang & Huang, 2007), with general acceptance that quality indicators can inform users of a global measure of quality without them having to examine the data in much detail. Although considerable research has focused on how to evaluate and improve geospatial data quality per se (Goodchild, 1995), no tangible user-defined quality or trust indicators (i.e., means to convey the resulting quality measures) to assist fitness-for-use evaluation have yet been identified within this domain.

The Global Earth Observation System of Systems (GEOSS) is a distributed 'system of systems' which is being constructed by the Group on Earth Observation (GEO) to "*provide decision support tools to a wide variety of users*" (GEO, 2012). Given that the GEOSS is estimated to contain more than 28 million dataset records, and is constantly growing, choices faced when selecting a dataset can (depending on usage domain) be quite daunting. With such a great choice of datasets comes the problem of data quality assessment and dataset selection decision-making. To tackle this challenge, the GEO Science and Technology Committee (STC) propose to establish a GEO label – a label "*related to the scientific relevance, quality, acceptance and societal needs for activities in support of GEOSS as an attractive incentive for involvement of the S&T communities*" (ST-09-02, 2010, p.2). The STC suggests that the development of such a label could significantly improve user recognition of the quality of geospatial datasets and that its use could help promote trust in datasets that carry the established GEO label (ST-09-02, 2010). Furthermore, GeoViQua believes that a GEO label could assist in dataset searching and selection activities by providing users with visual cues of dataset quality and possibly relevance; in essence, a GEO label could effectively operate as a decision-support mechanism for dataset selection.

GeoViQua is undertaking research to define and evaluate the concept of a GEO label. Our research aims to develop a GEO label which will represent, and facilitate interrogation of, dataset quality

information with a view to supporting efficient and effective dataset selection on the basis of quality, trustworthiness and fitness for use. We recognize the importance of a user-centred design (UCD) approach in order to develop a GEO label that is likely to garner user acceptance once deployed. Consequently, GeoViQua is approaching the development and evaluation of the GEO label via one preparatory and three main user-centred design phases (see Figure 1). To this end, we have thus far conducted 3 user studies to (1) identify the informational aspects of geospatial datasets upon which users rely when assessing dataset quality and trustworthiness (the preparatory phase), (2) elicit initial user views on the concept of a GEO label and its potential role as a solution to the stated problem of dataset selection (Phase I), and (3), evaluate prototype label visualizations (Phase II). The remainder of this report outlines the studies GeoViQua has conducted as part of the GEO label development process, presenting the results as they relate to a GEO label concept envisioned by geospatial data users and producers.

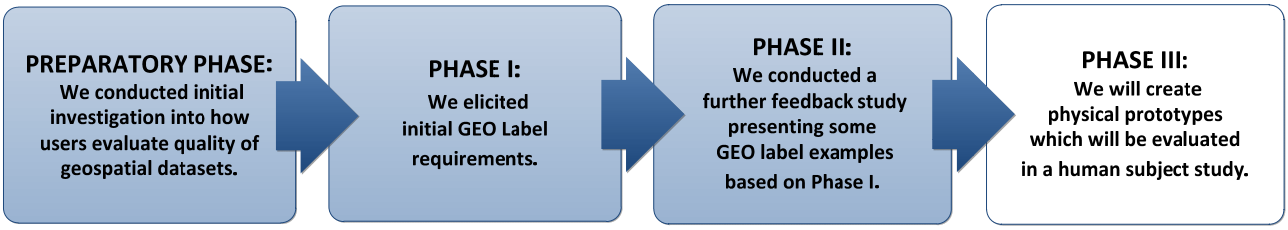


Figure 1: Phases of GEO label development.

At time of writing this report, we have completed the Preparatory Phase, as well as Phases I and II. Work is currently ongoing to develop the physical GEO label prototypes which will then be evaluated using established usability testing methods. An addendum to this report will be issued to publicise the results of Phase III, and will include a definitive specification for the final GEO label.

2. Preparatory Phase: Initial User Interviews

In this section, we present the results of an initial investigation that was conducted to elicit high level user requirements regarding geospatial data quality assessment and evaluation, and subsequent dataset selection.

2.1 Interview Process

We conducted an initial investigation into how users and producers of geospatial data evaluate quality and trustworthiness of datasets. Using a series of face-to-face and telephone interviews our intention was not to elicit specific requirements for the GEO label, but rather to uncover initial information about dataset selection, use and production within representative application areas in order to *inform* design and development of the GEO label. The interviews were relatively informal, and discussion was guided by the following set of high-level questions or prompts:

1. *Please describe a current area of your work in which you use external data sources.*
2. *What data do you use in your work, and where do they come from?*
3. *How do you choose which datasets to use in your work? What are the reasons for your decisions?*
4. *Are you aware of any data certificates or seals in selecting your data? Do you look for specific certificates or meta-information in a data set you use? How do you know whether to trust the data?*
5. *Do the data you use come with sufficient supporting information to allow you to make an informed judgement about which one(s) to choose? How much information do you need?*

Based on interviewee responses to the above cues, follow-up and clarification discussion ensued as appropriate to generate a rich set of qualitative information regarding dataset production, selection and use. In particular, where interviewees used community- or domain-specific jargon, they were asked for further explanation to eliminate any misunderstandings. The interviews were directed to capture sufficient contextually rich, qualitative information to allow us to distil specific information regarding the informational aspects that are perceived as significant in terms of determining dataset trustworthiness and dataset quality assessment for fitness for purpose-based dataset selection.

We identified and contacted representative interviewees – including geospatial data users, researchers, data archivists, academics and data producers – to participate in the initial interviews. The diversity of interviewees allowed us to elicit a broad and inclusive picture of user needs as they relate to quality assessment of geospatial datasets. A total of 18 participants were recruited for telephone or face-to-face interviews; each interview took approximately 30-60 minutes. Six of the interviews (the primary interviews) were conducted by the lead GEO label researchers at Aston University, with the remaining 12 interviews being conducted by other GeoViQua partners. The six primary interviews conducted at Aston University were audio-recorded to allow for detailed and accurate data capture as well as in-depth post-interview analysis; the interviewers also took written notes during the course of each interview.

Data saturation refers to the point at which consulting additional participants would not have provided new information or identified new themes in the data (Guest *et al.*, 2006; Francis *et al.*, 2010); data saturation points are specific to each study but 73% of thematic discovery can occur from as few as six interviews (Guest *et al.*, 2006). In our study, despite the diversity of interviewees, data saturation occurred after completing the six primary Aston-led interviews; we therefore used the additional 12 interview summaries from the interviews conducted by other research project partners for verification purposes. Table 1 profiles our six primary interviewees.

Interviewee 1 is a **data archivist** who works as part of a science network of people, organisations, and, most importantly, observation platforms, that performs Long-Term Ecological Research (LTER).
Interviewee 2 is a **researcher data user** who is a part of a group that is working on projects to monitor forests and the tropics or, specifically, changes in the forest cover or tree cover in the tropics.
Interviewee 3 is a **land use researcher** who works for a government department that covers areas such as: the natural environment; biodiversity; plants and animals; sustainable development and the green economy; food, farming and fisheries; animal health and welfare; environmental protection and pollution control; and rural communities and issues.
Interviewee 4 is a **climate forecaster** who works on climate forecasting for protected areas using climate data which he pre-processes himself to get more descriptive data for his own needs. Interviewee 4 does not use a lot of external data.
Interviewee 5 is primarily a **data provider** who typically takes low level data (typically oceanography-related) and works it up into higher levels to arrive at some physical product.
Interviewee 6 is an **academic researcher** in earth and environmental sciences who uses external data sources "*across the board*".

Table 1: Profiles of initial investigation interviewees.

Verbatim transcripts of the six primary Aston University interview recordings were generated to support detailed data analysis. A first pass of analysis led to derivation of user stories – that is, very high-level informal statements of requirements that capture what users want to achieve. User stories typically follow the template: "*As a <role>, I want <goal/desire> so that <benefit>*". These user stories (see Appendix A) were principally used to inform the overall requirements specification for the GeoViQua project as a whole. For the purpose of the GEO label development, the transcripts were further analysed specifically to identify the informational facets of importance to users when assessing dataset fitness-for-purpose and to derive detailed user requirements that relate specifically to quality and trustworthiness assessment of datasets for the purpose of making dataset selection decisions (see Appendix A). The remainder of this chapter discusses the identified informational facets as they relate to the design of the GEO label.

2.2 Interview Findings

Our analysis identified that geospatial data users highly value good quality metadata records. Our participants stated that complete and well-documented metadata records are *essential* in the assessment of geospatial data quality and trustworthiness. Core metadata defined in ISO and Dublin Core standards must, according to the majority of our interviewees, be provided with geospatial datasets to enable comparative evaluation of dataset quality and trustworthiness. Our study revealed the importance of dataset provenance and licensing information when assessing whether to trust a dataset based on its fit for purpose. Data users confirmed that provenance information is usually incomplete and licensing information is normally missing from the metadata records of datasets. Dataset users are also interested in soft knowledge about data quality – i.e., data providers' comments on (a) the overall quality of a dataset, (b) known data errors, (c) potential data use, and (d) any other information that can help in the assessment of fitness-for-use of datasets. Also important when selecting a quality dataset are peer recommendations and reviews: dataset users are keen to be able to obtain feedback from their peers and are willing to accept peer recommendations

when trying to select the most appropriate dataset for their given needs. Our study revealed the importance of citation information when assessing whether a dataset is fit for purpose, although there was general consensus that citation information is, unfortunately, hard to acquire. We discovered that, when selecting a dataset, users typically seek information about dataset providers and, in particular, value the availability of valid contact details for providers. Finally, our findings indicated that having side-by-side dataset and metadata comparison functionality would make the dataset selection process much easier for users. Each of these informational facets is explored in more detail below.

2.2.1 Metadata Completeness and Compliance with Standards

Our survey results revealed that metadata records play a very important role in the dataset discovery and trust-based selection process. Users of geospatial data heavily rely on information provided in the metadata records to assess a dataset's fitness for use, and to evaluate its quality and trustworthiness. For instance, the data archivist (interviewee 1) explained that his organisation "*should at least have metadata for all data that* [they] *can find, so that* [they] *know what exists*". The land use researcher (interviewee 3) stressed that "*what you need is good metadata which will tell you all about how it was collected, when it was, who did it, who to contact*". Unfortunately, at present, users find metadata records are typically incomplete with a lot of essential data omitted. As the data archivist stated, "*I don't think that metadata as it's provided at present contains enough information about the data to make it useful*". When discussing his previous workplace, the researcher data user (interviewee 2) recalled occasions when "*customers provided* [their organisation] *with data which* [they] *should use for some kind of data processing or analysis and there was a lot of metadata missing*". The climate forecaster (interviewee 4) also raised the metadata completeness issue, arguing that some datasets "*don't come with quality statements* [and] *are not particularly well described*". While users recognise that "*now there is more and more pressure for good metadata and standards in metadata*" (interviewee 3), users often "*have to manually inspect every single dataset before* [they] *start understanding whether the metadata adequately describes the data*" (interviewee 1).

Despite the standardisation bodies' work towards establishing core metadata elements and enforcing good metadata practices, dataset providers do not always follow metadata standards and leave metadata records incomplete. Nevertheless, we found that data providers typically agreed on the importance of metadata and metadata standards. The data archivist commented that "*if data sources are standardised and automated then one can obviously do a bit more with it*", and that his organisation "*support*[s] *the ISO family of spatial metadata standards* [and] *Dublin Core for non-spatial datasets*" (interviewee 1). The data producer (interviewee 5) explained that his organisation is currently using ad hoc standards to include information which seems most relevant, but they "*are trying to move a bit more towards using some of the ISO standards for the discovery data*". Our interviewees commented that lack of complete and well-documented metadata records particularly affects historical datasets and data that was collected as part of smaller scale projects or collected by individual researchers. As a result, users suffer from insufficient metadata records which makes the dataset selection process more difficult and time consuming.

Our interviewed dataset users stated that, when searching for geospatial data or evaluating data quality, as a minimum they require information on coverage, licensing, methodology, uncertainty, resolution, source, acquisition date, pre-processing steps, and accuracy (see Table 2 for full metadata elements list). Although all these metadata elements are, in fact, defined as core in the existing Dublin Core (DCMI, 2013) and ISO 19115:2003 (ISO 19115:2003, 2003) metadata standards, our interviewees stated that the metadata records that they typically encounter are far

from complete and are usually missing many of these core elements. These findings highlight the importance of metadata standards at the same time as illustrating that geospatial metadata still typically lacks metadata quality control.

Metadata Element	Metadata Element	Metadata Element
Title	Subject	Author/Responsible party
Associated party or parties (co-authors, etc.)	Topic	Category
Keywords	Abstract	Language
Character set	Scale	Temporal scale
Attribute	Format version	Data representation
Spatial reference system	Bounding coordinates	Coverage (main dimensions of the data)
Spatial coverage	Geographic coverage	Temporal coverage
Taxonomic coverage	Metadata standard	Metadata creation date
Custodian	Custodian's reference	Legal usage information
Restrictions	Caveats	Licensing
Usage rights	Data set owner(s)	Associated party or parties (co-authors, etc.)
Access control	Access rules	Contact
Methods (methodology)	Physical structure	Technical data set parameters
Attribute(s)	Online distribution	Online resource
Sum elevation	Uncertainty	Resolution
Spatial resolution	Temporal resolution	Precision
Source	Acquisition date (year and time)	The pre-processing steps
Accuracy	Horizontal accuracy	Vertical accuracy
Absolute accuracy	Projection	Units
Bias gain	Cloud cover	

Table 2: Metadata elements considered by interviewees when selecting datasets to use.

2.2.2 Metadata Visualisation and Comparison

Our interviews revealed a need for more sophisticated tools for visualisation of metadata records, with users commenting that, at present, metadata records are not only incomplete but are also typically not easy to examine and assimilate. As the land use researcher explained:

> "*Having just a little view of the attribute table…a description of what is in* [it], *what each attribute is and what is actually in your dataset, that's really handy. So you can, rather than downloading it, have a look at it … quickly to see what's in it*" (interviewee 3).

Metadata records are typically supplied as complex XML documents, making it far from easy to examine and assimilate them. Non-expert dataset users would appear to suffer the most from not being able to absorb and understand all of the information recorded in metadata. Considering the aforementioned importance of metadata in terms of the perceived fitness-for-use and trustworthiness of datasets, effective visualisation methods for metadata records need to be discovered to support users in data quality evaluation and trust-based decision-making.

Our interviews highlighted another important aspect of metadata visualisation – that is, the ability to *compare* metadata records across candidate datasets. Our dataset users indicated that side-by-side visualisation of all available metadata elements would allow them to compare geospatial datasets more effectively in order to determine which to trust. The side-by-side visualisation of metadata would be most beneficial when comparing datasets that are very similar and so the differences are hard to initially identify. For instance, the land use researcher argued that:

> "*there are so many datasets that probably do very much the same things but one might have an extra field in it that is crucial, or one might be at a different scale, or one has errors in it, or different units too, all sort of things like that. So it would be handy to sort of say 'oh that weather station data is much better than this weather station data'*" (interviewee 3).

Our interviewees stressed that selection of a suitable dataset can be a very difficult task, especially when there are several that potentially fit the purpose. A side-by-side visualisation functionality would support and simplify data searches, the selection decision-making process, and data quality evaluation. Metadata comparison would be particularly invaluable for less-experienced or non-expert users who find it hard to manually inspect datasets to assess their fitness-for-use and trustworthiness.

2.2.3 Peer Review/Recommendation

E-Commerce has utilised peer review to engender customer trust in vendors and their services. At present, a significant number of commercial websites use commenting and rating functionality to facilitate user feedback on products and services that they offer. In particular, auction-based websites, such as e-Bay, heavily rely on user feedback and ratings because peer reviews *define* the trustworthiness of vendors and the quality of their products. Surprisingly, geospatial data portals do not currently provide peer review functionality to allow dataset users to comment on and rate geospatial data products. On the basis of our interviews, it would appear that geospatial dataset users are very keen on having peer review/recommendation facilities available to them.

Crowd sourcing in our study appeared as one of the most prominent themes, with four out of six interviewees indicating its strong influence on the data selection process. The users of geospatial datasets we interviewed stated that they heavily rely on peer recommendations when selecting a dataset to use. They contact their peers to elicit suggestions on what datasets are most suitable for their purpose, are of good quality, and are trustworthy. The land use researcher, for instance, commented that, when evaluating data quality and trustworthiness, she would talk "*to other people that have used it*" because she trusts her peers (interviewee 3). The data provider agreed that his organisation "*certainly accept*[s] *recommendations from other people*" (interviewee 5) and would also "*welcome*" any comments on the data that they produce:

> "*we have a help desk* [and] *if we get comments back we normally try do something about them if there is anything that's a problem*" (interviewee 5).

The dataset provider also positively welcomed "*the idea of a community of practice who could rate* [their] *reputation in terms of the datasets* [they] *provide*" (interviewee 5). This indicates that geospatial dataset *producers* are also interested in having their datasets peer reviewed; having user feedback on datasets that they produce would allow data producers to identify and resolve any issues within their datasets, and afford them an opportunity to respond to users' comments.

The climate forecaster, when discussing one of the datasets being used, said "*one of my colleagues told me about this dataset that wasn't only one result, but also had uncertainty*" (interviewee 4) which further indicates the importance of peer advice. Also the data archivist confirmed the importance of peer recommendations and commented that his organisation "*have defined a framework for quality assessment that relies on peer review of some kind, almost "crowd sourcing" the assessment of the data by way of likes or dislikes, or frequency of use, or citation but* [they] *haven't implemented that yet*" (interviewee 1). The land use researcher actively supported the idea of "*people being able to comment on metadata, to have user feedback*" (interviewee 3). She argued that:

> "*Sometimes you'll look for a dataset, and you know people have used it, and you want to speak to people that, you know, you don't want to find them out yourself… And then having this active community where the person that publishes that data is responsible for what they are publishing. So then they can take the comments on board and comment back. I think it needs something like 'I used it for this', 'it's good for this but maybe not for this'*".

Peers typically provide valuable feedback on what datasets they used, what these datasets were good for, potential problems with the datasets and other potentially useful information. Having this sort of feedback available for every geospatial dataset would facilitate improved dataset selection and quality and trustworthiness evaluation. Peer review functionality, as proposed by the land research user, could also potentially be used to validate metadata records, highlight any inaccuracies or even fill in any informational gaps. Such feedback functionality would allow dataset users and geospatial data experts to provide their comments on datasets and flag any limitations or problems associated with the datasets.

Although our interviewees illustrated the importance of peer review, they qualified the value of such peer recommendations by indicating that they would not accept recommendations from just anyone – they mostly rely on known peers whose opinion they respect and trust. This suggests that any future peer review functionality for geospatial datasets would have to be controlled in order to enhance reliability and exclude the possibility of malicious actions.

2.2.4 Rating of Datasets

In line with having functionality to provide comments on datasets, the users we interviewed expressed their interest in being afforded the ability to *rate* the quality and trustworthiness of datasets. Users indicated that having something similar to 5-star ratings assigned to datasets would make quality-based dataset selection processes much simpler. The land use researcher provided an example of a data provider that uses quality indicators and star ratings to convey dataset quality information:

> "*they have these three or four little indicators at the bottom of their datasets that say how good the spatial coverage is, how accurate the dataset is… It is all on their website … so that is really, really good*" (interviewee 3).

It is recognised, however, that a single quantitative rating assigned to a dataset would not on its own provide enough information to *meaningfully* and *contextually* evaluate the dataset's quality and trustworthiness. For instance, a 1 star rating would not supply any valuable information regarding *why* the dataset is considered to be of poor quality. Furthermore, whilst a dataset might be rated poorly relative to one context of use, its rating might be significantly higher for another context

(perhaps one more closely aligned to its intended purpose). We suggest, therefore, that to be meaningful and of value, quantitative ratings would need to be justified with detailed explanations regarding why a particular rating was being given to a dataset. This further suggests that rating functionality would perhaps be best combined with peer review/recommendation facilities wherein ratings would act as visual indicators of overall quality but user comments and reviews would provide the underlying rationale to substantiate and contextualise the rating.

2.2.5 Expert Review

In line with having peer reviews and recommendations, it was suggested that domain *experts* could provide valuable and highly informed judgements of dataset quality and trustworthiness for the benefit of more general users. The data archivist (interviewee 1) described a new project that he is involved in where domain experts' reviews are used to describe datasets and their quality. The project consists of seven or ten themes, which "*are similar almost to the societal benefits areas that they use in GEOSS*", and where "*funded theme conveners and scientists that work on those themes describe the datasets that are available and most useful and so on*". The interviewee argued that "*not all datasets are useful or have equal value*" and therefore there could be considerable benefit in "*having some kind of value judgement by experts, on top of, let's say, more common requests for data supporting a given theme*". The interviewee further explained that his organisation has come up with three categories of peer review statements – (1) syntactic, (2) schematic and (3) semantic – to describe whether datasets are (1) syntactically correct and interoperable, (2) comply with a widely accepted schema, and (3) fit for a particular purpose.

This clearly demonstrates that effort is being made to provide the geospatial user community with expert value judgements of dataset quality. Nevertheless, as discussed in section 2.2.3, neither peer nor expert review functionality is yet available for public consumption. Domain experts' value judgements could potentially provide invaluable information about dataset quality, errors, suggested dataset use, areas of applications, etc.

2.2.6 Rating of Data Providers

The reputation of dataset providers was identified as one of the key factors in dataset selection. Users we interviewed typically rely on data from producers that they already know or those who have a very good reputation in the community. The researcher data user strongly supported the data provider reputation theme and, when discussing his former job, acknowledged that dataset choices were "*driven by reputation of the data provider*" (interviewee 2). The data provider's identity defines how trustworthy the data is perceived to be by users because "*knowing who provides the data* [is] *the measure of how you could treat it afterwards*" (interviewee 2). Furthermore, the reputation of a dataset provider is seen as "*the substitute for any quality seal*" (interviewee 2). Our results also showed that large international organisations and governmental data providers are accepted by data users as more reputable:

> "*When it comes to land set the sources you have are huge national or international organisations which provide the data. And they apply certain standards...quality standards… I would assume them to be very professional and reliable*" (interviewee 2).

The land use researcher further confirmed that large-scale data producers are seen as more reputable, noting that "*there are probably organisations that you do just trust*" (interviewee 3). The academic researcher also agreed that data from national repositories and governmental data producers "*tend to be pretty uniform standards*" (interviewee 6). It follows, therefore, that if current dataset users are more likely to select data from producers that already have established a good

reputation, smaller and unknown data producers are likely to experience much lower dataset demand. As argued by the researcher data user, "*if* [data producers] *have no reputation at all or low reputation you will act accordingly*" (interviewee 2). This is similar to e-Commerce, where new smaller vendors are initially much less trusted by customers, making it harder to secure online sales until they have established a positive reputation.

Our interviewees indicated the importance, when assessing the trustworthiness of data providers, of documentation supplied by data providers with their datasets. Well-organised and easily accessible documentation engenders user trust in both data providers and their datasets. For instance, the data provider argued:

> "[Producer X] *has a very good reputation. And that is strongly backed up by when you look at their documentation and such, you can see they've considered a vast number of things with great deal of care. And the more you dig into it it's very clear that they are very good at what they do*" (interviewee 5).

Data users will typically have more confidence in data providers that invest resources into documenting their data and will trust such data providers above others. A facility to support rating of dataset providers would allow emerging providers to gain, via word of mouth and excellent service provision, the reputation to support their successful entry into the GEO community. Similarly, it would encourage established providers to maintain a level of service over time.

2.2.7 Soft Knowledge

As already noted, metadata records provided with geospatial data are often incomplete and are sometimes even ambiguous. The dataset providers we interviewed commented that there are cases when data quality measures cannot be recorded in standard metadata records. For instance, a provider might be aware of problems with a particular satellite, such as higher uncertainty in specific areas of the image it takes; in such cases, they can provide some *soft knowledge* about the quality of the data, including information which they think may be relevant to potential users. As explained by the data provider (interviewee 5):

> "*for example, we have a sensor that has a particular range. We know it is pretty good in the middle of the range but at the edges we had seen indications that it is not so good. But we don't have any way to actually* […] *prove* […] *that. So all we can do is warn people that we believe it to be less good, they should be more cautious of it. But we don't actually have a quantitative estimate* […] *we can just point towards data signal noise and say 'clearly it is not going to be as good here'. So it is almost like a relative estimate*".

Interviewee 5 stated that his organisation follows some metadata standards such as NetCDF Climate and Forecast (CF) Metadata Conventions and ISO standards, but they also "*try to include information about what* [they] *think is good and bad in the dataset on general terms*". Although his organisation is now "*trying to move a bit more towards using some of the ISO standards for the discovery data*", they continue "*incorporating stuff that other people are suggesting would be good to have in there*". Interviewee 5 also argued that the organisation he works for cannot predict all possible uses of their datasets in a long term, but they "*certainly support any use that people can sensibly make of* [their data]".

In tandem, the users we interviewed stressed the importance of data producers' comments and recommendations relative to the datasets they provide. The climate forecaster (interviewee 4) argued:

> "*Often a dataset is derived* [for] *some particular purpose and it might be good for that purpose but it is not necessarily good for other users. And often the* [person] *that creates the dataset might know that better than the average user"* and noted that it would be useful to, at the very least, have "*some kind of soft knowledge of what are the boundaries, when should I trust the dataset, when should I not trust the dataset*".

Interviewee 4 further emphasised the importance of soft knowledge about data uncertainty and error estimates:

> "*the* [most important] *thing is the uncertainty* […] *Maybe the one who derived the dataset doesn't know the exact uncertainty themselves*...[but] *at least if they could include the soft knowledge about uncertainty, that would also help*".

It is clear that both producers and users of geospatial data appreciate the importance of 'soft knowledge' as provided by dataset producers. Although the standardised metadata records can provide key information about datasets, there exist cases when additional, producer-derived information can be more relevant and valuable to potential data users. In particular, descriptive estimates of dataset quality could be particularly valuable to non-expert data users who are not accustomed to reading and using complex XML documents.

2.2.8 Citation Information

Our interviews highlighted that the majority of users also base dataset quality evaluation on dataset citation information. When making dataset selections, users are interested in accessing publications where data quality checks are reported; consequently, journal articles that describe dataset use and evaluation are considered to be very important in dataset quality assessment. For instance, the land use researcher argued that "*when you get data from academic journals, that's good, because you can read exactly how they collected, why they collected and you get the sort of analysis after seeing all the errors*" (interviewee 3). The data provider stated that, when assessing quality and trustworthiness of datasets, their organisation "*tend*[s] *to look for reports on quality and such like, so that is more textual documentation*" which can typically be found on data producers' websites and documents repositories. As discussed by the data provider, availability of well organised textual documentation may also affect users' perceptions of data providers' credibility and define providers' reputation in the community.

The climate forecaster, when discussing one of the datasets that he used, said "[t]*his* [dataset] *was the first one that I was aware of that gave this relatively high resolution climate data. And it is also been used in several other papers*" (interviewee 4). Also interviewee 2 mentioned that "*there are loads of publications"* on the data that his organisation uses. This clearly indicates the extent to which citation information may affect dataset quality and trustworthiness evaluation and dataset selection decisions. Unfortunately, as stated by the data archivist, citation information is often missing, which complicates dataset discovery and fitness for use evaluation.

2.2.9 Quantitative Quality Information

In line with *qualitative* quality information discussed in the previous subsections, our interviewees stressed the importance of *quantitative* quality information in evaluation of dataset quality, trustworthiness and fitness-for-use. Four out of six interviewees listed a number of quantitative measures which they consider when selecting a dataset to use, namely: spatial and temporal resolution; spatial and temporal scale; precision; geometric correctness; horizontal, vertical and absolute accuracy; precision; error estimates; and uncertainty. The interviewees expressed particular interest in availability of uncertainty estimates, especially at the pixel level. The climate forecaster (interviewee 4), when describing the quality aspects that influence his dataset selection decisions, argued that "*uncertainty is the most important*" but conceded that he is still likely to use a dataset that has no uncertainty information available because uncertainty measures are usually missing.

The data provider (interviewee 5) further supported the importance of uncertainty measures in dataset quality evaluation:

> "*satellites* […] *measuring what is in the oceans* […] *can do fairly well out in the open ocean but as you are getting towards the shore line there is all kind of rubbish washing out of rivers and things that messes up the processing quite a lot. So we would expect higher uncertainty there, so you should treat those data with more caution*".

This data provider also explained that some of the projects he is involved in "*are actually trying to derive those* [uncertainty] *measurements*" and he is very much interested "*in actually associating the uncertainty measurement*" with data. Without knowing the uncertainty estimates, and without carrying out "*uncertainty propagation to estimate what the final error is*", it is not possible to identify "*how good* [the] *end products are*". For the datasets he produces, the interviewee attempts (as already mentioned) to provide at least "*a relative estimate*" – soft knowledge – of uncertainty and errors in cases when it is not possible to provide quantitative evidence; he noted that that *both* quantitative and qualitative quality descriptions are important in evaluation of datasets quality and trustworthiness, describing a different perspective on each:

> "*I guess I would see uncertainty as a somewhat mathematical estimation of how good or rather how accurate a dataset can be, whereas quality, I would probably say, is possibly more subjective. And we certainly have an interest in both of those angles.*" (interviewee 5).

Quantitative quality information describes the internal quality of datasets and is particularly important to expert users. Quantitative measures can define how data will be used and how trustworthy it is; for instance, data with high uncertainty and error estimates should not be used in high-risk and high-impact areas of application. Providing the GIS community with both objective and subjective quality information could ensure that users with different dataset quality requirements could make an informed dataset selection decision.

2.2.10 Data Provenance and Methodology

Our interview results highlighted that significant importance is placed on provenance information by geospatial data users when evaluating quality and trustworthiness. Five out of six interviewees indicated interest in availability of provenance information and identified the following provenance elements as essential in data quality and trustworthiness evaluation:

- original dataset provider;
- party (parties) who has subsequently processed the dataset;

- party (parties) who has used the dataset before;
- methodology adopted for dataset data collection;
- how a dataset was derived and on what it is based;
- dataset harvesting pathway;
- the purpose for which a dataset was originally collected; and
- dataset processing log.

The methodology adopted for data collection plays an important role in evaluation of data quality and trustworthiness. For instance, the data archivist (interviewee 1) stressed the importance of methodological information in long-term data preservation:

> "*the methodology is probably also important in the metadata because if we are going to preserve data for the very long term, in 50 years from now the people who generated that dataset are not going to be around anymore*".

Our results revealed that information on the equipment that was used for data gathering and any problems that occurred during the gathering process can help data users in quality and trustworthiness evaluation. Interviewees stressed the importance, in terms of fitness for use evaluation, of knowing the purpose for which the data was initially gathered "*because you could have someone collecting data for a purpose which misses out what you really need*" (interviewee 3).

The users we interviewed commented on the importance of knowing about the data processing steps and availability of a processing log which would allow users to trace the events and transformations in the life of a dataset. For instance, the researcher data user (interviewee 2) explained:

> "*We would definitely need what pre-processing steps have been applied and which methods* […] *we would want everything concerning the processing or pre-processing*".

Additionally, as indicated by the academic researcher (interviewee 6), access to the raw data is also important so that researchers *"can go back to the root of that processing 'cause that processing isn't always helpful*" and can then do things *"a little bit better* [to] *improve* […] *results subsequently*".

Having all the information on processing steps and algorithms applied to data would allow users to measure data accuracy and better evaluate its quality, fitness-for-use and trustworthiness. Processing information would also allow reversing any processing if necessary/possible to improve quality of end products.

Unfortunately, however, according to our interviewees dataset provenance information is, at present, not usually available to data users. As the data archivist explained (interviewee 1):

> "*the path that the metadata follows to arrive at your doorstep is lost. You only ever, usually, have a portal that you harvested it from, and maybe the starting point but you don't have the intermediaries. So one other thing we are looking at is to improve the way in which we store maybe a pathway where each portal that touches a metadata record has an element to describe who they are and where they are located and who to contact at the end of the metadata record, so that one can trace the path*".

This claim is very interesting because, although geospatial data portals and clearinghouses are *designed* to provide a gateway to datasets and enable better dataset discovery, in practice this valuable information on the source of datasets is usually lost. Interviewee 1 further argued that "*if you can cut out a very long harvesting route by going directly to another source then maybe one should be able to do so*". The academic researcher (interviewee 6) observed that acquiring processing information is "*going to be very difficult 'cause it's been programmed through the numerous people who did not necessarily document*" their processing. Incomplete metadata records supplied with datasets can also contribute to the loss of processing information.

2.2.11 Licensing

ISO 19115:2003 (ISO 19115:2003, 2003) and Dublin Core (DCMI, 2013) metadata standards include restrictions and licensing information as core metadata elements for all geospatial dataset (Figures 2 and 3). Despite this, data producers often fail to provide such information, with a number of our interviewees pointing out that licensing information is nearly always missing.

Term Name: rights	
URI:	http://purl.org/dc/elements/1.1/rights
Label:	Rights
Definition:	Information about rights held in and over the resource.
Comment:	Typically, rights information includes a statement about various property rights associated with the resource, including intellectual property rights.

Figure 2: Dublin Core Metadata Element Set, Version 1.1 – Rights element.

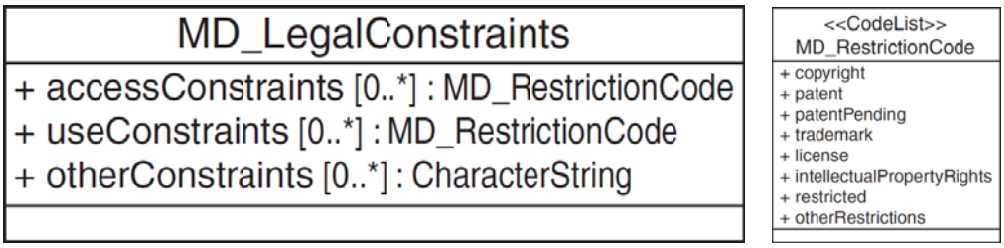


Figure 3: ISO 19115:2003(E) – Constraint information.

The researcher data user (interviewee 2) observed that even although geospatial data generally has usage limitations, the restrictions information is often not provided with the geospatial datasets and commented that "*a lot of people are not aware that geo data actually often has limitations on the way you are allowed to use it. This is less true for those data that you can download but if it is provided by via other sources it often has certain licence limitations and I think a lot of people have no clue about this*".

2.3 Preparatory Phase: Conclusions

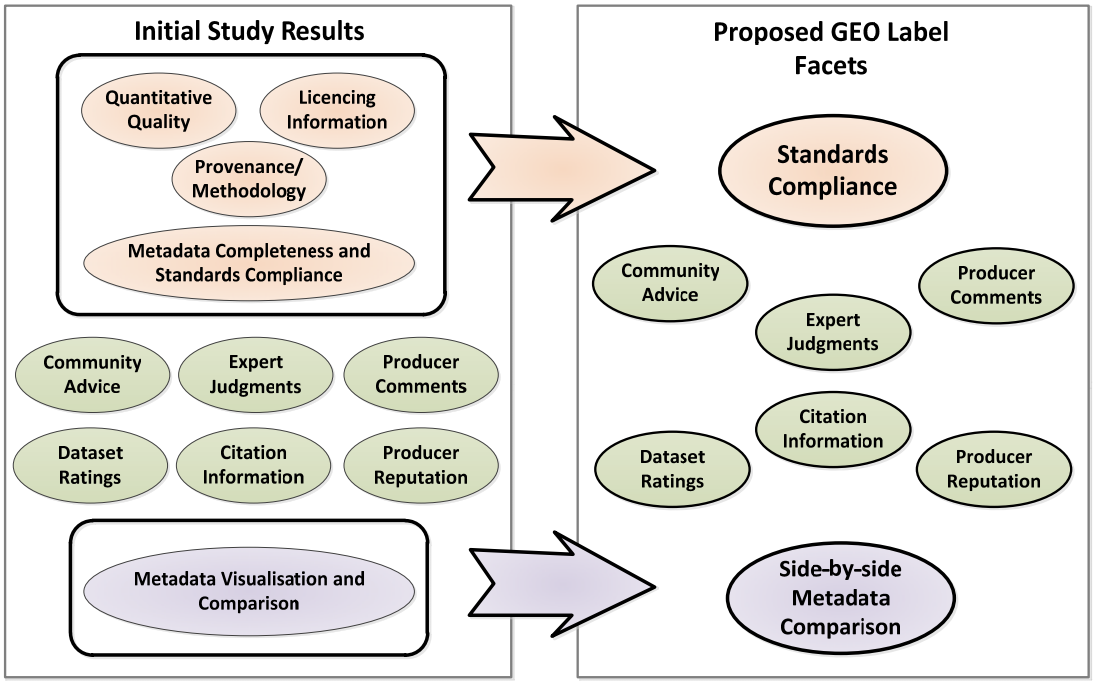


Figure 4: GEO label facets derived from the initial interviews results.

The interviews with GEO data users and producers were very enlightening in terms of identifying their informational dependence when selecting datasets for use within particular contexts. Discussion during this preparatory phase of our research suggested that a GEO label would best serve a drill-down function whereby, at the top level, it visually represented the *availability* of specific informational elements for its associated dataset and, thereafter, permitted users to click the label to drill down into and interrogate the detail for each informational element. We were able, based on our interviewees' responses, to extrapolate 11 GEO-label appropriate themes (as described in section 2.2) and, from these, we further identified 8 facets as potential candidates for inclusion in the GEO label (see Figure 4), namely:

- dataset compliance with international standards;
- side-by-side metadata records comparison;
- community advice;
- dataset ratings;
- expert value judgments;
- the reputation of the data producer;
- producer comments on dataset quality; and
- links to dataset citations.

The metadata completeness theme, including availability of quantitative quality information, licensing information, and provenance information, has been incorporated into the compliance with international standards facet. Interestingly, several of the identified candidate GEO label components reflect well-defined trust triggers that are already used extensively in business-to-consumer (B2C) e-Commerce to engender consumer trust and increase user willingness to engage in online transactions.

Having identified candidate informational/functional focus of the GEO label, we designed and administered a subsequent study to investigate users' and producers' opinions on the concept of a label, and to elicit their assessment of the role that such a label should assume (e.g., whether or not there was general agreement that a GEO label should provide a drill-down interrogation facility covering all 8 of our candidate facets). This study, forming the first main phase of our research agenda, is documented in the next section of this report.

3. Phase I: Identifying the Role a GEO Label Should Serve

In this section, we present the results of our Phase I study which was designed to solicit geospatial data producers' and users' views on the concept of a GEO label and the role it should serve.

3.1 Soliciting Opinion on a GEO Label

In order to conduct an initial investigation into both geospatial data producers' and users' views on the concept of a GEO label and the role it should serve, we conducted an online questionnaire-based survey. Our questionnaire comprised five parts, A to E, each of which is described below (a full copy of the questionnaire is included in Appendix B). On commencing the questionnaire, respondents were first asked to identify themselves as primarily either users or producers of geospatial data. Depending on their self-identified role, respondents were then presented with an appropriately tailored version of Section A. The user-oriented version of Section A (see Appendix B, Section A – Data User) focused on eliciting information about the degree to which users have a choice of dataset to use and what typically impacts or influences this choice, and comprised a series of questions asking respondents:

a) to classify themselves as belonging to one or more user categories (e.g., private sector data user, and/or governmental data user, and/or researcher data user, etc.);
b) to identify the data sources they rely on for their work;
c) to reflect on the importance of different informational aspects about datasets when selecting a dataset to use; and
d) to illustrate their awareness of any certificates or seals that apply to geospatial data.

Figure 5: Example Likert scale to gauge opinion about the importance of different informational aspects.

Using a 7-point Likert scale, ranging from 'extremely unimportant' (1) to 'extremely important' (7) (see Figure 5 for an example), dataset users were asked to reflect on how important they felt the availability of each of the following informational aspects (as derived from our preparatory phase research) associated with datasets is in terms of selecting a dataset to use:

- expert judgement of the dataset and its quality;
- a dataset's compliance with international standards;
- community advice and recommendations on what datasets are best to use for given types of application;
- information about the reputation of the dataset provider;
- dataset citations (e.g., a list of journal articles or other publications where the dataset has been used and quality checks have been reported);
- 'soft knowledge' (subjective and informal statements) about the dataset quality that is provided by the creator or provider of the dataset; and
- an ability to visualise metadata records side-by-side when comparing two or more datasets.

We intentionally omitted 'dataset ratings' (see Section 2.3) because practical implementations of such functionality are not currently provided within the GIS community. Although indicated as

desirable (see Section 2.2) it seemed unreasonable to ask about the in-practice importance of an aspect which is not yet currently available.

The data producer-oriented version of Section A (see Appendix B, Section A – Data Producer) was naturally focused on the production rather than selection of datasets. It comprised a series of questions asking respondents:

a) to classify themselves as belonging to one or more producer categories (e.g., GEO committee member, and/or data producer not part of GEOSS, and/or private sector data producer, and/or governmental data producer, and/or research/academic data producer, etc.);
b) about the type of data they produce and about international standards their datasets observe; and
c) about their awareness of any certificates or seals that apply to geospatial data.

The remaining sections of the questionnaire were common to all respondents. Section B comprised a small number of questions to gather information about users' and producers' initial views on the role that a GEO label should serve. Respondents were asked if and why geospatial data or metadata records would benefit from the application of certification programme(s). They were also asked to comment on the role they would want a GEO label to serve and identify whether the presence of such a label would influence their dataset selection decisions.

Section C focused on gauging respondents' awareness and opinion of commonplace e-Commerce rating systems and certification programmes. Respondents were asked what review or rating systems they use in their everyday life and, if used, to specify the frequency of use. Respondents were then presented with screenshots of two review and rating systems: one taken from an eBay products listing page (see Figure 6; also see Appendix B, Section C) with some of the listed products carrying a Top-rated Seller label, and the other taken from a TripAdvisor hotel listing page (see Figure 7; also see Appendix B, Section C) with all the listed hotels having user ratings and reviews.

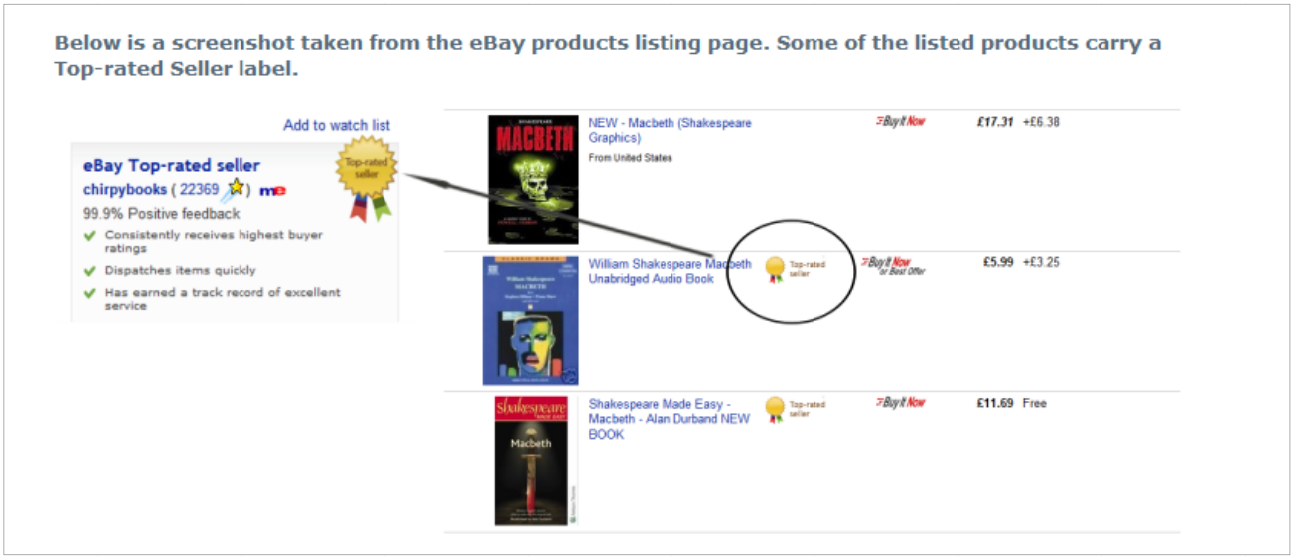


Figure 6: eBay product listing page used to solicit information about respondents' awareness and opinion of e-Commerce review/rating systems.

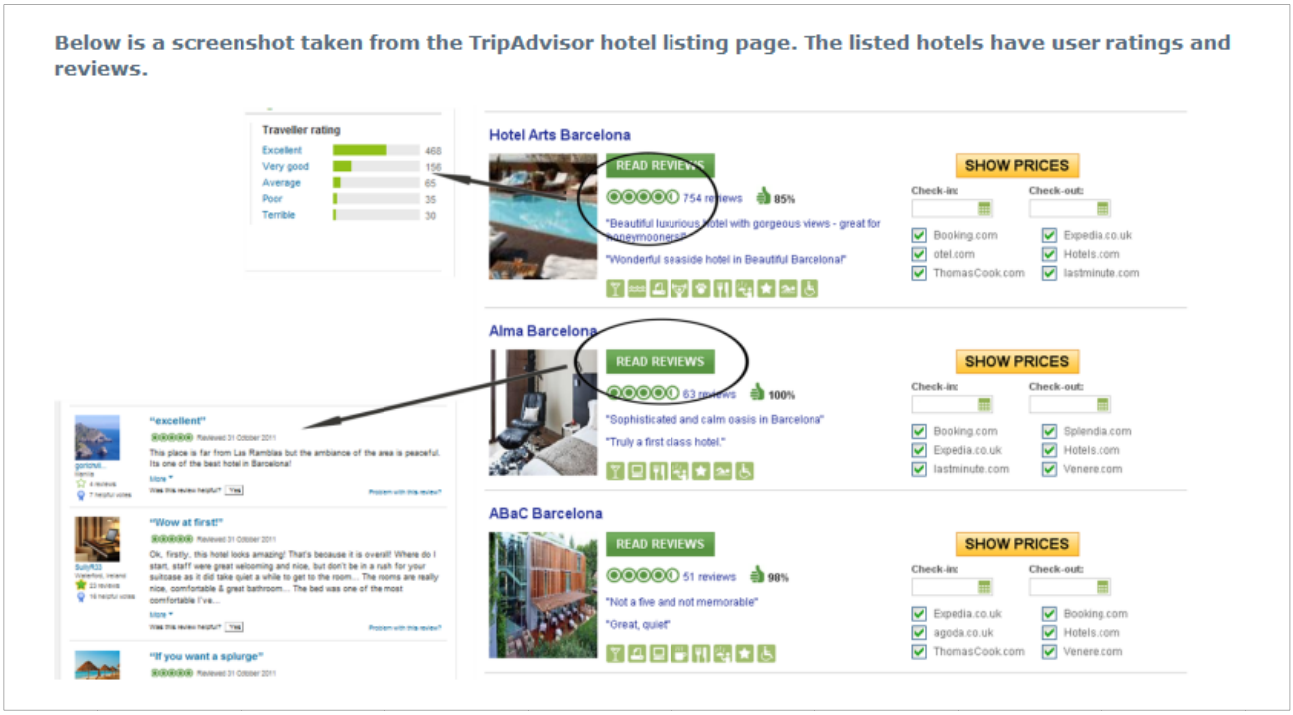


Figure 7: TripAdvisor hotel listing page used to solicit information about respondents' awareness and opinion of e-Commerce review/rating systems

Using a 5-point Likert scale, ranging from 'strongly disagree' (1) to 'strongly agree (5), respondents were asked to reflect on their level of agreement with a series of statements about both these systems (see Tables 3 and 4; also see Appendix B, Section C).

1. The Top-rated seller label encourages me to trust the vendor more than I would otherwise.
2. The Top-rated seller label would have a strong negative effect on my intention to purchase.
3. I would be more likely to purchase a product from a vendor that carries the Top-rated seller label.
4. A vendor that carries the Top-rated seller label provides products of high quality.
5. A vendor that carries the Top-rated seller label has a good reputation.
6. A vendor that carries the Top-rated seller label is more reliable than vendors that do not carry such a label.
7. A vendor that carries the Top-rated seller label has my best interests at heart.

Table 3: Trust questions related to the top-rated seller label.

1. A positive review encourages me to trust a hotel more than I would otherwise.
2. A positive review would have a strong negative effect on my intention to book a hotel.
3. I would be more likely to book a hotel that has positive reviews.
4. The hotels that have positive reviews are of high quality.
5. A hotel that has good reviews has a good reputation.
6. A hotel that has good reviews is more reliable than hotels that have bad reviews.
7. Good reviews do not promote trust towards a hotel.
8. I would be less likely to book a hotel that has positive reviews.

Table 4: Trust questions related to the TripAdvisor hotel reviews.

We used both positive and negative statements to try and ensure that respondents provided properly-considered ratings. As can be seen from Tables 3 and 4, the statements covered issues of trust, purchase intention, product quality, reputation, and reliability. These statements were intended

to encourage respondents to think of the type of functionality that is already offered by commonplace review and rating systems, and the effect they have on consumer decisions about the products to which they are applied.

Section D was designed to explore respondents' reaction to the concept of a GEO label that is clickable and supports a drill-down function such that, if the label was clicked, users would be navigated to a GEO label certification programme homepage which would provide users with information regarding the GEO label itself and offer a number of tools to help users to assess a dataset's fitness for use. To encourage respondents to think of how a GEO label could benefit from a drill-down function, and to provide some tangible examples of how such functionality is used in practice in other domains, we presented some examples e-Commerce seals of approval that use click-to-verify functionality (see Figure 8; also see Appendix B, Section D). We anticipated that respondents would recognise at least some of the presented seals of approval and that these examples would help them to better understand the proposed drill-down functionality.

Figure 8: Examples of the e-Commerce seals of approval that use click-to-verify functionality.

Respondents were asked whether they had ever come across any e-Commerce seals that use click-to-verify functionality, including those presented as the examples. Those who indicated their awareness of the seals of approval were then asked: (a) whether they ever clicked on any seals to verify that they were genuine; (b) the reason why they did or did not click on the approval seals for verification; and (c) whether they thought that a GEO label should fulfil a drill-down function and have click-to-verify functionality.

In the subsequent part of Section D, we explored both dataset users' and producers' opinions on eight potential facets that could be included as part of the GEO label drill-down functionality. Based on our previous interviews, we had already identified that GEO label tools could potentially:

- provide functionality to access experts' judgements about the value and quality of datasets;
- provide access to information on datasets' compliance with international standards;
- enable users to comment on datasets' quality, as well as to access comments provided by other community members;
- enable users to rate datasets' quality, as well as to access ratings provided by other community members;
- potentially rate the reputation of the providers that supplied datasets;
- give access or links to the documents, scientific papers and reports where datasets have been cited;

- provide access to 'soft knowledge' (subjective and informal statements) about datasets' quality as provided by the creator or provider of the dataset; and
- provide a facility to visualise several metadata records side-by-side to enable better dataset comparisons.

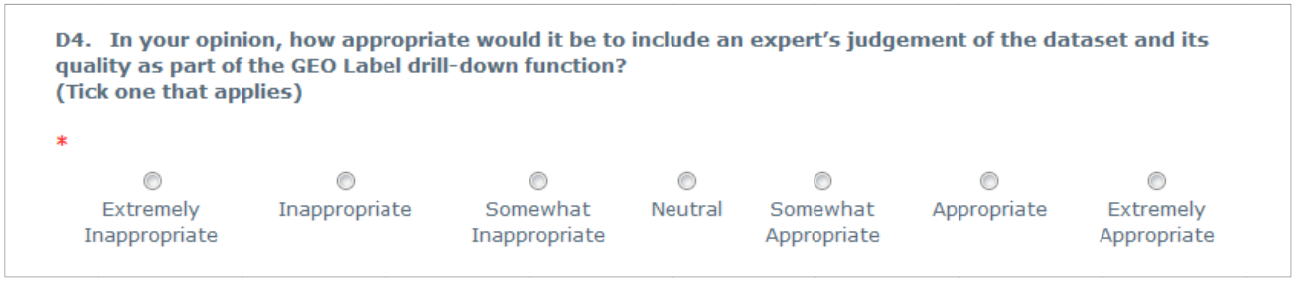


Figure 9: Example question regarding perceived appropriateness of including proposed facets as part of the GEO label function.

Using a 7-point Likert scale, ranging from 'extremely inappropriate' (1) to 'extremely appropriate' (7), we therefore asked respondents to rate how appropriate they felt it would be to include the facility to interrogate (and, where applicable, contribute to) each of the informational aspects listed above as part of the GEO label drill-down function (see Figure 9; also see Appendix B, Section D). Unlike our examination (Section A) of the features users *currently* rely on when selecting a dataset, here we presented respondents with *all* eight informational aspects, including 'dataset ratings'. We were essentially exploring users' and producers' opinions as to the appropriateness of including, in a GEO label for use by all, the informational aspects derived from our preparatory study. We were particularly interested in the level of correlation between (a) users' reflection on what was of importance to them personally as users of geospatial data and (b) what all respondents (users and producers alike) thought more generally about a global GEO label function.

Finally, in Section E, we asked respondents to indicate and explain their preferences for the role of a GEO label – specifically, we asked them whether it should stand as a certification seal or a drill-down interrogation facility; respondents were additionally given the option to suggest any other function they felt a GEO label could potentially serve. We also asked respondents whether they believe a GEO label should combine multiple functions – that is, whether they thought the label should combine several tools to access producer profile information and producer comments about dataset quality, access peer and expert reviews, access dataset citation information, visualise several metadata records side-by-side, provide quality assurance, and, by combining all these functions and tools, represent an all-in-one quality indicator.

We constructed and administered the questionnaire using the QuestionPro (QuestionPro, 2013) online-survey software. To inform potential respondents about the GEO label questionnaire, we produced a small leaflet (see Appendix C) that was distributed at the GEO Plenary session in Istanbul, Turkey on 16th of November 2012. We also emailed a number of professionals from key organisations such as NASA, ESA and EPA, academics and researchers that work in the GIS field, and other GIS professionals, asking them to complete the questionnaire and to, wherever possible, circulate the questionnaire more broadly within their network of contacts. Our goal was to target a variety of user and producer groups, ranging from individual researchers to experts who work in large-scale organisations. We received a total of 87 valid questionnaire responses: 57 from self-identified dataset users and 30 from self-identified dataset producers. The questionnaire was accessed and completed from a number of countries including Austria, Spain, Germany, Slovenia, Greece, United States, Netherlands, France, Italy, United Kingdom, Belgium, Switzerland, China,

Bolivia, and Estonia – suggesting that we have successfully solicited opinions of experts from a variety of user groups and cultures around the world.

3.2 Results and Discussion

Of the 87 valid responses received, 57 (66%) were from self-identified geospatial data users and 30 (34%) were from self-identified geospatial data producers. Amongst the former, 8 respondents identified themselves as Group on Earth Observations committee members, 2 as private sector data users, 15 as governmental data users, 40 as researcher data users, 27 as academic data users, and one respondent identified his/her user type as other, namely a manager within projects that use data (see Table 5; note that the users were free to self-identify as belonging to one or more categories). Among the data producers, 5 identified themselves as a Group on Earth Observations (GEO) committee member, 13 as a data producer with some dataset(s) in the Global Earth Observation System of Systems (GEOSS) Common Infrastructure, 7 as a data producer not part of Global Earth Observation System of Systems (GEOSS), 3 as a private sector data producer, 13 as a governmental data producer, 16 as a research/academic data producer, and 5 identified themselves as other (see Table 5; again, producers were free to self-identify as belonging to one or more categories).

User Type	Number of Respondents	Producer Type	Number of Respondents
Group on Earth Observations committee member	8	Group on Earth Observations (GEO) committee member	5
Private sector data user	2	Data producer with some dataset(s) in the Global Earth Observation System of Systems (GEOSS) Common Infrastructure	13
Governmental data user	15	Data producer not part of Global Earth Observation System of Systems (GEOSS)	7
Researcher data user	**40**	Private sector data producer	3
Academic data user	27	Governmental data producer	13
Other	2	Research/academic data producer	**16**
		Other	5

Table 5: Respondents' self-identified user and producer classifications (dominant types highlighted in bold).

3.2.1 Dataset Selection by Users

The majority of data users (91%) stated that they have a choice of dataset for their work. Of these, 86% stated that there is more than one data provider supplying the types of datasets they need. When asked to list the external data providers from whom respondents source their data, they indicated a broad spectrum of data providers including large governmental data producers such as NASA, NOAA, ESA, WorldClim, Ordnance Survey, etc., repositories that are largely free to the academic community, local universities, "*data sets from research papers*", and internet websites. Of the data users that have a choice of data, 85% confirmed that they considered metadata records when making a dataset selection. When asked to describe the types of metadata they typically consider, they indicated a broad spectrum ranging from literally any/all metadata that is available to

specific metadata aspects including, but not limited to, information about data resolution, accuracy, and lineage, license information, information about the software that processed the data, supported standards, the purpose for which the dataset was initially generated, missing values within the dataset, the cost of obtaining the dataset, author information, and domain-specific elements such as, for example, "*filed measurements of vegetation properties*". These findings suggest that users of geospatial data consider a wide variety of metadata elements and indicate the importance of the availability of complete metadata records for effective dataset selection.

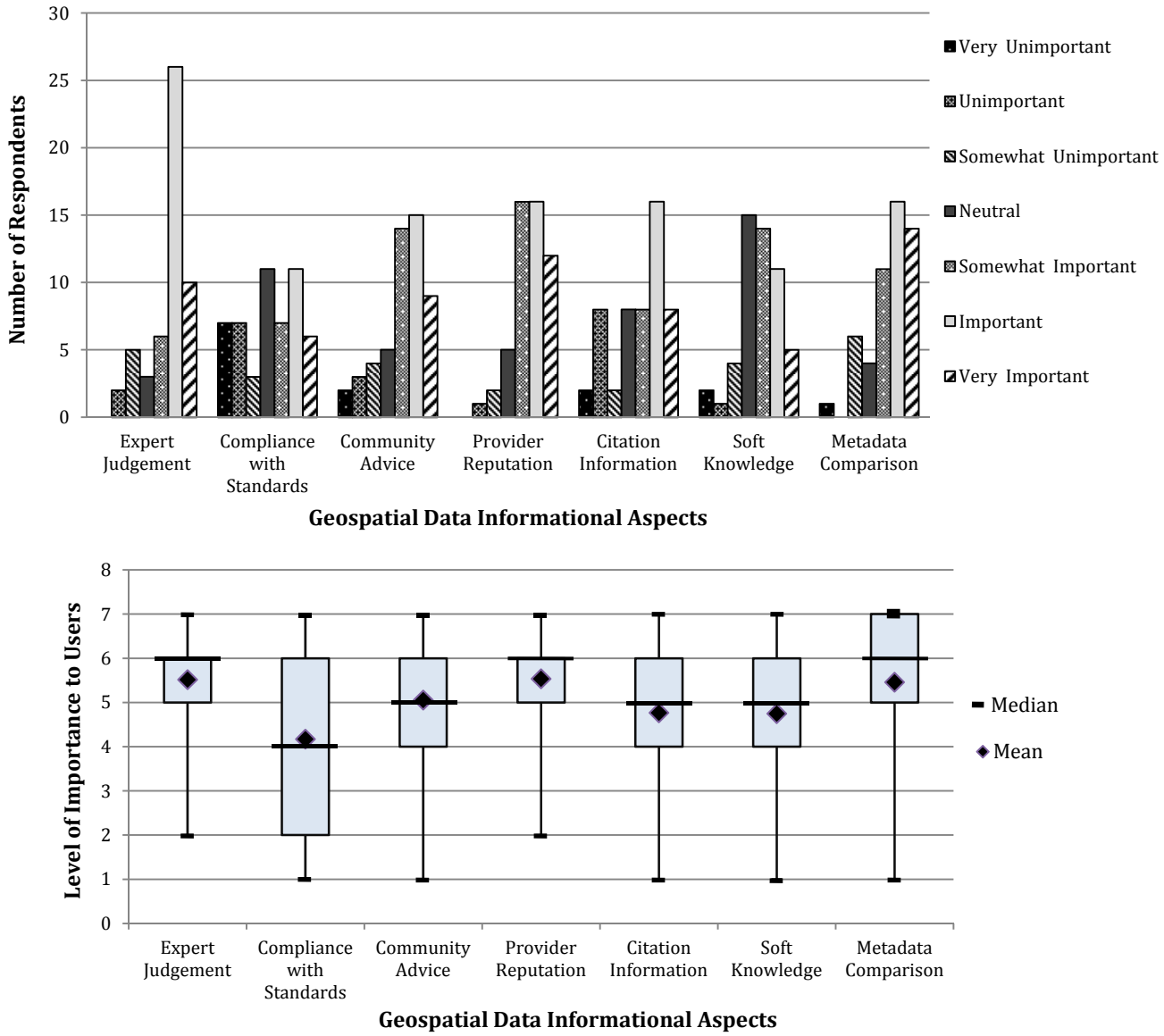


Figure 10: Data user attributed importance of informational aspects associated with geospatial datasets shown as bar chart and box plot respectively.

Figure 10 shows a summary of the importance ratings attributed by dataset users (who have a choice in dataset for their work activities) to the various informational aspects associated with datasets. With more than 70% of users rating them as important at some level, expert judgment, community advice, dataset provider reputation, and support for metadata comparison seem to be universally important across users. In contrast, the importance of compliance with standards and citation information was not generally agreed by users. This is somewhat surprising given that these

are the more metric-based or easily validated measures of quality. Although the majority of users rated soft knowledge as important at some level, the agreement on this was not as widespread as our earlier interviews suggested might have been the case.

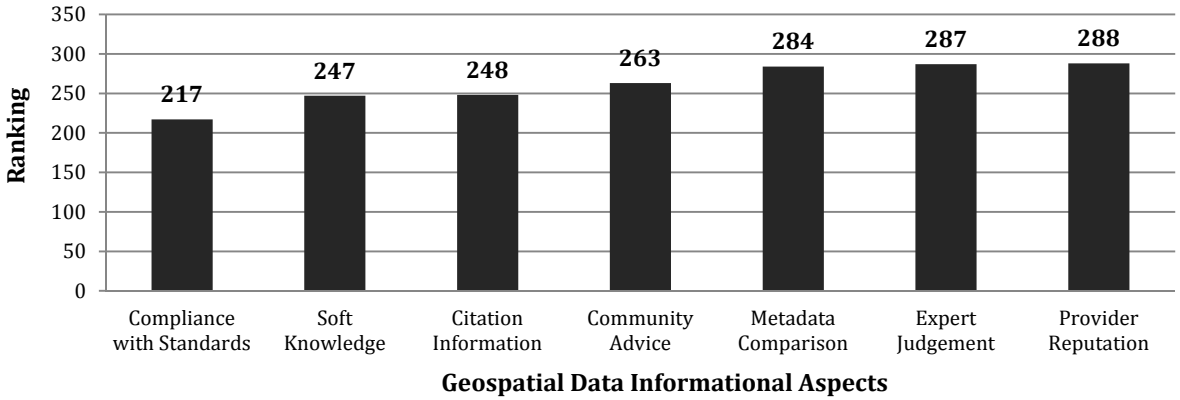


Figure 11: Ranking of overall importance of informational aspects according to dataset users.

Figure 11 shows an overall ranking of the importance of the 7 informational aspects (as noted previously, the 'dataset ratings' aspect was not included in the assessment of importance when considering what users *currently* rely on due to its as yet unavailability). To calculate this we applied (per question) a ranking to each Likert scale item ranging from 1 for 'extremely unimportant'/'very useless' to 7 for 'extremely important'/'very useful'; we then multiplied the number of responses for each item by its corresponding rank and added the ranks to arrive at an overall rank for each informational aspect. As can be seen, dataset users place more importance on the more subjective or 'softer' metadata aspects, with compliance with standards being ranked lowest overall.

3.2.2 Dataset Production

As already noted, 30 study respondents (34%) were self-identified as geospatial data producers. When asked about the data they produce, they listed a range of data types, including: climate data; environmental monitoring and observational data (natural hazards, hydrology, natural resources, etc.); weather forecasts; climate predictions; observations of the atmosphere, oceans, and hydrology; data about species occurrence, status and distribution; topographic maps and databases; informatics products; and socio-economic information.

The majority (93%) of data producers indicated that they provide metadata records with datasets they produce. They listed a range of metadata elements, including: ISO/FGDC/DIF metadata elements (all with translation between formats); all INSPIRE mandatory fields; standard NWS (National Weather Service) reporting; "*metadata for discovery and for assessing provenance, quality, etc.*"; "*station site, instrumentation and measuring parameters and their changes during the period of usage*"; "*Common Data Index, information on instruments, data and methodologies used*"; and "*quality, extent, units, lineage*". One of the data providers stated that "*the amount of detail and support depends on a defined 'level of service'*". Also, two data providers suggested that they also provide 'soft knowledge' metadata, listing "*several MS Word and PDF documents describing the data, Excel spreadsheets describing the single instruments*", and other "*descriptive documentation*".

When asked about the data and/or metadata standards they support, 87% of data producers stated that they observe international data or metadata standards, listing ISO 19115/19139/19119, FGDC, INSPIRE regulations on metadata, Dublin Core, Darwin Core, WMO, NASA DIF, and netCDF as

the main standards that they support. Of the data producers who do not support any international standards, only two provided some supporting comments stating that they do not yet support metadata standards because "*the need has not arisen yet*".

3.2.3 User and Producer Awareness of Geospatial Data Certifications

When asked about awareness of any certificates or seals that certify geospatial datasets or metadata records, only 15 study respondents (17%) indicated awareness of any such certificates. Two study respondents listed ISO 9000 – a family of quality management standards which includes ISO 9001:2008, "*the only standard in the ISO 9000 family which an organisation can become certified to*" (The British Assessment Bureau, 2013). One of the data users specified 5 STAR OPENDATA (5 Star Open Data, 2012) – a 5 star re-usability indicator for Public Sector Information (PSI), ranging from 'very poor' to 'perfect'. One data producer explained a certification framework that is used for the data he produces:

> "*As a US NWS[1] field office, we provide certified climate records (F6, CF6) for certain sites to NCDC[2]. We also collect/log various COOP[3] forms B-91, data tapes, and certain electronic transmissions and forward these to NCDC for archival. In turn, the NCDC at Asheville NC conducts data QA/QC involving such things as data completeness, representativeness, and nearest-neighbour comparisons to these datasets … and publishes these data as 'official' under a form of NOAA[4]/NCDC certification*".

Interestingly, 7 study respondents (47% of the respondents who indicated awareness) listed various international data standards as examples of such certificates: ISO 19100 (series of Geographic Information standards); ISO 19115; INSPIRE metadata implementation rules; OGC (Open Geospatial Consortium); OWS (OGC Web Services); etc. One of the data users provided a list of several international standards and initiatives, including "*metadata standards like those in use by ESA, NASA etc., e.g. the new GEOMS, statements of compliance with metrology standards like BIPM, GUM,* [the] *GEO QA4EO framework, HDF or NetCDF formalism (compliance mandatory for a list of data archives),* [and] *various ISO*".

International standards are not, technically, certification programmes but are clearly being viewed by some as serving this role. All 15 study respondents who indicated awareness of certificates or seals, agreed that these certifications are useful to the user community. While data users did not provide any commentaries to support their answers, four data producers explained why they consider these certifications valuable to the GIS community (in some way addressing the focus of the subsequent section of the questionnaire (see Section 3.2.4):

a) the certifications "*help the user to find the fit-for-purpose datasets*";
b) the certifications "*provide some kind of guarantee and standard procedures of claiming*";
c) "*in our case,* [the certifications] *ensure to the community the quality of our productive processes and existence of documentation about all the process steps, indicators of quality control, etc.*"; and
d) "*Local NWS office or subsequent NCDC publication of observations are routinely used and trusted by partner agencies, industrial users, academics, and others. NCDC 'certified'*

[1] National Weather Service.
[2] National Climatic Data Center
[3] Cooperative Observer Program
[4] National Oceanic and Atmospheric Administration

observations are regularly used in legal cases to establish weather or hydrologic conditions at the scene".

3.2.4 User and Producer Views on Certification of Geospatial Data

When asked their initial views as to whether geospatial data or metadata records would benefit from the application of certification programme(s), the opinions of users and producers were reasonably concordant: over a half of the study respondents (52%) agreed that certification would be beneficial; only 13% disagreed with the benefit of certification programmes; and 35% were not sure. Many respondents agreed that data certification "*would help to improve general quality of data* […] *would also help the user to know the limitations of the data, and if done in a standard, nonbiased manner, would be a useful comparison among similar datasets*". One of the data users pointed out that "*the amount of geospatial data without proper metadata is overwhelming; establishing the quality of data by trial and error takes too much time to benefit from the increasing availability of data*". Respondents argued that certification would "*ensure that a minimum amount of information is captured*", "*it would encourage data providers to follow a common framework of data formats or metadata provision*", and would ensure consistency of data quality. Furthermore, respondents suggested that certification would help to "*identify datasets from authoritative sources and distinguish those datasets from similar data of uncertain quality*". Respondents also confirmed our previous findings on importance of provenance and licensing information, stating that certification could ensure that metadata "*provides a record of the history of the processing, which tends to be neglected if there is a long path towards the final product. It may help with IP issues and similar questions. Same data sets are provided with restrictions on them which can be difficult to sort out after the event. Resolving them becomes a paper chase*".

Although geospatial data certification was viewed positively, some of the study respondents agreed that certification will never outweigh other important data characteristics such as data content, citation information and peers' recommendations. Generally, users appear to view geospatial data certification as a type of formal data quality control (e.g., certification of a dataset's conformance to a defined level of uncertainty, accuracy, resolution, etc., data/metadata interoperability; etc.) and control over metadata completeness; data content, peer review and citations do not appear to be considered as potential certification metrics. A study respondent highlighted that "[the] *most important quality indicator is actually ratings by users (partly equivalent to peer review)*". Another respondent further argued:

> "*In general it would be good to know whether fundamental metadata is attached to the data in a form that is straightforward to use. This might be helpful when browsing the data, but when it comes down to the choice of what to use for your application I do not see how this would circumvent the process of looking through metadata, searching the literature and talking to other users*".

Consistent with our initial interview results, these findings indicate the value of producer-supplied metadata records as well as more subjective information to support dataset quality evaluation.

In contrast, those respondents who disagreed with certification stated that "*certification is an extra effort* […and] *it seems unlikely asking for more extra effort will improve the current* [situation] *on a broad basis*". Data producers stated that they "*have in-house quality checks and provide information on these* [and the] *procedures are ISO-certified already*". ISO, OGC, IETF, OASIS, W3C, etc. also have their own conformance schemes, consequently "*there are already too many labels/certificate/etcetera in the world, and it is VERY difficult to distinguish the really*

useful/neutral labels with industry 'self-labelling' things". The cost of certification also raised a concern because the "*regimented bureaucracy of* [an] *approval process may be costly and difficult for data providers to implement*" and "*if you need too much time to produce this certification, the updating of the date can be compromised*". Also certification could potentially "*reduce the number of datasets made available (due to publishers not wanting to go through the certification process – it is hard enough to encourage filling in of Metadata records)*". This would not be desirable because certification would "*make the data much more expensive and hard to obtain*".

Finally, a number of study respondents did not believe that certification of geospatial data quality is feasible because "*quality is in the eye of the beholder, so that is not certifiable*". It was argued that "*at best you can certify whether the producer followed recommended practice of documentation and stewardship*" and it was suggested that "*data is used for a range of purposes, and data sets not passing the certification process could sometimes be better suitable for* [one's] *purpose than certified ones*".

3.2.5 Initial Perspectives on a GEO Label

When asked about what role they would want a GEO label to serve, respondents provided a variety of comments and suggestions. Some respondents were unsure about, or were not in favour of, a GEO label in general because "*quality is subjective*" and "*different data sets might have different needs*". Others suggested that a GEO label could act as some kind of quality indicator or could "*certify that the data have correct minimum metadata information and are ready to be used*". It was noted that a GEO label could act as an "*incentive for producers to provide metadata*", "*assuring metadata contents are trustworthy, properly filled, and quality control accepted*". It was also suggested that a GEO label "*should be a gold seal of approval by a third party indicating that the data or data sets meet all of the usability, quality and performance criteria*".

A number of respondents proposed that a GEO label "*should give an overview of the data set which can be grasped with one glance on the GEO label*" and provide "*an easy visual indication that data* [has] *met some quality standards,* […] *is complete, useful, etc.*" and would serve as "*an immediate vision that it can be a trusted data source"*. As proposed by study respondents, a GEO label could potentially:

a) indicate compliance with standards such as ISO, Inspire, QA4EO, etc.;
b) provide identification of standard-compliant metadata format;
c) mark that certain Quality Control (QC) procedures are in place;
d) give information about the most relevant metadata;
e) indicate metadata completeness (also containing methodology and uncertainty information);
f) indicate frequency-of-use (data popularity);
g) provide user feedback and ratings;
h) act as an endorsement by relevant experts and user communities;
i) inform users that information on the quality of the data is available;
j) inform users about what the dataset can be useful for;
k) indicate usability levels, certifications, and the main communities using the data;
l) rank the quality of the datasets;
m) describe how the data was created; and
n) provide information on data availability and affordability.

As a caveat to all the proposed functions it might serve, it was stressed that "*the label would only be useful if it is easy to use and understand*".

3.2.6 GEO Label as a Certification Seal

When asked whether the presence of a GEO label would, if provided with datasets to *certify* their quality/trustworthiness, influence respondents' dataset selection decisions, 48% of respondents stated that its presence *would* influence their decision, 22% stated that it would depend on whether they had previously used the data, and 11% stated that a GEO label would not influence their selection. When asked to provide a brief explanation to support their answers, a number of respondents argued that the importance of a GEO label would largely depend on the *availability* of datasets that fit a task in hand. Data users stated that at present there is not much choice in datasets that fit their needs and they are "*often lucky to find the data needed*" at all. It was also highlighted that "*a lot of the data* [that users] *deal with is only available from one source, as such there is often limited choice made when collecting it*". As a data user suggested, if faced with no alternative, he "*would use the data although the quality info is not provided*". Another data user also noted that "*if there* [is] *more than one similar dataset to choose from, and* [he is] *not personally aware of the differences, then* [having a GEO label] *would be useful*" in supporting a selection decision.

Other study respondents argued that a GEO label would influence dataset selection decisions because users "*would hopefully trust the ones who certified the dataset*" and because they felt that such "*data sets would become de facto standards*". A data producer argued:

> "*such a label could assist in selecting one of* [a] *few best options from a large range of possibly very different data sets. If/where this happens, the label might also develop into an incentive for producers to implement minimum standards (metadata, QC)*".

Although respondents generally agreed that they would prioritise certified data, they also noted that they would also spend time locating non-certified data from trusted sources. It was further suggested that "*people are looking first for good and reliable data sources*" and "*would have confidence in using data from trustworthy sources*" – implying that the source rather than the certification was significant. In line with our preparatory findings, these results indicate that the reputation of data providers plays an important role in data quality evaluation and is often viewed as a 'quality seal' in itself. Also in support of our interview findings, many study respondents suggested that even if provided with assurance seals for a dataset, users would still want to visualise data within the dataset and to talk to or read evaluations from other users of the data.

Respondents indicated that, in cases where users are already familiar with a dataset or source, the presence of a GEO label would not affect their perception of the dataset quality. In contrast, for those users who have never encountered a dataset, then the "*GEO Label can represent a warranty of the data*".

Finally, a number of study respondents stated that geospatial data cannot be usefully certified because its quality and trustworthiness depends entirely on the intended use. It was suggested that "*a dataset that suits one person's needs may be completely inappropriate for someone else*" and it was felt that "*this would be nearly impossible to capture*". Respondents argued that they are more concerned with whether a dataset is suitable for their particular requirements than whether or not it has a seal of approval; they indicated that they would rather check the data themselves than trust the assessment to someone else. The issue of certification costs was again raised, with respondents wondering "*who will pay for the sustainable maintenance of any accreditation scheme? The banks?*".

User Viewpoint:

"*The problem is that you cannot certify quality and trustworthiness if you do not know about the intended use of the data. I could see this would be helpful if the user's profile matches a typical user of the data - but there are many cases where people (successfully) use data for purposes other than what was intended. I do not see how the certification would help here.*"

Producer Viewpoint:

"*So how are you going to measure this? What makes something quality data? Why would I trust it? What value does this GEO label provide unless the process is totally transparent, as least as rigorous as peer-review of papers, and open. How likely is any of that!*"

3.2.7 GEO Label as a Review or Rating System

To first observe respondents' general awareness of review/rating systems, we asked them to identify everyday e-Commerce-type review/rating systems with which they were familiar (see Figures 12 and 13; also see Appendix B, Section C). Surprisingly, 23% of respondents indicated that they are not aware of any such systems; the remaining 77% indicated familiarity with eBay, Amazon, TripAdvisor, hotels.com, booking.com, and even Google maps search results. Of these, the majority of respondents stated that they use such systems less than once per month.

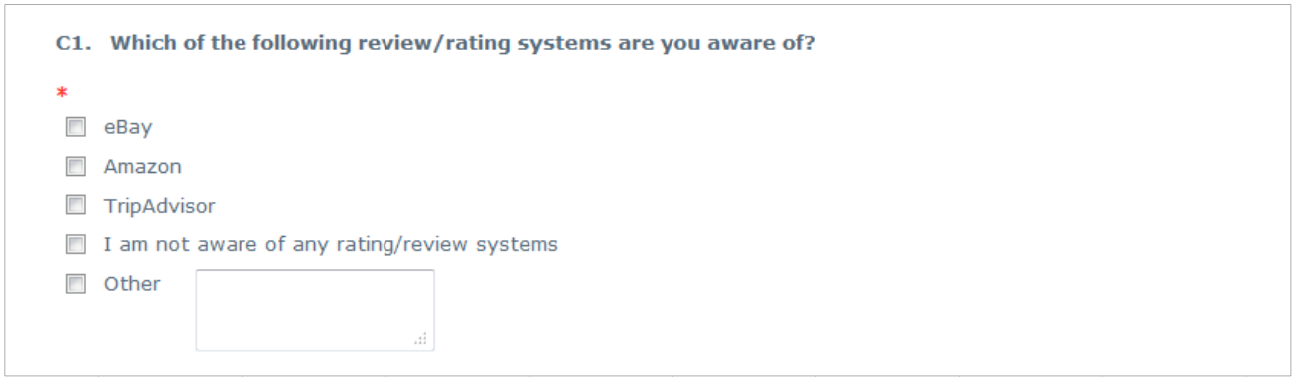


Figure 12: Example of questions designed to elicit general awareness of review and rating systems.

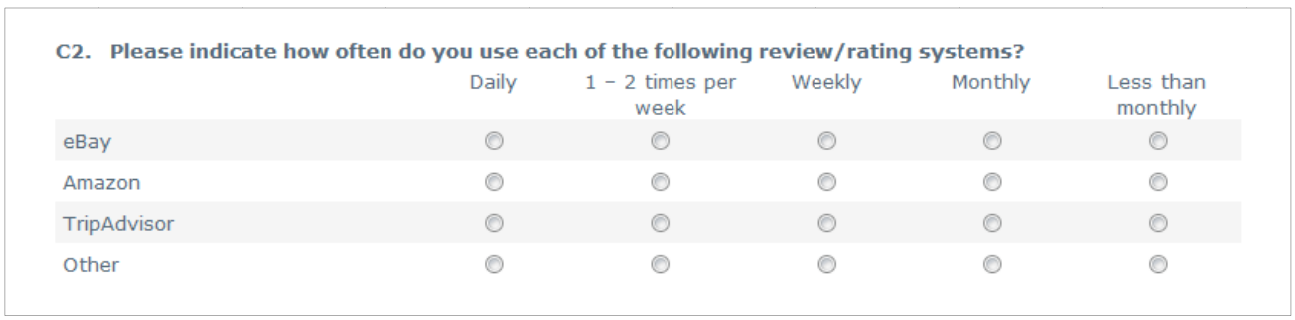


Figure 13: Example question to assess respondents' frequency of use of review and rating systems.

When presented with a screenshot of an eBay product listing page incorporating a Top-rated seller label (see Figure 14; also see Appendix B, Section C), respondents showed a positive attitude towards its presence: 63% agreed that they would be encouraged to trust the vendor more than they

would a vendor without the label and its associated meaning; 63% agreed that they would be more likely to purchase a product from a vendor that carries the Top-rated seller label; 56% agreed that a vendor that carries the Top-rated seller label has a good reputation; and 47% agreed that a vendor that carries the Top-rated seller label is more reliable than vendors that do not carry such a label. In contrast, the Top-rated seller label was not generally viewed as an indicator of product quality nor was it seen to carry assurance that the vendor has the consumers' best interests at heart. Reaction to a screenshot of TripAdvisor hotel reviews and ratings (see Figure 15; also see Appendix B, Section C) followed a similar pattern.

Figure 14: A screenshot of an eBay product listing page incorporating a Top-rated seller label used to elicit awareness and reaction to the labelling.

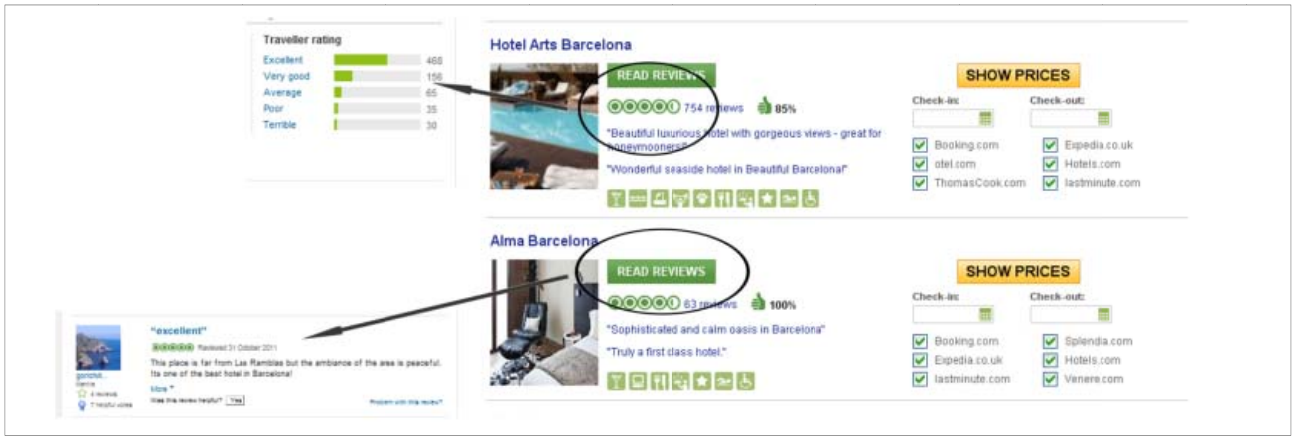


Figure 15: A screenshot of a TripAdvisor hotel listing page incorporating reviews and ratings used to elicit awareness and reaction to the rating presentation.

After presenting respondents with these examples, we asked them to state whether they believe a GEO label should support a similar role. Nearly half of the respondents (49%) agreed that a GEO label should fulfil an assurance and review/rating function; 34% recorded no opinion and 16% disagreed. When asked to provide a brief explanation to support their answer, a number of respondents agreed that user ratings systems are very useful, they provide more insight into the data, and "*while always subjective in nature, is a valuable tool for deciding on data relevance and utility*". Respondents observed that datasets recommended by many users with similar needs could be seen as more trustworthy and relevant. Furthermore, it was also suggested that introducing a review and rating system for GEO datasets "*would have added value to the community of users and give GEO an identity and make a real contribution to the understanding of the planet Earth*".

Producer Viewpoint:

"*I think it strongly depends on who is providing the label and how it's achieved. I'm highly suspicious of seller ratings as they can be 'farmed', but will be more likely to trust a large number of positive user/independent reviews (a small number will make me distrust the reviewers as family/friends).*

A user based review system is therefore more appealing to me than a certification programme."

Although study respondents agreed that labels and user ratings might initially attract their attention, they stressed the importance of actual comments as opposed to simple star-based ratings. They suggested that they would consider free text user comments to ultimately arrive at their own, independent "*judgement about the usefulness of the rating*". One data user suggested that user feedback and review functionality would actually be more valuable and relevant with respect to geospatial data than any form of label similar to the 'Top rated seller'. He argued that it is the products (geospatial datasets) that must be reviewed and not the dataset providers because "*the data provision procedure (IT aspects, etc.) is certainly important but secondary with respect to the information/data*" itself. A data producer noted that, if dataset ratings and user feedback are to be provided as part of the GEO label function, these subjective quality measures should not be combined with objective quality aspects.

Producer Viewpoint:

"*I'd be more interested in actual user comments than a simple star rating. Given the wide diversity of potential data uses (unlike things reviewed on Amazon or trip advisor) a star rating is not very meaningful. A five star data set for an atmospheric modeller could be a one star data set for a terrestrial ecologist.*"

In contrast, many respondents appeared to be unsure whether rating and review systems could be usefully applied to geospatial data. It was argued that "*rating systems are too one-dimensional for scientific data*", that they are "*too subjective*", and that e-Commerce-led review and rating systems are not viable comparable examples because "*scientific datasets are more complex than a hotel and their quality is much more difficult to assess*". Respondents once again highlighted the use case dependent nature of geospatial data quality, arguing that "*data sets serve different goals so for one purpose a dataset may be very good while for another it may be very poor, so then you cannot attach a single label, it all depends on the intended purpose*". A data user argued that "*just because someone 'highly rated' a dataset does not necessarily mean that it is of good quality"*; he also aptly commented that "*there are many aspects that one should take in to account regarding the user background, which would partially help in determining how the user perceived and rated* [the dataset]". Some respondents proposed that "*the label should be limited to reflecting that the data are documented with a specific level of metadata…* [and] *independently, the GCI should pursue hosting a ratings system to solicit feedback from users on each data set, acting as intermediary between user and provider, and sharing experiences of users*".

User Viewpoint:

"*I think it could support a reviewing system. But using tripAdvisor/booking.com as* [an] *example, the rating is usually relative to the expectation of the hotels. I would expect a 5 star hotel with an average rating of 6 still to be better for many things than a 1 star hotel with rating 8, as you pay a lot more. Rating of data sets would similarly depend on the expectation of the data set. But would a high resolution data set be better than a low resolution data set, even if the first has been downscaled from the second one with a simple and naive method? Many users would say yes, but the high resolution might give a false indication of precision. The second question is whether users would be able to recognize a good data set. I can see if a hotel room is dirty and the receptionist is impolite, but I might need to do my own cross-validation to be able to correctly rate a data set*".

Several study respondents indicated strong opinion that a GEO label should be a certification seal and not a review/rating system. They argued that the GEO label "*should be formally assigned by a data provider that certifies this dataset has the backing of the government agency that supplied it*" and should not include user reviews and ratings. As a data user stated, "*the GEO label should in my opinion be a certification of the completeness of the metadata, not the popularity among the users*". Another data user also argued that a GEO label should not fulfil a general user review function, but should instead support "*expert evaluation - not rating by the masses*".

The limited availability of suitable datasets was again referenced when a number of respondents argued that, unlike hotels or other electronically retailed products for which there is normally a wide choice of alternative products/vendors, there is often little choice when it comes to GEO datasets and so criteria other than ratings become more important when selecting a dataset to use. Indeed, respondents indicated that they would often have to use data of low quality in cases when there is no better choice; in such cases, user feedback and evaluation would not have any impact on the dataset selection decision.

3.2.8 GEO Label for Drill-Down Interrogation

Prompted by some examples (see Figure 16), we asked respondents about their awareness of e-Commerce seals and associated click-to-verify functionality.

Figure 16: Example e-Commerce seals presented to study respondents.

Three quarters (75%) of respondents stated that they had come across e-Commerce seals before; of these, 46% had clicked on an approval seal to verify if it was genuine. Respondents that had previously clicked on an approval seal stated that they "*clicked to check that they were legitimate*

and how they proved that they were legitimate". In general, respondents explained that, in accessing the seal's webpage, they were trying to reassure themselves about the security of the transaction, especially in terms of credit card use. A few, however, clicked "*to check what criteria are used*", "*to see briefly what it was, to understand it better*", or "*mostly out of curiosity*".

Three study respondents, who had never clicked on an approval seal, suggested that they "*only used trusted sources* [that they] *knew from previous experience*" and acknowledged that most of the time, they purchase products on the basis of already-established trust in a brand or producer, meaning that they largely only see the seals on the pages of vendors they already trust. Rather candidly, four respondents admitted that they never clicked on a seal as a result of naivety because they had never "*had a negative experience with fake seals*"; they commented that "*seeing the approval seal was enough*" and that they have generally taken them at face value. Other reasons for not investigating approval seals included a lack of belief in such systems, lack of consideration (i.e., the seals were not considered important or, worse, weren't even thought about at all), and lack of time. Finally, four respondents stated that they were not previously aware of the click-to-verify functionality, with one responding indicating that he would consider this more closely from now on!

When asked whether a GEO label should fulfil a drill-down function and have click-to-verify functionality, more than half of respondents (54%) agreed that a GEO label should fulfil such a function. Respondents were then asked to rate their perception of the appropriateness of different candidate data interrogation functions/foci that could be provided within a drill-down GEO label. Their responses are shown in Figure 17.

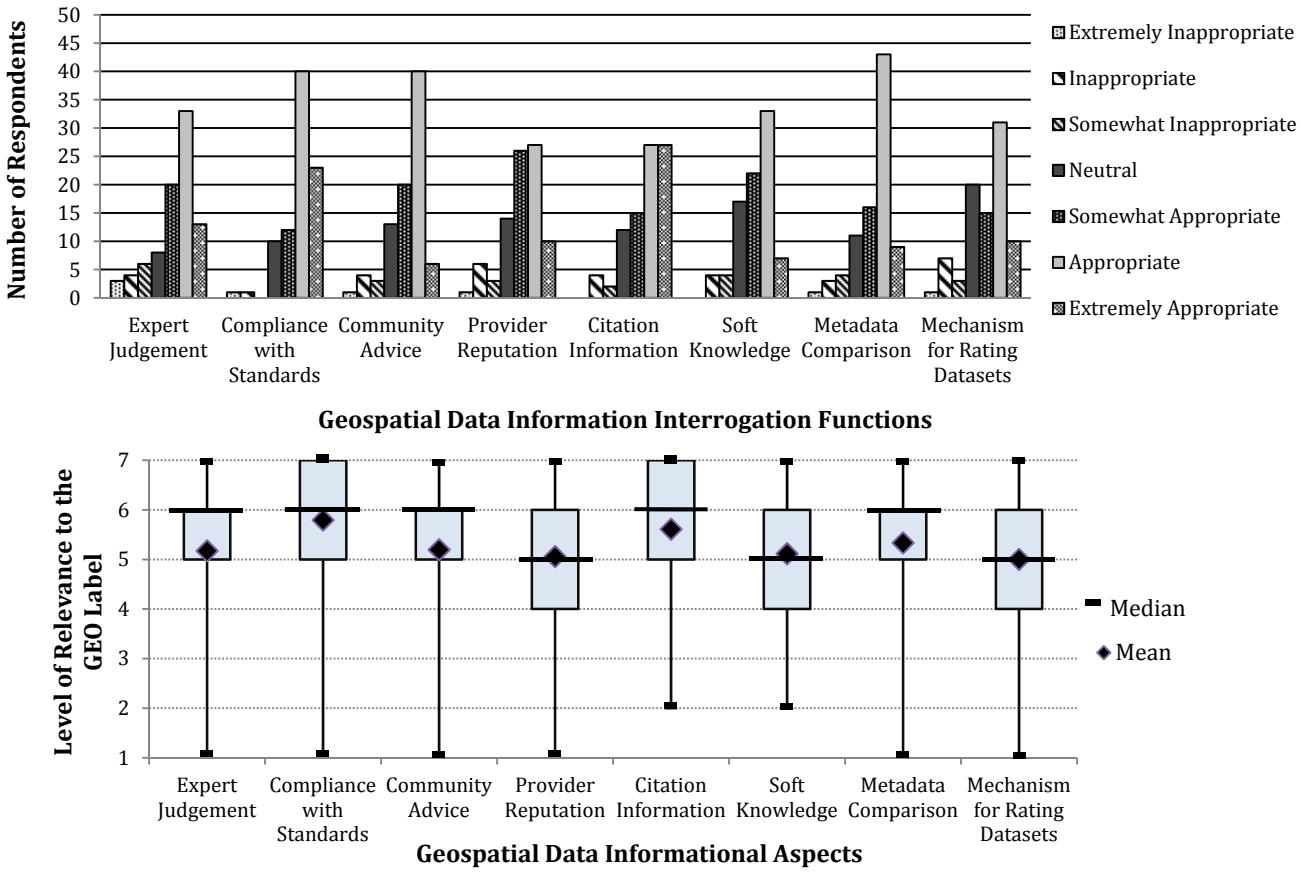


Figure 17: Attributed appropriateness of candidate information interrogation functions/foci within a GEO label shown as bar and box plots.

We used the Spearman's Rank Correlation Coefficient to discover the strength of correlation between users' personal perceptions of the importance of geospatial data informational aspects (when selecting datasets as discussed previously) and their assessment of the appropriateness of inclusion of associated informational interrogation functionality within a GEO label drill-down function. (Note that only dataset users' responses were included here because only this group was asked to rate importance of informational aspects for dataset selection.) Our analysis showed significant correlation for citation information ($r(50)=0.44$, $p=0.001$), soft knowledge ($r(50)=0.664$, $p=0.001$), and metadata comparison ($r(50)=0.509$, $p=0.001$). Compliance with standards ($r(50)=0.37$, $p=0.005$), community advice ($r(50)=0.353$, $p=0.01$), and expert judgement ($r(50)=0.323$, $p=0.025$) showed much weaker correlation. Finally, we found no significant correlation ($r(50)=0.226$, $p=0.10$) between the perceived importance of reputation of dataset providers and its value within a GEO label function. On this basis, we can see some level of variance between what users rely on personally when selecting datasets and their professional opinion in terms of what should be included within a GEO label drill-down function for dataset representation. Whereas in Section 3.2.1 we saw a clear emphasis on more subjective metadata, we are now perhaps witnessing some element of concern about whether it is *possible* to effectively or appropriately support such metadata in an interrogation facility.

We asked respondents to identify any additional functions/foci that they felt could usefully be provided within a drill-down GEO label. Their suggestions included:

a) indication of level of interest in the data set – a popularity indicator (e.g., how many users acquired and used the dataset);
b) information on the purpose of creation of the dataset;
c) example uses of the dataset;
d) complete provenance (lineage) information, if not provided in the metadata;
e) full processing history;
f) information on stability of the set over the years;
g) links to other relevant or similar data (e.g., data gathered as part of the same campaign, same geographic area, same time);
h) information on known gaps or shortcomings of the data;
i) automated checks (syntax, schema or structure, existence of the data link, etc.);
j) access to provider responses to community members' comments about a dataset;
k) discussion forums about the different datasets and/or providers; and
l) knowledge and information on licenses (free and open) – that is, a clear description of the ownership and use that can be made of the data, including commercial and quality (likely errors) restrictions.

Study respondents cautioned that a GEO label should supply information regarding "*who awarded the label* [and] *which criteria were used*". A data producer argued the redundancy of 'compliance with standards' assertions, suggesting that providers can state their level of compliance and this does not require independent assessment other than where community or expert feedback suggests that the provider's statement of compliance is inaccurate. Another data provider highlighted the importance of 'soft knowledge' and provided US National Weather Service COOP B-91 reports as a practical example: he commented that these reports had previously included tremendously useful observer remarks which have, unfortunately, "*since vanished* […] *due to automation or ha*[ve] *been erased from the historical record due to digitization*".

3.2.9 Preference for GEO Label Role

We asked respondents to identify their preference(s) for one or more of the following as the role a GEO label should serve:

a) certification seal;
b) drill down interrogation facility;
c) other; and/or
d) don't know.

The majority of respondents (50) indicated preference for a drill-down interrogation facility, with a large number additionally and/or alternatively stating preference for a certification seal. Where respondents suggested alternative functionality, they proposed that a GEO label represent a popularity indicator, user feedback facility, or a metadata completeness seal that would include a template of metadata elements that are required to be filled in. A data user argued that "*there are common metadata fields that should be included in EVERY data set, that are missing in part in almost every dataset available*" and that a standardised template would solve this issue.

When asked to provide a brief explanation in support of their stated preference(s), the respondents who selected only the certification role argued that certification would be "*very useful to verify data quality*" and could provide "*a quick way of verifying the usability of the dataset*". It was also suggested that because "*seals are simple and easier to notice"* they would therefore serve as effective "*means of noting quality of products to other users whether professional or non-professional*".

Respondents whose preference was solely the drill-down function argued that such a facility might be more flexible and complete compared to certification programs which "*usually apply to the existence of documentation accompanying the data, not to the quality of this documentation*". Respondents suggested that providing more information about datasets in this way would be the "*best way to provide the information, whether it is metadata from the data provider or comments/evaluations by users*". Respondents argued that dataset users should be able to arrive at their own assessment of data quality and, since quality is dependent on personal perception and intended use, they considered a drill-down function as the most convenient way to support such quality assessment. Respondents reiterated the concern that it may not be possible to determine quality without knowing the intended context of use and so a drill-down function to allow interrogation of dataset-related information would be more meaningful as opposed to some abstract assertion of quality. One data producer considered that information from providers and user reviews available via a drill-down facility were "*perhaps the most useful way to provide more information on a dataset*", adding that citations would also serve as "*a useful indication of what the data are suitable for*" but expressing concern about expert judgements and certification, based on who is purporting to be expert and on what basis the quality is being certified.

Respondents who were equally in favour of both certification and drill-down roles argued that, combined together, both functions would provide users with the information necessary to establish confidence or trust in a dataset, especially when a user is faced with an unfamiliar data platform. They highlighted that "*a certificate implies well defined and independent controls*" and "*can be useful to state that certain minimum requirements were followed*" whilst "*the drill down interrogation facility with rating could provide the user with lots of additional information*" and potentially support "*online comparison of essential items*". It was further suggested that the presence of a certification seal might encourage users to select those datasets for inspection and,

thereafter, a drill-down functionality would allow users to assess whether the data "*is worth working with*".

In contrast, a number of respondents were "*not sure how to integrate all these aspects in a simple form*" arguing that "*the one label for all-solution might be a bit optimistic and clutter everything more than necessary*".

Finally, respondents who did not indicate any preference expressed doubt about the fundamental usefulness of the GEO label (regardless of form and function) or did not understand the concept of 'drill-down functionality'.

When asked whether a GEO label should combine multiple functions (e.g., data ratings, reviews, quality assurance, etc.) and thereby represent an all-in-one quality indicator, the majority of respondents (66%) agreed, often on the basis that a single label of this nature would support initial decision-making and that it would circumvent the problem of having too many labels to deal with. One respondent considered this option for a GEO label as being an "*easily consultable*" option which would provide dataset users "*with a one-stop source of quality assurance and reliability*". Respondents who thought an all-in-one function was inappropriate argued that it would be impossible to provide all the information in one place, with many of them commenting that expert judgement, community advice, data ratings, quality assurance, etc., are different concepts and, as such, cannot be combined into one function and represented via a single label.

3.3 Phase I: Conclusions

Overall, the results of our study show that users and producers of geospatial datasets appear to have generally very positive attitudes towards the development and introduction of a GEO label. Interestingly, there was no distinct difference between user and producer views on the role that a GEO label should serve; we would like to think that this is because both groups equally recognise the challenges of assessing quality of geospatial data and that producers may be willing to place themselves under greater scrutiny to better support informed dataset selection amongst their clients, i.e., users. Our study illustrates that geospatial dataset users rely heavily on metadata records when assessing dataset fitness for use, and reiterates the problems associated with the current lack of uniform availability of quality-associated information despite ongoing standardisation efforts. For these reasons, many respondents agreed that a GEO label could potentially fulfil a certification or assurance seal function and be used to impose higher standards on provision of metadata records.

Respondents also demonstrated positive attitudes towards the concept of a GEO label that provides some sort of rating and review facilities, seeing this as appropriate support for more subjective metadata recording and assessment for datasets. **The majority of users and producers most strongly supported the notion of a GEO label providing an all-in-one drill-down interrogation facility that would combine expert value judgements, community advice, links to citation information, side-by-side visualisation of metadata records, etc.** This suggests that, in order to make an informed dataset selection decision, respondents require and would appreciate as much information as possible presented in one place in a format that allows for easy comparison.

The results of this study confirmed the importance of all 8 of the facets presented to study respondents, namely:

a) dataset producer information;
b) producer comments on the dataset quality;
c) dataset's compliance with standards;

d) user feedback;
e) user ratings of the dataset;
f) expert reviews;
g) dataset citations; and
h) side-by-side visualisation of metadata records.

On further reflection, however, since side-by-side metadata visualisation would require at least two datasets and doesn't represent an informational facet of a single dataset alone, we decided not to include this function in the GEO label visualisation itself. Instead, we felt that this level of metadata comparison functionality could and should be provided as a separate facility when the GEO label is developed and deployed in the GEOSS (or equivalent).

As part its work dedicated to the development of quantitative measures of dataset quality GeoViQua has defined an extended version of a standard ISO 19115 compliant metadata record to include quantitative quality information (<gvq:dataQualityInfo> metadata element). This, together with the fact that both our preparatory interviewees (see section 2.2.9) and respondents to our Phase I study indicated that both objective (quantitative) *and* subjective quality information was important in the assessment of dataset fitness-for-use, led us to include an additional facet – 'dataset quality information' – in our proposed GEO label, design.

Based on our findings, we developed three GEO label examples (see Figures 18, 19 and 20). These were prototypic graphic representations (i.e., static images) which could potentially be used to convey availability of spatial dataset quality information. These GEO label visualisations combine our 8 identified and confirmed informational aspects:

a) dataset producer information;
b) producer comments on the dataset quality;
c) dataset's compliance with standards;
d) user feedback;
e) user ratings of the dataset;
f) expert reviews;
g) dataset citations; and
h) quantitative dataset quality information.

Each informational facet was designed to show whether the information it represents is '*available*', '*not available*' or '*only available at a higher level*' for the dataset with which the GEO label is associated. The design of prototype example 1 (see Figure 18) was influenced by the GEOSS Societal Benefits logo (blue circles + white icons). The design of prototype example 2 (see Figure 19) was influenced by Amazon and eBay rating labels that are widely known and recognised in e-Commerce. Finally, the design of prototype example 3 (see Figure 20) was *based* on and adapted from an early proposal by the ST-09-02 in their Draft GEO Label Concept paper.

Figure 18: GEO label example 1.

Figure 19: GEO label example 2.

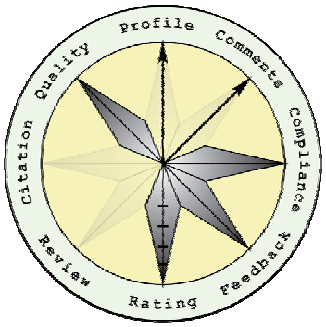


Figure 20: GEO label example 3.

To evaluate the comparative effectiveness of, and user preference for, the three prototype visualisations, we conducted a third user study, also administered as an online questionnaire. The study and its results are presented in the next section.

4. Phase II: Evaluating Proposed GEO Label Designs

In this section, we present the results of the second main phase of our GEO label research. This study was designed to solicit geospatial data producers' and users' views on our proposed GEO label visualisations. The main aim of this study was to evaluate the effectiveness of, or potential issues with, the proposed GEO label designs and to arrive (if possible) at a final, community-supported GEO label representation.

4.1 Soliciting Opinion on the Geo Label Prototype Designs

Our second online questionnaire-based study (see Appendix D) was again administered to geospatial data users and producers. The questionnaire comprised six sections, A to F, each of which is described below.

Section A consisted of a small number of questions to gather background information about the respondents and their requirements when selecting geospatial data to use. Here respondents were first asked to identify themselves as one of the following: primarily data users; primarily data producers; or equally data users and producers. The respondents were then asked: to pick one or more statements from a set which best describes their dataset user or producer type; to identify the type of organisation they work for; to indicate how long have they been working with geospatial data; and to approximate the percentage of their time they spend working directly with geospatial data. In this section, the respondents were also asked whether they have a choice of dataset to use, what clearinghouses they use, if any, and whether they find dataset selection a challenging task.

Section B was designed to explore respondents' levels of understanding of the proposed GEO label facets (informational elements) and the information the facets convey about the datasets they represent. This section first presented a short description of: how quality information can affect dataset selection decisions; what informational aspects may be considered when evaluating a dataset's quality; at a high level, the proposed GEO label and what it represents; and how the GEO label could be used to support dataset selection. After the introduction, the icons representing the eight GEO label information facets (see Figure 21) were presented to the respondents who were asked to describe what geospatial dataset informational aspect they believed each icon represented (see Figure 22 for an example; also see Appendix D, Section B).

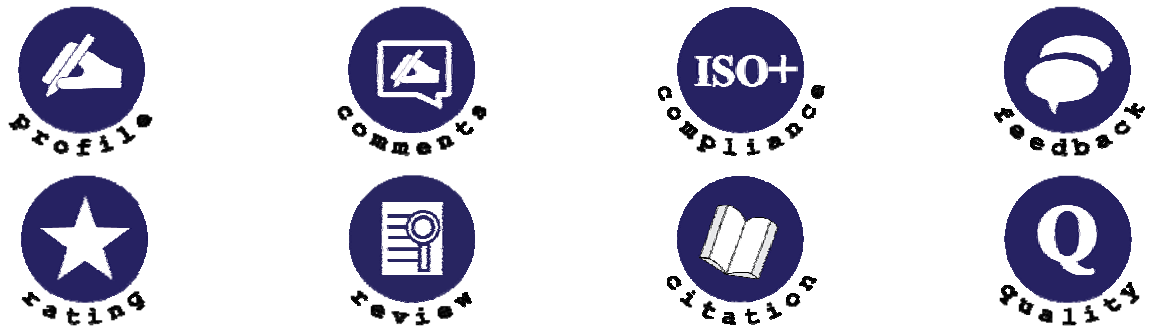


Figure 21: GEO label informational facets presented to study respondents.

The intention was to assess respondents' unguided initial interpretation of the meaning of each icon and thereby identify the effectiveness and intuitiveness of the graphical representations. After soliciting respondents' *initial* and unguided opinions as to what they believed the icons represented, the actual intended meaning of each icon was explained (see Figure 23 for an example; also see Appendix D, Section B). Armed with this information, the respondents were then asked to rate the

intuitiveness of each icon and to provide any comments or suggestions on each icon's representation and indicate possible improvements.

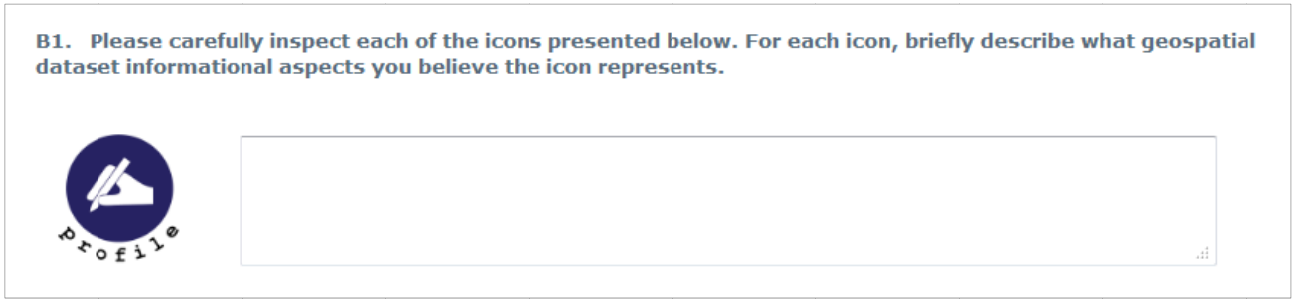


Figure 22: Question B1 (see Appendix D) asking respondents to identify the meaning of the icon.

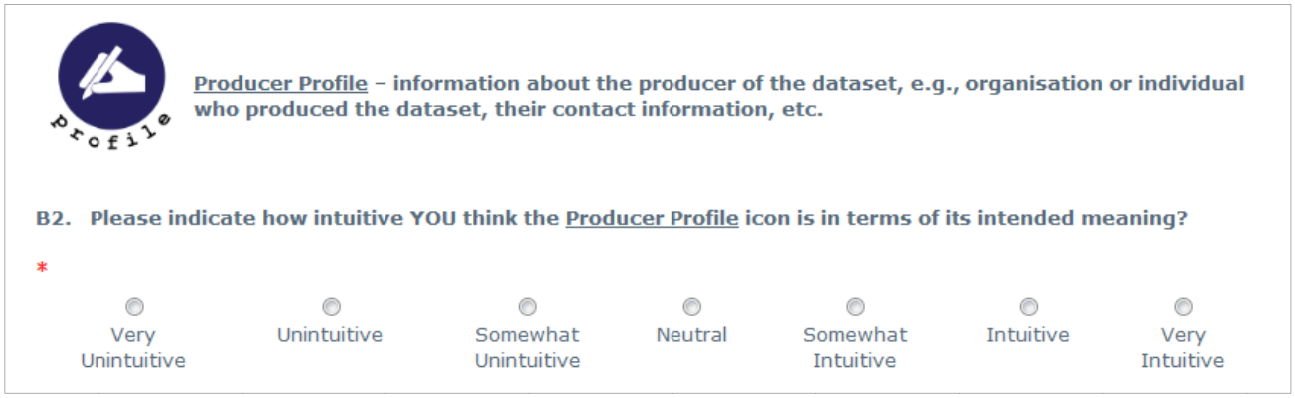


Figure 23: Question B2 (see Appendix D) providing the intended meaning of the icon and asking respondents to grade its intuitiveness relative to that meaning.

Once we had assessed the intuitiveness of the meaning of the icons themselves, we then assessed the effectiveness of the variations for each icon in terms of conveying the *availability* of quality information for a given dataset. As before, the availability variations for each icon were first presented to the respondents without explaining their intended meaning and respondents were asked to interpret their meaning without guidance (see Figure 24 for an example; also see Appendix D, Section B). The intended availability meaning was then indicated (see Figure 25 for an example; also see Appendix D, Section B), and respondents were asked to consider how intuitive they thought each availability representation was. Respondents were also welcome to provide any comments and suggestions regarding the icons' variations and their perceived meaning.

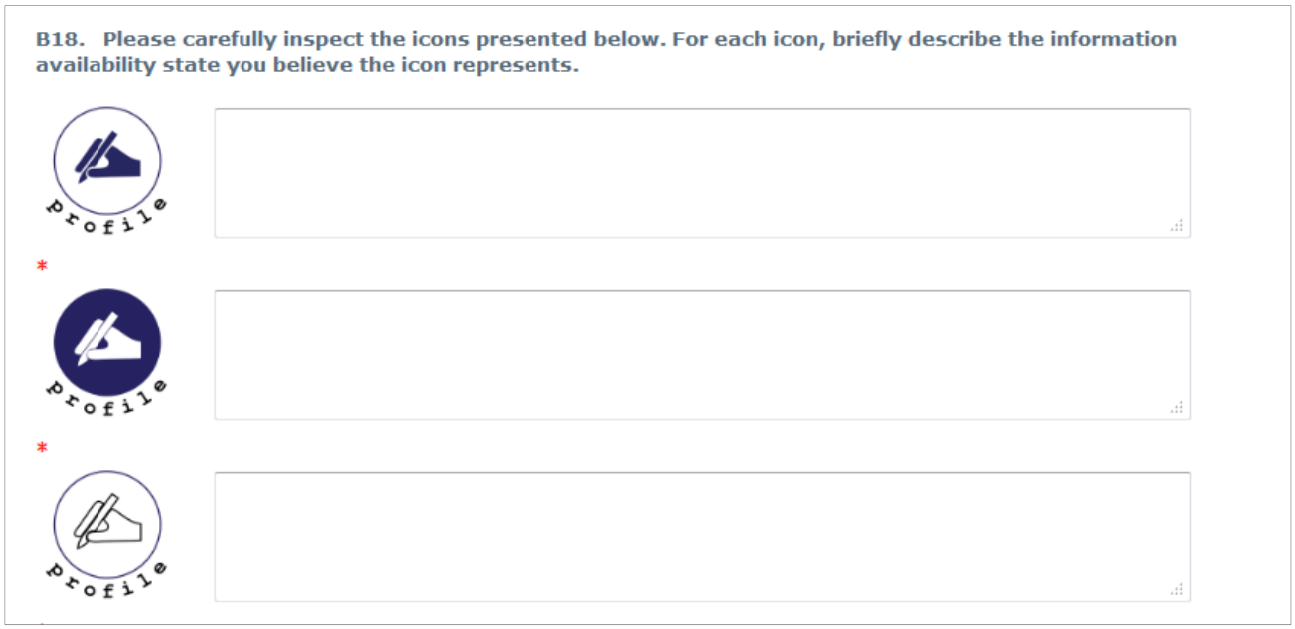


Figure 24: Question B18 (see Appendix D) asking respondents to identify the availability-related meaning of the icon variations.

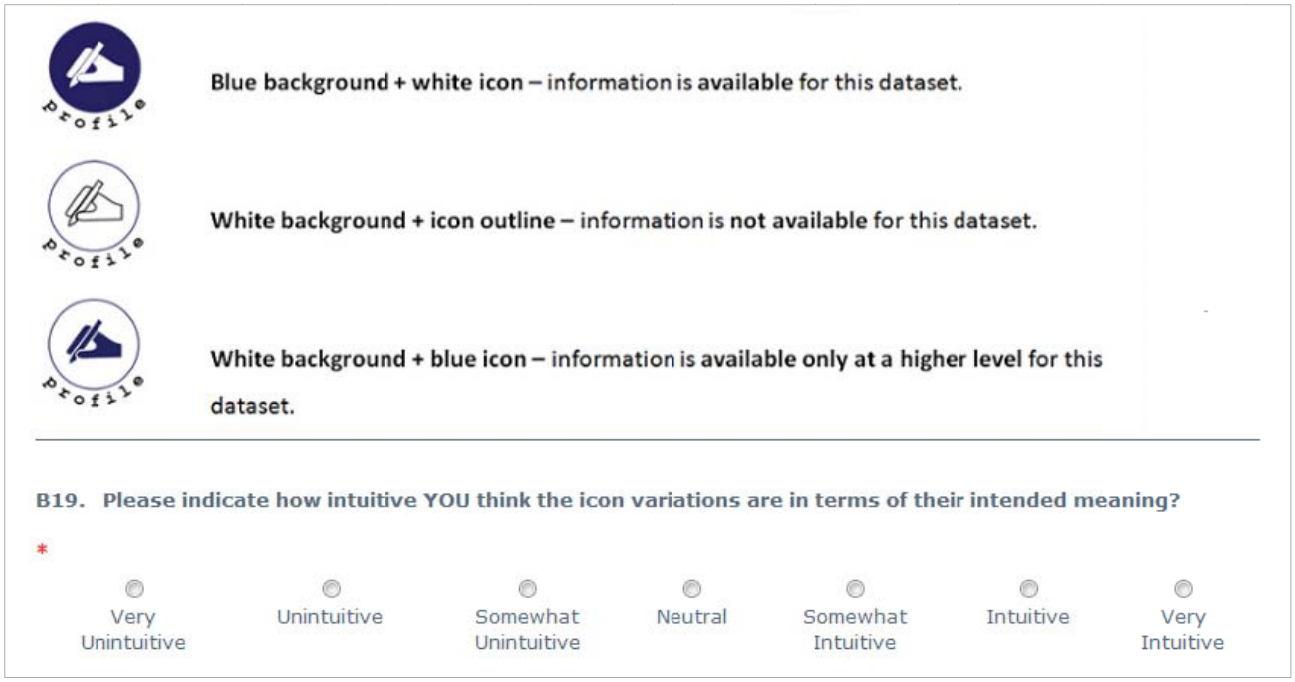


Figure 25: Question B19 (see Appendix D) providing the intended meaning of the icon variations and asking respondents to grade their intuitiveness relative to that meaning.

Section C was focused on gauging respondents' opinions of the effectiveness of the proposed GEO label prototypes – that is, the complete labels rather than the component parts (as studied up until this point) – at conveying availability of dataset quality information. This section presented three GEO label designs, two of which (examples 1 and 2 in Figures 18 and 19) used collective visualizations of the individual icons examined in section B, and one (example 3 in Figure 20) used an alternative visualization without iconic representation of the facets (drawing on ideas the ST-09-02 proposal). The prototype designs were presented to respondents separately. Each GEO label example was first presented together with a series of both true and false statements about quality information availability for a fictitious dataset that the label was supposed to represent; respondents

were asked to indicate those availability statements that *they* believed were correct (see Figures 26, 27 and 28; also see Appendix D, Section C). This exercise was designed to assess the ease of interpretation or intuitiveness of the proposed visualizations as well as ensure that participants were familiar with each GEO label representation before proceeding to more demanding dataset ranking scenarios (as described later).

Figure 26: GEO label example 1 presented with a mixed set of true and false availability statements from which the respondents were required to identify the true statements.

Please carefully inspect the label and proceed to the questions below.

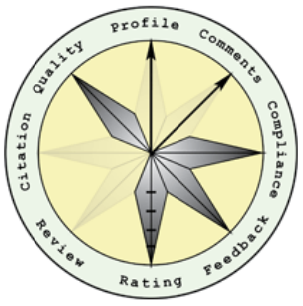
C11. Based on the GEO label provided, please select the statements about the dataset that you believe are TRUE.
(Tick all that apply)

*

- [ ] Producer comments are not available
- [ ] User feedback is available
- [ ] User rating is available
- [ ] Citation information is only available at a higher level
- [ ] Producer comments are only available at a higher level
- [ ] Expert review is not available
- [ ] Quality information is not available
- [ ] The dataset complies with ISO standard
- [ ] Producer profile information is only available at a higher level
- [ ] The dataset has a rating of 3

Figure 27: GEO label example 2 with a mixed set of true and false availability statements from which the respondents were required to identify the true statements.

Please again carefully inspect the label and proceed to the questions below.



C20. Based on the GEO label provided, please select the statements about the dataset that you believe are TRUE.
(Tick all that apply)

*

- [ ] Citation information is available
- [ ] Information about the dataset's compliance with international standards is not available
- [ ] Expert review is not available
- [ ] Producer comments are only available at a higher level
- [ ] User feedback is available
- [ ] Citation information is only available at a higher level
- [ ] Quality information is only available at a higher level
- [ ] User rating is not available
- [ ] Producer profile information is only available at a higher level
- [ ] Expert review is available

Figure 28: GEO label example 3 with a mixed set of true and false availability statements from which the respondents were required to identify the true statements.

Following this, each GEO label example was examined within the context of a dataset selection scenario: respondents were presented with a scenario identifying key dataset qualities that were flagged as important for a given selection decision. They were then provided with 5 different mock-ups (based on the given GEO label design) that conveyed availability of different quality information for 5 fictitious datasets, and were asked to examine the mock-up GEO labels and rank them (as representatives of their underlying datasets) in order of fitness-for-use based on a match between the specified scenario and the information the labels conveyed (see Figure 29 for an example; also see Appendix D, Section C). After each ranking scenario, respondents were asked to indicate how effective the GEO label designs were at supporting, and how easy it was to use them for, dataset selection (see Figure 30). At the end of the section, respondents were asked to rank the three different GEO label prototypes in order of preference and to provide some justification regarding their indicated preferences (see Figure 31).

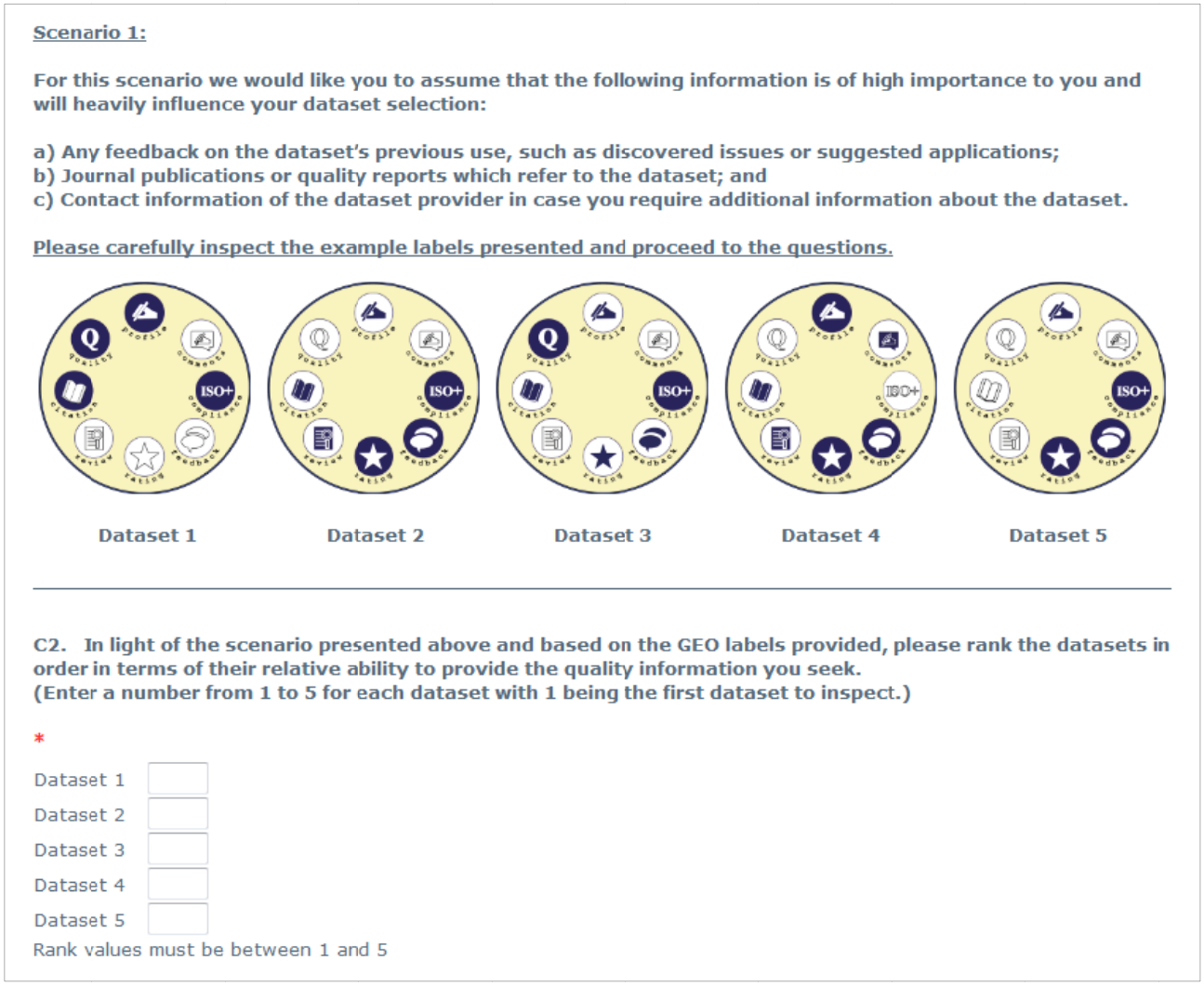


Figure 29: GEO label example 1 presented within the context of a dataset selection scenario where respondents were asked to rank the datasets according to best fit for purpose on the basis of the representative GEO labels.

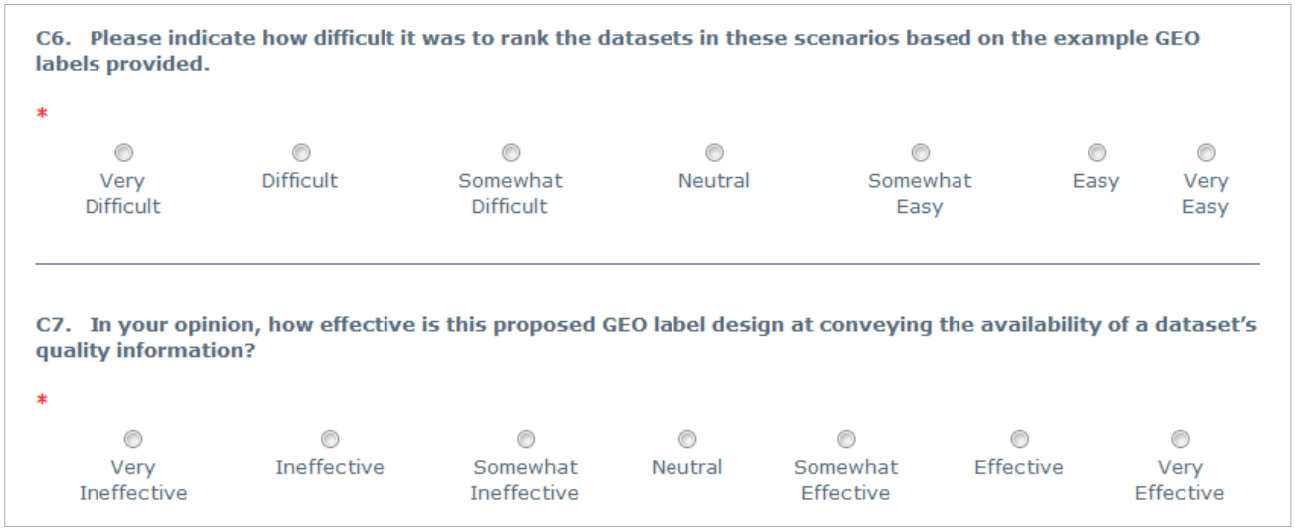


Figure 30: Questions C6 and C7 (see Appendix D) in which respondents were asked to reflect on the use of ranking datasets according to the GEO labels for each and to indicate the label effectiveness, respectively.

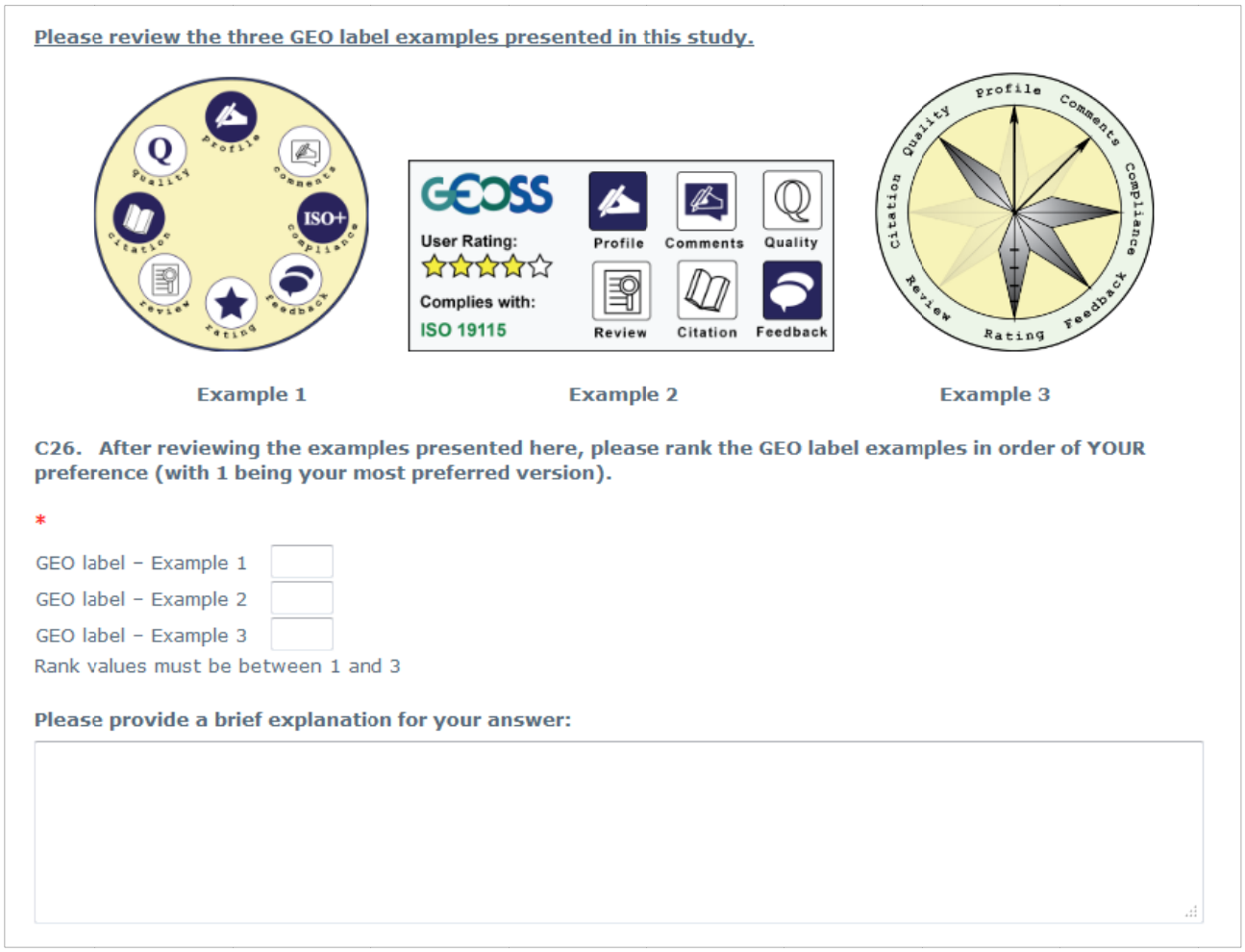


Figure 31: Question C26 (see Appendix D) in which respondents were asked the rank the three prototype GEO labels in order of preference.

Section D consisted of a small number of questions to gather respondents' opinions on the informational aspects presented in the GEO label examples. Here respondents were asked to identify the informational aspects that they consider important and relevant to the GEO label, to indicate the aspects that they considered to be redundant and should not be included in the GEO

label, and to describe any additional aspects that they felt may be relevant to the GEO label function. This was done to (a) further validate findings from the previous phases of our research, and (b) to identify whether, when used in reality within the context of a proposed GEO label, respondents felt differently to the proposed informational elements than had been suggested would be the case in our previous investigation.

Section E consisted of a small number of questions designed to gather respondents' opinions on the use of 'GEO' branding in the GEO label. In this section, respondents were presented with two GEO label examples (see Figure 32), one with 'GEO' branding and one without any branding. Using a 5-point Likert scale, ranging from 'strongly disagree' (1) to 'strongly agree (5), respondents were asked to reflect on their level of agreement with a series of statements about the perceived trustworthiness of the two examples (see Figure 33 for examples of the statements). We used both positive and negative statements to try and ensure that respondents provided properly-considered ratings. Respondents were ultimately asked to indicate whether they would prefer a GEO label with 'GEO' branding or a label without such branding; they were asked to justify their choice.

Figure 32: Examples of a GEO label with and without branding (see Appendix D).

Figure 33: Questions E1 and E2 (see Appendix D) asking respondents to reflect on the impact of GEO branding in terms of their interpretation of the label.

Finally, in section F, the respondents were asked to provide any further comments and suggestions on the GEO label and the proposed GEO label designs.

As with our previous GEO label study, we constructed and administered the questionnaire using the QuestionPro (QuestionPro, 2013) online-survey software. To inform potential respondents about the questionnaire, we emailed a number of professionals, academics and researchers who work in the GIS field, asking them to complete the study. The questionnaire was accessed and completed from a number of countries including Spain, Germany, United States, Netherlands, France, Italy, United Kingdom and China.

4.2 Study Results and Discussion

The very detailed commentaries provided by our respondents supported very rich qualitative data analysis which is of significant benefit to our ongoing design efforts, especially in terms of gauging potential community acceptance of a future GEO label.

4.2.1 Background Information

We received a total of 26 valid questionnaire responses: 10 from 'primarily dataset users', 3 from 'primarily dataset producers', and 13 from 'equally data users and data producers'. In terms of the best description(s) of their dataset user and/or producer type, 1 respondent self-identified as a Group on Earth Observations committee member, 3 as private sector data users or data producers, 4 as governmental data users or data producers, 13 as research data users or data producers, 12 as academic data users or data producers, and 1 as other: "*private company service provider*". Over half of the respondents (14) indicated that they work in an academic institution. All of the study participants had at least two years of experience working with geospatial data or maps, with 10 respondents working with geospatial data for between 2 to 9 years. The results indicated that, in the context of respondents' current positions, most respondents (10) only work directly with geospatial data 5%–20% of the time. When asked about choice of datasets to use in their typical work, 22 study participants (85%) stated that they do have a choice of data; of those, 12 participants indicated that they use data portals or clearinghouses for selecting datasets to use. Participants listed a number of data sources that they use including the GEOSS portal, NASA, ESA, NERC, National Snow and Ice Data Centre (NSIDC), INSPIRE, and even Google. Of the 22 respondents who have a choice of dataset, 17 indicated that they find selecting datasets to fit their needs a challenging task (detailed respondents' profiles are provided in Appendix E).

4.2.2 Recognising the Intended Meaning of the GEO Label Facets

4.2.2.1 *Producer Profile*

Figure 34: Producer profile facet.

When asked to describe their interpretation of the meaning of the '*producer profile'* facet (see Figure 34), only one respondent was able to guestimate what the proposed icon represented, describing it as an indicator of "*who created the data or is commenting on it*". The majority of respondents did not appear to understand what informational aspect the icon represents, with some stating that the word '*profile*' suggests information about a dataset's "*general contents*", "*some overall metadata about a dataset*", or a dataset's "*basic metadata*" (e.g., title of the dataset, abstract, description, time period, resolution, etc.).

When the intended meaning of the facet was explained, many respondents suggested adding the word '*producer*' to the description label: they suggested this would better focus the profile to the producer rather than the dataset itself, and thereby eliminate the aforementioned confusion. The visual presentation of the label was identified as a potential problem because "*when these icons are made smaller, having the text in a curve will hamper clarity*".

Regarding the icon itself, there was no general agreement as to whether or not it is suitable to represent '*producer profile*', with three respondents stating that the 'writing hand' was perhaps more indicative of comments or commenting rather than a profile of a producer because "*it seems you are writing*" and so hints at "*editing more than producing*". In contrast, other respondents argued that it was acceptable because it could be intuitively linked to authorship. The difficulty in generating a perfect icon for producer profile information is perhaps best summed up by an academic data user who suggested that "*there is probably no widely-accepted icon for 'producer' that could be used here and the icon here is probably as good as any*".

4.2.2.2 *Producer Comments*

Figure 35: Producer comments facet.

As with the '*producer profile*' facet (see Figure 35), the majority of respondents were unable to identify the intended meaning of the '*producer comments*' facet. Sixteen respondents stated that they considered it to convey some kind of "*human-readable*" "*free text comments*", although they were "*not sure if this represents users specifically, or whether this also encompasses comments from the data producers*". Only three study respondents were able to correctly identify the intended meaning stating that the facet represents:

a) "*additional comments by data creators describing pitfalls and problems the data set has or things the user of this dataset should consider when using the data*";
b) "*qualitative comments from the producers, issues with the data set, assumptions behind generation or use of the data set*"; and
c) "*comments* [from the] *data provider possibly about potential use*".

After learning the intended meaning of the facet, many study participants again suggested adding 'producer' to the logo. They also raised the issue that it is "*somehow unclear what the difference is between 'comments' and 'feedback'*", with the result that producer comments could be misinterpreted as user feedback and vice versa.

Respondents did not provide many comments on the effectiveness of the actual facet icon itself, but they did recognise the connection between the previous '*producer profile*' and '*producer comments*' icons, arguing that informational facets associated with the producer were very clear and visibly connected once the key producer icon was known.

4.2.2.3 *Compliance with Standards*

Figure 36: Compliance with standards facet.

When asked to describe their interpretation of the intended meaning of the '*compliance with standards*' facet (see Figure 36), 25 respondents were able to identify that this facet represents compliance with some international standards; of these, 17 assumed compliance with various ISO standards. Only one respondent suggested that the facet indicates that data "*has some certification*". Although most respondents linked the representation to ISO standard compliance, they argued that there was no helpful information about *which* standard and associated date. The '+' symbol was not perceived as intuitive and respondents were uncertain whether it indicated that the dataset complied with other, non-ISO standards as well. Interestingly, one respondent reacted rather negatively to this facet saying that it indicated that "*the data is standards compliant which means the structure will be complex*", meaning that he would "*have to find software to read it - which might not exist!*".

When the intended meaning was explained, respondents argued that the explicit 'ISO' component of the symbol seems to place heavy or even sole focus on ISO compliance at the expense of other standards. Respondents again suggested that "*some reference to which version of ISO would be desirable*", as would a link to the corresponding ISO standard's webpage. Consequently, it was proposed to replace the symbol 'ISO+' with word 'Standard' or to "*introduce more symbols in the icon*" to indicate that "*standards are multiple and not only ISO*".

Some respondents more deeply questioned the inference of the facet: they questioned what 'compliance' actually means, who would "*police such claims*", and "*to what must* [a dataset] *be compliant to get this*". It was argued that 'compliance with standards' may have limited meaning to some users who are neither aware of nor interested in ISO or other standards. Correctly interpreting the icon's meaning, one academic data user and producer argued it is impossible to achieve full compliance with ISO *and* other standards; another academic data user suggested that "*in reality, data and metadata can partially conform to many standards, so assessing the level of compliance can be difficult*". This respondent further suggested that "*the 5-star 'open data' rating proposed by Tim Berners-Lee could be adapted"* in which case our *'compliance with standards'* facet could *"become 'available in an open data format' or 'uses non-proprietary standards'*".

More positively, some respondents argued that our '*compliance with standards'* facet "*is rather intuitive*" and is, in fact, "*the most intuitive of all the icons*" because ISO is well known, even if other standards are used. One respondent agreed that 'ISO+' is, itself, slightly misleading but conceded that it was clearly connected to standards and could not suggest a way to make the intention clearer.

4.2.2.4 *User Feedback*

Figure 37: User feedback facet.

When asked to describe their interpretation of the intended meaning of the '*user feedback*' facet (see Figure 37), the majority of respondents (18) correctly recognised that the facet represents availability of user feedback. Interestingly, however, a small number of participants assumed that this facet indicates "*an option to provide feedback*" rather than just to read existing feedback.

When the intended meaning was explained, respondents argued that the "*difference between 'feedback' and 'comments'* [as in '*producer feedback*'] *is not so clear*" and these two facets can be confused. Respondents proposed adding the word '*user*' to the label to avoid ambiguity. Regarding the actual icon itself, respondents recognised it as "*very intuitive*" based on its common use, especially in social networking environments.

4.2.2.5 *User Ratings*

Figure 38: User ratings facet.

When asked to describe their interpretation of the intended meaning of the '*user rating*' facet (see Figure 38), 18 respondents correctly described the facet as representing some sort of user rating, but some were unsure as to the source of the rating (e.g., user, supplier, peer-review, or that of an independent body). As with findings regarding the '*user feedback*' facet, several study respondents mistakenly assumed our '*user rating*' facet linked to a facility for actively rating geospatial datasets as opposed to indicating the provision of user ratings.

After learning the intended meaning of the facet, respondents agreed that this is "*one of the most intuitive icons*" and that the representation is "*recognizable from hotel ratings, etc.*". Despite the facet's overall intuitiveness, some responses suggested that the filled-in star might be mistaken for the actual rating (i.e., 1 out of 5 stars) as opposed to an indication that ratings are available. In line with '*user feedback'*, respondents suggested that we add the word 'user' to the description label to avoid ambiguity and highlight that the ratings are provided by data users. To further improve the facet, respondents also proposed that we visually indicate (via some kind of visual similarity) a connection between our '*user feedback*' and '*user rating*' facets. It was further suggested that we should use colour coding to better distinguish between facets related to users and producers.

Regarding the facet in general, some respondents demonstrated strong concerns regarding the criteria that users would use to rate the datasets because of the subjective nature of the perceived quality of a dataset based on the area of application. They suggested that user ratings should only be permitted if supported by feedback or a review, and that it would be important to distinguish between ratings provided by authoritative experts and novice users; this could possibly be resolved by enforcing user registration before allowing any feedback.

4.2.2.6 *Expert Review*

Figure 39: Expert review facet.

When presented with the '*expert review*' facet (see Figure 39), six study respondents were able to correctly identify the facet's intended meaning, describing it as: (a) "*expert opinion*"; (b) "*scientific review*"; (c) "*a formal review of a dataset, perhaps published in the literature*"; (d) "*expert review of the data, more expert-based than the above rating and feedback*"; (e) "*peer review… mainly specialized scientists*"; and (f) "*technical reviews of the data*".

The remaining 20 respondents were unable to correctly identify the intended meaning of the icon, arguing that the facet is not intuitive. Six respondents identified the facet as representing user reviews (such as feedback and comments) – which led to their confusion with the comment- and feedback-related facets already discussed. According to respondents, the description label was misleading because it could variably be interpreted as referring to a singular review or as an invitation to submit a review (as opposed to the facility to read existing reviews). Interestingly, one of the respondents assumed that the facet conveys the "*results of comparison of the dataset to other geospatial datasets offering the same kind of data*". The remaining respondents were unable to interpret the intended facet's meaning, and therefore did not provide any specific descriptions.

After learning the intended meaning, six respondents suggested that the word 'expert' should appear in the facet's label; without it, it is "*not clear who supplied the review*" or "*it seems like an invitation*" to supply one. A private company service provider warned that some users/producers may not be familiar with the notion of expert review which he considered to be an academic concept; somewhat corroborating this academic/commercial distinction, an academic data user and producer argued that "*the magnifying glass is very intuitive*" and effectively conveys the intended meaning.

To improve this facet's recognition, a data producer proposed that we visually link our user- and expert-review icons, stating that "*it'd be nice if this was somehow linked to the user reviews icon - e.g., a star with some indication of 'expertise' added. Seeing the two together would definitely help make it clear how they differed*". Although a valid suggestion, we felt that introducing visual similarity between user and expert icons could lead to further confusion as to why there would be *three* feedback-related facets within a GEO label.

4.2.2.7 *Citation Information*

Figure 40: Citation information facet.

When presented with the '*citation information*' facet (see Figure 40), 9 respondents were able to correctly identify the facet's intended meaning, describing the facet as, for example:

a) a "*list of papers that used the dataset*";
b) "*links to papers that have cited the data*"; and
c) a "*list of publications (both peer-reviewed and grey literature) which describe the data set or the instruments and data processing steps used to create the dataset*".

Six respondents were unsure whether the facet was supposed to convey availability of references to "*paper*[s] *published in the literature that cite a dataset*" or whether it "*indicates the presence of a 'canonical citation' about a dataset*". Five respondents assumed that the facet provides information

on "*how the data set can be referenced*". The remaining 6 respondents were unable to identify the intended meaning.

When presented with the intended meaning, respondents generally agreed that the label should read "citations" because it is otherwise unclear whether it is indicating how the dataset itself should be cited or where you can find those articles where it has been cited. Regarding the facet's icon, study respondents did not provide any comments or suggestions, this suggesting that the proposed icon is effective and appropriate and would only benefit from a slight labelling tweak.

4.2.2.8 *Quality Information*

Figure 41: Quality information facet.

When asked to identify the intended meaning of the '*quality information*' facet (see Figure 41), only one respondent was able to correctly identify that it related to numerical measures of uncertainty. Three respondents assumed that it represents the 'big five' spatial data quality indicators, namely "*positional accuracy, attribute accuracy, completeness, logical consistency, scale*". The remaining respondents were unsure as to its intended meaning, but some guessed that it represents "*some quality indicator*" or "*some sort of overall quality flag*", with one academic data user commenting that it "*probably represents the presence of some information about data quality, but is rather vague about the specifics*".

After learning the intended meaning (that being, it represents the presence of quantitative quality information (such as uncertainty measures recorded in UncertML, errors, accuracy information, etc.), a data producer remarked that perhaps a more iconic represent would be better, with one respondent suggesting some kind of graph-based representation (e.g., normal distribution or error bars). An academic data user and producer observed that the 'Q' is only meaningful in languages where the word for 'quality' begins with a 'Q'.

Regarding the facet's description label, an academic data user and producer proposed that the label should be extended to include the word "information" for clarity, whilst other respondents recommended changing the description to "*quality control*", "*quality assurance*" or "*quantitative (uncertainty)*". While some study respondents admitted that the facet "*is intuitive*", they highlighted that it does not clearly convey "*what kind of quality is offered*".

4.2.3 Intuitiveness of the Proposed GEO Label Facets

Overall, our respondents found *most* of the proposed GEO label icons workably intuitive (see Figure 42) and were able to identify their intended meaning without the benefit of additional explanation. As can be seen from Figure 42, respondents considered the producer profile, producer comments and expert review icons to be the least intuitive.

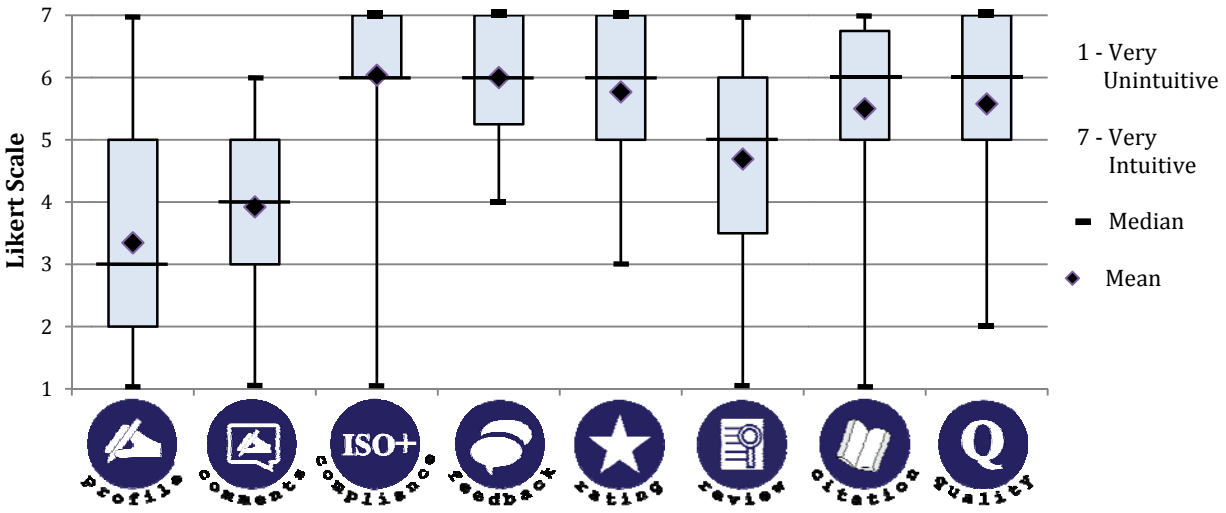


Figure 42: Respondent-attributed intuitiveness of the GEO label icons.

Intuitiveness \ Icon	profile	comments	ISO+ compliance	feedback	rating	review	citation	quality
1 / Very Unintuitive	2 7.7%	3 11.5%	1 3.9%	0 0.0%	0 0.0%	1 3.9%	1 3.9%	0 0.0%
2 / Unintuitive	**8** **30.8%**	3 11.5%	0 0.0%	0 0.0%	0 0.0%	2 7.7%	1 3.9%	1 3.9%
3 / Somewhat Unintuitive	6 23.0%	5 19.2%	0 0.0%	0 0.0%	1 3.9%	4 15.4%	2 7.7%	2 7.7%
4 / Neutral	2 7.7%	3 11.5%	1 3.9%	1 3.9%	3 11.5%	0 0.0%	1 3.9%	2 7.7%
5 / Somewhat Intuitive	6 23.0%	**6** **23.1%**	3 11.5%	6 23.1%	6 23.1%	11 42.3%	3 11.5%	5 19.2%
6 / Intuitive	1 3.9%	**6** **23.1%**	10 38.5%	**11** **42.3%**	7 26.9%	**6** **23.1%**	**11** **42.3%**	**8** **30.8%**
7 / Very Intuitive	1 3.9%	0 0.0%	**11** **42.3%**	8 30.8%	**9** **34.6%**	2 7.7%	7 26.9%	**8** **30.8%**
Mean	3.35	3.92	6.04	6.00	5.77	4.69	5.50	5.58
Standard Deviation	1.60	1.72	1.31	0.85	1.18	1.57	1.63	1.42

Table 6: Respondents ratings of intuitiveness of the GEO label icons (dominant score highlighted in bold).

Table 6 presents the results of respondents' ratings of icons' intuitiveness. As can be seen, the '*producer profile*' icon was the least intuitive of the eight proposed iconic representations; as

described in section 2.2.2.1, this was primarily due to ambiguous facet labelling. Consequently, we feel confident that modifying the facet description label would improve this facet's recognition. The ratings of intuitiveness for the '*producer comments*' icon confirmed that, as with the '*producer profile*', the representation was not sufficiently effective. Respondents did, however, highlight that knowing what the '*producer profile*' icon means would help them to identify the meaning of the '*producer comments*' icon – that is, their relationship should help with mutual interpretation. The '*compliance with standards*' icon was rated as the most intuitive of the eight proposed visualisations, perhaps because the ISO reference is widely known in the GIS community. The '*user feedback*' icon was the second most intuitive icon, with no respondents rating it as unintuitive to any degree. The '*user ratings*' was slightly less intuitive than the '*user feedback*'; this is perhaps because some respondents were uncertain whether this facet represents availability of user ratings, conveys an actual user rating, or invites them to rate a dataset. The results reflect respondents' disagreement on the intuitiveness of the '*expert review*' icon, which would appear to stem from the '*review*', '*comments*', and '*feedback*' labels having very similar perceived meanings. Finally, the intuitiveness ratings for '*citation information*' and '*quality information*' were very similar, with both icons being rated as intuitive.

4.2.4 Conveying Information Availability through Icon Variations

Overall, respondents' comments on icon variations to convey information availability (see Figure 43) indicated that the variations were not as effective as we had hoped. Respondents indicated that the intended meaning could only be estimated "*by process of elimination*" because the variations were not distinct enough.

Information is available **Information is NOT available** **Information is available at a higher level**

Figure 43: Icon variations to convey information availability.

4.2.4.1 *'Information is Available' Icon Variation*

When asked to describe their interpretation of the intended meaning of the '*available*' icon variation, 10 study respondents were able to correctly identify the intended meaning; 9 were unable to arrive at a conclusion regarding the meaning, arguing that the icon is '*not clear*'; the remaining 7 participants incorrectly interpreted the meaning, of which 4 participants assumed that the variation conveys the *degree* of information availability – i.e., "*full information present*".

4.2.4.2 *'Information is Not Available' Icon Variation*

When asked to describe their interpretation of the intended meaning of the '*information is not available*' icon variation, 18 respondents were able to correctly describe its intended meaning regarding information availability. Five respondents were unable to interpret the intended meaning, arguing that the icon's meaning was not at all clear, especially if viewed in isolation. A research data producer proposed that we place an "X" over each underlying icon to make the variation more intuitive. The remaining three participants incorrectly described the availability state as either '*available*' or '*available at a higher level*'.

4.2.4.3 *'Information is Only Available at a Higher Level' Icon Variation*

When asked to describe their interpretation of the intended meaning of the '*available only at a higher level*' icon variation, only 6 study participants were able to correctly identify its intended meaning. Of these, however, one respondent argued that he was only able to guess the intended meaning "*by process of elimination!*". The majority of respondents (11) were unable to state the intended availability state, arguing that they could not differentiate between this icon and the 'not available' icon without the availability of a legend. The remaining 9 respondents incorrectly described the intended availability, with 5 stating that it represents the '*available*' state and 4 identifying the state as indicating '*partial*' or '*low*' availability.

4.2.4.4 *Icon Variations Comments and Suggestions*

After learning the intended meaning of the three icon variations, respondents stated that the proposed variations are not sufficiently distinct to be effective at conveying degrees of information availability. They conceded that the '*available*' and '*not available*' variations "*were reasonably clear*" when presented together, but felt that the '*available at a higher level*' representation was very unclear and unintuitive. Even with the benefit of explanation, respondents found the semantics of the distinction between the '*available*' and '*available at a higher level*' icon variations hard to retain over time. Where respondents were able to guess the relative meanings, they commented that the icon meanings were not obvious, with some going so far as to reject the variations as "*just style choices*" which "*don't indicate any information on the existence or not of data*".

In terms of the colour alterations we had used in creating the icon variations, a number of respondents agreed that such colour saturation had helped them to identify information availability. They stated that "*the more coloured*" the icons, "*the more available*" the information was interpreted to be, confirming our choice of unfilled for no information and filled for available information and lauding the former colour scheme for '*not available*' as the most intuitive of all three variations.

In contrast, other respondents argued that the blue colour and its alterations were not effective, indicating that they could not see the link between icon fill and availability of information and that the *'available'* and *'available at higher level'* variations should not look as opposite/different as they do. Consequently, respondents proposed a number of alternative representations to improve effectiveness, suggesting that we, for example:

a) use "*red/green/yellow*" or "*red, amber, green*" colour schemes;
b) "*use pale color*" or "*softer blue background*" to indicate availability at higher level;
c) leave the "*'not available' as it is*" and make "*'available' as* [the] *opposite of that, i.e. all dark, light lines* [and] *'available at higher level' like 'available' but lines dotted or colors shaded*"; and
d) "*use a red line through* [the icon] *to mean not available, or ghost it out, and various shading to indicate how full it is*".

In general, the use of a cross or line through the icon to indicate '*not available*' proved popular, with respondents indicating it would better convey the meaning because at present all the icons could be interpreted as indicating information was available.

User Viewpoint:

"*'Available' is pretty intuitive because of the use of lots of 'ink', indicating positivity. 'Not available' is only intuitive if you have 'available' to compare it with. A line through the icon would reinforce its negative nature. . 'Available at a higher level' is always going to be a tricky concept to convey, since it is specific to this case. I think the icon here is probably the best that can be done, particularly if 'not available' is clarified.*"

4.2.4.5 *Respondents' Ratings of Intuitiveness of Icon Variations*

Overall, as a set the icon variations proposed for conveying information availability were not particularly effective (M = 3.38, SD = 1.83, where 7 is '*very intuitive*'), and results indicated a substantial level of disagreement between respondents in terms of perceived intuitiveness (see Table 7). For some, the intended meaning could only be estimated by process of elimination, and the variations were generally not considered distinct enough to effectively convey, as intended, information availability states.

Intuitiveness	Number of Respondents	Percentage of Respondents
1/ Very Unintuitive	5	19.2%
2/ Unintuitive	6	23.1%
3/ Somewhat Unintuitive	3	11.5%
4/ Neutral	1	3.9%
5/ Somewhat Intuitive	**9**	**34.6%**
6/ Intuitive	1	3.9%
7/ Very Intuitive	1	3.9%

Table 7: Respondents' ratings of intuitiveness of the proposed set of icon variations for information availability.

Of the three different icon variations designed to convey the three information availability states (see Figure 43), the '*not available*' variation was perceived to be the most intuitive; the '*available*' icon variation proved to be a bit less interpretable; and the '*available at a higher level*' variation was not perceived to be intuitive at all. The results also indicate that there is potential for the icon variations (as they currently stand) to, in fact, be misinterpreted as representing the degree of information completeness – i.e., '*fully available*', '*partially available*', and '*not available*'.

4.2.5 Conveying Information Availability through Star Arm Variations

Section 4.2.4 has discussed respondents' reactions to the availability representation based on the iconic GEO label prototypes (examples 1 and 2, see Figure 31). We also investigated the effectiveness of the star-arm variations as used in example 3 (see Figure 31) to convey the three information availability states (see Figure 44). When presented with these variations, the majority of respondents were able to correctly recognise the intended meaning of each, with overall results indicating that all three star arm visualisations were intuitive.

Information is available

Information is NOT available

Information is available at a higher level

Figure 44: Star arm variations to convey information availability.

4.2.5.1 *'Information is Available' Star Arm Variation*

When presented with the '*available*' star arm variation, 22 respondents were able to correctly interpret the variation's intended meaning. Three respondents were unable to describe the intended state, arguing that the visualisation is "*not intuitive*". The remaining respondent identified the variation as indication that "*there is information available only at a higher level*".

4.2.5.2 *'Information is Not Available' Star Arm Variation*

The '*not available*' icon variation proved to be equally intuitive, with 22 respondents being able to correctly interpret its intended meaning.

4.2.5.3 *'Information is Only Available at a Higher Level' Star Arm Variation*

When presented with the '*available*' star arm variation, 21 respondents were able to correctly interpret the variation's intended meaning. One respondent was partially correct in his interpretation that "*there is information available*", but four respondents were unable to describe the intended availability state.

4.2.5.4 *Star Arm Variations Comments and Suggestions*

Given that the vast majority of respondents were able to correctly interpret the intended availability states of all three star arm variations, we were initially surprised to find that the majority of follow-up comments discussing the intuitiveness of the star arm availability variations were negative in tone. Respondents argued that the arrow that indicates '*available at a higher level*' can be confusing and "*is not intuitive, since it could be pointing up, down or sideways in the final icon*". Respondents also suggested that the text provided with the star arms is too small and too curved to be practicably readable, further commenting that this impedes identification of which information element is available. Respondents suggested using only colour variations[5] to convey availability, and remove the arrow from the design altogether. For instance, it was proposed that we use a paler colour for information at a higher level rather than introduce another arrow. Only two respondents, both governmental data users and producers, provided positive comments about the proposed star arm visualisations. They stated that these variations are "*much easier*" and "*much more intuitive than the filled symbols*" studied previously.

4.2.5.5 *Respondents' Ratings of Intuitiveness of Star Arm Variations*

Table 8 shows respondents' ratings of the intuitiveness of the proposed star arm variations. As our findings indicate, all three star arm variations were intuitive (M = 5.12, SD = 1.75, where 7 is '*very*

[5] It should be noted that colour-only based distinction in icon design is considered poor design practice and excludes informational access for those with colour vision deficiencies.

intuitive'). This visualisation garnered greater levels of agreement across the respondents, with 57.7% of respondents rating the visualisation mechanism as '*intuitive*'.

Intuitiveness	Number of Respondents	Percentage of Respondents
1/ Very Unintuitive	2	7.7%
2/ Unintuitive	2	7.7%
3/ Somewhat Unintuitive	1	3.9%
4/ Neutral	0	0.0%
5/ Somewhat Intuitive	4	15.4%
6/ Intuitive	**15**	**57.7%**
7/ Very Intuitive	2	7.7%

Table 8: Respondents' ratings of the intuitiveness of the proposed star arm variations.

With hindsight, we suggest that the better levels of interpretation (and associated intuitiveness ratings) returned for the star arm variations are likely a consequence of learning effect brought about by respondents having previously considered the associated semantics in relation to the icon-based graphics; as such, the more accurate interpretation in this instance was not likely to be a true reflection of their acceptance of the visualisations (as realised in the accompanying comments) or their stand-alone intuitiveness.

4.2.6 Using GEO Labels for Identifying Information Availability

As discussed in section 4.1, after exploring the intuitiveness of the icons and availability graphics used within each GEO label example, each complete label was then presented together with a series of both true and false statements about quality information availability for a fictitious dataset that the label was supposed to represent; respondents were asked to indicate those availability statements which they believed were *true* (see Figures 26, 27 and 28). Table 9 shows the percentage of possible true statements that were correctly selected (percentage calculated out of the total number of true statements multiplied by the number of respondents), as well as the number of erroneous selections made. As can be seen, the results show a very similar pattern for all three GEO label examples, indicating that all three examples – regardless of form – were equivalently functional in terms of conveying information availability. Whilst 80%+ is not a poor accuracy rate, we would obviously like to see an improvement in this for the final GEO label proposal.

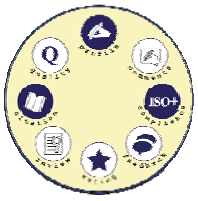
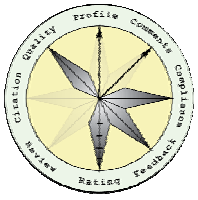
			
Total Statements:	9 (3 true, 6 false)	10 (6 true, 4 false)	10 (4 true, 6 false)
% True Statements Correctly Selected:	87.2% (68 out of 78 possible)	80.8% (126 out of 156 possible)	89.4% (93 out of 104 possible)
Total Incorrect Selections:	27	26	21

Table 9: Percentage correct selection of true availability statements and total incorrect selections.

4.2.7 GEO Label Example 1

4.2.7.1 *Using Mock-up GEO Labels for Dataset Ranking*

Figure 45: GEO Label Design 1.

As described in section 4.1, each GEO label example was examined within the context of a dataset selection scenario: respondents were presented with a dataset use scenario and 5 different mock-up GEO labels, and were asked to rank the mock-ups in order of fitness-for-use based on the scenario description. After completing the ranking exercises for GEO label example 1 (see Figure 45 for one mock-up example), respondents were asked to provide a brief explanation to support their ranking decisions. Although some respondents did provide positive comments regarding their use of the mock-ups in terms of comparing the datasets for use, the majority of respondents were somewhat negative about the GEO label design in terms of supporting such a ranking exercise. They argued that "*the representations are not that great for ranking*" and they "*found it too difficult to compare the labelling in a circular format*"; to this end, some commented that a more "*tabular format would have been much easier*" but this relates more to the layout of the labels next to each other than the design of the labels themselves and so is somewhat outside the scope of the label design, other than to bear in mind its use in a side-by-side comparison tool. Many of the more specific comments regarding the visualisation of the label reiterated concerns already expressed by respondents when considering the facet icon and availability indication design as previously discussed. Respondents agreed that the visualisation needs further work "*to make it easier to get an overview*" of overall information availability for a given dataset. These comments and feedback indicate that, although the proposed visualisation may be considered effective at conveying the availability of quality information for a given dataset, the design is too demanding to allow for efficient dataset comparison in terms of selection for further inspection.

Interestingly, despite the fact that the '*available at a higher level*' icon variation was not shown to be effective (as previously outlined), some study respondents admitted that this availability state influenced their selection decision, suggesting that once familiar with the concept, it proved useful when assessing datasets. In relation to data availability, a number of study participants commented that their ranking decisions were based on the presence of the blue colour, oftentimes simply picking the dataset with the most icons "*with background in blue*". This suggests that the saturation of the icons was the most engaging and dominant visual component of the labels and should therefore be taken into consideration when redesigning the icons and labels.

4.2.7.2 *Respondents' Feedback and Comments on GEO Label Design 1*

Respondents largely agreed that the proposed design is generally not sufficiently effective and is difficult to use for dataset selection. Their specific comments echoed the findings previously reported for each of the icons and availability variations, including comments about issues with reading the curved text and, more generally, the lack of intuitiveness of the colour coding and the availability representations. Being generally perceived as too complex, respondents agreed that the proposed circular GEO label needed to be simplified; they highlighted that there is no obvious ordering in terms of positioning of the facets around the circle. Regarding the number of facets, respondents argued that eight facets is too many for a label when using the label to compare datasets based on fitness-for-use; including 8 was perceived as imposing too much cognitive demand when trying to compare different labels, with respondents suggesting that the facets should either be limited to 5 or that nesting should be used to reveal more information on drill-down whilst

reducing the complexity at the top level. Aside from the icon-related improvements already discussed, some respondents suggested the inclusion of a legend with the label to help interested users interpret the label's information.

4.2.8 GEO Label Example 2

4.2.8.1 *Using Mock-up GEO Labels for Dataset Ranking*

Figure 46: GEO Label Design 2.

After ranking 5 fictitious datasets using the second of the GEO label designs (see Figure 46 for an example), 16 respondents provided brief comments to support their ranking decisions. Of these, five respondents attributed very high importance to the top-level availability of the 5-star user ratings, arguing that the easily visible user rating "*is the only part that tells you directly how good the data is*" as opposed to merely indicating the availability of quality information. These respondents noted that the user rating was the very first thing that caught their attention and therefore highly influenced their ranking decision – for example, "*my eyes were drawn to the yellow stars so this defined my ranking*". Although the star-based user rating was very positively accepted, respondents admitted that they would have liked to have been able to determine the reliability of the users providing the ratings, including to determine whether the users had taken assumptions about the dataset into account when submitting their ratings.

In contrast, other respondents argued that "*the 'user rating' category is probably the least useful*" because geospatial data quality is use case dependent. As with the feedback on the previous example, respondents again noted that the presence of the blue colour had substantially influenced their ranking decision.

4.2.8.2 *Respondents' Feedback on GEO Label Design 2*

Our findings suggest that respondents generally preferred the rectangular label format (see Figure 46) over the circular format discussed in section 4.2.7, in part because of its similarity to other webpage-related labels. Respondents commented that this format was easier to work with, allowed for easier scanning of the facets, appeared more structured, was more compact (so used space more efficiently), and that the icons were more readable. They also considered this design to have more informational content, probably because the actual user rating and specific standards information was itemised at this top level – which they highlighted as very useful. That said, some respondents argued that the label should not include a 5-star-based rating, suggesting that "*users will focus too much on the yellow stars*" (as earlier comments did, indeed, suggest had been the case) and that its use could be misleading, with one respondent suggesting that example one supported "*a more fair comparison of aspects*". As before, comments regarding the facets and information availability presentation echoed that already discussed.

4.2.9 GEO Label Example 3

4.2.9.1 *Using Mock-up GEO Labels for Dataset Ranking*

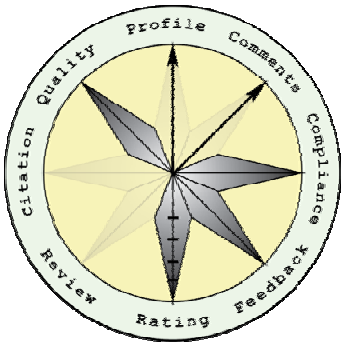


Figure 47: GEO Label Design 3.

After ranking 5 fictitious datasets using the third of the GEO label designs (see Figure 47 for an example), a number of study respondents commented rather negatively on the label design, arguing that the star label representation is too complicated, creating confusion and failing to deliver any useful information. Respondents suggested that it is "*hard to tell what the user rating is*" and, due to the very small font size used, the labels at the end of the star arms are unreadable – with some respondents going so far as to indicate they mainly considered "*the number of available items, not so much which these were*" on account of the lack of readability. Two study respondents stated that they based their ranking decision on "*the number of bold arrows*" and dark colours within the star arms, further demonstrating the effect of colour on perceived information availability. At best, respondents commented that "*it looks good for an overall picture of record completeness, but* [it is] *hard to deal with detail*".

4.2.9.2 *Respondents' Feedback on GEO Label Design 3*

Despite a better response to the availability interpretability of the star arm variations (as discussed in section 4.2.5), we found no overall agreement on the effectiveness of the star arm-based proposed GEO label visualisation when used to compare dataset suitability for a given context of use. The respondents who felt this label design *was* effective at conveying information availability argued that overall availability information "*is available in a single glance, rather than many eye movements*" making it "*easier to see how much information is given*"; this benefit is, however, countered by the fact that other respondents considered it less intuitive than the other design and felt that the design made it hard to deal with the detail. It was generally perceived that iconic representation of the facets (despite issues with the icons themselves) was more effective than the text-only representation in this design which made facet recognition very difficult, forcing respondents "*to read the labels all the time*" in order to identify the informational aspects that the star arms represented[6]. These findings indicate that, as confirmed in section 4.2.5, the star arms are perhaps most effective (of the three designs studied) at conveying the three information availability states and, consequently, when combined in a GEO label, are good at delivering a global overview of information availability. The lack, however, of effective indication of what information each individual arm represents, i.e. lack of iconic representations, makes the star design hard to use in practice. Confirming this observation, some respondents went so far as to propose a combination of the star design with the icons to arrive at a more effective label visualisation. Combining the two design concepts together could potentially support both easy facet recognition and perceived information completeness. The combination of the star arms for information availability and the icons to indicate the facets themselves would seem to address many of the concerns previously discussed regarding both designs – it would seem eliminate the weaknesses and play to the strengths of both designs.

4.2.10 Comparative Difficulty of Use of the GEO Label Designs

Table 10 and Figure 48 present respondents' ratings of the difficulty of use of the three GEO label designs tested. Overall, the results suggest that none of the proposed GEO label visualisations are

[6] These findings are more in line with established design principles.

particularly easy to use for ranking fictitious datasets. According to respondents' ratings, the circular GEO label design (example 1) was the most difficult to use for evaluating dataset fitness-for-use (M = 2.81, SD = 0.98, where 7 is '*very easy*'), with nearly 90% of respondents rating it as difficult to some degree. The rectangular design (example 2) was perceived as slightly easier to use (M = 3.42, SD = 1.21, where 7 is '*very easy*') than example 1, which is probably due to the label layout being similar to commonly used e-Commerce trust labels. Finally, although overall ratings indicated that the star design (example 3) was the easiest to use of the three proposed visualisations (M = 3.54, SD = 1.61, where 7 is '*very easy*'), the ratings were widely distributed across respondents, demonstrating no general agreement on the difficulty of its use. It is also likely that its strength at representing information availability had an unduly strong influence on its perceived ease of use overall.

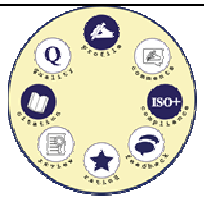
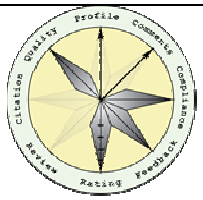
Label Example / Difficulty of Use	 Example 1	 Example 2	 Example 3
1 / Very Difficult	1 3.9%	0 0.0%	2 7.7%
2 / Difficult	9 34.6%	5 19.2%	6 23.1%
3 / Somewhat Difficult	**13** **50.0%**	**13** **50.0%**	**7** **26.9%**
4 / Neutral	0 0.0%	2 7.7%	2 7.7%
5 / Somewhat Easy	3 11.5%	4 15.4%	5 19.2%
6 / Easy	0 0.0%	2 7.7%	4 15.4%
7 / Very Easy	0 0.0%	0 0.0%	0 0.0%
Mean	2.81	3.42	3.54
Standard Deviation	0.98	1.21	1.61

Table 10: Respondents' ratings of the difficulty of use of the proposed GEO label designs, with majority rating highlighted in bold.

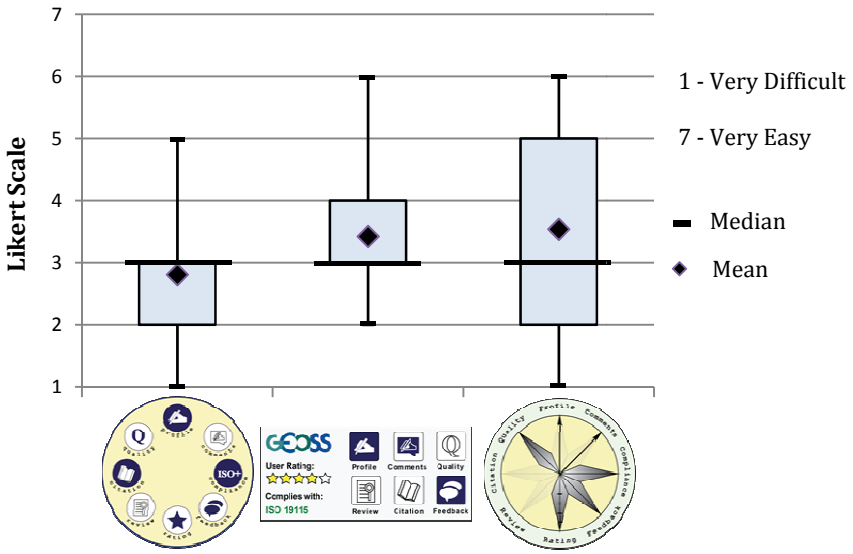


Figure 48: Respondent-attributed difficulty of use of the GEO label examples.

4.2.11 Comparative Effectiveness of the GEO Label Designs

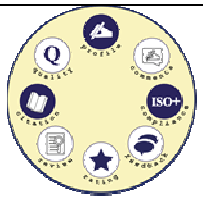
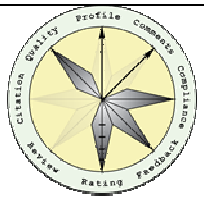
Label Example / Effectiveness	 Example 1	 Example 2	 Example 3
1 / Very Ineffective	1 3.9%	0 0.0%	2 7.7%
2 / Ineffective	3 11.5%	2 7.7%	5 19.2%
3 / Somewhat Ineffective	8 30.8%	6 23.1%	4 15.4%
4 / Neutral	0 0.0%	3 11.5%	1 3.8%
5 / Somewhat Effective	**10** **38.5%**	7 26.9%	5 19.2%
6 / Effective	4 15.4%	**8** **30.8%**	**9** **34.6%**
7 / Very Effective	0 0.0%	0 0.0%	0 0.0%
Mean	4.04	4.50	4.12
Standard Deviation	1.48	1.36	1.82

Table 11: Respondents' ratings of the effectiveness of the proposed GEO label designs, with majority rating highlighted in bold.

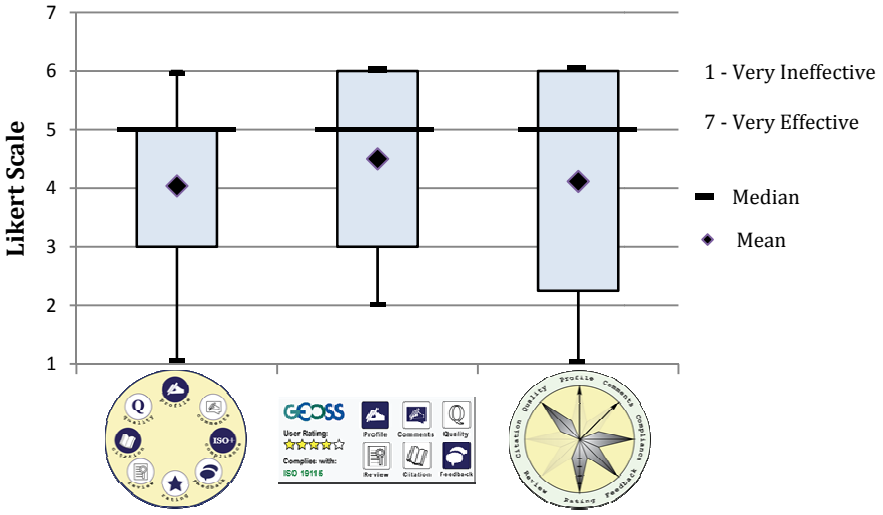


Figure 49: Respondent attributed effectiveness of the GEO label examples.

Table 11 and Figure 49 present respondents' ratings of the effectiveness of the proposed GEO label designs. As can be seen, whist perceived to be more effective than easy to use, the overall results suggest that none of the proposed designs are, as yet, sufficiently effective. Respondents' ratings indicated that the circular GEO label design (example 1) was perceived as the least effective of three proposed visualisations (M = 4.04, SD = 1.48, where 7 is '*very effective*'). The star design (example 3) was, as with ease of use, perceived slightly more favourably than example 1 (M = 4.12; SD = 1.82, where 7 is '*very effective*'); once again, however, respondents' ratings were widely distributed for this design, demonstrating no general agreement on its perceived effectiveness. Although the rectangular GEO label design (example 2) had the highest rating for effectiveness overall (M = 4.50; SD = 1.36, where 7 is '*very effective*'), here too the ratings were widely distributed for this design, indicating no strong agreement among study respondents as to its effectiveness.

4.2.12 Respondents' Ranking of the Proposed GEO Label Example

Having worked with each GEO label design for the purpose of ranking datasets according to scenarios of user, respondents were asked to rank the 3 proposed GEO label designs themselves in order of preference. Figure 50 shows the respondents' rankings. Figure 51 shows the results in the form of overall weighted rankings; to calculate the weighted ranks, for each label we multiplied the number of responses for each rank by 3 for 1st choice, 2 for 2nd choice, and 1 for 3rd choice, and added the ranks to arrive at an overall weighted rank for each GEO label example.

As can be seen, the circular GEO label design (example 1) was the least preferred (weighted rank 43) with only 2 respondents (7.7%) ranking it as their first choice. These results are in line with our previous findings, where respondents agreed that the circular example was the hardest to use and was the least effective at conveying information availability. The star design (example 3) was slightly better received (weighted rank 46) than the circular design, with 7 study respondents (26.9%) ranking it as their first choice. On the basis of previously-reported respondent feedback, preference for example 3 is likely to reflect that the fact that, although this GEO label design failed to effectively represent individual facets, it was most effective at conveying overall information availability. Finally, the rectangular design was the preferred design (weighted rank 67), with 17 study respondents (65.4%) ranking it as their first choice. Overall, this GEO label example received most positive comments, with respondents finding it easier to use because of perceived commonality with e-Commerce trust seals they have encountered before.

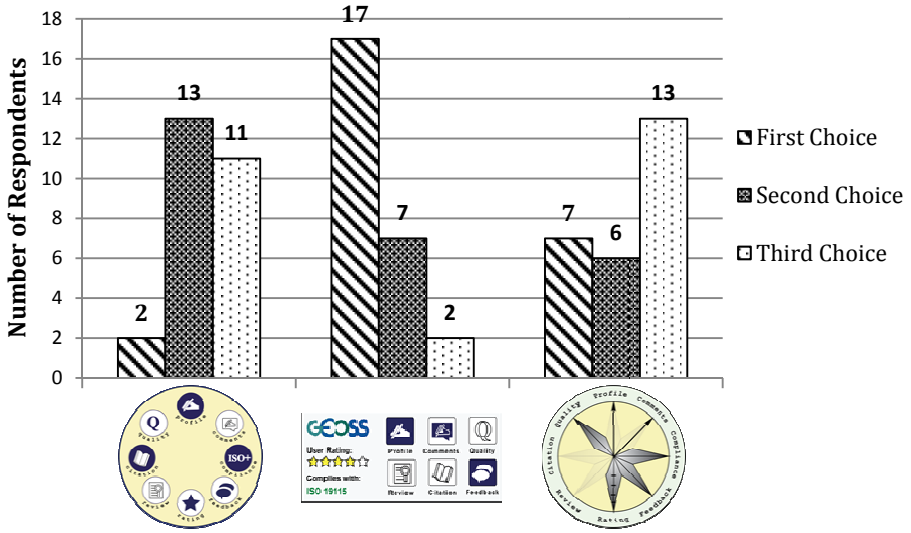


Figure 50: Respondent-attributed ranking of the GEO label examples in order of preference.

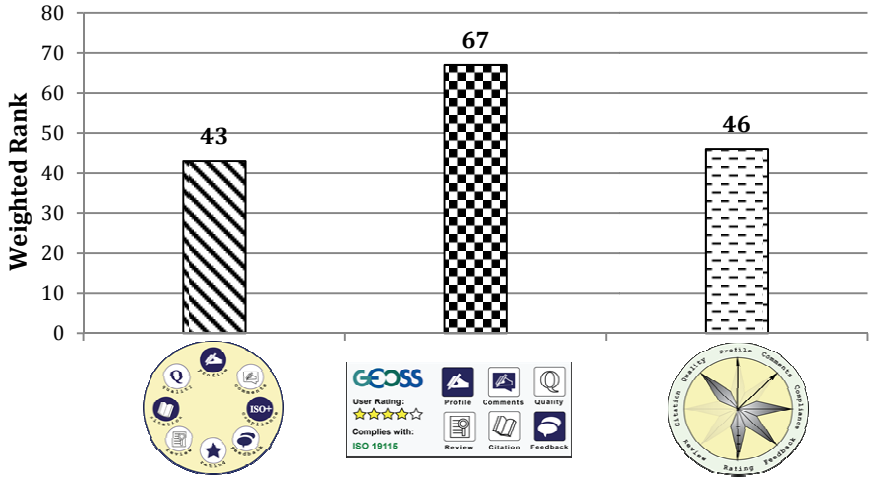


Figure 51: Weighted ranking of the GEO label examples in order of respondent preference.

4.2.13 GEO Label Facets

In Section D of our online survey, respondents were presented with a list of the 8 informational aspects included in the GEO label examples and asked to identify the aspects that *they* considered important and relevant to the GEO label function. Respondents were asked to provide comments to support their assessment. The results (see Figure 52) were in line with our previous two studies and indicated that all eight informational aspects were generally considered important and relevant to the GEO label function.

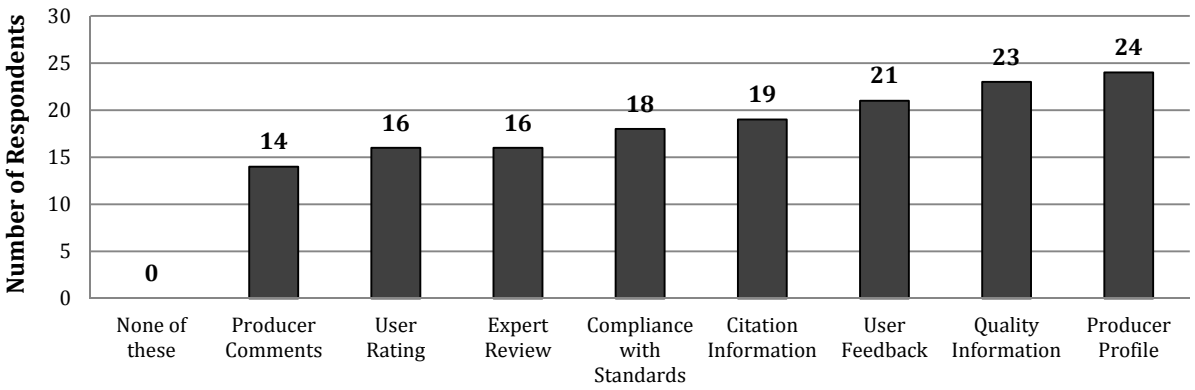


Figure 52: Respondent-attributed importance and relevance to the proposed eight informational GEO label aspects.

The informational aspects related to 'producer comments', 'user rating', and 'expert review' were perceived as being of the lowest importance to respondents. Attribution of low importance to these 'soft knowledge' related elements could be a consequence of the fact that such information, especially the likes of producer comments, is not currently typically provided with geospatial datasets (with users as yet mainly relying on formal metadata records for assessment and some users commenting that important producer comments should be included within the metadata itself). Additionally, some users were sceptical that, since they perceived producers as only being interested in selling their data, any producer comments could be biased. The relatively low importance attributed to user ratings would appear, on the basis of comments provided in the previous sections, to be a consequence of the fact that user ratings are not perceived to be of any value unless supported with textual feedback. Respondents' repeated concerns regarding how expertise would be determined with respect to expert reviews appears to have manifested in their low attribution of importance to this informational facet.

Producer profile and quantitative quality information were shown to be of highest importance to respondents. Indeed, this reflects our findings to date which have shown that users are more likely to acquire data from producers they know and those they trust. The same is true of the importance assigned to quantitative quality information: in addition to subjective quality information, users want to make their own judgements about data quality and its fitness for intended use on the basis of quantitative measurements of quality.

User Viewpoint:

"I would primarily look for dataset quality information. I'd also want to know about the dataset producer so I could see if they are 'trusted' and find a contact point for questions. 'Producer comments' are probably relatively unlikely to be available but could be useful. User feedback could be very useful provided the user gives enough information to be useful, and for me to know whether their use case was comparable. Citations would be a highly-trusted way to find third-party information about the dataset.

As I've discussed above, I don't think 'user rating' is very useful. There are unlikely to be enough users to provide a meaningful rating, meaning that results are probably going to be skewed, or not relevant to me. 'Expert review' appears to overlap with 'citation information', and could be merged. 'Compliance with standards' is only useful if this is defined more precisely, since there are so many potentially-relevant standards. A dataset could publish Dublin Core metadata, but this may be far

too high-level for my needs. I would suggest borrowing from the Open Data community and using something like 'published in a non-proprietary format', or something similar that is easier to define"

Respondents were then asked to rank the 8 informational aspects in order of importance; the results of their rankings are shown in Figure 53. Figure 54 shows the results in the form of overall weighted rankings; to arrive at the weighted ranks, for each informational aspect we multiplied the number of respondents who attributed each rank to the facet (1st choice, 2nd choice, … 7th choice, 8th choice and so on) by a score for that rank (by 1 for '8th choice', 2 for '7th choice', …, 8 for '1st choice'), and then added the results. As can be seen, producer profile and quantitative quality information were again ranked as the most important aspects. When weighted, citation information and user rating facets proved to be of least importance to respondents. It is possible that the low importance being attributed to citation information is due to the fact that such information is not generally available with datasets at present and, as our preparatory research suggested, users currently find it challenging to locate publications on datasets in which they are interested. Possible causes of low importance attribution to user rating information have already been discussed in this section.

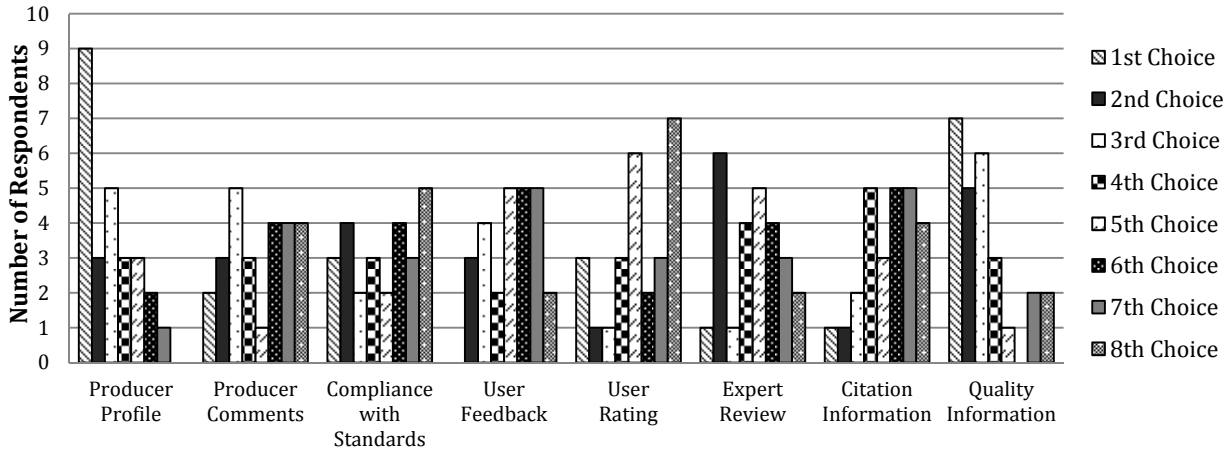


Figure 53: Respondent-ranked importance of the eight GEO label informational aspects.

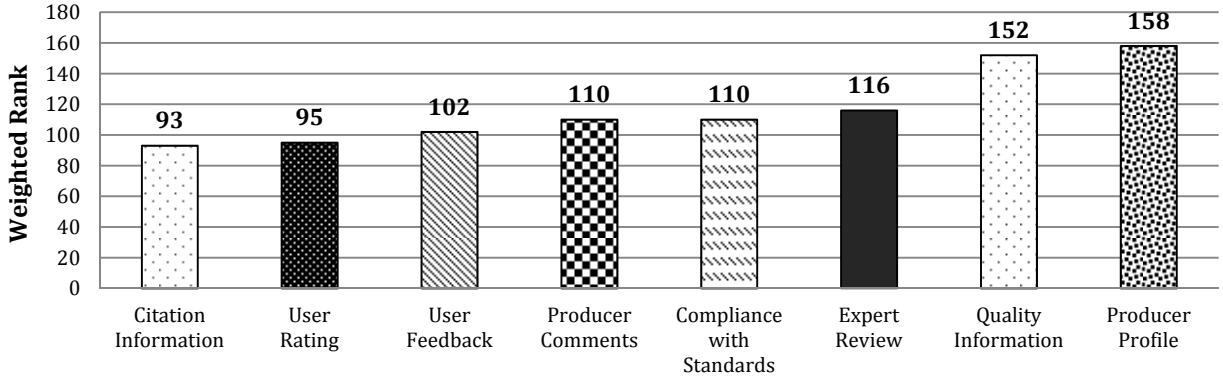


Figure 54: Weighted respondent ranking of importance of the eight GEO label informational aspects.

Respondents were then asked to indicate the informational aspects that they consider redundant, and which should not be included in the GEO label (see Figure 55). Overall, respondents did not indicate strong redundancy for any of the informational aspects; in accord with respondents' previously discussed reservations about the facet, only user rating received a relatively high number

of redundancy votes (9 respondents, 34.6%). Consistent with their attributed importance levels, producer profile and quantitative quality information were not considered to be redundant by any of the respondents.

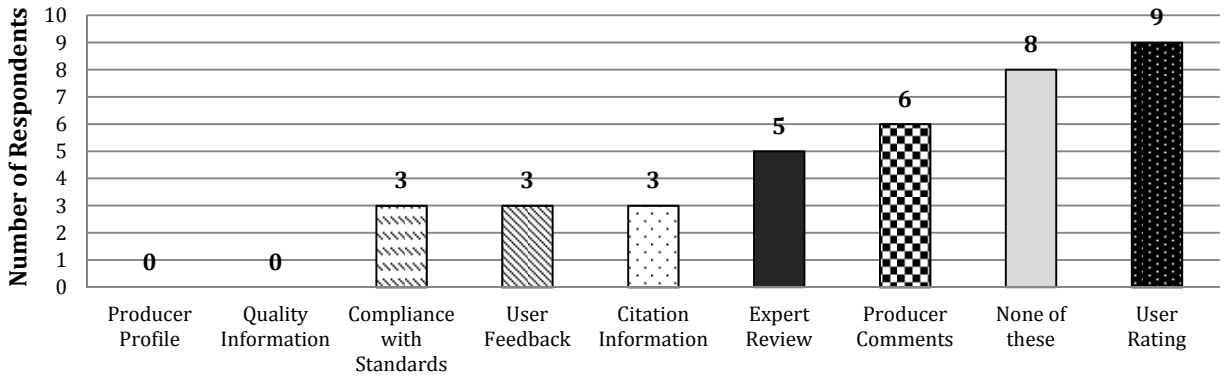


Figure 55: Respondent-attributed redundancy of the eight GEO label informational aspects.

When asked to describe any additional aspects that they felt may be relevant to the GEO label function, respondents typically listed specific metadata elements, namely: geographic extents; coverage; data format; feature types, i.e., vector (point, polyline, polygon), raster; and licensing information.

4.2.14 Using Branding in the GEO Label

In section E, respondents were presented with two versions of a GEO label – one using 'GEO' branding and one without the branding – and asked to indicate which version they prefer, supporting their selection with brief explanation. As can be seen from Figure 56, the majority of respondents (61.5%) preferred a GEO label with branding. Perhaps unsurprising (especially in light of known e-Commerce findings related to the importance of branding in promotion of trust in online environments (e.g., Jarvenpaa *et al*., 2000)), these results indicate that users are more likely to trust well-known and established sources. Respondents commented that the branding indicates the organisation which initiated the scheme and "*gives a 'traceability' to the label itself*".

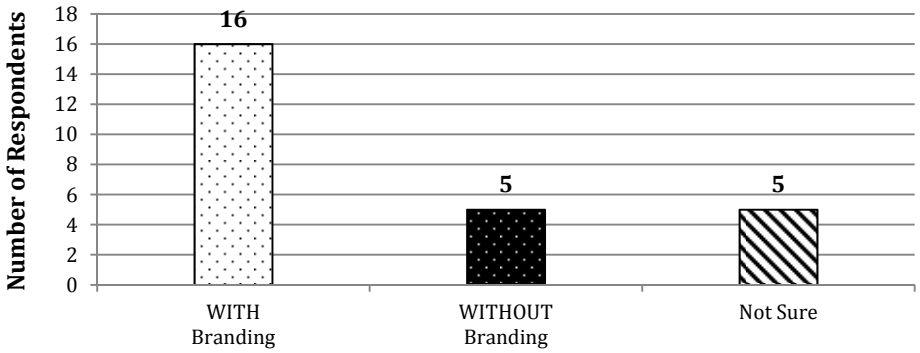


Figure 56: Respondents' opinion on the use of branding in the GEO label.

Respondents who preferred a label without the branding stated that without it "*it is easier to concentrate on the provided information*". Two study respondents also explained that because they "*don't know the GEO branding*" and "*have never actually used GEOSS to access data*" they were rather sceptical of the value of the brand. This again indicates that consumers put more trust in well-established brands with which they are already familiar.

4.3 Phase II: Conclusions and Final GEO Label Requirements

Overall, the study results indicated that, unfortunately, none of the proposed GEO label visualisations are as yet sufficiently effective to stand as the final GEO label design. Nevertheless, respondents' feedback has provided rich information on which basis to identify essential GEO label design modifications and improvements and derive final GEO label requirements.

4.3.1 Study Results Summary

4.3.1.1 *GEO Label Facets*

One of the aims of this study was to identify whether, when included as part of a GEO label, the eight informational aspects identified in our previous studies would still be perceived as important and relevant to the GEO label role. With producer information and quantitative quality information being clearly identified as the most important GEO label facets, our study results confirm that the final GEO label visualisation should comprise:

a) dataset producer information;
b) producer comments on the dataset quality;
c) dataset's compliance with standards;
d) user feedback;
e) user ratings of the dataset;
f) expert reviews;
g) dataset citations; and
h) dataset quality information.

4.3.1.2 *GEO Label Icons*

The study results indicate that icons are absolutely essential to achieve effective representation of individual GEO label facets. Respondents did, however, propose a number of modifications to improve the proposed GEO label icons – as summarised in Table 12 below:

Icon	Recommendations for Improvement
	Could require modification because the writing hand symbol suggests commenting or editing.
	With above changes affected, the producer profile and producer comments icons must retain visual similarity to support facet recognition.
	Compliance with standards icon doesn't require modification because it was largely recognised; additionally, when implemented, the GEO label service will require ISO compliant metadata documents to generate a GEO label for a dataset so having 'ISO' as part of the imagery of this icon is appropriate.
	User feedback icon should be modified to indicate the relationship to users.
	User ratings icon should only convey availability of user ratings and not the average user rating directly; given the use-case dependent nature of geospatial data quality, provision of an actual average rating within the label itself could mislead or falsely direct selection decisions.

	As with the producer icons, the user feedback and user rating icons should include visual similarity to indicate connection and support better facet recognition (in particular, the meaning of the ratings icon).
	Results suggest the expert review and citation information icons do not require modification and are intuitive in their current form.
	Quantitative quality information icon needs modified to better reflect the statistical nature of the information and to remove linguistic dependency if possible.

Table 12: Recommended improvements to facet icons.

4.3.1.3 *GEO Label Facets Labelling*

The study results indicated that it is important to include effective labels with facet icons to fully convey the intended meaning of the GEO label informational components, with our study respondents relying heavily on the labels in order to interpret our facet icons. Whilst the aforementioned improvements to the icon designs should hopefully alleviate reliance on labelling, it is important to take on board that, when the facet labels are curved or too small, the text becomes unusable. In practical terms, when integrated in the GEOSS, based on the size of the label as a whole, the facet labels could easily become too small to remain readable. A suggested solution to this is to provide a legend (or key) to itemise the facets; this could prove particularly useful for first-time users who are not familiar with the GEO label concept, as well as acting as an on-demand reminder for users who are more familiar with the GEO label. Alternatively, or indeed in addition, a dynamic hover-over functionality could be utilised to display facet labels.

4.3.1.4 *Final GEO Label Visualisation Layout*

The study results indicate that the circular GEO label design (example 1) was the least effective and the most difficult to use, especially in terms of conveying information availability and in supporting side-by-side comparison of GEO labels. Despite its shortfalls, however, respondents did react positively to the provision of the facet icons in this GEO label representation – noting their support for easy facet recognition and recall. Conversely, although the star-based GEO label design (example 3) effectively represented information availability, it failed to successfully represent the individual informational facets. Consequently, study respondents proposed to combine these two GEO label visualisations to arrive at a final GEO label design.

The rectangular GEO label visualisation (example 2) was generally favoured by respondents on the basis of its similarity to common e-Commerce features that they had previously encountered. Although this label design was considered the most intuitive and the easiest to use for dataset selection, it should be remembered that respondents came to this visualisation with the benefit of learning from using the first visualisation, a fact that will undoubtedly have positively skewed their opinion of this design. A caveat to bear in mind when considering this design is that respondents indicated that the upfront average user rating was very influential, potentially to the detriment of the other GEO label facets. Respondents agreed that, considering the subjective nature of geospatial data quality, such a prominent average rating could be misleading; some went so far as to suggest it should not, therefore, be included as part of the GEO label function.

Overall, respondents did not indicate strong acceptance of any of the proposed GEO label visualisations as presented. Consequently, we conclude that the final user-dictated graphical GEO label representation should *either* be a hybrid of two of the tested prototype designs (the circular and star-based designs) *or* should adopt a modified version of the rectangular design, comprising

the 8 informational aspects but solely conveying information availability (i.e., changing the user rating meaning). On this basis, we propose to develop and further evaluate (in Phase III), two modified GEO label designs in order to arrive at the final GEO label representation.

4.3.1.5 *Representation of Information Availability*

Study respondents were strongly in favour of the intuitive use of colour/colour boldness to indicate information availability; our proposed additional use of arrows to convey information availability was not accepted (see section 4.2.5.4). Consequently, respondents suggested that we use white icon fill for 'not available', a dark icon fill colour for 'available', and a light or graduated icon fill to indicate information 'available at a higher level'. Going one step further, respondents actually indicated that they felt the 'available at a higher level' information state was redundant, suggesting that it should be omitted altogether to avoid overcomplicating GEO label visualisation; they argued that it makes it hard to process the GEO label information if they are required to consider too many availability options – being forced to do so largely makes the GEO label unusable.

4.3.1.6 *GEO Label Colour Scheme*

The study respondents argued that existing arrangements of the GEO label facets did not clearly indicate any organisation, grouping, or relationships between facets (see section 4.2.7.2). To address this issue, we propose to reorder the facets to use adjacency to indicate relationships; we also propose to use different colour schemes to further strengthen visually grouping of the GEO label facets according to contextual relationships. We propose that the following four groups could adopt four different colours to indicate that they convey related information:

- producer profile and producer comments facets both relate to dataset producer;
- compliance with standards and quantitative quality information facets relate to more objective quality information;
- user comments and user ratings facets relate to data users and their feedback; and
- expert review and citation information facets both relate to expert feedback/reports on data quality.

4.3.1.7 *Use of Branding in the GEO Label*

The study results indicate that the final design of the GEO label *must* include branding to gain better user acceptance. As discussed in section 4.2.14, the 'GEO' branding would encourage users to trust the GEO label and would make the label more recognisable.

4.3.2 Finalised GEO Label Representation

Based on the GEO label requirements discussed above, we developed updated user-dictated proposals for the GEO label (see Figures 57 – 63). It is important to note at this point that these visualisations have not yet been validated; their evaluation will be carried out as part of Phase III of our research and the results, together with a finalised and validated specification for the GEO label will be published in an official addendum to this report.

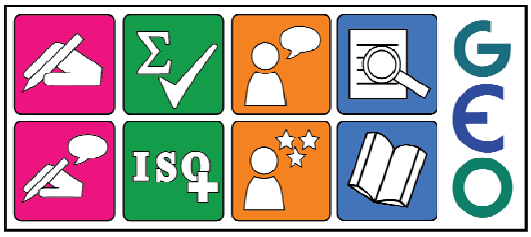


Figure 57: User-dictated rectangular GEO label design (information is available).

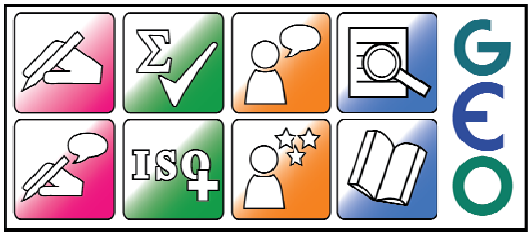


Figure 58: User-dictated rectangular GEO label design (information is available at a higher level).

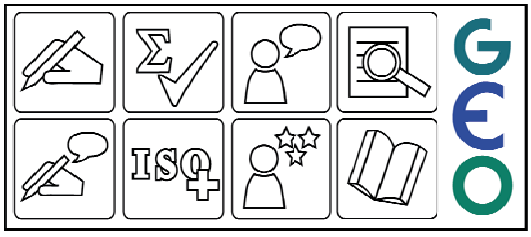


Figure 59: User-dictated rectangular GEO label design (information is not available).

Figure 60: User-dictated circular GEO label design (information is available).

Figure 61: User-dictated circular GEO label design (information is available at a higher level).

Figure 62: User-dictated circular GEO label design (information is not available).

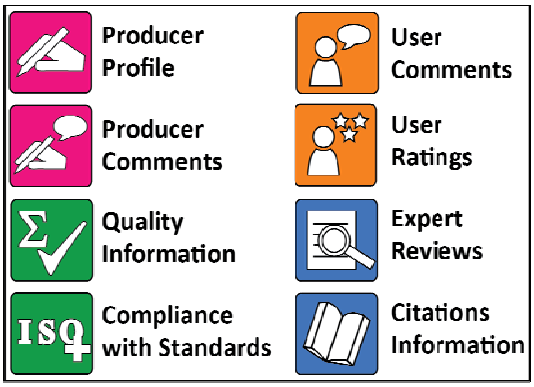


Figure 63: GEO label legend.

5. Research Summary & Ongoing Work

This document has presented the user-centred design research that has been conducted to date to establish and evaluate the concept of a GEO label which will act as a decision-support mechanism for geospatial dataset selection. It has presented the results of 3 user studies conducted to (1) identify the informational aspects of geospatial datasets upon which users rely when assessing dataset quality and trustworthiness, (2) elicit initial user views on the concept of a GEO label and its potential role in supporting dataset comparison and selection, and (3), evaluate prototype label visualisations.

The results of our preparatory phase (initial investigation) revealed eight informational facets that could potentially be included as part of the GEO label function. These findings then formed the basis of our Phase I study which investigated geospatial data producers' and users' views on the concept of a GEO label and the role it should serve. The results of this study indicated that users and producers support the concept of a GEO label providing an all-in-one drill-down interrogation facility that would combine all eight of the geospatial data informational aspects identified in the initial investigation. On the basis of our findings from Phase I, we developed three prototype GEO label visualisations which we then evaluated in our Phase II study. The findings of this study led us to conclude that the final user-dictated graphical GEO label representation should *either* be a hybrid of two of the tested prototype designs (the circular and star-based designs) *or* should adopt a modified version of the rectangular design, comprising the 8 informational aspects but solely conveying information availability (i.e., changing the user rating meaning). Consequently, we are now actively developing and will further evaluate (in Phase III), two modified GEO label designs in order to arrive at the final GEO label representation.

When integrated in the GEOSS, an individual GEO label will be provided for each dataset in the GEOSS clearinghouse (or other data portals and clearinghouses) based on its available quality information. Producer and feedback metadata documents will be used to dynamically assess information availability and generate the GEO labels. The producer metadata document can either be a standard ISO compliant metadata record supplied with the dataset, or an extended version of a GeoViQua-derived metadata record, and will be used to assess the availability of a producer profile, producer comments, compliance with standards, citations and quantitative quality information. GeoViQua is also currently developing a feedback server to collect and encode (as metadata records) user and producer feedback on datasets; these metadata records will be used to assess the availability of user comments, ratings, expert reviews and user-supplied citations for a dataset. The GEO label will provide a drill-down functionality which will allow a user to navigate to a GEO label page offering detailed quality information for its associated dataset. As envisioned, the developed GEO label will act as a decision-support mechanism for dataset selection and thereby hopefully improve user recognition of the quality of datasets.

At time of writing, we are actively engaged in Phase III of the GEO label development and evaluation. The physical GEO label prototypes will be evaluated/validated using rigorous and tried-and-tested usability evaluation methods as part of our Phase III activities. On the basis of the results of this evaluation process, we will derive a finalised and validated specification for the GEO label which we will publish as an official addendum to this report. We are also developing a proof-of-concept GEO label service that will be used to provide GEO labels on demand based on supplied metadata records and will, in due course, make this publicly available.

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Appendix A – User Stories and GEO Label Requirements

6.1 User Type Abbreviations

User Type Abbreviation	Description
ACAD	**Academic**
ARCH	**Archivist**
CF	**Climate Forecaster**
DU	**Data User**
PROD	**Producer**
RES	**Researcher**
S-ARC	**System Architect**

6.2 User Stories Derived from Aston University Interviews

User Story ID	User Story (Derived from User Interviews)	User Type
US-1	As a data archivist/system architect, I want to be able to accurately describe and archive/preserve data to make it available longterm for selection and use.	Archivist, System Architect
US-1.1	As a data archivist/system architect, I want to look for and gather environmental observation data so that I can archive/preserve that data for a very long term future use.	
US-1.2	As a data archivist/system architect, I want to be able to access all the information provided with the dataset.	
US-1.3	As a data archivist/system architect, I want to find and use data that may be anywhere in the world so that I can describe and reference data sources.	
US-1.4	As a data archivist/system architect, I want to have quality assessment that relies on peer review, almost “crowd sourcing”, the assessment of the data by way of likes or dislikes, or frequency of use, or citation.	
US-2	As a climate forecaster/data user I want to be able to ascertain key metadata information as well as to investigate the uncertainty of information in a dataset so that I can accurately determine its quality, decide on pre-processing that needs to be done, and make a decision as to whether or not to trust the source.	Climate Forecaster, Data User
US-2.1	As a climate forecaster/data user, I want to be able to get a community advice on the datasets.	
US-2.2	As a climate forecaster/data user, I want dataset providers to record some soft knowledge about their datasets so that I can see the purpose for which the datasets were created, what are the boundaries of the datasets and when should I trust or not to trust the datasets.	

US-3	As a researcher/data user, I want to be able to ascertain key metadata information as well as to investigate the quality of information at specific points in the dataset so that I can accurately determine its quality, usefulness for my purpose, and the extent of callibration required before being able to use the dataset.	Researcher, Data User
US-3.1	As a researcher/data user, I want data providers to have certain quality standards and provide the documentation on the standards that they support.	
US-3.2	As a researcher/data user, I want to have more complete metadata records provided with the datasets so that I can do proper calibration if data is not calibrated.	
US-4	As a land use researcher, I want to be able to ascertain key metadata information as well as to contribute in a peer review sense to metadata for existing datasets and to compare dataset metadata across a range of datasets in order to make an informed dataset selection.	Researcher, Data User
US-4.1	As a land use researcher/data user, I want to know who to contact (someone who actually replies) about the data so that I can get additional information.	
US-4.2	As a land use researcher/data user, I want to access dataset citations so that I know exactly why and how the data was collected, and what the errors are in the dataset	
US-5	As an academic/researcher, I want to be able to trace the processing steps that have been applied to the data as well as to access the raw data so that I can go back to the root of the data processing, if the processing applied is not useful for me, and process the data myself.	Academic, Researcher
US-5.1	As an academic/researcher, I am interested in the data itself rather than metadata records so I only want a light number of elements from the metadata record as well as the log of all the processing steps applied to the data.	
US-5.2	As an academic/researcher, I want to acquire the datasets that are free or at a very low cost.	
US-6	As a researcher/data producer, I want to be able to populate metadata records in multiple, ad-hoc metadata standards and also flag (warn in general terms) the potential lack of quality in the data I produce.	Researcher, Data Producer
US-6.1	As a researcher/data producer, I want to be able to find out about the data from other sources (word of mouth) and accept recommendations from others as well as obtain feedback on the data that I produce.	
US-6.2	As a scientist/data producer I want to have access to data provider's documentation on the datasets they provide.	

6.3 User Stories Derived from Reading University Interviews

User Story ID	User Story (Derived from User Interviews)	User Type
US-READ-1	As an environmental researcher/data user, I want to be able to ascertain key metadata information, particularly methodology and data citations, as well as to accept community advice and recommendations in order to make an informed dataset selection.	RES, DU
US-READ-1.1	As a scientist, for a reanalysis product, I want to know: what version of the code that was used in generating the reanalysis, what observation data used to generate reanalysis, what methods used in generating reanalysis, what assimilation system used in generating the reanalysis, and documentation of the reanalysis of the product, etc.	RES, DU
US-READ-1.2	As a generic user or scientist, I want to know the up-to-date version/ beta version of this dataset, build-up history of the dataset (derived or measured dataset (e.g. reanalysis product, in-situ observation)), methodology consistency, retrieval algorithm (if used), whether known issues fixed, etc. so that I can latter derive more quality information on this dataset.	RES, DU
US-READ-1.3	As a generic user or a scientist, I want to know the methodology that is used to derive or measure the dataset (e.g. reanalysis product, in-situ observation), so that I can have more quality information about this dataset.	RES, DU
US-READ-1.4	As a scientist or a generic user, I want to know what communities or projects are using or have used this dataset; I also want to know the associated information about the communities, so that it can help me to make a judgement about how much I can trust the dataset.	RES, DU
US-READ-2	As a researcher/data user, I want to be able to ascertain key metadata information, particularly information on data errors, as well as to obtain community advice and recommendations on what datasets can be trusted so that I can make an informed dataset selection.	RES, DU
US-READ-2.1	As a scientist or a generic user, I want to know where and when this dataset has been published, so that it can help me to make a judgement about how much I can trust the dataset.	RES, DU
US-READ-2.2	As a scientist or a generic user, I want to know the error estimates for this dataset, so that it can help me to make a judgement about how much I can trust the dataset.	RES, DU
US-READ-2.3	As a scientist or a generic user, if the data has been published, I want to know how many citations in scientific literature, so that it can help me to make judgement about how much I trust the dataset (i.e. as a trust trigger).	RES, DU

US-READ-2.4	As a generic user or scientist, I want to know some key 'profile' information of the dataset: for example, spatial resolution, temporal resolution, time period coverage, geolocation coverage, etc., these key profile information can help me to better understand the quality of the dataset.	RES, DU
US-READ-2.5	As a scientist or generic user, I want to know whether the dataset has gone through certain 'validation campaign', what the 'validation campaign ' is, and what the validation results are, etc. so that I make a judgement about much I can trust the dataset.	RES, DU
US-READ-2.6	As a generic user or scientist, I want the system to tell me any inter-comparison result(s) with other dataset, so that it can help me to make a judgement about how much I can trust this dataset. The item to be compared can include: geolocation resolution, temporal resolution, time period coverage, geospatial coverage, time of the data produced, citations, etc. (More items can be identified at a later stage)	
US-READ-2.7	As a generic user, I want the system to provide a mechanism that can encourage the data users to make comments on the data they have used.	DU
US-READ-2.8	As a scientist or a generic user, I want to know what communities or projects are using or have used this dataset; I also want to know the associated information about the communities, so that it can help me to make a judgement about how much I can trust the dataset.	RES, DU
US-READ-3	As an environmental researcher/data user, I want to be able to ascertain key metadata information, particularly information on data provenance; I want to use the datasets that come from reputable source as well as to accept community recommendations when selecting a dataset to use.	RES
US-READ-3.1	As a scientist, for a reanalysis product, I want to know: what version of the code that was used in generating the reanalysis, what observation data used to generate reanalysis, what methods used in generating reanalysis, what assimilation system used in generating the reanalysis, and documentation of the reanalysis of the product, etc.	RES
US-READ-3.2	As a scientist, I want to know whether the dataset has gone through certain 'validation campaign', what the 'validation campaign ' is, and what the validation results are, etc. so that I make a judgement about much I can trust the dataset.	RES
US-READ-4	As a meteorology researcher/data user, I want to be able to compare a new dataset with a “trusted” one as well as accept community recommendations in order to make an informed dataset selection.	RES, DU

US-READ-4.1	As a generic user or a scientist, if a quality label is provided, I want to know the method(s) used to create the label, who creates the label, so that it can help me to make a judgment whether I should trust the label	RES, DU
US-READ-4.2	As a generic user or scientist, I want to know the up-to-date version / beta version of this dataset, build-up history of the dataset (derived or measured dataset (e.g. reanalysis product, in-situ observation)), methodology consistency, retrieval algorithm (if used), whether known issues fixed, etc. so that I can latter derive more quality information on this dataset.	RES, DU
US-READ-4.3	As a generic user or scientist, I want to know which data centre or organisation is hosting this dataset, what is access methods (e.g. FTP), any standard(s) (e.g. IPCC standard) are imposed on the archival of dataset, any access restrictions, etc., so that it can help me to make a judgement whether I will use this dataset.	RES, DU
US-READ-4.4	As a scientist, if the quantified error estimates of a dataset are provided, I want to know what methodology is used to determine the error estimates, and the peer-reviewed comments or publications for the methodology, so that I can understand better about how much uncertainties on this error estimates.	RES, DU
US-READ-4.5	As a scientist, I want the system to provide a kind of mechanism for me to compare the dataset with a 'trusted' reference dataset, so that I can make a judgement about much I can trust the dataset.	RES, DU
US-READ-4.6	As a scientist or a generic user, I want to know what communities or projects are using or have used this dataset; I also want to know the associated information about the communities, so that it can help me to make a judgement about how much I can trust the dataset.	RES, DU
US-READ-4.7	As a scientist or generic user, I want to know the problems identified and highlighted about the dataset, so that it can help me to make a judgement about how much I can trust the dataset.	RES, DU
US-READ-5	As a meteorology researcher/data user, I want to be able to ascertain key metadata information, particularly price, resolution and availability of the data, as well as to obtain community advice and recommendations on datasets and data providers' reputation so that I can make an informed dataset selection.	RES, DU
US-READ-5.1	As a data provider, I want the system to provide me a kind of mechanism (e.g. template) that can guide me to provide required quality information for the dataset.	RES, DU (PROD?)

US-READ-5.2	As a scientist or a generic user, I want to know more information (e.g. website, email) about the data provider, or more information (e.g. email, background, publications) about the data author, so that I can make a judgement about how much I can trust the dataset, or I can ask them specific questions straightaway.	RES, DU
US-READ-5.3	As a generic user or scientist, I want to know some key 'profile' information of the dataset: for example, spatial resolution, temporal resolution, time period coverage, geolocation coverage, etc., these key profile information can help me to better understand the quality of the dataset.	RES, DU
US-READ-5.4	As a scientist or a generic user, I want to know what communities or projects are using or have used this dataset; I also want to know the associated information about the communities, so that it can help me to make a judgement about how much I can trust the dataset.	RES, DU
US-READ-6	As a meteorology researcher/data user, I want to be able to ascertain key metadata information, particularly error estimates, correlations between error estimates and provenance information, as well as to obtain users' comments on the datasets so that I can make an informed dataset selection.	RES, DU
US-READ-6.1	Sometimes choosing which dataset to use depends on specific research question, model used, etc. As a scientist, I want the system to have some kind of intelligence: after entering specific information (e.g. research question, model information), the system can recommend me the appropriate dataset.	RES
US-READ-6.2	As a generic user or a scientist, I want to know which model(s) (if any) are suggested to use with this reanalysis product.	RES, DU
US-READ-6.3	As a scientist or generic user, I want to know whether the dataset has gone through certain 'validation campaign', what the 'validation campaign ' is, and what the validation results are, etc. so that I make a judgement about much I can trust the dataset.	RES, DU
US-READ-6.4	As a scientist, if some error estimates of a dataset are provided, I want to know the correlations between the error estimates, so that I can understand whether there is any error over-lapping.	RES
US-READ-6.5	As a generic user, I want to see more user comments and any recommendations on this dataset, etc. so that I make a judgement about much I can trust the dataset.	DU

6.4 GEO Label Requirements

6.4.1 Metadata Querying and Standards

Req. ID	Requirement	Derived from User Story	User Type
R-3.4	The system should support the querying/search of a wide range of meta data values by individuals selecting datasets to use.	US-1, US-3.2, US-6	ARCH, S-ARC, RES, DU, PROD
R-3.4.20.	The system should support the querying of the meta-data standard attribute from the dataset metadata record.	US-1	ARCH, S-ARC

6.4.2 Peer Review and Rating Functionality

Req. ID	Requirement	Derived from User Story	User Type
R-10.	The system should support peer review ("crowd sourcing") of datasets (and subsequent querying of such reviews) such that dataset users can recommend or otherwise datasets to other users in the community.	US-1.4, US-2.1, US-4, US-6.2, US-READ-6.5	ARCH, S-ARC, CF, DU, RES, PROD
R-10.1	The system should support the reviewing of the datasets by providing the users with a standardised form to record their dataset evaluation.	US-4	RES, DU
R-10.3	The system should support the querying of all the submitted peer reviews for the selected dataset.	US-1.4, US-2.1, US-4, US-6.2	ARCH, S-ARC, CF, DU, RES, PROD
R-10.4	The system should support the querying of all the comments on metadata records submitted by the users.	US-4	RES, DU
R-11	The system should support the ability to rate (potentially by peer-review) the reputation of a dataset and to allow this rating to be subsequently edited, queried, and searched and to allow the dataset provider to respond to the rating.	US-4	RES, DU
R-11.1	The system should support the ability to rate the reputation of a dataset.	US-4	RES, DU

R-11.2	The system should support the ability to edit the rating of the reputation of a dataset.	US-4	RES, DU
R-11.3	The system should support the ability to query the ratings of the reputation of a dataset.	US-4	RES, DU
R-11.4	The system should support the ability to search the ratings of the reputation of a dataset.	US-4	RES, DU
R-11.5	The system should allow the dataset provider to respond to the rating of the dataset reputation.	US-4	RES, DU
R-12	The system should support the ability to rate (potentially by peer-review) the reputation of a dataset provider and to allow this rating to be subsequently edited, queried, and searched and to allow the dataset provider to respond to the rating.	US-2.1, US-3, US-4	CF, DU, RES
R-12.1	The system should support the ability to rate the reputation of a dataset provider.	US-2.1, US-3, US-4	CF, DU, RES
R-12.2	The system should support the ability to edit the rating of the reputation of a dataset provider.	US-2.1, US-3, US-4	CF, DU, RES
R-12.3	The system should support the ability to query the ratings of the reputation of a dataset provider.	US-2.1, US-3, US-4	CF, DU, RES
R-12.4	The system should support the ability to search the ratings of the reputation of a dataset provider.	US-2.1, US-3, US-4	CF, DU, RES
R-12.5	The system should allow the dataset provider to respond to the rating applied to them.	US-2.1, US-3, US-4	CF, DU, RES

6.4.3 Citations Information

Req. ID	Requirement	Derived from User Story	User Type
R-13	The system should support the recording, editing and querying of the dataset citations information.	US-3.1, US-4.2, US-6.2, US-READ-2.1, US-READ-2.3	RES, DU, PROD

R-13.1	The system should support the recording of links to journal articles (or other publications) in which dataset quality checks are reported.	US-3.1, US-4.2, US-6.2	RES, DU, PROD
R-13.1.1	The system should support the recording of links to journal articles in which dataset quality checks are reported.	US-3.1, US-4.2	RES, DU
R-13.1.2	The system should support the recording of links to dataset provider documentation in which any additional information on the dataset is provided.	US-3.1, US-6.2	RES, DU, PROD
R-13.2	The system should support the editing of links to journal articles (or other publications) in which dataset quality checks are reported.	US-3.1, US-4.2, US-6.2	RES, DU, PROD
R-13.2.1	The system should support the editing of links to journal articles in which dataset quality checks are reported.	US-3.1, US-4.2	RES, DU
R-13.2.2	The system should support the editing of links to dataset provider documentation in which any additional information on the dataset is provided.	US-3.1, US-6.2	RES, DU, PROD
R-13.3	The system should support the querying of links to journal articles (or other publications) in which dataset quality checks are reported.	US-3.1, US-4.2, US-6.2	RES, DU, PROD
R-13.3.1	The system should support the querying of links to journal articles in which dataset quality checks are reported.	US-3.1, US-4.2	RES, DU
R-13.3.2	The system should support the querying of links to dataset provider documentation in which any additional information on the dataset is provided.	US-3.1, US-6.2	RES, DU, PROD

6.4.4 Dataset Provider Information

Req. ID	Requirement	Derived from User Story	User Type
R-14	The system should support the recording, editing, reviewing, and querying of the information on the dataset provider.	US-1.2, US-3.1, US-4.1, US-5, US-READ-5.2	ARCH, S-ARC, RES, DU, ACAD

R-14.1	The system should support the recording, editing, reviewing, and querying of the quality standards that the dataset provider supports.	US-3.1, US-READ-4.3	RES, DU
R-14.1.1	The system should support the recording of the quality standards that the dataset provider supports.	US-3.1	RES, DU
R-14.1.2	The system should support the editing of the quality standards that the dataset provider supports.	US-3.1	RES, DU
R-14.1.3	The system should support the reviewing of the quality standards that the dataset provider supports.	US-3.1	RES, DU
R-14.1.4	The system should support the querying of the quality standards that the dataset provider supports.	US-3.1	RES, DU
R-14.2	The system should support the recording, editing, reviewing, and querying of the links to the textual documents in which dataset providers' quality standards are reported.	US-3.1	RES, DU
R-14.2.1	The system should support the recording of the links to the textual documents in which dataset providers' quality standards are reported.	US-3.1	RES, DU
R-14.2.2	The system should support the editing of the links to the textual documents in which dataset providers' quality standards are reported.	US-3.1	RES, DU
R-14.2.3	The system should support the reviewing of the links to the textual documents in which dataset providers' quality standards are reported.	US-3.1	RES, DU
R-14.2.4	The system should support the querying of the links to the textual documents in which dataset providers' quality standards are reported.	US-3.1	RES, DU
R-14.3	The system should support the recording, updating, referencing and querying of contact details for the person(s) responsible for the creation of a given dataset.	US-1.2, US-4.1	ARCH, S-ARC, RES, DU
R-14.3.1	The system should support the recording of contact details for the person(s) responsible for the creation of a given dataset.	US-1.2, US-4.1	ARCH, S-ARC, RES, DU

R-14.3.2	The system should support the updating of contact details for the person(s) responsible for the creation of a given dataset.	US-1.2, US-4.1	ARCH, S-ARC, RES, DU
R-14.3.3	The system should support the referencing of contact details for the person(s) responsible for the creation of a given dataset.	US-1.2, US-4.1	ARCH, S-ARC, RES, DU
R-14.3.4	The system should support the querying of contact details for the person(s) responsible for the creation of a given dataset.	US-1.2, US-4.1	ARCH, S-ARC, RES, DU
R-14.4	The system should support the recording, editing, reviewing, and querying of the location of the dataset producer.	US-1.2	ARCH, S-ARC
R-14.4.1	The system should support the recording of the location of the dataset producer.	US-1.2	ARCH, S-ARC
R-14.4.2	The system should support the editing of the location of the dataset producer.	US-1.2	ARCH, S-ARC
R-14.4.3	The system should support the reviewing of the location of the dataset producer.	US-1.2	ARCH, S-ARC
R-14.4.4	The system should support the querying of the location of the dataset producer.	US-1.2	ARCH, S-ARC

6.4.5 Soft Knowledge

Req. ID	Requirement	Derived from User Story	User Type
R-19	The system should support the recording, editing, reviewing, and querying of soft knowledge about a dataset as provided by the creator of the dataset and to include: why it was originally derived - for what purpose; anticipated limitations of the dataset; anticipated boundaries of use for the dataset; conditions under which the data should be trusted or not trusted, etc.	US-2.2, US-4	CF, DU, RES
R-19.1	The system should support the recording of soft knowledge about a dataset as provided by the creator of the dataset.	US-2.2, US-4	CF, DU, RES
R-19.1.1	The system should support the recording of soft knowledge about why/for what purpose the dataset was originally derived as provided by the creator of the dataset.	US-2.2, US-4	CF, DU, RES

R-19.1.2	The system should support the recording of soft knowledge about the anticipated limitations of the dataset as provided by the creator of the dataset.	US-2.2, US-4, US-READ-4.7	CF, DU, RES
R-19.1.3	The system should support the recording of soft knowledge about the anticipated boundaries of use for the dataset as provided by the creator of the dataset.	US-2.2, US-4	CF, DU, RES
R-19.1.4	The system should support the recording of soft knowledge about the conditions under which the data should be trusted or not trusted as provided by the creator of the dataset.	US-2.2, US-4, US-READ-4.7	CF, DU, RES
R-19.1.5	The system should support the recording of at least soft knowledge about the dataset uncertainty as provided by the creator of the dataset.	US-2.2	CF, DU
R-19.1.6	The system should support the recording of soft knowledge about the model(s) that are suggested to use with the selected dataset.	US-READ-6.2	RES, DU
R-19.2	The system should support the editing of soft knowledge about a dataset as provided by the creator of the dataset.	US-2.2, US-4	CF, DU, RES
R-19.2.1	The system should support the editing of soft knowledge about why/for what purpose the dataset was originally derived as provided by the creator of the dataset.	US-2.2, US-4	CF, DU, RES
R-19.2.2	The system should support the editing of soft knowledge about the anticipated limitations of the dataset as provided by the creator of the dataset.	US-2.2, US-4, US-READ-4.7	CF, DU, RES
R-19.2.3	The system should support the editing of soft knowledge about the anticipated boundaries of use for the dataset as provided by the creator of the dataset.	US-2.2, US-4	CF, DU, RES
R-19.2.4	The system should support the editing of soft knowledge about the conditions under which the data should be trusted or not trusted as provided by the creator of the dataset.	US-2.2, US-4	CF, DU, RES

R-19.2.5	The system should support the editing of at least soft knowledge about the dataset uncertainty as provided by the creator of the dataset.	US-2.2	CF, DU
R-19.2.6	The system should support the editing of soft knowledge about the model(s) that are suggested to use with the selected dataset.	US-READ-6.2	RES, DU
R-19.3	The system should support the querying of soft knowledge about a dataset as provided by the creator of the dataset.	US-2.2, US-4	CF, DU, RES
R-19.3.1	The system should support the querying of soft knowledge about why/for what purpose the dataset was originally derived as provided by the creator of the dataset.	US-2.2, US-4	CF, DU, RES
R-19.3.2	The system should support the querying of soft knowledge about the anticipated limitations of the dataset as provided by the creator of the dataset.	US-2.2, US-4, US-READ-4.7	CF, DU, RES
R-19.3.3	The system should support the querying of soft knowledge about the anticipated boundaries of use for the dataset as provided by the creator of the dataset.	US-2.2, US-4	CF, DU, RES
R-19.3.4	The system should support the querying of soft knowledge about the conditions under which the data should be trusted or not trusted as provided by the creator of the dataset.	US-2.2, US-4	CF, DU, RES
R-19.3.5	The system should support the querying of at least soft knowledge about the dataset uncertainty as provided by the creator of the dataset.	US-2.2	CF, DU
R-19.3.6	The system should support the querying of soft knowledge about the model(s) that are suggested to use with the selected dataset.	US-READ-6.2	RES, DU

6.4.6 Inter-comparison

Req. ID	Requirement	Derived from User Story	User Type

R-15	The system should support side-by-side visual comparison of metadata attributes across a range of datasets.	US-4	RES, DU
R-32	The system should provide the results of the dataset inter-comparison with other dataset(s).	US-READ-2.6	RES, DU
R-32.1	The system should provide the results of inter-comparison of the datasets' geolocation.	US-READ-2.6	RES, DU
R-32.2	The system should provide the results of the inter-comparison of the datasets' resolution.	US-READ-2.6	RES, DU
R-32.3	The system should provide the results of the inter-comparison of the datasets' temporal resolution.	US-READ-2.6	RES, DU
R-32.4	The system should provide the results of the inter-comparison of the datasets' time period coverage.	US-READ-2.6	RES, DU
R-32.5	The system should provide the results of the inter-comparison of the datasets' geospatial coverage.	US-READ-2.6	RES, DU
R-32.6	The system should provide the results of the inter-comparison of the datasets' citation information.	US-READ-2.6	RES, DU
R-33	The system should provide the results of inter-comparison of the selected dataset with a 'trusted' dataset.	US-READ-4.5	RES, DU

6.4.7 GEO Label Provenance Information

Req. ID	Requirement	Derived from User Story	User Type
R-27	The system should provide the GEO Label provenance information.	US-READ-4.1	RES, DU
R-27.1	The system should provide the users with information on the methods used to generate the label.	US-READ-4.1	RES, DU
R-27.2	The system should provide the users with information on the label provider.	US-READ-4.1	RES, DU

R-27.3	The system should provide the users with information on underlying quality assessment mechanisms if the GEO Label is used to convey quality assessment of the datasets.	US-READ-4.1	RES, DU

Appendix B – Phase I GEO Label Questionnaire

See next page.

GEO Label Questionnaire

Introduction

GeoViQua is an EU project that is working on providing the GEO data user community with innovative quality-aware visualisation and advanced geo-search capabilities. One of the objectives of our project is to contribute to defining a concept of a GEO Label. This questionnaire aims to collect initial user views on a GEO Label and its potential role.

We would be very grateful if you could spare some time to complete this questionnaire. It should take you no more than approximately 30 minutes to complete. Your responses will be completely anonymous and confidential, and will only be used in our study. Your responses will provide important information that will help us in defining what role a GEO Label should fulfil.

Before beginning this questionnaire, please identify yourself as one of the following:
(Tick one that applies)

- ☐ Data user ➔ Please go to **Section A – Data User**
- ☐ Data producer ➔ Please go to **Section A – Data Producer**

Section A – Data User

Section A – Background Information

This section consists of questions to gather background information about you, the data sources you use in your work and your awareness of any certificates or seals that apply to geospatial data.

A1. Please select the description(s) of user that most accurately describe you:
(Tick all that apply)

- ☐ Group on Earth Observations committee member
- ☐ Private sector data user
- ☐ Governmental data user
- ☐ Researcher data user
- ☐ Academic data user
- ☐ Other: please specify _____

A2. In your typical work do you use data from external data providers?

- ☐ Yes
- ☐ No

If you answered **No** skip to question **A14**, otherwise continue to question **A3**

A3. Please list the external data providers from whom you source your data. If possible, describe the type(s) of data that you use.

A4. Is there more than one data provider supplying the types of datasets you need?

☐ Yes

☐ No

If you answered **YES** skip to question **A6**, otherwise continue to question **A5**

A5. From the sole data provider, do you have a choice of datasets to meet your needs?

☐ Yes

☐ No

If you answered **NO** skip to question **A14**, otherwise continue to question **A6**

A6. Do you consider metadata records or any other supporting information when selecting datasets for use?

☐ Yes

☐ No

If **Yes,** what metadata or supporting information do you consider when working with geospatial datasets?

A7. When selecting a dataset to use, how important to you is an expert's judgement of the dataset and its quality?
(Tick one that applies)

☐	☐	☐	☐	☐	☐	☐
Very Unimportant	Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Important	Very Important

A8. When selecting a dataset to use, how important to you is a dataset's compliance with international standards? E.g., compliance with Dublin Core, ISO19115 standards, etc.
(Tick one that applies)

☐	☐	☐	☐	☐	☐	☐
Very Unimportant	Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Important	Very Important

A9. When selecting a dataset to use, how important to you are community advice and recommendations on what datasets are best to use for your application?
(Tick one that applies)

☐	☐	☐	☐	☐	☐	☐
Very Unimportant	Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Important	Very Important

A10. When selecting a dataset to use, how important to you is the reputation of the dataset provider?
(Tick one that applies)

☐	☐	☐	☐	☐	☐	☐
Very Unimportant	Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Important	Very Important

A11. When selecting a dataset to use, how important to you are dataset citations (e.g., a list of journal articles or other publications where the dataset has been used and quality checks have been reported)?
(Tick one that applies)

☐	☐	☐	☐	☐	☐	☐
Very Unimportant	Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Important	Very Important

A12. When selecting a dataset to use, how important to you is 'soft knowledge' (subjective and informal statements) about the dataset quality that is provided by the creator or provider of the dataset?
(Tick one that applies)

☐	☐	☐	☐	☐	☐	☐
Very Unimportant	Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Important	Very Important

A13. When selecting a dataset to use, how useful would it be for you to be able to visualise metadata records side-by-side when comparing two or more datasets?
(Tick one that applies)

☐	☐	☐	☐	☐	☐	☐
Very Useless	Useless	Somewhat Useless	Neutral	Somewhat Useful	Useful	Very Useful

A14. Are you aware of any certificates or seals that certify spatial datasets or metadata records?

☐ Yes

☐ No

If you answered **No** skip to **Section B**, otherwise continue to question **A15**

A15. Please provide the names of the certificates or seals that you have encountered:

A16. In your opinion, are these certificates or seals useful to the user community?

- ☐ Yes
- ☐ No

If **Yes**, please elaborate on why these certificates or seals are **USEFUL** to the user community:

If **No**, please elaborate on why these certificates or seals are **NOT USEFUL** to the user community:

Now proceed to **Section B**

Section A – Data Producer

Section A – Background Information

This section consists of questions to gather background information about you, the data you produce in your work and your awareness of any certificates or seals that apply to geospatial data.

A1. Please select the description(s) of producer that most accurately describe you:
(Tick all that apply)

- ☐ Group on Earth Observations (GEO) committee member
- ☐ Data producer with some dataset(s) in the Global Earth Observation System of Systems (GEOSS) Common Infrastructure
- ☐ Data producer not part of Global Earth Observation System of Systems (GEOSS)
- ☐ Private sector data producer
- ☐ Governmental data producer
- ☐ Research/academic data producer
- ☐ Other: please specify _____

A2. Please list and describe the type(s) of data that you produce.

A3. Do you provide metadata records or any other supporting information with the datasets that you produce?

☐ Yes

☐ No

If **Yes,** what metadata or supporting information do you provide with your datasets?

If **No**, please explain why not:

A4. Do you support any data and/or metadata standards, such as ISO, Dublin Core, Darwin Core, etc?

☐ Yes

☐ No

If **Yes,** list the data and/or metadata standards that you support:

If **No**, please explain why not:

A5. Are you aware of any certificates or seals that certify spatial datasets or metadata records?

☐ Yes

☐ No

If you answered **No** skip to **Section B**, otherwise continue to question **A6**

A6. Please provide the names of the certificates or seals that you have encountered:

A7. In your opinion, are these certificates or seals useful to the user community?

- ☐ Yes
- ☐ No

If **Yes**, please elaborate on why these certificates or seals are **USEFUL** to the user community:

If **No**, please elaborate on why these certificates or seals are **NOT USEFUL** to the user community:

Now proceed to **Section B**

Section B – Initial User Perspectives on a GEO Label

For the purpose of this questionnaire we consider a GEO Label to be some form of graphical representation that accompanies a dataset.
The following set of questions is designed to gather information about your initial view on the role that a GEO Label should serve.

B1. Do you think geospatial data or metadata records would benefit from certification programme(s) being applied to them?

- ☐ Yes
- ☐ No

If **Yes**, please provide a brief explanation as to why you think certification programme(s) **WOULD** be beneficial:

If **No**, please provide a brief explanation as to why you think certification programme(s) **WOULD NOT** be beneficial:

B2. If a GEO Label is provided, what role would you want it to serve? Please provide a brief explanation as to what would you want a GEO Label to represent:

B3. If a GEO Label is provided with datasets to certify their quality/trustworthiness, do you think the presence of such a label would influence your dataset selection decision?

- ☐ Yes
- ☐ Depends on whether I have previously used the data
- ☐ No
- ☐ Don’t know

Please provide a brief explanation to accompany your answer:

Now proceed to **Section C**

Section C – Your Awareness of Everyday Rating Systems and Certification Programmes

To inform the definition and role of a GEO Label, it is useful to first consider common certificates, labels, rating systems, and feedback facilities that are used in everyday life to help in product or service selection. We are interested in your opinion on such systems so that we can draw on the strengths of these when developing the GEO Label.

C1. Which of the following review/rating systems are you aware of?
(Tick all that apply)

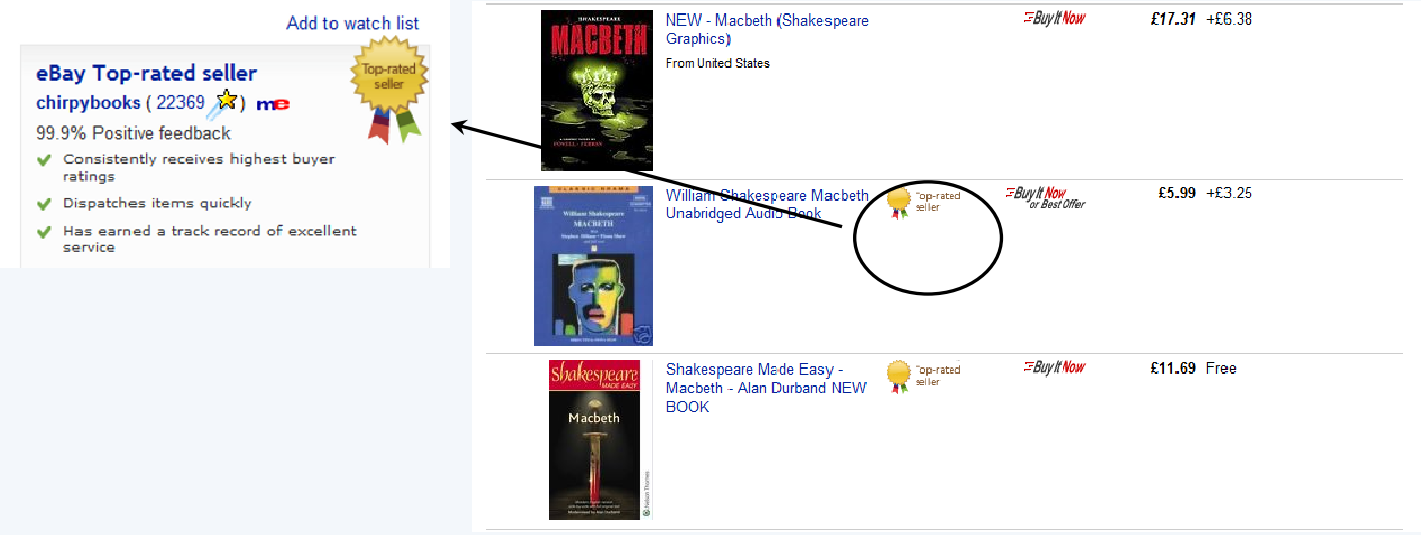
- ☐ eBay
- ☐ Amazon
- ☐ TripAdvisor
- ☐ I am not aware of any rating/review systems
- ☐ Other _____

If you answered "**I am not aware**…" skip to question **C3**, otherwise continue to question **C2**

C2. Please indicate how often do you use each of the following review/rating systems?

eBay:	Amazon:	TripAdvisor:	Other:
☐ Daily	☐ Daily	☐ Daily	☐ Daily
☐ 1 – 2 times per week	☐ 1 – 2 times per week	☐ 1 – 2 times per week	☐ 1 – 2 times per week
☐ Weekly	☐ Weekly	☐ Weekly	☐ Weekly
☐ Monthly	☐ Monthly	☐ Monthly	☐ Monthly
☐ Less than monthly	☐ Less than monthly	☐ Less than monthly	☐ Less than monthly

Below is a screenshot taken from the eBay products listing page. Some of the listed products carry a ***Top-rated Seller*** label.



For each of the following statements, **indicate your level of agreement** using the scale provided.

C3. **The Top-*rated seller* label encourages me to trust the vendor more than I would otherwise.**
(Tick one that applies)

☐	☐	☐	☐	☐
Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree

C4. **The *Top-rated seller* label would have a strong negative effect on my intention to purchase.**
(Tick one that applies)

☐	☐	☐	☐	☐
Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree

C5. **I would be more likely to purchase a product from a vendor that carries the *Top-rated seller* label.**
(Tick one that applies)

☐	☐	☐	☐	☐
Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree

C6. **A vendor that carries the *Top-rated seller* label provides products of high quality.**
(Tick one that applies)

☐	☐	☐	☐	☐
Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree

C7. **A vendor that carries the *Top-rated seller* label has a good reputation.**
(Tick one that applies)

☐	☐	☐	☐	☐
Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree

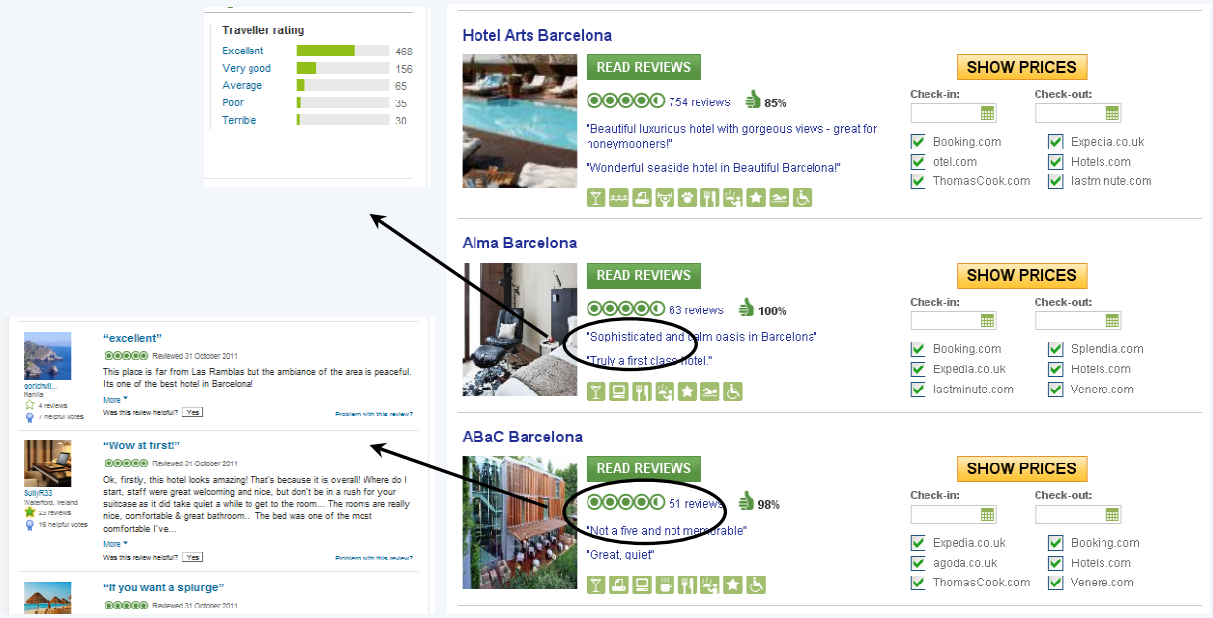
C8. **A vendor that carries the *Top-rated seller* label is more reliable than vendors that do not carry such a label.**
(Tick one that applies)

☐	☐	☐	☐	☐
Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree

C9. **A vendor that carries the *Top-rated seller* label has my best interests at heart.**
(Tick one that applies)

☐	☐	☐	☐	☐
Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree

Below is a screenshot taken from the TripAdvisor hotel listing page. The listed hotels have user ratings and reviews.



For each of the following statements, **indicate your level of agreement** using the scale provided.

C10. A positive review encourages me to trust a hotel more than I would otherwise.
(Tick one that applies)

Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
☐	☐	☐	☐	☐

C11. A positive review would have a strong negative effect on my intention to book a hotel.
(Tick one that applies)

Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
☐	☐	☐	☐	☐

C12. I would be more likely to book a hotel that has positive reviews.
(Tick one that applies)

Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
☐	☐	☐	☐	☐

C13. The hotels that have positive reviews are of high quality.
(Tick one that applies)

☐	☐	☐	☐	☐
Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree

C14. A hotel that has good reviews has a good reputation.
(Tick one that applies)

☐	☐	☐	☐	☐
Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree

C15. A hotel that has good reviews is more reliable than hotels that have bad reviews.

☐	☐	☐	☐	☐
Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree

C16. Good reviews do not promote trust towards a hotel.
(Tick one that applies)

☐	☐	☐	☐	☐
Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree

C17. I would be less likely to book a hotel that has positive reviews.
(Tick one that applies)

☐	☐	☐	☐	☐
Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree

C18. Considering your previous experience with rating/review systems or in light of the examples provided, should a GEO Label support a similar role?

- ☐ Yes
- ☐ No
- ☐ Don’t know

Please provide a brief explanation of your answer:

Now proceed to **Section D**

Section D – Drill-Down Functionality

We believe that a GEO Label could potentially be clickable and fulfil a drill-down function such that if the GEO Label was clicked, the user would be navigated to a GEO Label certification programme home page. The home page would provide information on the certification programme, describe the underlying criteria used when assigning the label to a dataset and provide more detailed information about the dataset itself.

E-Commerce privacy, security and business integrity seals of approval use click-to-verify functionality to confirm that the seal displayed by the vendor is genuine. Below (Figure D1) are example images of the most commonly used seals that use click-to-verify functionality.

Figure D1: Example seals with click-to-verify functionality.

D1. Have you ever come across any e-Commerce seals (including those in Figure D1) that use click-to-verify functionality?

- ☐ Yes
- ☐ No
- ☐ I was not aware of click-to-verify functionality

If you answered **No** or **I was not aware** skip to question **D4**, otherwise continue to question **D2**

D2. Have you ever clicked on any of the approval seals to verify if they are genuine?

- ☐ Yes
- ☐ No

Please provide a brief explanation as to why you have/have not clicked on approval seals for verification:

D3. Considering your previous experience with approval seals, do you think a GEO Label should fulfil a drill-down function and have click-to-verify functionality?

- ☐ Yes
- ☐ No
- ☐ Don’t know

Please provide a brief explanation to accompany your answer:

D4. In your opinion, how appropriate would it be to include an expert's judgement of the dataset and its quality as part of the GEO Label drill-down function?
(Tick one that applies)

☐	☐	☐	☐	☐	☐	☐
Extremely Inappropriate	Inappropriate	Somewhat Inappropriate	Neutral	Somewhat Appropriate	Appropriate	Extremely Appropriate

D5. In your opinion, how appropriate would it be to include information about a dataset's compliance with international standards (e.g., Dublin Core, ISO19115, etc) as part of the GEO Label drill-down function?
(Tick one that applies)

☐	☐	☐	☐	☐	☐	☐
Extremely Inappropriate	Inappropriate	Somewhat Inappropriate	Neutral	Somewhat Appropriate	Appropriate	Extremely Appropriate

D6. In your opinion, how appropriate would it be to include community (i.e., not necessarily expert) review functionality as part of the GEO Label drill-down function?
(Tick one that applies)

☐	☐	☐	☐	☐	☐	☐
Extremely Inappropriate	Inappropriate	Somewhat Inappropriate	Neutral	Somewhat Appropriate	Appropriate	Extremely Appropriate

D7. In your opinion, how appropriate would it be to establish a mechanism for rating datasets and including the rating as part of the GEO Label drill-down function?
(Tick one that applies)

☐	☐	☐	☐	☐	☐	☐
Extremely Inappropriate	Inappropriate	Somewhat Inappropriate	Neutral	Somewhat Appropriate	Appropriate	Extremely Appropriate

D8. In your opinion, how appropriate would it be to establish a mechanism for rating dataset's <u>providers</u> and including this rating as part of the GEO Label drill-down function?
(Tick one that applies)

☐	☐	☐	☐	☐	☐	☐
Extremely Inappropriate	Inappropriate	Somewhat Inappropriate	Neutral	Somewhat Appropriate	Appropriate	Extremely Appropriate

D9. In your opinion, how relevant would it be to include dataset citations (e.g., a list of journal articles or other publications where the dataset has been used and quality checks have been reported) as part of the GEO Label drill-down function?
(Tick one that applies)

☐	☐	☐	☐	☐	☐	☐
Extremely Irrelevant	Irrelevant	Somewhat Irrelevant	Neutral	Somewhat Relevant	Relevant	Extremely Relevant

D10. In your opinion, how useful would it be to include side-by-side metadata records visualisation for comparing two or more datasets as part of the GEO Label drill-down function?
(Tick one that applies)

☐	☐	☐	☐	☐	☐	☐
Extremely Useless	Useless	Somewhat Useless	Neutral	Somewhat Useful	Useful	Extremely Useful

D11. In your opinion, how relevant would it be to include 'soft knowledge' (subjective and informal statements) about the dataset quality that is provided by the creator or provider of the dataset as part of the GEO Label drill-down function?
(Tick one that applies)

☐	☐	☐	☐	☐	☐	☐
Extremely Irrelevant	Irrelevant	Somewhat Irrelevant	Neutral	Somewhat Relevant	Relevant	Extremely Relevant

D12. What other functionality (if any) do you think would be appropriate to include as part of the GEO Label drill-down function?

Now proceed to **Section E**

Section E – Closing Summary

E1. Please indicate your preference(s) for the role of a GEO Label
(Tick all that apply)

- ☐ Certification seal
- ☐ Drill down interrogation facility
- ☐ Other _____
- ☐ Don’t know

Please provide a brief explanation for your stated preference(s):

E2. In your opinion, should a GEO Label combine multiple functions (data ratings, reviews, quality assurance, etc.) and represent an all-in-one quality/trustworthiness indicator?

- ☐ Yes
- ☐ No

If **Yes**, please provide a brief explanation as to why do you think a GEO Label **SHOULD** be an all-in-one seal:

If **No**, please provide a brief description of what single function a GEO Label should adopt and explain why:

E3. Please feel free to leave any other comments or suggestions on a GEO Label or its potential role:

Thank you for taking the time to complete this questionnaire!

Please leave your contact details if you would like to be informed about the outcome of this survey or would be happy to participate in further studies associated with the GeoViQua research project.

Name: _____

E-mail: _____

☐ Yes, I would like to be informed about the results of this survey.

☐ Yes, I would be happy to participate in further studies.

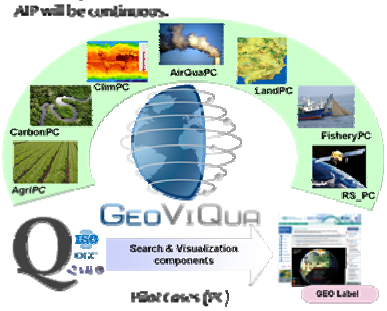
Appendix C – GEO Label Leaflet for the GEO Plenary Session 2012

GEOVIQUA OBJECTIVES

1. Provision of innovative tools to enhance the current infrastructure capability. GeoViQua's major technical innovation is search and visualization tools for the community which communicate and exploit data quality information from GEOSS catalogues.

2. Development of the GEOLabel. GEOLabel requirements are identified (Work Package WP2), integrated with components (WP6), validated and applied into pilot cases (WP7), and disseminated to the community (WP8). It will be completed in collaboration with the GEO task ST-09-02.

3. Harmonization, exploitation and dissemination of project outputs. A careful validation process is conducted in collaboration with a number of communities of practice and standards committees to ensure that the project contributes effectively to the GCI architecture. Collaboration to AIP will be continuous.



CONTACT

www.geoviqua.org
contact@geoviqua.org

Edifici C
Campus de Bellaterra (UAB)
08193 Cerdanyola del Vallès
Barcelona, Catalonia, Spain

Phone: +34 935811311
Fax: +34 935814151

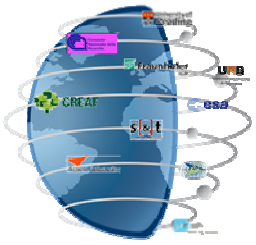
For more information about the GEO Label Questionnaire please contact:

Victoria Lush
School of Engineering and Applied Science
Aston University, Aston Triangle,
Birmingham, B4 7ET, UK

E-mail: lushv@aston.ac.uk

GEO Label Questionnaire

SEVENTH FRAMEWORK PROGRAMME (n° 265178)
THEME [ENV.2010.4.1.2-2]
Integrating new data visualisation approaches of earth Systems into GEOSS development



GeoViQua

QUality aware Visualisation for the Global Earth Observation system of systems

01/02/2011 31/01/2014

INTRODUCTION

What is GEO Label:
At present the Science and Technology Committee (S&T) is actively discussing the topic of establishing a GEO Label to assist the user in assessing the quality of geospatial data. Thus far, however, this initiative has scarce research on which to base its agenda: hence, it remains open to proposals for establishing the GEO Label.

GeoViQua's Role:
GeoViQua is expected to highly contribute to define the concept of the GEO Label so to allow for an increasing trustworthiness over GEOSS data and services delivery. GeoViQua will conduct online surveys, focus groups and controlled structured studies to define the role that a GEO Label should serve. We will apply the defined GEO Label protocol to the pilot case studies and identify major issues and possibility for improvements.

GEO Label Aim:
- Encourage scientists, researchers, and others to contribute their data and systems to GEOSS by offering an accepted voluntary label that provides recognition that their contribution is valued by the GEO community.
- Differentiate components, data and products delivered through GEOSS and provide a "trusted brand" to GEOSS users; member governments may base their decisions on data/products of such contributions.

(Extracted from ST-09-02 Draft GEO Label Concept document)

GEO LABEL DEVELOPMENT PHASES

Phase I:
We will conduct an online survey (GEO Label Questionnaire) that will be looking at:
- background information about the survey participants, the data sources they use or produce in their work and their awareness of any certificates or seals that apply to geospatial data;
- initial user and producer view on the role that a GEO Label should serve;
- some examples of common review and rating systems to identify the participants' opinion on such systems so that we can draw on the strengths of these when developing the GEO Label;
- some examples of commonly used seals that use click-to-verify functionality and the relevance of such functionality to the GEO Label;
- further comments and suggestions on a GEO Label or its potential role.

Phase II:
When Phase I results are analysed, we will conduct a further study presenting some GEO Label examples that will be based on our first study results. We will elicit feedback on these examples under controlled conditions and in a well-managed and structured way.

Phase III:
We will create physical prototypes which will be used in a human subject study. The most successful prototypes will then be used to define the GEO Label concept and the role that a GEO Label will serve.

GEO LABEL QUESTIONNAIRE

As part of Phase I of the GEO Label development process, we produced an online questionnaire to collect the initial GEO Label requirements and to identify the role that a GEO Label should serve. The questionnaire consists of more generic questions not to bias the users in any direction. Initial questions attempt to identify whether users believe a GEO Label is relevant to geospatial data; whether users want a single "one-for-all" label or separate labels that will serve particular roles; the function that would be most relevant for a GEO Label to carry; the functionality that users would want to transfer to a GEO Label from common rating and review systems they use.

PARTICIPANTS NEEDED!

We would be very grateful if you could spare some time to complete our GEO Label questionnaire. Your responses will provide important information that will help us in defining what role a GEO Label should fulfil.

For more information on how to complete our online questionnaire, please visit:

http://www.geoviqua.org/Eng/GeoLabel.htm

Appendix D – Phase II GEO Label Questionnaire

See next page.

Designing a GEO Label: Evaluating Prototype Label Designs

Introduction

GeoViQua is an EU research project that is working to provide the GEO data user community with innovative quality-aware visualisation and advanced geo-search capabilities. One of the objectives of our research is to contribute to defining the concept of a GEO label – that is, a label to assist users in quality assessment of geospatial datasets. This questionnaire represents the second phase of our GEO label research: having already solicited initial opinions from the user community as to the role the GEO label should serve and the information it should convey, we have consequently developed some prototype GEO label visualisations and it is on these we would like to elicit your opinion via this survey.

We would be very grateful if you could spare some time to complete this questionnaire. It should take you no more than approximately 40 minutes to complete. Your responses will be completely anonymous and confidential, and will only be used in our research. Your responses will provide important information that will help us to fully define and establish a GEO label that meets the needs of the geodata user community.

Section A – Background Information

Section A – Background Information

This section consists of a small number of questions to gather background information about you and your requirements when selecting geospatial data to use.

A1. Please identify yourself as one of the following:
(Tick one that applies)

- ☐ Primarily a data user
- ☐ Primarily a data producer
- ☐ Equally a data user and data producer

A2. Please select the description(s) that most accurately describe you:
(Tick all that apply)

- ☐ Group on Earth Observations committee member
- ☐ Private sector data user OR data producer
- ☐ Governmental data user OR data producer
- ☐ Research data user OR data producer
- ☐ Academic data user OR data producer
- ☐ Other: please specify _____

A3. What type of organization do you work for?
(Tick one that apply)

- ☐ Private company
- ☐ Public corporation
- ☐ Federal ministry or governmental organization
- ☐ Provincial ministry or governmental organization
- ☐ Municipal governmental organization
- ☐ Academic institution
- ☐ Non-for-profit organization
- ☐ Other: please specify _____

A4. In the context of your current and previous position(s), for how long have you been working with geospatial data or maps?
(Tick one that apply)

- ☐ Less than 2 years
- ☐ 2 to 9 years
- ☐ 10 to 19 years
- ☐ More than 20 years

A5. In the context of your current position, what approximate percentage (between 0 and 100) of your time is spent working directly with geospatial data?
(Please enter a number between 0 and 100)

☐ %

A6. In your typical work is there a choice of datasets you can use?

- ☐ Yes
- ☐ No
- ☐ Not applicable

If you answered **No** or **Not applicable** skip to **Section B**, otherwise continue to question **A7**

A7. Do you use any data portals or clearinghouses[1] for selecting datasets to use in your work?

[1] By 'data portals and clearinghouses' we mean large data repositories that collect, store and make available geospatial data and metadata, e.g. GEOSS clearinghouse, Geo.Data.gov, etc.

- ☐ Yes
- ☐ No
- ☐ Not sure

A8. If you answered Yes to A7, please list the data portals and clearinghouses that you use.

A9. In general, do you find selecting datasets that fit your needs a challenging task?

- ☐ Yes
- ☐ No
- ☐ Not sure

Please provide a brief explanation to your answer:

Now proceed to **Section B**

Section B – Understanding GEO Label Facets

Section B – Understanding GEO Label Facets

Geospatial data quality and the GEO label:

When selecting and using geospatial data, users typically need information on its quality. *Objective* quality information is often found in formal metadata documents supplied by the dataset provider or in technical reports which describe quality checks. *Subjective* quality information is also available and can include informal reports from other users describing how they used a dataset, users' ratings of data or assessment of data relevance, recommendations for appropriate/inappropriate uses of the data, or supplementary advice from dataset providers, such as warnings about problems in specific areas. At present, most standards-compliant geospatial data has a metadata record, but other (subjective) quality information can be scattered or unavailable. For this reason, the GEO label is proposed as a representation and interrogation facility to combine objective and subjective quality information in one place.

The GEO label itself will be a graphic representation (i.e., a static image) which will be generated individually for each dataset in the GEOSS (or other data portals and clearinghouses[1]) based on the quality information that is available for that dataset. The role of the GEO label in the data selection process can be best explained using a small scenario:

Consider yourself searching for a dataset in the GEOSS (or any other data portal or clearinghouse). You enter a search query and the search engine returns a number of datasets that match your criteria. Each of these datasets is accompanied by a GEO label which visually summarises the availability of quality information for that dataset. This allows you to make a quick assessment as to whether or not the information available suits your needs in terms of making an informed dataset selection. If you decide to investigate a dataset further, you can click on its GEO label and access the actual quality information for the dataset.

[1]*By 'data portals and clearinghouses' we mean large data repositories that collect, store and make available geospatial data and metadata, e.g. GEOSS clearinghouse, Geo.Data.gov, etc.*

Aim of this section:

From the results of a previous study, we established a set of eight user information needs that dataset users and producers felt a GEO label should address. In this section we present eight GEO label facets (that is, components of the overall GEO label) designed to represent those information needs. We want to explore **your level of understanding of the GEO label facets and the information they convey** about the datasets they represent before considering their collective visualisation within a single label. We are also keen to solicit your feedback and opinion on the examples presented.

B1. Please carefully inspect each of the icons presented below. For each icon, briefly describe what geospatial dataset informational aspects you believe the icon represents.

_____

_____

_____

_____

_____

_____

_____

_____

In the previous question we asked you to give your initial impression of the meaning of each icon. Now we will explain the *intended* meaning of each icon and ask you to consider how intuitive YOU think they are.

Producer Profile – information about the producer of the dataset, e.g., organisation or individual who produced the dataset, their contact information, etc.

B2. Please indicate how intuitive YOU think the <u>Producer Profile</u> icon is in terms of its intended meaning?
(Tick one that applies)

☐	☐	☐	☐	☐	☐	☐
Very Unintuitive	Unintuitive	Somewhat Unintuitive	Neutral	Somewhat Intuitive	Intuitive	Very Intuitive

B3. Please provide any comments or suggestions on the <u>Producer Profile</u> icon. For example, describe how easy/difficult it was to interpret its meaning, what you like/dislike about the icon, and provide any suggestions on how the icon can be improved, etc.

Producer Comments – any informal comments about the dataset quality as provided by the dataset producer, e.g., any identified problems, suggested use, etc.

B4. Please indicate how intuitive YOU think the <u>Producer Comments</u> icon is in terms of its intended meaning?
(Tick one that applies)

☐	☐	☐	☐	☐	☐	☐
Very Unintuitive	Unintuitive	Somewhat Unintuitive	Neutral	Somewhat Intuitive	Intuitive	Very Intuitive

B5. Please provide any comments or suggestions on the <u>Producer Comments</u> icon. For example, describe how easy/difficult it was to interpret its meaning, what you like/dislike about the icon, and provide any suggestions on how the icon can be improved, etc.

Compliance with Standards – information about dataset's compliance with international standards, e.g., compliance with ISO 19115, Dublin Core, etc.

B6. Please indicate how intuitive YOU think the <u>Compliance with Standards</u> icon is in terms of its intended meaning?
(Tick one that applies)

☐	☐	☐	☐	☐	☐	☐
Very Unintuitive	Unintuitive	Somewhat Unintuitive	Neutral	Somewhat Intuitive	Intuitive	Very Intuitive

B7. Please provide any comments or suggestions on the Compliance with Standards icon. For example, describe how easy/difficult it was to interpret its meaning, what you like/dislike about the icon, and provide any suggestions on how the icon can be improved, etc.

User Feedback – feedback and comments provided by the users of the dataset, e.g., general comments on dataset quality, identified problems, suggested use for the dataset, etc.

B8. Please indicate how intuitive YOU think the User Feedback icon is in terms of its intended meaning?
(Tick one that applies)

☐	☐	☐	☐	☐	☐	☐
Very Unintuitive	Unintuitive	Somewhat Unintuitive	Neutral	Somewhat Intuitive	Intuitive	Very Intuitive

B9. Please provide any comments or suggestions on the User Feedback icon. For example, describe how easy/difficult it was to interpret its meaning, what you like/dislike about the icon, and provide any suggestions on how the icon can be improved, etc.

User Ratings – ratings of the dataset quality as provided by the users of the dataset (based on a 5-star rating system).

B10. Please indicate how intuitive YOU think the User Ratings icon is in terms of its intended meaning?
(Tick one that applies)

☐	☐	☐	☐	☐	☐	☐
Very Unintuitive	Unintuitive	Somewhat Unintuitive	Neutral	Somewhat Intuitive	Intuitive	Very Intuitive

B11. Please provide any comments or suggestions on the User Ratings icon. For example, describe how easy/difficult it was to interpret its meaning, what you like/dislike about the icon, and provide any suggestions on how the icon can be improved, etc.

Expert Review – domain experts' comments on dataset quality, e.g., results of formal quality checks, expert suggestions on the dataset applications, etc.

B12. Please indicate how intuitive YOU think the Expert Review icon is in terms of its intended meaning?
(Tick one that applies)

☐	☐	☐	☐	☐	☐	☐
Very Unintuitive	Unintuitive	Somewhat Unintuitive	Neutral	Somewhat Intuitive	Intuitive	Very Intuitive

B13. Please provide any comments or suggestions on the Expert Review icon. For example, describe how easy/difficult it was to interpret its meaning, what you like/dislike about the icon, and provide any suggestions on how the icon can be improved, etc.

Citation Information – list of citations where the dataset was used and cited, e.g., formal reports on dataset quality checks, journal articles, etc.

B14. Please indicate how intuitive YOU think the Citation Information icon is in terms of its intended meaning?
(Tick one that applies)

☐	☐	☐	☐	☐	☐	☐
Very Unintuitive	Unintuitive	Somewhat Unintuitive	Neutral	Somewhat Intuitive	Intuitive	Very Intuitive

B15. Please provide any comments or suggestions on the Citation Information icon. For example, describe how easy/difficult it was to interpret its meaning, what you like/dislike about the icon, and provide any suggestions on how the icon can be improved, etc.

Quality Information – formal quality measures of the dataset, e.g., uncertainty measures recorded in UncertML, errors, accuracy information, etc.

B16. Please indicate how intuitive YOU think the <u>Quality Information</u> icon is in terms of its intended meaning?
(Tick one that applies)

☐	☐	☐	☐	☐	☐	☐
Very Unintuitive	Unintuitive	Somewhat Unintuitive	Neutral	Somewhat Intuitive	Intuitive	Very Intuitive

B17. Please provide any comments or suggestions on the <u>Quality Information</u> icon. For example, describe how easy/difficult it was to interpret its meaning, what you like/dislike about the icon, and provide any suggestions on how the icon can be improved, etc.

Visualisation of information availability:
As the GEO label is intended to convey the availability of quality information for a given dataset, each informational facet can represent one of three availability states: '***available***', '***not available***', and '***available only at a higher level***'[2]. These three information availability states will be expressed through varying the appearance of the facet icons. The following set of questions is designed to explore **the intuitiveness of these icon variations and how effective they are at conveying information availability.**

[2] *'Available only at a higher level' indicates that information is not immediately available for the dataset, but is available for a parent dataset. For example, quality information may be available for the Landsat 7 data product, but not for a specific tile.*

B18. Please carefully inspect the icons presented below. For each icon, briefly describe the information availability state you believe the icon represents.

_____

_____

_____

In the previous question we asked you to give your initial impression of the meaning of the icon variations. Now we will explain the *intended* meaning of each icon variation and ask you to consider how intuitive YOU think they are.

Blue background + white icon – information is **available** for this dataset.

White background + icon outline – information is **not available** for this dataset.

White background + blue icon – information is **available only at a higher level** for this dataset.

B19. Please indicate how intuitive YOU think the icon variations are in terms of their intended meaning?
(Tick one that applies)

☐	☐	☐	☐	☐	☐	☐
Very Unintuitive	Unintuitive	Somewhat Unintuitive	Neutral	Somewhat Intuitive	Intuitive	Very Intuitive

B20. Please comment on the design of the availability icons. For example, describe how easy/difficult was it to interpret their meaning, what do you like/dislike about the icons, and any suggestions on how the icons can be improved, etc.

Now proceed to **Section C**

Section C – GEO Label Examples

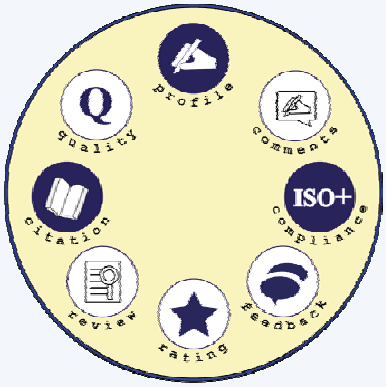
Section C – GEO Label Examples

The following section is designed to explore the effectiveness of the proposed GEO label prototypes at conveying the availability of a dataset's quality information. Here we will present you with three different designs for the GEO label, two of which use the icons you have previously considered, to solicit your feedback and opinion on these designs.

GEO label – Example 1:

Below is a prototype example of the GEO label. As described in the previous section, the GEO label is intended as a representation and interrogation facility that combines several informational aspects: **dataset producer information**, **producer comments on the dataset quality, dataset's compliance with standards, user feedback**, **user ratings of the dataset**, **expert reviews**, **dataset citations**, and **dataset quality information**. As you may remember from Section B, each informational facet shows whether the information it represents is 'available', 'not available' or 'only available at a higher level' for the dataset with which it is associated.

Please carefully inspect the label and proceed to the questions below.



C1. Based on the GEO label provided, please select the statements about the dataset that you believe are TRUE.
(Tick all that apply)

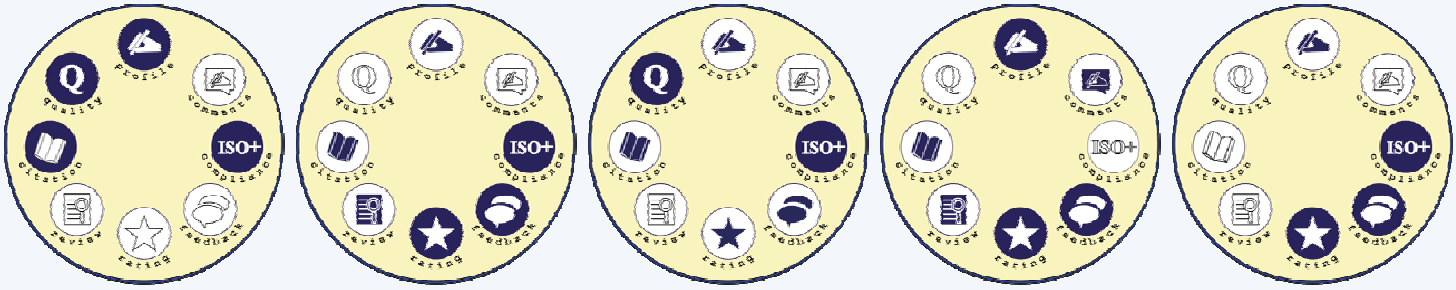
- ☐ Expert review is **available**
- ☐ User rating is **only available at a higher level**
- ☐ Information about the dataset's compliance with international standards is **available**
- ☐ Quality information is **not available**
- ☐ User feedback is **not available**
- ☐ Producer comments are **only available at a higher level**
- ☐ Citation information is **available**
- ☐ Producer profile information is **not available**
- ☐ User feedback is **available**

Please read this carefully before proceeding to the questions:
Consider a scenario where you are searching an established data portal or a clearinghouse for a dataset to use in your work. You enter your search criteria and get a list of datasets that match your query. The datasets returned are accompanied by a GEO label.

Scenario 1:
For this scenario we would like you to assume that the following information is of high importance to you and will heavily influence your dataset selection:

a) Any feedback on the dataset's previous use, such as discovered issues or suggested applications;
b) Journal publications or quality reports which refer to the dataset; and
c) Contact information of the dataset provider in case you require additional information about the dataset.

Please carefully inspect the example labels presented and proceed to the questions.



C2. In light of the scenario presented above and based on the GEO labels provided, please rank the datasets in order in terms of their relative ability to provide the quality information you seek.
(Enter a number from 1 to 5 for each dataset with 1 being the first dataset to inspect.)

- ☐ Dataset 1
- ☐ Dataset 2
- ☐ Dataset 3
- ☐ Dataset 4
- ☐ Dataset 5

C3. Please provide a brief explanation to your ranking decision, for example explain how the informational aspects represented within the label influenced your decision.

Scenario 2:
As in the previous scenario, you are selecting a dataset for further inspection. Here we would like you to assume that the following information is of high importance to you and will heavily influence your dataset selection:
a) Formal quality information such as uncertainty measures and dataset accuracy;
b) The dataset's compliance with international standards;
c) Experts' opinions on the dataset quality; and
d) Reports on quality checks which refer to the dataset.
Please carefully inspect the example labels presented and proceed to the questions.

Dataset 1 **Dataset 2** **Dataset 3** **Dataset 4** **Dataset 5**

C4. In light of the scenario presented above and based on the GEO labels provided, please rank the datasets in order in terms of their relative ability to provide the quality information you seek.
(Enter a number from 1 to 5 for each dataset with 1 being the first dataset to inspect.)

- ☐ Dataset 1
- ☐ Dataset 2
- ☐ Dataset 3
- ☐ Dataset 4
- ☐ Dataset 5

C5. Please provide a brief explanation to your ranking decision, for example explain how the informational aspects represented within the label influenced your decision.

C6. Please indicate how difficult it was to rank the datasets in these scenarios based on the example GEO labels provided.
(Tick one that applies)

☐	☐	☐	☐	☐	☐	☐
Very Difficult	Difficult	Somewhat Difficult	Neutral	Somewhat Easy	Easy	Very Easy

C7. In your opinion, how effective is this proposed GEO label design at conveying the availability of a dataset's quality information?
(Tick one that applies)

☐	☐	☐	☐	☐	☐	☐
Very Ineffective	Ineffective	Somewhat Ineffective	Neutral	Somewhat Effective	Effective	Very Effective

C8. Please describe which aspects of this proposed GEO label design you find most effective/ineffective in conveying the availability of a dataset's quality information.

Currently we are considering a number of different versions of the information 'available only at a higher level' icon designs. After reviewing the first proposed GEO label design, we would like your opinion on these alternatives so that we can select the most effective and intuitive version for the GEO label.

Version 1

Version 2

Version 3

Version 4

Version 5

Version 6

C9. Of the GEO label icon versions you have just viewed, please rank the versions in the order of YOUR preference from 1 to 6.
(Enter a number from 1 to 6 for each version with 1 being the most preferable.)

- ☐ Version 1
- ☐ Version 2
- ☐ Version 3
- ☐ Version 4
- ☐ Version 5
- ☐ Version 6

C10. Please provide any comments about or suggestions related to the icon versions you have just viewed.

GEO label – Example 2:

Below is a second prototype example for the GEO label. As you can see, this example is very similar to the prototype shown in example 1. It also shows availability of **dataset producer information**, **producer comments on the dataset quality, user feedback**, **expert reviews**, **dataset citations**, and **dataset quality information**. **User ratings of the dataset** in this example are presented as an average 5-star rating. The label also provides information on the **specific international standard(s)** with which the dataset complies.

Please carefully inspect the label and proceed to the questions below.

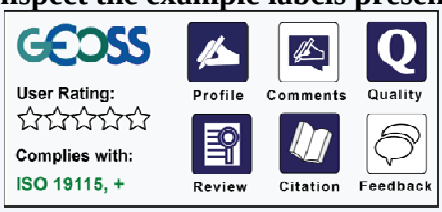
C11. Based on the GEO label provided, please select the statements about the dataset that you believe are TRUE.
(Tick all that apply)

- ☐ Producer comments are **not available**
- ☐ User feedback is **available**
- ☐ User rating is **available**
- ☐ Citation information is **only available at a higher level**
- ☐ Producer comments are **only available at a higher level**
- ☐ Expert review is **not available**
- ☐ Quality information is **not available**
- ☐ The dataset **complies with ISO standard**
- ☐ Producer profile information is **only available at a higher level**
- ☐ The dataset has a **rating of 3**

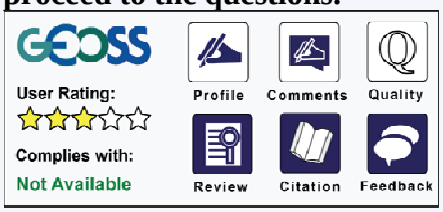
Please read this carefully before proceeding to the questions:
As in the previous example, consider a scenario where you are searching an established data portal or a clearinghouse for a dataset to use in your work. You enter your search criteria and get a list of datasets that match your query. The datasets returned are accompanied by a GEO label.

Scenario 1:
For this scenario we would like you to assume that the following information is of high importance to you and will heavily influence your dataset selection:
a) The dataset's average rating which should be of 3 or above;
b) Experts' opinions on the dataset quality;
c) The dataset's compliance with international standards; and
d) Journal publications or quality reports which refer to the dataset.

Please carefully inspect the example labels presented and proceed to the questions.

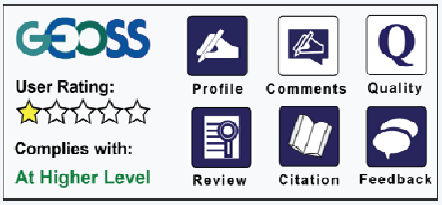


Dataset 1



Dataset 2

Dataset 3



Dataset 4

Dataset 5

C12. In light of the scenario presented above and based on the GEO labels provided, please rank the datasets in order in terms of their relative ability to provide the quality information you seek.
(Enter a number from 1 to 5 for each dataset with 1 being the first dataset to inspect.)

- ☐ Dataset 1
- ☐ Dataset 2
- ☐ Dataset 3
- ☐ Dataset 4
- ☐ Dataset 5

C13. Please provide a brief explanation to your ranking decision, for example explain how the informational aspects represented within the label influenced your decision.

C14. Please indicate how difficult it was to rank the datasets in these scenarios based on the example GEO labels provided.
(Tick one that applies)

☐	☐	☐	☐	☐	☐	☐
Very Difficult	Difficult	Somewhat Difficult	Neutral	Somewhat Easy	Easy	Very Easy

C15. In your opinion, how effective is this proposed GEO label design at conveying the availability of a dataset's quality information?
(Tick one that applies)

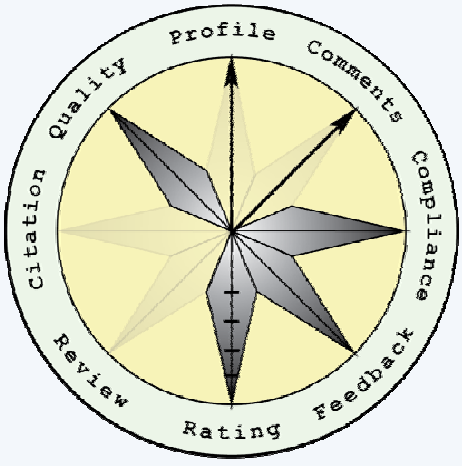
☐	☐	☐	☐	☐	☐	☐
Very Ineffective	Ineffective	Somewhat Ineffective	Neutral	Somewhat Effective	Effective	Very Effective

C16. Please describe which aspects of this proposed GEO label design you find most effective/ineffective in conveying the availability of a dataset's quality information.

GEO label – Example 3:

Below is the third prototype example of the GEO label. Unlike the first two examples which used icons to represent informational aspects, this GEO label uses eight star points to convey whether the information is 'available', 'not available' or 'only available at a higher level' for the dataset with which it is associated. As in the previous examples, the label combines eight informational aspects: **dataset producer information**, **producer comments on the dataset quality, dataset's compliance with standards, user feedback**, **user ratings of the dataset**, **expert reviews**, **dataset citations**, and **dataset quality information**.

Please carefully inspect the label and proceed to the questions below.



Visualisation of information availability:
As you may remember from the previous section, each informational facet can represent one of three availability states: '***available***', '***not available***', and '***available only at a higher level***'[2]. In this example design, these three information availability states are represented by varying the appearance of the arm of the star. The following set of questions is designed to explore **the intuitiveness of these star arm variations and how effective they are at conveying information availability.**

[2] *'Available only at a higher level' indicates that information is not immediately available for the dataset, but is available for a parent dataset. For example, quality information may be available for the Landsat 7 data product, but not for a specific tile.*

C17. Please carefully inspect the icons presented below. For each icon, briefly describe what information availability state you believe the icon represents.

_____

_____

_____

In the previous question we asked you to give your initial impression of meaning of the variations in the star arms. Now we will explain the *intended* meaning of each star arm variation and ask you to consider how intuitive YOU think they are.

Gray star arm with black outline – information is **available** for this dataset.

Transparent star arm – information is **not available** for this dataset.

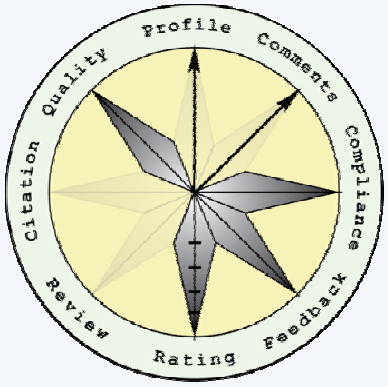
Transparent star arm with black arrow – information is **available only at a higher level** for this dataset.

C18. Please identify how intuitive do YOU think the variations in the star arms are in terms of their intended meaning?
(Tick one that applies)

☐	☐	☐	☐	☐	☐	☐
Very Unintuitive	Unintuitive	Somewhat Unintuitive	Neutral	Somewhat Intuitive	Intuitive	Very Intuitive

C19. Please comment on the design of the availability icons. For example, describe how easy/difficult was it to interpret their meaning, what do you like/dislike about the icons, and any suggestions on how the icons can be improved, etc.

Please again carefully inspect the label and proceed to the questions below.



C20. Based on the GEO label provided, please select the statements about the dataset that you believe are TRUE.
(Tick all that apply)

- ☐ Citation information is **available**
- ☐ Information about the dataset's compliance with international standards is **not available**
- ☐ Expert review is **not available**
- ☐ Producer comments are **only available at a higher level**
- ☐ User feedback is **available**
- ☐ Citation information is **only available at a higher level**
- ☐ Quality information is **only available at a higher level**
- ☐ User rating is **not available**
- ☐ Producer profile information is **only available at a higher level**
- ☐ Expert review is **available**

Please read this carefully before proceeding to the questions:

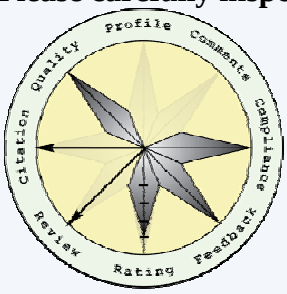
As in the previous example, consider a scenario where you are searching an established data portal or a clearinghouse for a dataset to use in your work. You enter your search criteria and get a list of datasets that match your query. The datasets returned are accompanied by a GEO label.

Scenario 1:

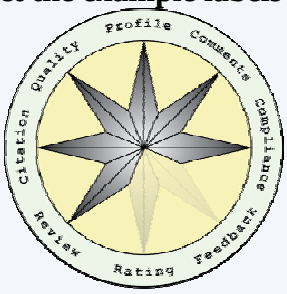
For this scenario we would like you to assume that the following information is of high importance to you and will heavily influence your dataset selection:

a) The dataset's average rating which should be of 4 or above;
b) Formal quality information such as uncertainty measures and dataset accuracy;
c) Information about the dataset's producer, such as who produced the data and how to contact them; and
d) Producer comments on the dataset quality.

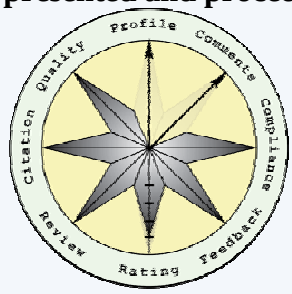
Please carefully inspect the example labels presented and proceed to the questions.



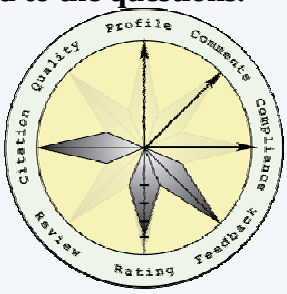
Dataset 1



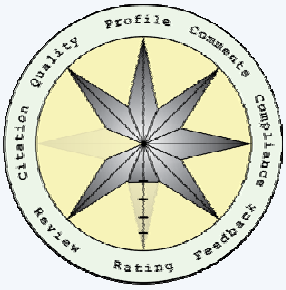
Dataset 2



Dataset 3



Dataset 4



Dataset 5

C21. In light of the scenario presented above and based on the GEO labels provided, please rank the datasets in order in terms of their relative ability to provide the quality information you seek.
(Enter a number from 1 to 5 for each dataset with 1 being the first dataset to inspect.)

- ☐ Dataset 1
- ☐ Dataset 2
- ☐ Dataset 3
- ☐ Dataset 4
- ☐ Dataset 5

C22. Please provide a brief explanation to your ranking decision, for example explain how the informational aspects represented within the label influenced your decision.

C23. Please indicate how difficult it was to rank the datasets in these scenarios based on the example GEO labels provided.
(Tick one that applies)

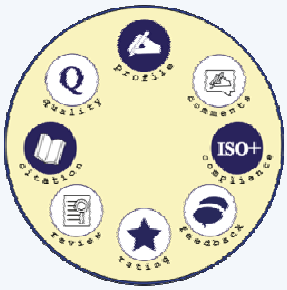
☐	☐	☐	☐	☐	☐	☐
Very Difficult	Difficult	Somewhat Difficult	Neutral	Somewhat Easy	Easy	Very Easy

C24. In your opinion, how effective is this proposed GEO label design at conveying the availability of a dataset's quality information?
(Tick one that applies)

☐	☐	☐	☐	☐	☐	☐
Very Ineffective	Ineffective	Somewhat Ineffective	Neutral	Somewhat Effective	Effective	Very Effective

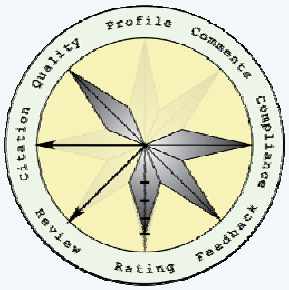
C25. Please describe which aspects of this proposed GEO label design you find most effective/ineffective in conveying the availability of a dataset's quality information.

Please review the three GEO label examples presented in this study.



Example 1

Example 2



Example 3

C26. After reviewing the examples presented here, please rank the GEO label examples in order of YOUR preference (with 1 being your most preferred version).

- ☐ GEO label – Example 1
- ☐ GEO label – Example 2
- ☐ GEO label – Example 3

Please provide a brief explanation for your answer:

Now proceed to **Section D**

Section D – GEO Label Facets

Section D – GEO Label Facets

This section consists of a small number of questions to gather your opinion on the informational aspects presented in the GEO label examples.

D1. Of the informational aspects included in the GEO labels you have viewed, please select the informational aspects that YOU think are useful in dataset selection and that YOU think should be included in the GEO label.
(Tick all that apply)

- ☐ Dataset producer information
- ☐ Producer comments
- ☐ Compliance with international standards
- ☐ User feedback
- ☐ User rating
- ☐ Expert Review
- ☐ Citation information
- ☐ Dataset quality information
- ☐ None of these

Please provide a brief explanation for your answer:

D2. Of the informational aspects included in the GEO labels you have viewed, please rank the aspects in the order of importance to YOU from 1 to 8.
(Enter a number from 1 to 8 for each informational aspect with 1 being the most important)

- ☐ Dataset producer information
- ☐ Producer comments
- ☐ Standards Compliance
- ☐ User feedback
- ☐ User rating
- ☐ Expert Review
- ☐ Citation information
- ☐ Dataset quality information

Please provide a brief explanation for your ranking:

D3. Please select any informational aspect(s) that you believe are redundant and should NOT be present in the GEO label.
(Tick all that apply)

- ☐ Dataset producer information
- ☐ Producer comments
- ☐ Standards Compliance
- ☐ User feedback
- ☐ User rating
- ☐ Expert Review
- ☐ Citation information
- ☐ Dataset quality information
- ☐ None of these

Please provide a brief explanation for your answer:

D4. Please provide any comments or suggestions about the informational aspects presented in the GEO label examples. List any informational aspects that you believe are missing and should be included in the GEO label.

Now proceed to **Section E**

Section E – GEO Label Branding

Section E – GEO Label Branding

This section consists of a small number of questions to gather your opinion on the use of branding in the GEO label.

Use of branding in the GEO label:

In this section we would like to explore your opinion on the use of GEO branding in the GEO label.

Please carefully inspect the labels and proceed to the questions below.

For each of the following statements, **indicate your level of agreement** using the scale provided.

E1. **Presence of the GEO branding encourages me to trust the GEO label more than I would otherwise.**
(Tick one that applies)

☐	☐	☐	☐	☐
Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree

E2. **A GEO label that carries the GEO branding is more reliable than a label that has no branding.**
(Tick one that applies)

☐	☐	☐	☐	☐
Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree

E3. I would be less likely to trust a label that has the GEO branding.
(Tick one that applies)

☐	☐	☐	☐	☐
Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree

E4. Of the GEO label examples provided above, please indicate which version you prefer:

☐ The GEO label **WITH the GEO branding**

☐ The GEO label **WITHOUT the GEO branding**

☐ Not sure

Please provide a brief explanation for your answer:

Now proceed to **Section F**

Section F – Closing Summary

Section F – Closing Summary

F1. Please feel free to leave any other comments or suggestions on a GEO label and the examples presented here:

Thank you for taking the time to complete this questionnaire!

Please leave your contact details if you would like to be informed about the outcome of this survey or would be happy to participate in further studies associated with the GeoViQua research project.

Name: _____

E-mail: _____

☐ Yes, I would like to be informed about the results of this survey.

☐ Yes, I would be happy to participate in further studies.

Appendix E – Phase II Study Respondents' Profiles

QuestionPro ID	Respondent's Profile
9896673	**Respondent 1** is a research data producer who works for academic institution. Respondent 1 has been working with geospatial data for more than 20 years and, in the context of the current position, he/she spends approximately 80% of his/her time working directly with geospatial data. Respondent 1 has a choice of datasets to use but he/she does not use any data portals or clearinghouses for selecting datasets. Respondent 1 finds selecting datasets that fit his/her needs a challenging task.
9921227	**Respondent 2** is a governmental data user and data producer who works for a federal ministry or a governmental organization. Respondent 2 has been working with geospatial data for more than 20 years and, in the context of the current position, he/she spends approximately 40% of his/her time working directly with geospatial data. Respondent 2 has a choice of datasets to use and he/she uses WMO WIS, WMO GTS, GEOSS and Exeter GISC data portals or clearinghouses for selecting datasets. Respondent 2 **does not** find selecting datasets that fit his/her needs a challenging task because he/she has a lot of experience and "*routinely use*[s] *(undocumented) reputation of many data producers*".
9944350	**Respondent 3** is a research data user and data producer who works for an academic institution. Respondent 3 has been working with geospatial data for about 2 to 9 years and, in the context of the current position, he/she spends approximately 50% of his/her time working directly with geospatial data. Respondent 3 has a choice of datasets to use and he/she uses NASA, ESA; GEOSS, Spanish SDI data portals or clearinghouses for selecting datasets. Respondent 3 finds selecting datasets that fit his/her needs a challenging task because of "*lack of clear metadata information, that easily describe*[s] *the data*".
9956809	**Respondent 4** is an academic data user and data producer who works for an academic institution. Respondent 4 has been working with geospatial data for more than 20 years and, in the context of the current position, he/she spends 100% of his/her time working directly with geospatial data. Selection of geospatial data is not applicable to the respondent 4.
9959670	**Respondent 5** is an academic data user who works for an academic institution. Respondent 5 has been working with geospatial data for about 2 to 9 years and, in the context of the current position, he/she spends only about 5% of his/her time working directly with geospatial data. Respondent 5 has no choice of datasets to use.
9973692	**Respondent 6** is a research data user who works for an academic institution. Respondent 6 has been working with geospatial data for about 2 to 9 years and, in the context of the current position, he/she spends approximately 20% of his/her time working directly with geospatial data. Respondent 6 has a choice of datasets to use but he/she does not use data portals or clearinghouses for selecting datasets.

	Respondent 6 finds selecting datasets that fit his/her needs a challenging task because he/she does not know how to use data portals and there is no clear explanation on how data portals work. Also "*at local scale data is not available*" and "*thematic areas (e.g. soil data) have specialized portals* [users] *are not aware of*".
9980194	**Respondent 7** is a research data user and data producer who works for a non-for-profit organization. Respondent 7 has been working with geospatial data for about 10 to 19 years and, in the context of the current position, he/she spends approximately 25% of his/her time working directly with geospatial data. Respondent 7 has a choice of datasets to use and he/she uses EDGAR and GENESI-DEC data portals or clearinghouses for selecting datasets. Respondent 7 finds selecting datasets that fit his/her needs a challenging task because "*it is often hard to find a suitable data set which is freely available for direct download*".
10748369	**Respondent 8** is a research data user who works for a federal ministry or a governmental organization. Respondent 8 has been working with geospatial data for about 2 to 9 years and, in the context of the current position, he/she spends approximately 30% of his/her time working directly with geospatial data. Respondent 8 has a choice of datasets to use and he/she uses INSPIRE Geoportal, RNDT, and SILVenezia data portals or clearinghouses for selecting datasets. Respondent 8 finds selecting datasets that fit his/her needs a challenging task because of "*bad metadata, not optimal discovery tools, lack of licences associated with data*".
10765670	**Respondent 9** is a private company service provider and data user who works for a private company. Respondent 9 has been working with geospatial data for about 10 to 19 years but, in the context of the current position, he/she spends only about 10% of his/her time working directly with geospatial data. Respondent 9 has a choice of datasets to use and he/she uses GEO portal, ESA, NASA, USGS, and a number of thematic portals for selecting datasets. Respondent 9 finds selecting datasets that fit his/her needs a challenging task because of "*too many choices, not good description of meta data, what the data can be used for*" and because data selection "*require*[s] *too much specialist knowledge*".
10789209	**Respondent 10** is a research and academic data user who works for an academic institution. Respondent 10 has been working with geospatial data for about 2 to 9 years and, in the context of the current position, he/she spends only about 10% of his/her time working directly with geospatial data. Selection of geospatial data is not applicable to the respondent 10.
10810835	**Respondent 11** is a research data user who works for a non-for-profit organization. Respondent 11 has been working with geospatial data for about 10 to 19 years and, in the context of the current position, he/she spends approximately 75% of his/her time working directly with geospatial data. Respondent 11 has a choice of datasets to use but he/she does not use any data portals or clearinghouses for selecting datasets. Respondent 11 **does not** find selecting datasets that fit his/her needs a challenging task because in general his/her organisation knows which datasets it needs. "*However* [his/hers

	organisation is] *always looking for updated versions, and of course new datasets which could be used*".
10812895	**Respondent 12** is an academic data user and data producer who works for an academic institution. Respondent 12 has been working with geospatial data for more than 20 years and, in the context of the current position, he/she spends approximately 50% of his/her time working directly with geospatial data. Respondent 12 has a choice of datasets to use and he/she uses ESPON, OSI.IE, CSO.IE, and various EU for selecting datasets. Respondent 12 finds selecting datasets that fit his/her needs a challenging task however he/she argues that this depends on a situation. "*Sometimes the problems arises from the emergence of a new dataset (it permits some questions that we've had rumbling around to be answered). Other times, the spatial resolution of a dataset (this is a problem with Irish censuses) is a challenge. You conclusions are necessarily conditioned on the data (this is a statement of the blindingly obvious, but it's not always recalled).*"
10820938	**Respondent 13** is a governmental data user and data producer who works for a federal ministry or a governmental organization. Respondent 13 has been working with geospatial data for about 10 to 19 years and, in the context of the current position, he/she spends approximately 50% of his/her time working directly with geospatial data. Respondent 13 has a choice of datasets to use but he/she does not use any data portals or clearinghouses for selecting datasets. Respondent 13 finds selecting datasets that fit his/her needs a challenging task. The "*most problematic is to find a data set that is of good quality, has a decent resolution and is consistent, i.e. there are no sudden jumps in time series*".
10829438	**Respondent 14** is a governmental, private sector, research and academic data producer who works for a non-for-profit organization. Respondent 14 has been working with geospatial data for about 2 to 9 years and, in the context of the current position, he/she spends approximately 50% of his/her time working directly with geospatial data. Respondent 14 has a choice of datasets to use and he/she uses NASA OBPG, ESA portals, GEOSS registry, and NERC portal for selecting datasets. Respondent 14 finds selecting datasets that fit his/her needs a challenging task. "*When a data source is known (e.g. by a colleague), then it's relatively easy. Finding a new data source for a new problem is often trickier. Google is normally the best way to find something!*"
10854825	**Respondent 15** is a research data producer who works for a provincial ministry or a governmental organization. Respondent 15 has been working with geospatial data for More than 20 years and, in the context of the current position, he/she spends approximately 90% of his/her time working directly with geospatial data. Respondent 15 has a choice of datasets to use and he/she uses I.Stat, FAO and EEA data portals and clearinghouses for selecting datasets. Respondent 15 finds selecting datasets that fit his/her needs a challenging task but does not provide more detail on the actual reasons.

10867181	**Respondent 16** is an academic data user who works for an academic institution. Respondent 16 has been working with geospatial data for more than 20 years and, in the context of the current position, he/she spends approximately 25% of his/her time working directly with geospatial data. Respondent 16 has no choice of datasets to use.
10892939	**Respondent 17** is an academic data user and data producer who works for an academic institution. Respondent 17 has been working with geospatial data for about 2 to 9 years and, in the context of the current position, he/she spends approximately 80% of his/her time working directly with geospatial data. Respondent 17 has a choice of datasets to use but he/she does not use any data portals or clearinghouses for selecting datasets. Respondent 17 finds selecting datasets that fit his/her needs a challenging task but does not provide more detail on the actual reasons.
10896211	**Respondent 18** is a governmental data user and data producer who works for a federal ministry or a governmental organization. Respondent 18 has been working with geospatial data for about 2 to 9 years and, in the context of the current position, he/she spends 100% of his/her time working directly with geospatial data. Respondent 18 has a choice of datasets to use but he/she does not use any data portals or clearinghouses for selecting datasets. Respondent 18 finds selecting datasets that fit his/her needs a challenging task but does not provide more detail on the actual reasons.
10901021	**Respondent 19** is a private sector and research data user and data producer who works for a non-for-profit organization. Respondent 19 has been working with geospatial data for about 10 to 19 years but, in the context of the current position, he/she spends only about 5% of his/her time working directly with geospatial data. Respondent 19 has a choice of datasets to use and he/she uses SeaZone product set, Geo.Data.gov, ArcGIS supplied datasets, and Natural England for selecting datasets. Respondent 19 is not sure whether selecting datasets that fit his/her needs is a challenging task because he/she is "…*well aware of datasets available directly in* [his/her] *area of expertise, but less sure when* [he/she] *need*[s] *something else*."
10922275	**Respondent 20** is an academic data user and data producer who works for a public corporation. Respondent 20 has been working with geospatial data for about 10 to 19 years and, in the context of the current position, he/she spends 100% of his/her time working directly with geospatial data. Respondent 20 has a choice of datasets to use but he/she does not use any data portals or clearinghouses for selecting datasets. Respondent 20 finds selecting datasets that fit his/her needs a challenging task because "[he/she] *work*[s] *with soil profiles and the major challenge is to determine whether 2 soil profiles are in reality different or identical but with different reference sources or semantics*".
10923696	**Respondent 21** is an academic data user and data producer who works for an academic institution. Respondent 21 has been working with geospatial data for more than 20 years and, in the context of the current position, he/she spends

	approximately 50% of his/her time working directly with geospatial data. Respondent 21 has a choice of datasets to use and he/she uses www.nationaalregister.nl, www.geocommons.com, and pdok.pleio.nl for selecting datasets to use. Respondent 21 finds selecting datasets that fit his/her needs a challenging task because, "*provided metadata is mostly insufficient to decide on fitness for use, therefore the pick involves risk of dataset's misfit for* [his/her] *task*".
10952298	**Respondent 22** is an academic data user who works for an academic institution. Respondent 22 has been working with geospatial data for about 10 to 19 years but, in the context of the current position, he/she only spends approximately 10% of his/her time working directly with geospatial data. Respondent 22 has a choice of datasets to use and he/she uses BADC archive, Streetmap, and Google for selecting datasets to use. Respondent 22 finds selecting datasets that fit his/her needs a challenging task. "*Finding the right data - fragmented nature of data on the web, hence google being the main tool! Main challenge is to compare datasets ... this is very tricky since no two datasets are that similar*".
11032412	**Respondent 23** is an academic data user and data producer who works for an academic institution. Respondent 23 has been working with geospatial data for more than 20 years but, in the context of the current position, he/she only spends approximately 10% of his/her time working directly with geospatial data. Respondent 23 has a choice of datasets to use but he/she does not use any data portals or clearinghouses for selecting datasets. Respondent 23 finds selecting datasets that fit his/her needs a challenging task. "*I develop methodologies and need data sets to test and illustrate them. I don't collect data myself so I rely on others. often it is difficult to get hold of data that are useful.*".
11138974	**Respondent 24** is an academic data user who works for an academic institution. Respondent 24 has been working with geospatial data for about 2 to 9 years and, in the context of the current position, he/she only spends approximately 20% of his/her time working directly with geospatial data. Respondent 24 has a choice of datasets to use but he/she does not use any data portals or clearinghouses for selecting datasets. Respondent 24 is not sure whether selecting datasets that fit his/her needs is a challenging task because he/she is "*mostly a technology provider so do*[es] *not use geospatial data to answer questions of* [his/her] *own*". Respondent 24 is therefore does not have "*specific scientific 'needs' about data*".
11163053	**Respondent 25** is an academic data user and data producer who works for a non-for-profit organization. Respondent 25 has been working with geospatial data for more than 20 years but, in the context of the current position, he/she only spends approximately 15% of his/her time working directly with geospatial data. Respondent 25 has a choice of datasets to use but he/she does not use any data portals or clearinghouses for selecting datasets. Respondent 25 finds selecting datasets that fit his/her needs a challenging task because, as he/she says, "*you*

	never really know there isn't a better one!".
11289301	**Respondent 26** is an academic data user who works for an academic institution. Respondent 26 has been working with geospatial data for about 2 to 9 years and, in the context of the current position, he/she only spends approximately 20% of his/her time working directly with geospatial data. Respondent 26 has a choice of datasets to use and he/she uses National Snow and Ice Data Centre (NSIDC) and MODIS LP DAAC for selecting datasets to use. Respondent 26 **does not** find selecting datasets that fit his/her needs a challenging task because his/her "*work is around the comparison of datasets to assess their consistency, or to compare to models*". The database that Respondent 26 uses – CEOS database – is "*an excellent resource for finding out which missions have flown at which times, delivering which parameters*". Although, "*the difficulty can come in accessing the data and finding out enough ancillary information about it, rather than selection per se*".