

Thesis in Geographical Information Technics nr 15

Designing a Generic User Interface for Distribution of Open Geodata

Based on FME Server Technology

Magdalena Nyberg

Program in Surveying and Land Management
Faculty of Engineering

Department of Physical Geography and Ecosystem Science
Lund University





Lund University
Faculty of Engineering

Designing a Generic User Interface for Distribution of Open Geodata

EXTM05 Master Thesis, 30 ECTS
Program in Surveying and Land Management

Magdalena Nyberg

Supervisor: Lars Harrie
Department of Physical Geography and Ecosystem Science

Opponent: Lisette Danebjer
Examiner: Margareta Hellström

June 05, 2015

Copyright © Magdalena Nyberg, LTH

Department of Physical Geography and Ecosystem Science
Lund University
Sölvegatan 12
223 62 Lund

Telephone: 046-222 30 30
Fax: 046-222 03 21
Web: <http://www.nateko.lu.se>

Examensarbete i geografisk informationsteknik nr 15
Printed by E-tryck, E-huset, 2015

Preface

This report is the result of a master thesis project completed by Magdalena Nyberg at the Department of Physical Geography and Ecosystem Science, Lund University. The project was done as the last part of the Surveying and Land Management programme at the Faculty of Engineering.

First of all I would like to thank Mikael Månsson, employee at Sweco Position, for great ideas and continuous support during the project. Björn Harrtell, Ulf Månsson, and Nariman Emamian do all deserve a big applaud for great technical advice during the implementation phase.

A special thanks to Lars Harrie, my supervisor at Lund University, for providing valuable comments all along the project.

I would also like to thank everyone else at the office of Sweco Position in Malmö for words of encouragement, essential coffee breaks, and the ever so delightful Tuesday breakfast.

June 5, 2015

Magdalena Nyberg

Summary

There are currently numerous web services that provide the user with the opportunity to download geodata. These services are often different regarding what type of data they provide and the way they distribute the data. Another aspect that differs between these services is if the download of geodata is free of charge (open) or subject to a fee. There is currently a trend in the society striving towards more and better public access to open geodata. Hence, the number of open geodata distribution services on the web will increase.

Considering the expected future of open geodata and open geodata distribution services, it is of high importance for the society to be able to establish numerous new download services in a short amount of time. In this project, a generic user interface is developed that with slight modifications can be used in several different types of open geodata distribution systems. One goal is to design and develop the user interface in a way that makes it applicable in many future projects.

A number of available open geodata distribution services are studied and analyzed to be able to draw some conclusions regarding the best way to manage and distribute open geodata. Different services present different features and opportunities to assist the user in finding the wanted data sets. Some different components, user parameters, and download processes of the studied services are described and compared. Furthermore, the open geodata situation of different countries is discussed, as well as the consequences that can follow a release of open geodata.

A proper design of any type of interactive product is essential, not only for pure aesthetic reasons but also for the usability of it. When developing a web application the main goal should be to improve efficiency for the user. The concept of user-centered design is to take the user into account in every part of the development. Considerations regarding usability and user centered design have to be taken during the implementation phase of this project to reach the goal of a user-friendly design and efficient download procedure. Based on feedback from the application, the user should know what to do now, but also in the next step.

In this study, a generic user interface for open geodata distribution is developed. The design of the user interface is based on the comparative study of open geodata portals and on general design theories. The application was implemented in JavaScript and HTML. Developed

application is considered generic since it can handle most data types and any combination of user parameters. It is working properly, and the system can because of its generic nature be used to establish many new open geodata distribution services in the future. According to a number of test persons, the application is simple and self-explanatory. The application thereby satisfies the goal of a generic and user-friendly design.

This project is conducted in cooperation with Sweco Position AB in Malmö.

Sammanfattning

Det finns för närvarande ett stort antal webbtjänster som ger användaren möjlighet att ladda ned geodata. Dessa tjänster är ofta olika när det gäller vilken typ av geodata som erbjuds och på vilket sätt dessa data distribueras. En annan aspekt som skiljer sig åt mellan dessa tjänster är huruvida nedladdningen av geodata är gratis (öppen) eller avgiftsbelagd. Det finns för tillfället en trend i samhället som strävar mot mer och bättre allmän tillgång till öppna geodata. I och med denna trend kommer antalet webbaserade distributionstjänster av öppna geodata att öka.

Med tanke på den förväntade framtiden för öppna geodata och dess distributionstjänster är det av stor betydelse för samhället att kunna etablera ett stort antal nya nedladdningstjänster inom en kort tid. I detta projekt utvecklas ett generiskt användargränssnitt som efter mindre ändringar kan användas i flera olika typer av distributionssystem för öppna geodata. Ett av målen med projektet är att utforma och implementera användargränssnittet på ett sätt som gör det användbart i många framtida projekt.

I det här projektet studeras och analyseras ett antal i dagsläget tillgängliga distributionstjänster för öppna geodata för att kunna dra några slutsatser om det optimala sättet att hantera och distribuera öppna geodata. Olika tjänster erbjuder olika funktioner och möjligheter för att assistera användaren under processen att hitta de önskade data. Några olika komponenter, användarparametrar och nedladdningsprocesser hos de olika studerade tjänsterna beskrivs och jämförs. Dessutom diskuteras situationen för öppna geodata i olika länder, liksom de konsekvenser som kan följa av ett frisläppande av öppna geodata.

Utformningen av alla typer av interaktiva produkter är väsentlig för rent estetiska skäl, men även för användbarheten av produkten. När man utvecklar en webbapplikation bör det huvudsakliga målet vara att förbättra effektiviteten för användaren. Begreppet användarcentrerad design innebär att man tar användaren i beaktning under alla faser av implementationen. Överväganden gällande användbarhet och användarcentrerad design måste tas under genomförandefasen av projektet för att nå målet om en användarvänlig design och effektiv nedladdningsprocess. Baserat på feedback från applikationen ska användare veta vad de ska göra nu, men också i nästa steg.

I detta projekt utvecklas ett generiskt användargränssnitt för nedladdning av öppna geodata. Utformningen av användargränssnittet baseras på den jämförande studien av tillgängliga nedladdningstjänster, och på allmänna designteorier. Applikationen implementeras i JavaScript och HTML. Utvecklad applikation anses generisk eftersom den kan hantera de flesta datatyper och alla kombinationer av användarparametrar. Systemet kan på grund av sin generiska karaktär användas för att etablera många nya distributionstjänster för öppna geodata i framtiden. Enligt ett antal testpersoner är produkten enkel och självförklarande, applikationen uppfyller därmed målet om en generisk och användarvänlig design.

Detta projekt utförs i samarbete med Sweco Position AB i Malmö.

Contents

1 INTRODUCTION.....	1
1.1 BACKGROUND	1
1.2 AIM.....	2
1.3 METHOD	3
1.4 OUTLINE.....	4
1.5 LIMITATIONS	4
2 OPEN GEODATA	5
2.1 THE OPEN GEODATA DEFINITION	5
2.2 EU DIRECTIVE INSPIRE	7
2.3 OPEN GEODATA IN SWEDEN	9
2.4 OPEN GEODATA IN DENMARK	11
2.5 OPEN GEODATA IN OTHER COUNTRIES.....	13
3 CONSEQUENCES OF OPEN GEODATA	15
3.1 EFFECTS OF OPEN GEODATA IN SWEDEN	15
3.2 EFFECTS OF OPEN GEODATA IN DENMARK	16
3.3 CONCLUDING COMMENTS	18
4 USABILITY ENGINEERING AND INTERACTION DESIGN	19
4.1 GENERAL	19
4.2 INTERACTION DESIGN FOR THE WEB	21
4.3 INTERACTION DESIGN FOR GEODATA DISTRIBUTION SERVICES.....	23
5 COMPARATIVE STUDY OF OPEN GEODATA DISTRIBUTION USER INTERFACES	29
5.1 COMPONENTS AND PROCESSES OF THE USER INTERFACE.....	29
5.2 COMPARATIVE STUDY OF COMPONENTS AND PROCESSES	30
5.3 USER PARAMETERS OF THE USER INTERFACE	43
5.4 COMPARATIVE STUDY OF USER PARAMETERS	44
5.5 COMPARATIVE STUDY OF DOWNLOAD PROCESSES.....	58
6 DESIGN OF THE GENERIC USER INTERFACE.....	61
6.1 DESCRIPTION OF THE GENERIC USER INTERFACE.....	61
6.2 GENERAL USER INTERFACE DESIGN CONSIDERATIONS	61

6.3 SPECIFIC USER INTERFACE DESIGN CONSIDERATIONS.....	62
6.4 MOCKUP	66
7 USER VIEW OF THE GENERIC USER INTERFACE	67
8 IMPLEMENTATION OF THE GENERIC USER INTERFACE	73
8.1 BACKGROUND	73
8.2 SOFTWARE PRODUCTS	74
8.3 CASE DATA	79
8.4 METHOD	80
9 FEEDBACK ON THE GENERIC USER INTERFACE	93
9.1 QUESTIONNAIRE TO ACQUIRE COMMENTS ON THE GENERIC USER INTERFACE.....	93
9.2 COMMENTS ON THE GENERIC USER INTERFACE.....	94
10 DISCUSSION	97
11 CONCLUSIONS.....	105
REFERENCES.....	109
APPENDICES.....	117
APPENDIX A - SCREENSHOTS OF IMPORTANT DESIGN DETAILS FROM DIFFERENT OPEN GEODATA DISTRIBUTION SERVICES	119
APPENDIX B - CONFIGURATION FILE: OSM.JSON	141
APPENDIX C - GEOJSON FILE: D500.JSON	143
APPENDIX D - HTML CODE: INDEX.HTML	145
APPENDIX E - JAVASCRIPT CODE 1: MAIN.JS	149
APPENDIX F - JAVASCRIPT CODE 2: DRAW.JS	151
APPENDIX G - JAVASCRIPT CODE 3: UNIGIS.JS.....	157

1 Introduction

1.1 Background

Geodata is information about entities or phenomena that have specific geographic positions (Geodata 2014a). Different synonyms of the word geodata are used in different contexts, many companies, authorities, and organizations have their own formal standards of what word to use. Common denominations besides geodata are spatial information, spatial data, geographic information, and geographic data. In this thesis, the word geodata will be used consistently.

Numerous institutions, in Sweden and in the rest of the world, supply web services that support for downloads of geodata and different type of maps. Many of these services are expensive to use, but some provide data for free. The services are often different regarding what type of data they provide and the way they distribute the data. Some offer a lot of flexibility for the user, with several user parameters and possibilities of personal settings, while others have made a number of predefined data sets available for immediate download.

The download of geodata might sometimes be subject to a fee. Despite that, these data are occasionally denoted *open* or *public*. Different companies, authorities, and organizations have their own opinions and definitions regarding which geodata that are *open* and which that are *public*. In this thesis, *open geodata* is used for publicly available geodata that are *free* of charge.

There is currently a trend in the society striving towards more and better public access to open geodata. Not very many people or organizations have expressed concerns or negative thoughts about this trend, both users and distributors seem pleased with where this is going. Because of this trend, the number of companies, authorities, and organizations that provide services supporting open geodata downloads will increase. Denmark and Norway are countries in the leading edge when it comes to supplying open geodata.

In 2007, an EU directive called Inspire (2007/2/EG) was formed. This directive consists of rules meant to support the establishment of an infrastructure of geodata in the European Union. The

main aim with the infrastructure is to facilitate sharing of data and increase the amount of public accessible geodata that can be used for environmental purposes via web services. However, there is currently no rule within Inspire that the geodata should be open (in terms of free of charge). By 2019, full implementation of the directive is required by all member states of EU. (European Commission 2014) The amount of open geodata distributors in the European Union has increased since Inspire was introduced, and some countries have already implemented the rules of Inspire in their society (European Environment Agency and European Union 2014).

To ease the establishment of many new open geodata distribution services, a generic user interface for the purpose is developed in this project. The user interface will uncompeled adapt, depending on what user parameters that are available for the specific distribution service. Examples of user parameters in this type of service are the area definition and the choice of coordinate system.

Sweco Position AB in Malmö came up with the idea of this project and initialized it. Their original idea was to investigate how the software FME can be integrated with JavaScript code, and the best way to do this. Their hope is that FME technology can be used to create dynamic input forms in the web application, and that geodata can be modified based on input from these forms. The generic user interface developed in this project is built has an extra feature for a web map application developed by Sweco Position AB, but this is something they let me decide myself. Besides the initial idea of integrating FME and JavaScript, Sweco Position AB has allowed me to make the decisions that ultimately resulted in the final product.

1.2 Aim

The main aim is to design and develop a working system and a user interface that can be used to establish open geodata distribution services in many future projects. The specific goals of the project are to create a user-friendly design and write a code that can be used for the stated aim.

One goal of the study is to perform a competitive study of open geodata distribution services. These services are described and analyzed, with the user-friendliness in focus, to see what the best way to distribute data is.

Another goal with the theoretical part, besides the study of available services, is to examine how some countries and organizations have dealt with open geodata so far. How much of their data, and what sorts, are open for further distribution? Moreover, the consequences of open geodata are discussed based on experiences from a number of countries and organizations.

1.3 Method

The first part of the project is theoretical. Open geodata and some possible consequences of it are defined, theory on design principles of geoportals is studied, and a number of available open geodata distributors are examined. This part is based on literature studies and online research.

Based on the study of available web services for open geodata distribution and the theory on design principles, a design proposal of the user interface is constructed. No programming is done in this phase, the design proposal is a simple paper sketch. This design proposal is being improved until it satisfies the goals. Subsequently, a priority of the different functionalities is created, the most crucial parts of the system should be developed first to ensure a finished product that satisfies the goals. When the design model of the system, the mockup, is complete, the technical development can begin. During the implementation phase, it is easy to discover if some of the functionalities in the mockup have to be edited, added, or removed.

The practical part of the project, that concerns implementation of the system, requires programming in both JavaScript and HTML. The developed system is evaluated and tested in the last part of the project.

1.4 Outline

The second chapter explains open geodata, the Inspire directive, and the open geodata situation in Sweden and Denmark. Possible consequences of open geodata are described in the third chapter. In the fourth chapter, usability engineering and interaction design are addressed briefly. Components, parameters and download processes of available open geodata distribution services are described and compared in the fifth chapter. Chapter 6 discusses usability and design aspects of a generic user interface for open geodata distribution. Developed generic user interface is presented in chapter 7 of this thesis. The implementation of the user interface is reported in chapter 8. Chapter 9, 10, and 11 contain the evaluation of the implementation, a discussion and conclusions.

1.5 Limitations

The project described in this thesis only considers open geodata and open geodata services. Commercial geodata that are subject to a fee, and services offering those data, are not addressed.

2 Open Geodata

This chapter aims to define and describe aspects of open geodata and how it is managed in different countries. The EU directive Inspire, which regulates how environmental geodata held by authorities should be collected, produced, stored and distributed, is examined and summarized. Every geodata owner or distributor within the union needs to be aware of the directive and handle their data accordingly. Other open geodata policies are also studied and described.

2.1 The Open Geodata Definition

According to the Open Definition (Open Definition 2015), open geodata can be:

“... freely used, modified, and shared by anyone for any purpose”.

According to the Swedish Association of Local Authorities and Regions, open geodata could be defined as information from public authorities that may be provided and used without significant technical or legal restrictions (SKL 2014).

The WMO Resolution 40 (Cg-XII) is a policy for exchange of meteorological (and related) data and products. The policy states that basic meteorological data and products should be freely and unrestrictedly exchanged, with minimum charges. Costs are limited to the cost of reproduction and delivery. The resolution concentrates on data used for research and education. (Doldirina 2013)

International Council for Science World Data System recognizes the benefits and significance of the increased international efforts of open data, and has adopted the data sharing principles as follows (ibid.):

- “full and open exchange of data
- metadata and products shared within WDS

- all shared data, metadata and products will be made available with minimum time delay and at minimum cost
- all shared data, metadata and products being free of charge or no more than cost of reproduction will be encouraged for research and education.”

The word *open* could be misleading since geodata sometimes, by some companies, authorities, and organizations, are denoted open despite being subject to a fee. Some consider the data open as long as it is available for anyone to download. In this thesis, *open geodata* is used for publicly available geodata that are *free* of charge.

Geodata can be divided into three subgroups based on who the distributor is, see figure 2.1. Authorities all around the world provide geodata, some of their data are free to download while other are subject to a fee. Some companies and organizations do also provide geodata, sometimes for free but most often because of the economic benefit from it. These data can be denoted commercial geodata. The last group, Volunteered Geographic Information (VGI), consists of geodata that have been voluntarily shared by a person or an organization.

Open geodata can be distributed by any of these groups, see figure 2.1 again. All VGI is considered open since these data are publicly available and free of charge. Some authorities, companies or NGOs provide public and free geodata, and these data are considered open in this thesis.

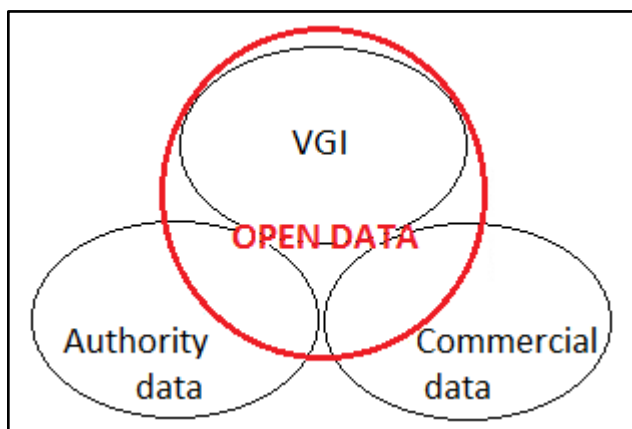


Figure 2.1. *There are three subgroups of geodata based on who the distributor is. Open geodata can be found within each subgroup.*

2.2 EU Directive Inspire

This chapter is mostly based on the Inspire directive (European Parliament and of the Council: 2007/2/EG), if one part is not, the reference is presented.

The EU directive Inspire (Infrastructure for Spatial Information in Europe) (2007/2/EG) became effective on 15 May 2007. The directive is implemented in various stages, but member states of the European Union are required to have reached full implementation by 2019 (European Commission 2014).

Inspire regulates how certain geodata is collected, produced, stored and distributed. Any geodata owner or geodata provider must consider the directive and national laws to make proper choices about the management of the data. The rules of Inspire apply to electronic geodata that are held by public authorities and to geodata that are used by them. Under certain conditions, the directive should additionally apply to geodata held by others, if they request so. The institutions that this directive applies to must adapt their geodata and services according to it.

The main aim of Inspire is to eliminate any obstacles to access public geodata that can be used for environmental purposes via services on the Internet. As a result of Inspire, it should be easier and more efficient for public authorities to share data. Geodata from another country within EU should be possible to integrate seamlessly (Geodata 2014a).

The directive regulates the establishment of an infrastructure for geodata in the European Union. This infrastructure will assist policy-making regarding policies and activities that might have an impact on the environment. The environmental policies of the European Union must be implemented in an integrated way, regional and local differences should be taken into consideration. An infrastructure for geodata means that the following elements are established, operated or made available: metadata, spatial data sets and spatial data services, network services and technologies, agreements on sharing, access and use, and coordination and monitoring mechanisms, processes and procedures.

According to the directive, geodata are at the moment organized and accessed in a large number of formats and structures. This hampers the efficient implementation and evaluation of European

Union policy-making that may affect the environment. It should be easier to use geodata from different sources within the union. Member states of EU are required to provide any data or information needed to ensure interoperability. The interoperability is the possibility for geodata sets to be combined, and for geodata services to interact without any manual action.

The infrastructure for geodata should be designed to guarantee the possibility to combine geodata from various distributors and countries in a consistent way. The directive consists of rules supposed to regulate how geodata is accessed in a uniform way (Geodata 2014a). Geodata are needed for the implementation of the European Union policy on the environment. The Inspire directive emphasizes the importance of establishing a measure of coordination between users and providers of geodata, to facilitate the combination of geodata from different sources. Moreover, it should be possible to collect geodata at one level of a public authority, and share it with other public authorities.

The infrastructure will make it easier to discover available geodata and evaluate how suitable they are for the purpose based on provided metadata. Member states are required to provide descriptions of their available geodata and geodata services as metadata.

The Inspire directive gives public authorities of the member states of EU the opportunity to demand payment for the usage of their provided geodata and geodata services. Such payments may not in any way hamper the facilitated sharing of geodata and geodata services between public authorities. If charges are applied to the usage of geodata, they should be kept as small as possible and get invested to ensure the necessary quality and supply of geodata and geodata services. The geodata provider may in addition to that count for a reasonable return on investment. Therefore, not all geodata covered by the directive are considered *open* in this thesis.

A member state of the European Union is according to the Inspire directive free to decide whether the exchange of geodata between two national public authorities should be subject to any type of cost. No matter their decision, any charge applied may not exceed the cost of collection, production, reproduction and distribution of the geodata, together with a reasonable return on investment.

2.3 Open Geodata in Sweden

In Sweden, the Act (SFS 2010:1767; SV Lagen om geografisk miljöinformation) and the Ordinance (SFS 2010:1770; SV Förrordningen om geografisk miljöinformation) on spatial information are regulating the implementation of Inspire. The main aim of the Act on spatial information is to establish an infrastructure which can facilitate the sharing of digital geodata. The purpose of the Ordinance on spatial information is to present the authorities with information responsibility. The authorities with information responsibility are required to make geodata and geodata services publicly available. (Geodata 2011b)

Lantmäteriet, the Swedish mapping, cadastral and land registration authority, have national responsibility for the coordination of the Swedish infrastructure for geodata (Geodata 2011a). The authority has the responsibility to develop and administer the national infrastructure for geodata, with help from a number of local authorities. They should also coordinate and support the Swedish implementation of the directive, and interpret the requirements of Inspire. The Geodata Advisory Board of Sweden contributes to the development and coordination of the infrastructure for geodata, and supports collaboration between authorities regarding development and distribution of geodata (Geodata 2014b).

Lantmäteriet, together with the municipalities of Sweden, have the responsibility to provide accurate and up-to-date geodata that cover all of the country (Lantmäteriet 2014). In March 2015, Lantmäteriet announced that they have decided to make some of their geodata openly available (Lantmäteriet 2015). To make all their geodata open, it must be budgeted by the government and the local authorities, but no money in the Swedish governmental budget of 2015 was earmarked for a release of open geodata from Lantmäteriet. Some of their small scale geodata will become available on 1 July 2015, and some additional data sets are released on 1 January 2016. When the funding has been solved, more detailed geodata can be released.

The economic balance of the geodata system will be affected as soon as any data set is made openly available by an authority. Therefore, SKL, Lantmäteriet and the municipalities of Sweden have jointly developed a plan of action to ease the transition to open geodata (ibid.). The main

goals of the agreement are to increase the knowledge level among concerned people, define actions that can ensure a long-term collaboration, provide support, and give recommendations.

In 2011, the city of Stockholm decided to develop a plan of action for their future distribution of open geodata. The plan of action was based on the PSI directive established by the European Union (Stockholms Stad 2014a). The main aim of this directive is to facilitate the individual's use of documents provided by authorities (Sveriges Riksdag 2010), and make it more convenient to find public data (Stockholms Stad 2014a).

Since 2011, the city of Stockholm has published open geodata with several different themes. Among these themes are Environment, Streets and Parking, Maps and Aerial photographs. These geodata are open and free for anyone to reach through APIs (Application Programming Interface) or web services. The city of Stockholm does additionally provide some geodata that the customer will have to pay for. (ibid.)

In 2012, a competition called Open Stockholm Award was launched by the city of Stockholm (Stockholms Stad 2014b). The purpose of this contest is to encourage usage of the provided open geodata for service and for development of mobile applications, and through this create new ideas and practical solutions that are of interest for the residents, the city and the whole region. Participants can compete in three different categories: Traffic, Environment and Sustainability, and Intelligent Solution for the residents of Stockholm.

The above mentioned competition was an initiating force for the first release of open geodata in the city of Stockholm. Maps and geodata were needed for visualization purposes in the competition. The first two data sets that were released, and distributed for free as wms services, were a simplified map of Stockholm and a set of older orthophotos (Belda 2014). These data sets were chosen prior to other since the economic loss as a result of the release was low, additionally because of the high quality and large area of application of these data sets. (Eriksson 2014)

In 2014, three more data sets were made available by the city of Stockholm, the City map, the Urban Center map, and a 3D map of Buildings in the city. Neither of these data sets did yield a high income, and are therefore now distributed for free (Belda 2014). The Stockholm Base map is still not available for free, since that would mean a high economic loss for the city.

The city of Stockholm is limiting their open geodata to certain maps and themes because of economic reasons, furthermore because of certain agreements with other public authorities. The quality of upcoming work of the city is relying on earnings from previous projects and sales. Certain data sets provided by the city yield a significant income, necessary for the economic viability of the city. The income loss as a result of the distribution of open geodata will need to be compensated to assure high quality and up to date geodata in the future. (ibid.)

SGU (Geological Survey of Sweden) is another authority of Sweden that has made many geodata openly available. They consider their release of open geodata as beneficiary for both themselves and the society as a whole. The data are for example accessible through the open service *Kartgeneratorn*, which is further investigated in chapter 5. Open geodata that are available are for example hydrogeological (information on groundwater), marine geological (information on seabed) and biogeochemistry information. Data are available as JSON, CSV and sometimes as picture formats. (Geological Survey of Sweden 2015)

2.4 Open Geodata in Denmark

There is an international trend of releasing open geodata (Danish Geodata Agency 2013) and also an increased demand of it. Many countries of the world have started their work towards a national release of open geodata (SKL 2014). Some countries have come further in the process than others, Denmark is one of the countries that could be called a frontrunner (Danish Geodata Agency 2013).

The Government of Denmark and the Local Government of Denmark have agreed on a *basic data program* (Danish Geodata Agency 2014a). This program consists of a number of improvements and initiatives regarding public basic data that is meant to increase efficiency in the public sector and increase the growth in the private sector.

A large part of the Danish Geodata Agency's data are available and free, for anyone to download and use. Geodata are provided as web services and as predefined data sets that can be downloaded through the web map service *Kortforsyningen* (Danish Geodata Agency 2014b). The

Danish Geodata Agency would not have been able to make their geodata public if it was not for the modification of the *Act on the Danish Geodata Agency*, which was accepted in the end of year 2012. (Danish Geodata Agency 2014a)

The Danish Geodata Agency provides public access to topographic maps, cadastral data, and an updated version of the Danish Elevation Model. Use of the open geodata does not come with restrictions regarding commercialization or further distribution to third party. However, when using geodata from the Agency, they will expect an acknowledgement. (Svan Colding 2014)

From the year of 2012, when geodata were made open, the number of users of the Danish Geodata Agency's data has increased from 800 per year to more than 20 000 in 2014. Figure 2.2 shows the monthly distribution of new users. Green represents citizens, red represents NGOs, yellow represents authorities, and blue represents businesses/companies. (ibid.)

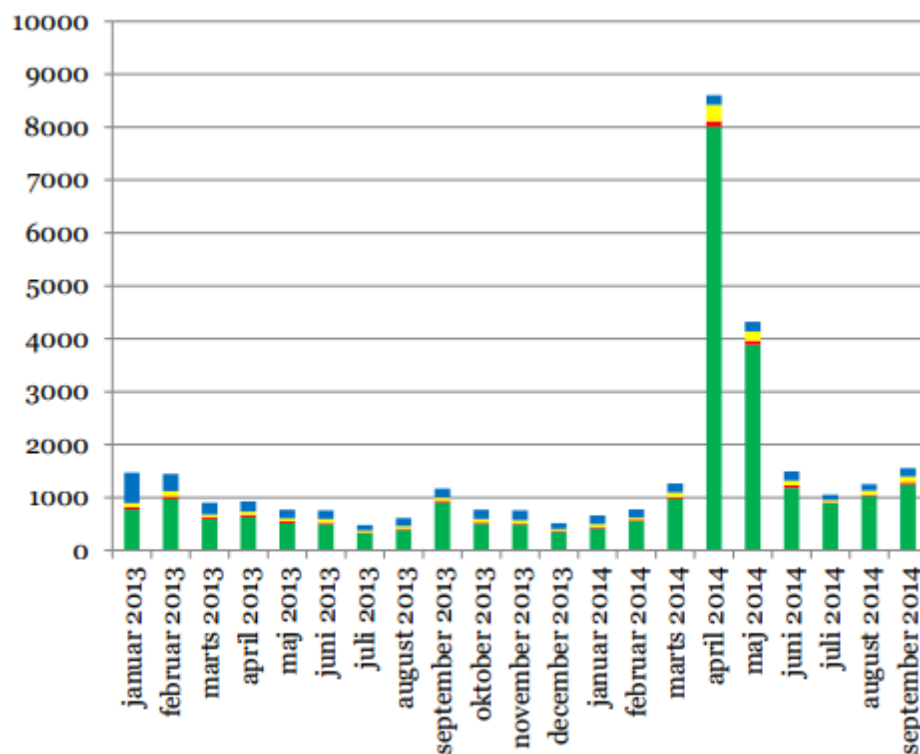


Figure 2.2. *Monthly distribution of new users of the Danish Geodata Agency's data.* (Svan Colding 2014)

2.5 Open Geodata in Other Countries

USA

USA was the first country to use the term Open Data. The Landsat policy is applicable in the country. This policy states that “all data products are available to any user at no more than the cost of fulfilling user requests”. The cost of fulfilling user requests is the total cost of product generation, reproduction, and distribution of data according to user requests. The cost should not include price of acquisition or return on investments. (Doldirina 2013)

Canada

Canada is going towards an open access approach regarding sharing of geodata held by authorities (ibid.). Some open geodata portals of the country provide geodata according to the *Unrestricted Use License Agreement* that grants the user the right to (Government of Canada 2013):

- “use, reproduce, publish, freely distribute, or sell the Information;
- use, reproduce, publish, freely distribute, or sell Value-added Products; and,
- sublicense any or all such rights, under terms consistent with this agreement.

In doing any of the above, you shall:

- reproduce the Information accurately;
- not use the Information in a way that suggests that Statistics Canada endorses you or your use of the Information;
- not misrepresent the Information or its source;
- use the Information in a manner that does not breach or infringe any applicable laws;
- not merge or link the Information with any other databases for the purpose of attempting to identify an individual person, business or organization; and
- not present the Information in such a manner that gives the appearance that you may have received, or had access to, information held by Statistics Canada about any identifiable individual person, business or organization.”

United Kingdom

The Ordnance Survey license is a worldwide, royalty-free and non-exclusive authorization to use information (Doldirina 2013). Users are encouraged to use and re-use the data that the license is applicable for. The data can be used freely and flexible with only a few restrictions.

Switzerland

Sharing of geodata among authorities should be direct and free of charge. The exchange of data with international establishments is also direct and free as long as no relevant international agreements specify otherwise. The principle of access to and use of data held by Swiss local authorities is that it is free of charge, but different districts can define their own rules regarding this matter. (ibid.)

Italy

The Digital Public Administration Act states the rules for all aspects regarding openness in the public sector of Italy (Moody 2015). Rules on free and open source software as well as rules on open formats and open data can be found in the act. Open data are according to the act (ibid.):

“1) available under the terms of a license permitting their use by anyone, even for commercial purposes, in disaggregated format;

2) accessible through the information and communication technologies, including public and private telecommunication networks, in open formats; are suitable for automatic processing by computer programs and equipped with relative metadata;

3) available for free through the information and communication technologies, including public and private computer networks, or are available to the marginal costs incurred for their reproduction and dissemination.”

3 Consequences of Open Geodata

3.1 Effects of Open Geodata in Sweden

According to a survey performed during the summer of 2014, there are both positive and negative possible consequences following a release of open geodata. The survey was conducted by the Swedish Association of Local Authorities and Regions, and the opinions were gathered from people working for the Swedish municipalities (Leckström 2014). Some positive consequences mentioned by the respondents were: the increased usability of geodata, the possibility of new inventions and services, a greater social benefit, cheaper administration, and an increased quality of the data.

Some, according to the survey, negative consequences of open geodata are: higher risk of manipulation of data, greater variation in quality of data, worse overall product quality because of the income loss, new development costs, demanding to control that no personal information is further distributed, lower stimulus to produce new geodata, and a higher dependency on state funding (ibid.). Besides that, it is mentioned that there is a risk that some GIS personnel at municipalities of Sweden might lose their jobs when the geodata market is no longer beneficiary.

The consequences of a release of open geodata can be hard to recognize, and might vary for different individuals, cities, municipalities, countries, etc. According to Belda (2014) one positive effect of their release is that other cities and municipalities are starting to follow their example, as they have seen that it worked well in Stockholm. Another, rather obvious, consequence of the release is that any person now has free access to their geodata, and the maps are more widely used (ibid.). A wider and more frequent use of their geodata can lead to a great number of new ideas and perspectives (Eriksson 2014). New thinking will hopefully, among other things, lead to a positive impact on the environment and great thoughts on city planning.

In addition to the consequences mentioned above, the city of Stockholm has defined some more advantages and disadvantages with their release of open geodata (Eriksson 2014). As mentioned, their release will contribute to an increased number of other open geodata services. The quality of these services will be kept high because of the competitive field of business. As more web

based geodata services are established, many workflows can become more efficient. The administration will decrease since no contracts need to be signed and no bills need to be sent out. The city of Stockholm sees the release as a chance to improve the collaboration with the citizens. One hazard, according to the city of Stockholm, following the release is for example that the quality of the data might be at risk if income compensations are left out. Furthermore, their geodata could get manipulated before it is further distributed.

3.2 Effects of Open Geodata in Denmark

An important player in the open geodata market is the Danish Geodata Agency. A large amount of geodata from the agency was made open on 1 January 2013. The aim of the release was to contribute to a more efficient public sector and a better growth in the private sector. The efficiency effect is an expression of cost savings as a result of the use of open geodata in internal work. The effects of the release of geodata in Denmark have been examined by Deloitte, on behalf of the Danish Geodata Agency, in a written report from 2014 (Danish Geodata Agency 2013). Deloitte has made a preliminary assessment of the effects that open geodata may result in, but the final assessment will be done in 2016.

The effects of the release will be measured by assessing the value of geodata from the Danish Geodata Agency before the release of open geodata, and compare that value with the value from a new assessment in 2016. The baseline value from before the release includes calculations of the economic effects of geodata. The measurement from 2012 showed that the use of geodata from the Danish Geodata Agency added a socioeconomic value of DKK 1.6 billion. (ibid.)

The release of open geodata is of larger importance for individuals and companies than it is for public users, e.g. authorities, because geodata more often has been subject to a fee for these users. The crucial difference for public users is the new ability to freely exchange geodata with private distributors and users. (Danish Geodata Agency 2014c)

The release of open geodata is expected to affect the national economy of Denmark in a positive way, and to stimulate growth and efficiency in the society (ibid.). It is also expected that public

authorities will be able to reduce costs related to updating and maintaining geodata since it will be possible with collaboration across authorities.

The change theory presented in the report written by Deloitte is the expected effect chain that the release of open geodata will result in, see figure 3.1. It is expected that a lower price of geodata will increase the demand for geodata. A higher demand will probably result in a higher degree of usage of geodata. New products and services are expected to result in increased efficiency in many aspects. It is also possible that new products and services can result in better service, better decision-making and improved communication with citizens and companies. (Danish Geodata Agency 2014c)

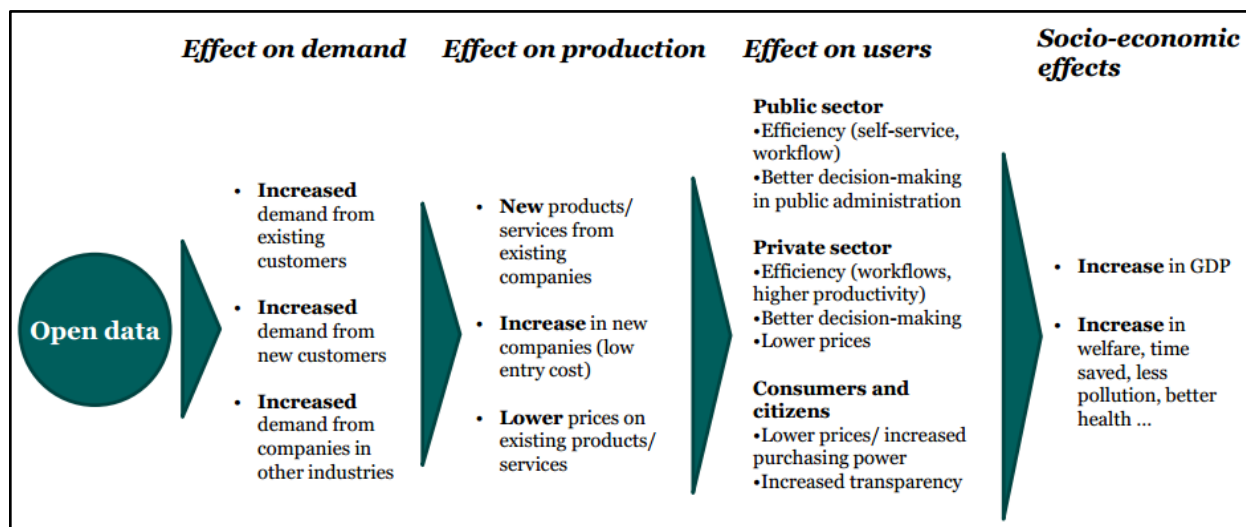


Figure 3.1. *Change theory – the expected effect chain that a release of open geodata will result in.* (Svan Colding 2014)

At the societal level, it is possible that the release of open geodata will contribute to an increased level of production and lower prices. Expected welfare gains are for example an improved environment, improved health, and time savings. (Danish Geodata Agency 2014c)

To complete the analysis, Deloitte has used two additional sources of information besides the value chain analysis (ibid.). One of them is the data traffic and download frequency from the Danish Geodata Agency's web service, and the other one is surveys used to assess information regarding users' usage of geodata and the significance of geodata.

There are indications that the public sector as well as the private sector will benefit from the release of open geodata (ibid.). The assessment performed by Deloitte states that the annual average net earnings will be approximately DKK 100m per year up until 2020, this in spite of revenue loss for some public authorities. Up until 2020, the private sector will have earned a total of DKK 822m. In 2013, one year after the release, the earnings were estimated to DKK 75m. The analysis shows that the market is expected to grow by 5.5% towards 2015 compared to the size of the market in 2012.

Based on conducted surveys, there are some welfare gains of the release. These welfare gains would be a result of, for example, faster case management, reduced search costs and improved resource utilization. (ibid.)

The two main goals of the release of open geodata are innovation and competition in the market. Deloitte's analysis shows that the release has increased the innovation activity in existing companies, and that new companies have been formed. This makes it likely that the competition in the market will be intensified. It is possible that the Danish Geodata Agency's release of open geodata will contribute even more to the market effect since their release will change the market situation. (ibid.)

3.3 Concluding Comments

It is still too early in the process of the worldwide release of open geodata to discover and be able to evaluate all consequences that will follow. The consequences discovered by the Swedish Association of Local Authorities and Regions, the city of Stockholm, and the Danish Geodata Agency are most likely universal, hence possible to apply for any organization, city, municipality, or country. Factors that might be affected by the release of open geodata are for example: environment, economy, social behavior, business, city planning, etc. Some of these factors have been brought up by the Swedish Association of Local Authorities and Regions, the city of Stockholm and by the Danish Geodata Agency.

4 Usability Engineering and Interaction Design

4.1 General

A proper design of any kind of interactive product is essential, not only for pure aesthetic reasons but also for the usability of it. The product might be complicated, like a software product most often is, but the design of it can simplify the usage significantly. A product should preferably be developed and designed with the users in mind (Preece, Rogers & Sharp 2007).

When designing interactive products, consideration about several matters will be required (ibid.). You will need to consider who is going to be using them, how the products will be used, and where the products are used. The designer/developer has to understand the type of activities that the product is used for, and how the user is interacting with the product. A finished product needs to understand the user, and optimize the user's interactions in effective ways.

Key considerations when developing an interactive product are for example: what are users good/bad at, what features might ease the usage of the product, what would contribute to a qualitative user experience, and what do users want out of the design. A developer has to identify users' needs to be able to create a successful and useful product (ibid.). Interaction design is not bound to a certain way of designing a product. Preece, Rogers and Sharp (2007) write about it as a way of

“creating user experiences that enhance and augment the way people work,
communicate, and interact”.

The process of interaction design includes the following four steps (Preece, Rogers & Sharp 2007, p. 17):

1. Identifying needs and establishing requirements for the user experience.
2. Developing alternative designs that meet those requirements.
3. Building interactive versions of the designs so that they can be communicated and assessed.
4. Evaluating what is being built throughout the process and the user experience it offers.

Designers and developers need extensive knowledge about how users and technologies interact in order to create a user-friendly environment. Basic knowledge is how different users act and react to different events and how users and events communicate. Besides the technical part of the development, designers and developers will also need to understand emotions, aesthetics, business, manufacturing and marketing to ensure an effective and engaging user experience. (ibid.)

The user experience is the experience that a product creates for the user, and it is a crucial part of interaction design. It states how users feel about a product, how they feel when using it, looking at it, and touching it. Both the users' general impression of the product as well as their feelings about the details of it are included in the user experience (ibid.). Developers are often too focused on the functions of a product, and are over-looking how the product *actually* works. The design should, among other things, be based on the psychology and the behavior of the users to support a user friendly environment (Garrett 2003). Following are six examples of user experience goals of the product design: satisfying, helpful, motivating, rewarding, fun and aesthetically pleasant (Preece, Rogers & Sharp 2007).

Aesthetic design ensures that the product has an appealing color, shape and texture. The functional design makes sure that the right function is executed when a certain button is pressed. The user experience design takes care of the context of different features (Garrett 2003). For example, how large should a button for a very important/not important function be?

Certain design principles are used by designers and developers to ensure a positive user experience. A common example of a design principle is the feedback. Based on feedback from the product, the user should know what to do in the next step (Preece, Rogers & Sharp 2007). Visibility is another crucial design principle, different functions should be clearly visible for the user. If not, it might be hard for the user to know what to do in the next task (Butler, Holden & Lidwell 2003). Consistency is a design principle that says that similar operations and similar elements should be used for performing similar tasks. The usability will be improved if similar components are expressed in similar ways (ibid.). These are just three examples of design principles, but there are many more.

The usability of a service describes how simply and intuitively the user interface can be interacted with. Usability needs to be considered for all aspects of a system with which human interaction might happen (Nielsen 1993). Usability is traditionally associated with the following usability attributes (Nielsen, 1993, p. 26):

- Learnability - the system should be easy to learn
- Efficiency - the system should be efficient to use
- Memorability - the system should be easy to remember
- Errors - the system should have a low error rate
- Satisfaction - the system should be pleasant to use.

4.2 Interaction Design for the Web

Proper interaction design is an essential part of successful web-based interactive products. Poor interaction design of products can break a developing company fast. Products and applications on the web are parts of an extremely competitive field of business, and these products need to be easy, effective, and engaging to stand out and attract users. (Preece, Rogers & Sharp 2007)

The user experience is more significant for a web product compared to other type of products since web products are based on a complicated technology. It is troublesome for a normal user to find, understand, and fix a problem with the application if it is not working the way it should. A perfect web application should work the exact way a user expect it to (Garrett 2003). Applications on the web are self-service products (ibid.). The web site will not come with a user manual, and it is rather uncommon with customer service representatives that can help the user with the web site.

As we now know, the user experience is of high importance for the success of a web product. Despite this knowledge, the understanding of what factors that will bring a satisfied user has been, and is, of low priority. It is common that developers pay little attention to what users really want, like, and are able to use. In the end, it is the user experience that will differentiate one company from another, and determine whether the customer will return. (ibid.)

Many programmers and programming companies will rush the development of a web site to make sure to be first on the market with a new concept, thinking that will be the key to success. Competitors to this web site will often append more information, content and features as an attempt to attract new and more customers, and gain market share. However, more functionality will increase the complexity of the web site, making it unappealing and complicated to use. Great features and well-developed functionality will always attract users, but the user experience is of more importance for user loyalty. (ibid.)

When developing a web application with the users in mind, as you should, the main goal is to improve efficiency for the user. There are two main things that should be considered: how do we speed up people's work and how do we help people make fewer mistakes while working with the web application (ibid.)? An improved efficiency of the web application might improve the productivity of a whole business. Every minute spent on a certain task means that less time remains for other activities.

The concept of user-centered design is to take the user into account in every part of the development (ibid.). You will need to consider every possible course of event and take into account the user's expectations of every part of the system. Compromises because of time or money will probably have to be done, but should not happen by accident. In this way, you can create engaging and efficient user experiences.

Icons on a web user interface are used to represent objects as parts of the desktop. It is assumed that icons are easier to learn and remember than text labels. Another advantage is that icons can be designed to be compact and easier to position nicely on a screen. Many icons are designed to be very detailed and sometimes even animated, the goal is to make them both visually attractive and informative. (Preece, Rogers & Sharp 2007)

The best designed icons are those that have direct mapping between what they should represent and how it is represented (ibid.). One way to think about the design of an icon is to use a combination of objects and symbols that can capture the most prominent part of an action being performed on objects by using analogy, association, or convention. When designing an icon, we want it to be distinguishable, identifiable, and memorable. The developer, or designer, need to

think about what type of application the icon should represent, is it a fun user application or a serious utility program? What type of application the icon is supposed to represent should preferably be obvious.

It is not possible, and not of interest, to discuss the usability of an icon without knowing its context and when it will be used. Icons are often easier to design for objects than for operations since objects can be portrayed representationally. A study made by Rogers in 1986 showed that the best icons for operations showed both the object being operated upon, e.g. a paper, and a representation of the operation, e.g. a pencil. (Nielsen 1993)

Graphical design, including icons, is central when developing a web service in order to make it distinctive, impressive, and pleasurable for the user. But download time of a web page is also crucial for the success of it, a user won't wait too long and is likely to move on somewhere else (Preece, Rogers & Sharp 2007). Therefore, a developer will need to prioritize between the aesthetics and the usability of a web page, too much graphics will rather scare off than impress users.

4.3 Interaction Design for Geodata Distribution Services

According to Tait (2005), a geoportal is a web page that provides geographic content, and has that as its primary focus. A web page presenting a map revealing the location of for example a business should not be considered a geoportal if that web page has more important purposes, e.g. a web shop, information about the company, etc. In the last 15 years, there has been an increased demand and development of geodata distribution services on the web. Among other things, this could be a result of the increased recognition of the many benefits that GIS and geodata can bring for several business processes. (ibid.)

As of the establishment of the web, the GIS technology has evolved from being limited to desktops, workstations and server based computing platforms, to have capabilities known as distributed GIS. Distributed GIS can be explained as GIS technology developed for the web. One

of many benefits of the distributed system is that many geodata systems can be combined and provided as a single virtual system. (ibid.)

At present, most developers of services, including geodata distribution services, tend to focus on functionality rather than users' needs and requirements. The expected use of the system, the usability, is not included in the design and development process. This can probably be explained by the large investment of time and money that will be necessary (Resch & Zimmer 2013). However, many geoportals has a large number of users, with different needs and requirements, and it might not be possible to satisfy them all. Additionally, new methods for visualization of geodata are constantly deployed, and traditional map design and evaluation methods might not always be applicable (Nivala, Brewster & Sarjakoski 2008).

The main reason to consider usability when developing a geodata distribution system is that the technology itself does not necessarily ensure the success and usefulness of the service. The developers of a system will need to understand and think about the users' minds, experiences, and acceptance during the interface deployment (Aditya & Kraak 2005). There are three main aspects in advancing the usability of geoportals (ibid.). The first aspect, establishing requirements, can be done with the help of literature studies, users profiling, and interviews. The second aspect, facilitating users' tasks, is about analysis and design of the interface, the user interactions should be effective and satisfy users' needs. The third aspect, the iterative design process, highlights the possibility to improve the interface through usability testing.

There are nine main reasons for errors and incompletions in geoportals (He, Persson and Östman, 2012, p. 98):

- unclear display of active search criteria
- Google-like data entry was not supported
- unclear procedures for entering geospatial search criteria
- unreadable symbols
- obscure presentation of search results
- user interface was not suitable to smaller screens
- hidden buttons for enabling WMS functions

- unclear procedures for WMS operations
- unclear cartographic rendering.

There are many aspects of the design of a geoportal that need to be carefully considered to produce a user friendly environment. The map is one essential part of the service, its size, resolution, content density, and functionality are examples of important considerations. Other important components of the geoportal are the search dialogues and the presentation of search results. Some available geodata distribution services offer free-text search, some spatial search, and some category-based search. A combination of these, or the possibility for the user to choose between them, might be optimal. The icons for user interaction in a geoportal are also of great importance, these should be well designed in order to represent the functionality of it. The developer should also consider the time it takes to load the web page and its content, how self-explanatory the service is, and other aspects such as legends, animated graphics and pop-up windows. (Resch & Zimmer 2013)

4.3.1 The Map

It is not necessary for a geoportal to provide map previews, however, it can easily expand search possibilities and add value to the service (Tait 2005). Pan, zoom, and feature identify capabilities can be combined with the map to aid the user in the search of a data set (Nivala, Brewster & Sarjakoski 2008).

According to a study performed by Resch and Zimmer in 2013, a larger map is to prefer in order to support the user to perform the actual task, and not be too occupied with the map interaction. A good indication of an appropriate map size is that it should occupy approximately 70% of the screen, similar to common desktop GIS services (Resch & Zimmer 2013). This is also acknowledged by Skarlatidou and Haklay, their study shows that the usability of a geoportal is in direct correlation with the size of the map. Big and detailed maps are to prefer to make it possible for users to identify more features around the place under search. (Skarlatidou & Haklay 2006)

The map design itself is also of importance for the user experience of the service. The colors used for the map, and the described features, will affect the users. Color blind people are one group of users that should be especially considered. Furthermore, users expect to understand the map symbols without the aid from a legend (ibid.). The map design needs to be optimized for visualization on a computer screen, the maps should be simple and intuitive. Traditional design for paper maps is not applicable for maps on the web (Nivala, Brewster & Sarjakoski 2008).

4.3.2 Search Options and Search Results

Search functions of geoportals are commonly executed in sequential steps. The first step is often to locate the specific place of interest, which for example can be done through a place name search, or by selecting a location from a list. Once the place of interest has been found, the second step is executed, this is when the user search for a certain data set (Tait 2005).

According to the study performed by Resch and Zimmer (2013), 46% of users prefer keyword search, 36% prefers spatial search, 15 % of the users prefer category based search, and 3 % of the users preferred other search options. 39% of the test users in their study wanted better flexibility of the search. 41% of the test persons wanted the search results to be presented in a tabular form, structured and clear. 28 % wanted the search results to be presented directly in a map.

Based on a study performed by Nivala, Brewster and Sarjakoski (2008), different types of searches should preferably be supported, but it is of importance for the user to know what type of search that is carried out. It should also be obvious to the user how the search results relate to the query.

4.3.3 Icons and User Interactions

Icons in a geoportal should, according to Resch and Zimmer (2013), be designed to comply with the following criteria: clarity, accuracy, simple interpretability, and visual feedback for the

symbol that is currently in use. It can be a good idea to make a hint appear when the mouse pointer moves over the icon to avoid ambiguity.

When it comes to user interactions on the map, a drag-and-drop approach is to prefer over navigation buttons for panning. It is also considered better to use the mouse to zoom, instead of a zoom bar with a number of discrete zoom levels. (ibid.)

4.3.4 Other considerations

The user should be able to start using the service immediately when entering the geoportal (Nivala, Brewster & Sarjakoski 2008). Long loading times of a geoportal does, according to the study performed by Resch and Zimmer (2013), generally decline the satisfaction. If a long waiting time awaits, the system should notice the user by an interactive message. By making the processes of the system more transparent, the user satisfaction can increase.

The use of scroll bars in a geoportal should be avoided to increase the comprehensiveness of the geoportal (ibid.). All important information should be available at once, and not found by scrolling, to ensure that no information is lost. Accordingly, short and comprehensive legends are to prefer.

According to Skarlatidou and Haklay (2006), the amount of advertisement on the web page does not seem to affect the usability of it. However, many users in their study indicated that advertisement can be disturbing when trying to interpret the geodata. A large amount of advertisement will increase the size of the web page, thus increase the loading time. The number of advertisement boxes and animations should be modest and located in such a way that they do not interrupt the user (Nivala, Brewster & Sarjakoski 2008).

5 Comparative Study of Open Geodata Distribution User Interfaces

5.1 Components and Processes of the User Interface

There are several open geodata distribution services available on the web. Some of these are similar while others differ significantly regarding *how* they provide the geodata to the customer. Different services present different features and possibilities to assist the user in finding the wanted data set. In this thesis, the following components are considered:

- registration
- preview
- metadata
- delivery.

Some open geodata distributors require you to be registered and logged on to use their service. The services' registration procedures are sometimes straightforward but sometimes very complicated. In some cases, you type in your email address and choose a password, while in other cases, you have to answer several questions about yourself and your intended use of the data.

A preview of the data that you are about to download could be convenient but it might not always be necessary. Most of the available open geodata web services provide preview for some data sets but not all of them. In many cases, only a preview of the extent of the map download is available.

Metadata should preferably be available as text or as a link to text on the web page, effortlessly accessible for the user. There is an ISO standard (ISO 19115-1:2014) that delineates the schema for description of geodata and geodata services using metadata. This standard defines mandatory, conditional and optional metadata elements, and the minimum set of metadata elements that is required to serve most of the metadata applications (ISO 2014).

The metadata requirements that are stated in the Inspire directive are based in the previously mentioned ISO standard. According to Inspire, metadata is information that describes geodata sets and geodata services and makes it possible to use them. In addition to this, it is stated in the directive what metadata should include. Metadata about geodata should consist of: (Directive 2007/2/EC of the European Parliament and of the Council)

- the conformity of spatial data sets with implementation rules
- conditions regarding access to and use of geodata and services
- the data set's quality and validity
- the responsible public authority
- limitations on public access.

The data delivery based on a data request can be done in various ways. Some distributors make the data accessible directly from the web page, which makes it possible to obtain the data within seconds. Other distributors send an email with a link to the download. Danish *Kortforsyningen* and Norwegian *Kartverket* require an extra step before a download is possible. These services require you to put the wanted data set(s) in your customer basket, and press *Order*. When pressing *Order*, the data set will become available for download through the web page.

5.2 Comparative Study of Components and Processes

In the beginning of this chapter, some examples of how different components of the user interface have been integrated and designed are presented and compared. More examples can be found in appendix A. In table 5.1 below, the 17 different open geodata web map services that have been studied in this project are listed.

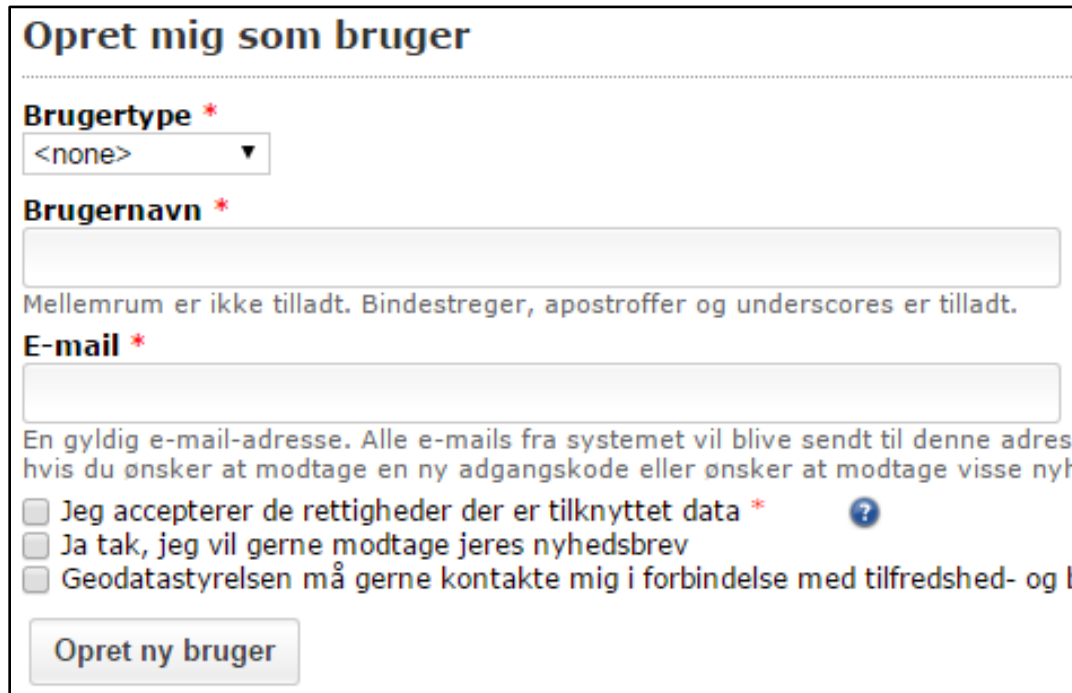
Table 5.1. *Web sources of the 17 open geodata download services that have been compared in this study.*

Web Map Service	Web Source
Baltic Sea Hydrographic Commission, <i>Baltic Sea Bathymetric Database</i>	http://data.bshc.pro/#2/58.6/16.2
City of Vancouver, <i>Open Data Catalogue</i>	http://data.vancouver.ca/datacatalogue/index.htm
Danish Geodata Agency, <i>Kortforsyningen</i>	http://download.kortforsyningen.dk/content/geodataprodukter
European Environment Agency, <i>European Union Open Data Portal</i>	http://open-data.europa.eu/data/publisher/eea?
Federal Geographic Data Committee, <i>The Geospatial Platform</i>	https://www.geoplatform.gov/node/201/%26fq%3Dmetadata_type%3A%22geospatial%22%2BAND%2B
Geological Survey of Sweden, <i>Kartgeneratorn</i>	http://apps.sgu.se/kartgenerator/maporder_sv.html
Geospatial Information Authority of Japan, <i>Global Map Japan</i>	http://www.gsi.go.jp/kankyochiri/gm_japan_e.html
Government of Canada, <i>GeoGratis</i>	https://www.nrcan.gc.ca/earth-sciences/geography/topographic-information/free-data-geogratis/11042
Kartverket	http://data.kartverket.no/download/content/geodataprodukter
Linköping kommun	http://www.linkoping.se/open/Oppna-data1/Geodata/

Table 5.1. *Web sources of the 17 open geodata download services that have been compared in this study. (continued)*

Web Map Service	Web Source
Natural Earth	<u>http://www.naturalearthdata.com/downloads/</u>
OpenStreetMap	<u>https://www.openstreetmap.org/</u>
Stockholms Stad, <i>Open Stockholm Portal</i>	<u>http://dataportalen.stockholm.se/dataportalen/</u>
Trimble Data Marketplace, USA	<u>http://data.trimble.com/market/index.html</u>
United Nations Environment Programme, <i>Environmental Data Explorer</i>	<u>http://geodata.grid.unep.ch/</u>
United States Geological Survey, <i>EarthExplorer</i>	<u>http://earthexplorer.usgs.gov/</u>
Washington State Department of Ecology	<u>http://www.ecy.wa.gov/services/gis/data/data.htm</u>

Figure 5.1 shows an example of a registration procedure from Danish *Kortforsyningen*. To register, you will need to enter what type of user you are, your name, and your email address. You will also have to accept the rights associated with the data before registration is complete.



The screenshot shows a web form titled "Opret mig som bruger" (Create me as a user). The form contains the following fields and elements:

- Brugertype ***: A dropdown menu with "<none>" selected.
- Brugernavn ***: A text input field. Below it, a note states: "Mellemrum er ikke tilladt. Bindestreger, apostroffer og underscores er tilladt." (Spaces are not allowed. Hyphens, apostrophes, and underscores are allowed).
- E-mail ***: A text input field. Below it, a note states: "En gyldig e-mail-adresse. Alle e-mails fra systemet vil blive sendt til denne adresse, hvis du ønsker at modtage en ny adgangskode eller ønsker at modtage visse nyheder." (A valid e-mail address. All e-mails from the system will be sent to this address, if you wish to receive a new password or wish to receive certain news).
- Three checkboxes with labels:
 - ☐ Jeg accepterer de rettigheder der er tilknyttet data *
 - ☐ Ja tak, jeg vil gerne modtage jeres nyhedsbrev
 - ☐ Geodatastyrelsen må gerne kontakte mig i forbindelse med tilfredshed- og tilfældighedsundersøgelser
- A button labeled "Opret ny bruger" (Create new user).

Figure 5.1. Screenshot showing the registration procedure of the open geodata distribution service called *Kortforsyningen*. (Danish Geodata Agency 2015b)

Figure 5.2 and 5.3 show two different versions of data set previews. Figure 5.2 shows a data set that is overlaid on a Google maps background layer. Some web map services do not offer a preview of the complete data set, or a preview of the wanted area, but instead an example preview of what the data set looks like and contain. Figure 5.3 shows an example of this.

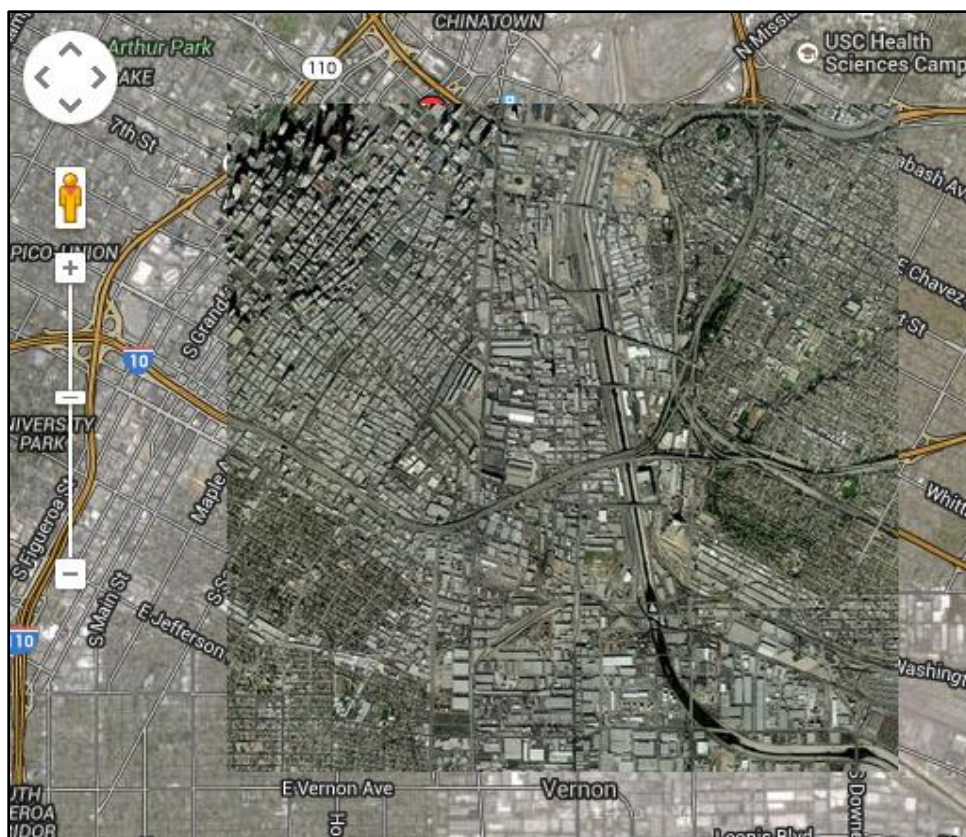


Figure 5.2. Screenshot showing an example of the preview functionality of the open geodata distribution service called *EarthExplorer*. (United States Geological Survey 2015)



Figure 5.3. Screenshot showing an example of the preview functionality of the open geodata distribution service of Norwegian *Kartverket*. (Kartverket 2015)

Sometimes, it might be enough with a preview of the extent of a data set. Figure 5.4 and 5.5 shows different examples of extent previews.

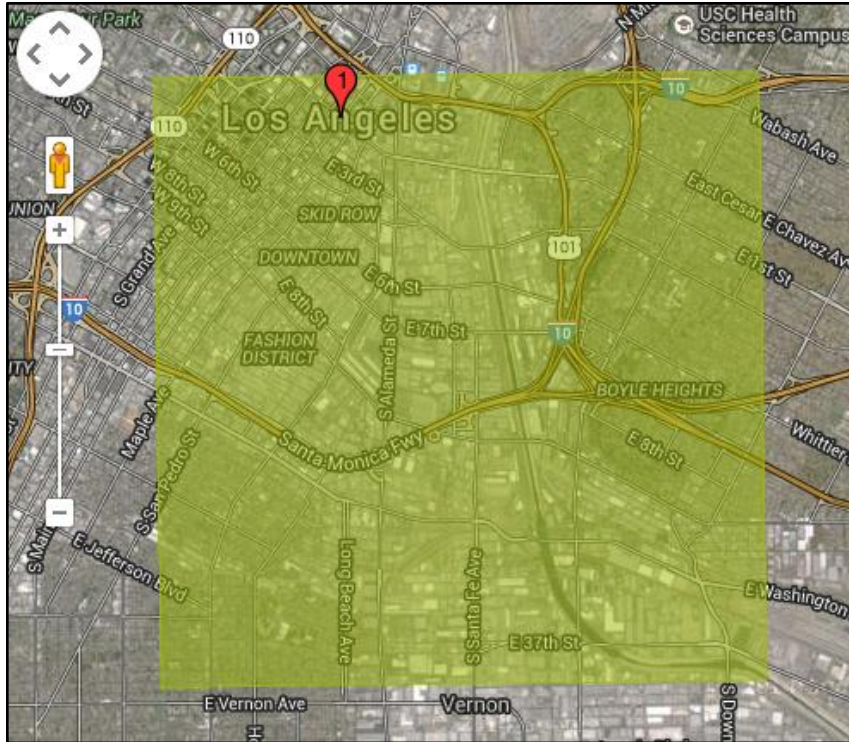


Figure 5.4. Screenshot showing an example of the data set extent preview functionality of the open geodata distribution service called *EarthExplorer*. (United States Geological Survey 2015)

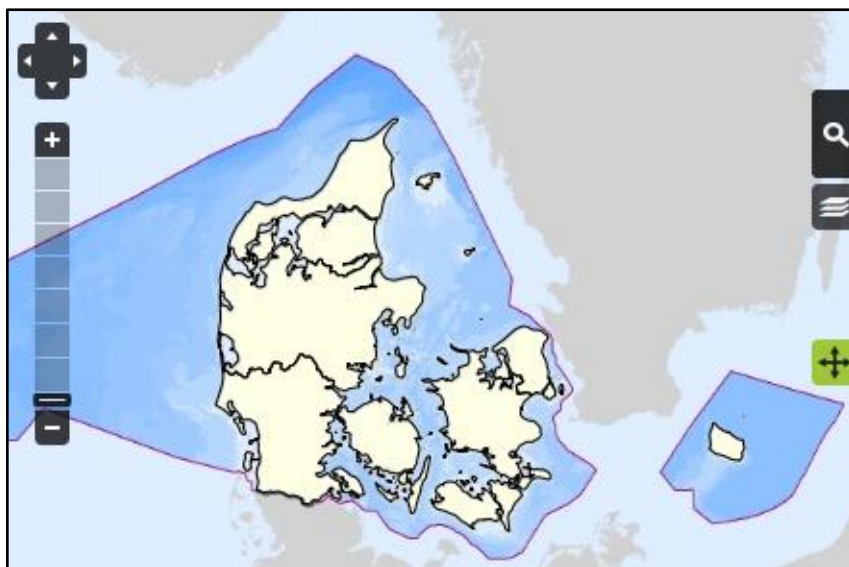


Figure 5.5. Screenshot showing an example of the data set extent preview functionality of the open geodata distribution service called *Kortforsyningen*. (Danish Geodata Agency 2015b)

According to the EU directive Inspire, metadata should be easy accessible for the user of a geodata distribution service. Different open geodata download services compared in this study provide metadata in different ways. Some services present the metadata after a certain data set has been chosen, while other services present it directly in the list of available data sets. Figure 5.6 shows an example from *Environmental Data Explorer*, they provide the user with metadata after a specific dataset has been selected, as an optional part of the download procedure. *Washington State Department of Ecology* on the other hand, see figure 5.7, provide metadata before a data set has been chosen.

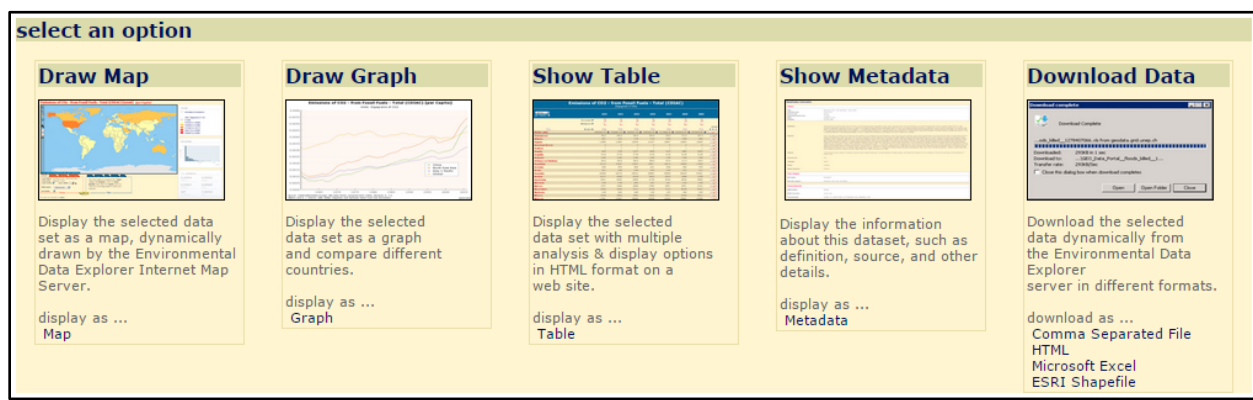


Figure 5.6. Screenshot showing the metadata access of the open geodata distribution service called *Environmental Data Explorer*. (United Nations Environment Programme 2015)










A B C D E F G H I J K L M N O P Q R S T U V W X Y Z																										
DATA LAYER NAME																								VIEW FGDC METADATA	VIEW IMAGE	DOWNLOAD ZIP FILE
Ambient Water quality monitoring stations																										
Baseflow Stations Baseflow characteristics of Washington streams																										
Washington Public Beach Access Points A detailed GIS database of public access locations (point features) with attributes along the coastal shorelines.																										

Figure 5.7. Screenshot showing the metadata access of the open geodata distribution service of *Washington State Department of Ecology*. (Washington State Department of Ecology 2015)

To download geodata, the user will sometimes receive an email with the download link, but most often, the download is done directly through the web page. Figure 5.8 shows an example from *Natural Earth*, download is in this distribution service done by clicking a button on the web page.

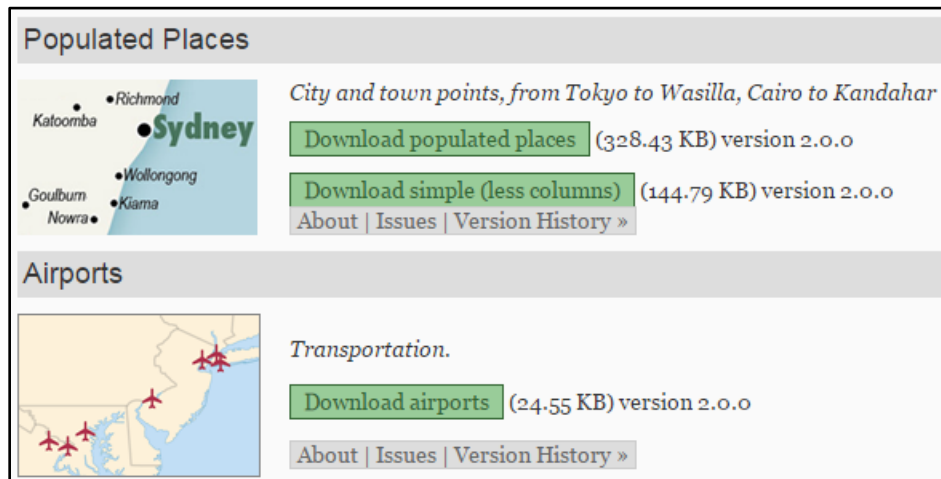


Figure 5.8. Screenshot showing how geodata is downloaded from the open geodata distribution service called *Natural Earth*. (Natural Earth 2015)

Figure 5.9 shows the customer basket from the Danish web map service *Kortforsyningen*. The data sets that you have added to the basket will be listed as in the image. You can add or remove items from the basket. By clicking the green button, you will confirm the order and be redirected to a download page.



Figure 5.9. Screenshot showing the customer basket functionality of the open geodata distribution service called *Kortforsyningen*. (Danish Geodata Agency 2015b)

In table 5.2, 17 open geodata download services have been compared based on four crucial components of a download service.

Table 5.2. A comparison of 17 different open geodata distributors based on four crucial components of a download service.

Name	Registration Required	Preview	Metadata	Data Delivery
<i>Baltic Sea Hydrographic Commission, Baltic Sea Bathymetric Database (Commercial data)</i>	No	Yes	Yes	Download from web page.
<i>City of Vancouver, Open Data Catalogue, Canada (Authority data)</i>	No	Preview in Google or Bing maps available for some data sets.	Yes	Download from web page.
<i>Danish Geodata Agency, Kortforsyningen, Denmark (Authority data)</i>	Yes	<p>Small preview for all data sets, but not always for the wanted area. Preview of wanted area is available for some data sets.</p> <p>For most of the data sets, only a background map to show extent is available.</p>	Sometimes available.	<p>Download the zip file from the web page. Order available on your account for a week. Order the way you normally do on the web; put data sets in your basket and confirm.</p> <p>Takes a few days to receive the data if the user has specified an own polygon.</p>

Table 5.2. *A comparison of 17 different open geodata distributors based on four crucial components of a download service.*
(continued)

Name	Registration Required	Preview	Metadata	Data Delivery
<i>European Environment Agency, European Union Open Data Portal (Authority data)</i>	No	Preview is available for some data sets.	Yes	Download from web page.
<i>Federal Geographic Data Committee, The Geospatial Platform, USA (Authority data)</i>	No	Preview is available for some data sets. Preview of extent of data set is available.	Yes	Download from web page.
<i>Geological Survey of Sweden, Kartgeneratorn, Sweden (Authority data)</i>	No	Yes	Yes	Once order is ready, you will receive an email with download instructions.
<i>Geospatial Information Authority of Japan, Global Map Japan (Authority data)</i>	No	No	No	Download from web page.

Table 5.2. *A comparison of 17 different open geodata distributors based on four crucial components of a download service.*
(continued)

Name	Registration Required	Preview	Metadata	Data Delivery
<i>Government of Canada, GeoGratis, Canada (Authority data)</i>	No	Yes	Yes	Download from web page.
<i>Kartverket, Norway (Authority data)</i>	Yes	Small preview for all data sets, but not always for the wanted area. Preview of wanted area is available for some data sets. No information regarding which map that is shown as preview, but it is mostly just a background map to show extent.	Yes	Download the zip file from the web page. Order available on your account for 24 hours. Order the way you normally do on the web; put data sets in your basket and confirm order.
<i>Linköping kommun, Sweden (Authority data)</i>	No	No	Yes	Download from web page.
<i>Natural Earth (VGI)</i>	No	Small preview picture for all data sets, but not always for the wanted area.	No	Download from web page.

Table 5.2. *A comparison of 17 different open geodata distributors based on four crucial components of a download service.*
(continued)

Name	Registration Required	Preview	Metadata	Data Delivery
<i>OpenStreetMap, USA (VGI)</i>	No	Yes	No	Download through OSM or other sources that provide their data.
<i>Stockholm Stad, Open Stockholm Portal, Sweden (Authority data)</i>	No	Yes, except for 3D data.	Yes	Download from web page.
<i>Trimble Data Marketplace, USA (Commercial data)</i>	Yes	Yes	Yes	Once order is ready, you will receive an email with download instructions. Order available on your account for a week.
<i>United Nations Environment Programme, Environmental Data Explorer (Authority data)</i>	No	Available for most data sets.	Yes	Download from web page.

Table 5.2. *A comparison of 17 different open geodata distributors based on four crucial components of a download service.*
(continued)

Name	Registration Required	Preview	Metadata	Data Delivery
<i>United States Geological Survey, EarthExplorer, USA (Authority data)</i>	Yes	Preview is available for some data sets. For some data, it is only possible to visualize the extent of the data set.	Yes	Download from web page.
<i>Washington State Department of Ecology, USA (Authority data)</i>	No	Yes	Yes	Download from web page.

5.3 User Parameters of the User Interface

Some of the available open geodata services are similar while others differ greatly regarding what user parameters that are offered during the download process. In this thesis, the following user parameters are considered:

- search options
- area definition
- other parameters.

Many web map services offer the possibility to perform a text based search for a data set. Depending on service, the user is sometimes able to search for a place name and sometimes for a specific keyword related to the data set. Some web map services offer a combination of these search possibilities.

There are web map services that assist the user to browse through their data catalogue with help of filter options. The filter possibilities can for example be checkboxes which let the user decide what type of data that is wanted, or from which publisher. Some web map services present their data catalogue as a list without any filter or search possibilities while other services can provide the user with a number of different possible combinations of search and filter options.

The extent, or area of download, of a data set can be defined in many ways. Some open geodata services provide data sets with predefined areas, it could for example be a US state, a Danish county or a 10*10km block. In some open geodata services, and for some data sets, the user is allowed to draw a polygon on the map to define what area data should be extracted for. Some services make it possible for the user to upload a file in which the area has been defined. The area could for example be specified in a KML (Keyhole Markup Language) file. It is not always possible for the user to decide the area of the download. In some cases, you will have to download the full extent of the data set.

Some web maps services allow the user to specify additional parameters before proceeding with the download. A common user parameter is the download format, the user can often specify if the data should be downloaded as for example ESRI Shapefile, TAB or JPEG. Data are often available in several formats. Other examples of user parameters are coordinate system, layers, and spatial resolution.

5.4 Comparative Study of User Parameters

In the beginning of this chapter, some examples of how different user parameters of the user interface have been integrated and designed are presented and compared. More examples can be found in appendix A.

Figure 5.10 shows an example of a web map service, *Open Stockholm Portal*, which offer a combination of text based search and filter options. The user can enter any keyword and check wanted options to narrow the search as much as possible. Norwegian *Kartverket* does only offer filter possibilities, see figure 5.11. The user can filter based on parameters in four different drop down menus.

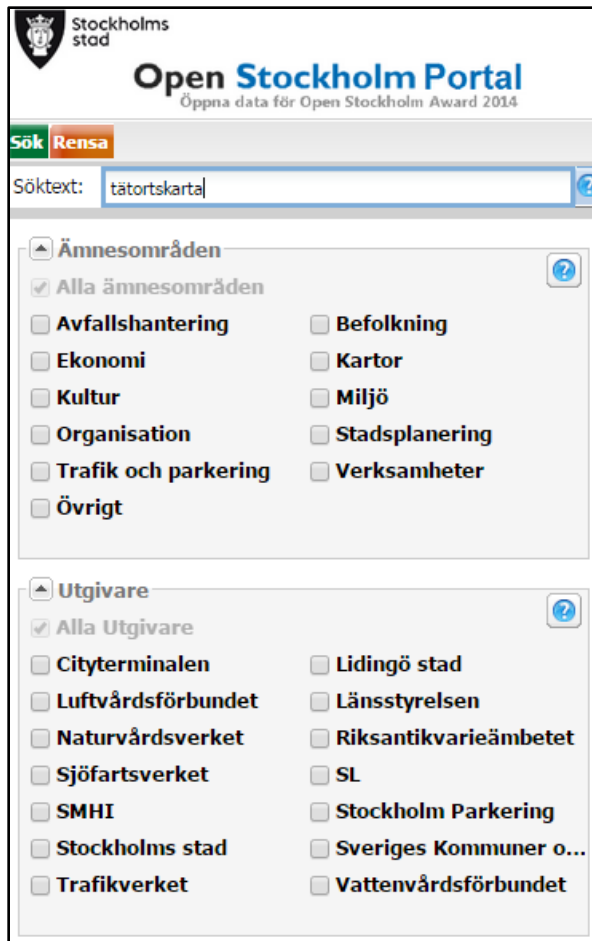


Figure 5.10. Screenshot showing the search and filter possibilities of the open geodata distribution service called Open Stockholm Portal. (Stockholms Stad 2015)



Figure 5.11. Screenshot showing the filter possibilities of the open geodata distribution service of Norwegian Kartverket. (Kartverket 2015)

Some open geodata distribution services offer the possibility to search for a place name in the background map. Sometimes, this search does only affect where the map is centered, but some services make it possible to see only those data sets that exist within the current extent of the background map. *Trimble Data Marketplace* gives the user the possibility to search for a location, see figure 5.12, the list of available data sets is determined based on current extent of the background map.

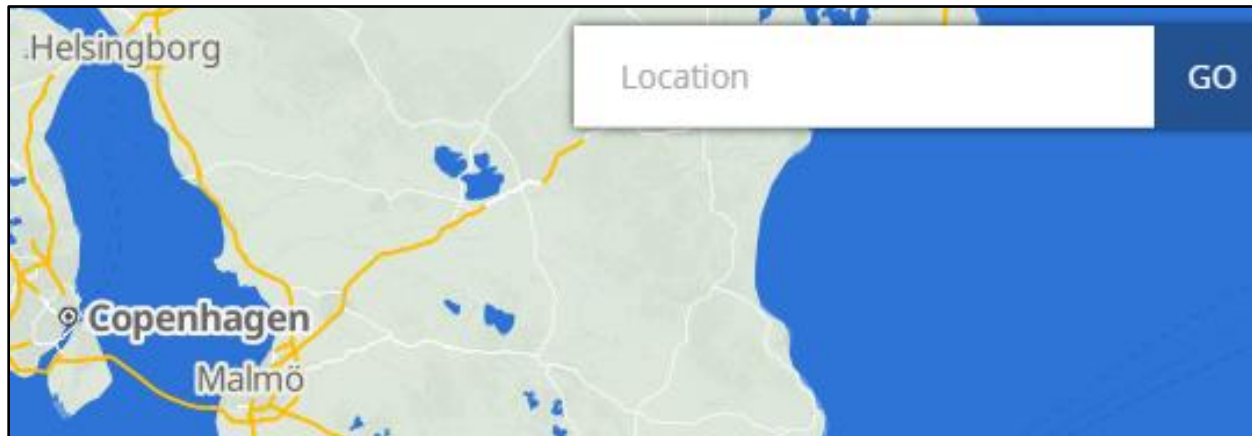


Figure 5.12. Screenshot showing the location search possibilities of the open geodata distribution service called *Trimble Data Marketplace*. (Trimble Data Marketplace 2015)

When the data extent is not predefined, the user will need to specify it. Different web map services use different techniques for this. *Kortforsyningen* and *Trimble Data Marketplace* are examples of services that allow the user to draw a polygon on the map to define the area, see figure 5.13. This allows the user to specify any kind of shape.

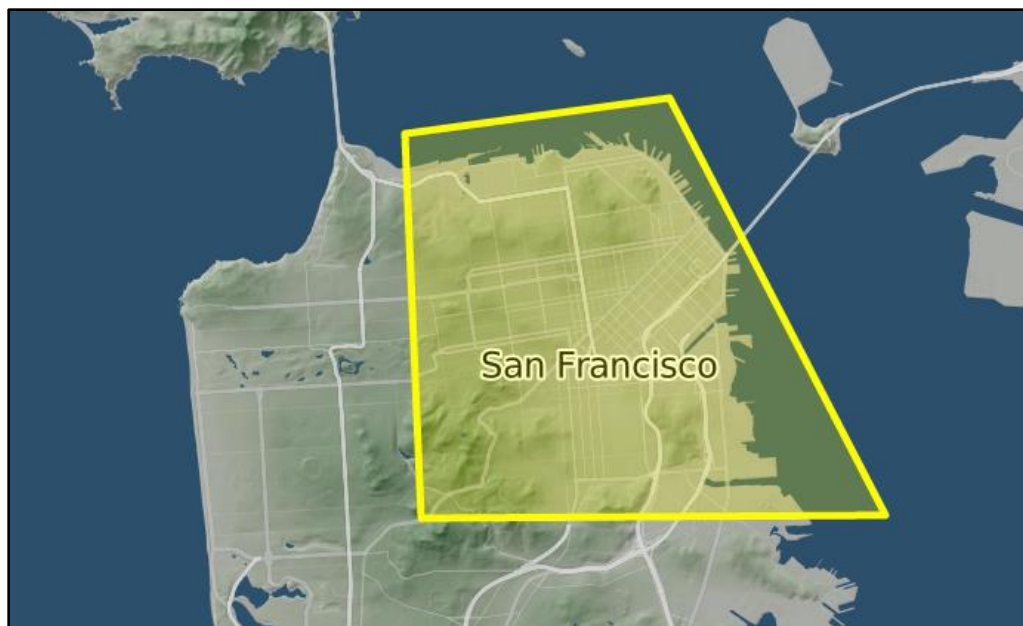


Figure 5.13. Screenshot showing the area definition functionality of the open geodata distribution service called *Trimble Data Marketplace*. (Trimble Data Marketplace 2015)

EarthExplorer is an example of a service that allows users to specify the area based on coordinates, see figure 5.14 and 5.15. The user can either type in coordinates manually, or zoom in to the wanted extent and extract those coordinates. It is easy to obtain coordinates for a rectangular area, but if another shape is wanted, the user will need to know the exact coordinates of that.

In *OpenStreetMap*, the current zoom extent when the user click *Export* will define the area. If the user would prefer another extent, it is possible to manually select another by drawing a rectangle on the map.

Coordinates	Predefined Area	Shapefile	KML
<div> <div>Degree/Minute/Second</div> <div>Decimal</div> </div>			
1. Lat: 34° 31' 10" N, Lon: 119° 30' 13" W			
2. Lat: 34° 31' 10" N, Lon: 120° 00' 18" W			
3. Lat: 34° 18' 56" N, Lon: 120° 00' 18" W			
4. Lat: 34° 18' 56" N, Lon: 119° 30' 13" W			
<div> <div>Use Map</div> <div>Add Coordinate</div> <div>Clear Coordinates</div> </div>			

Figure 5.14. Screenshot showing one part of the area definition functionality of the open geodata distribution service called EarthExplorer. (United States Geological Survey 2015)

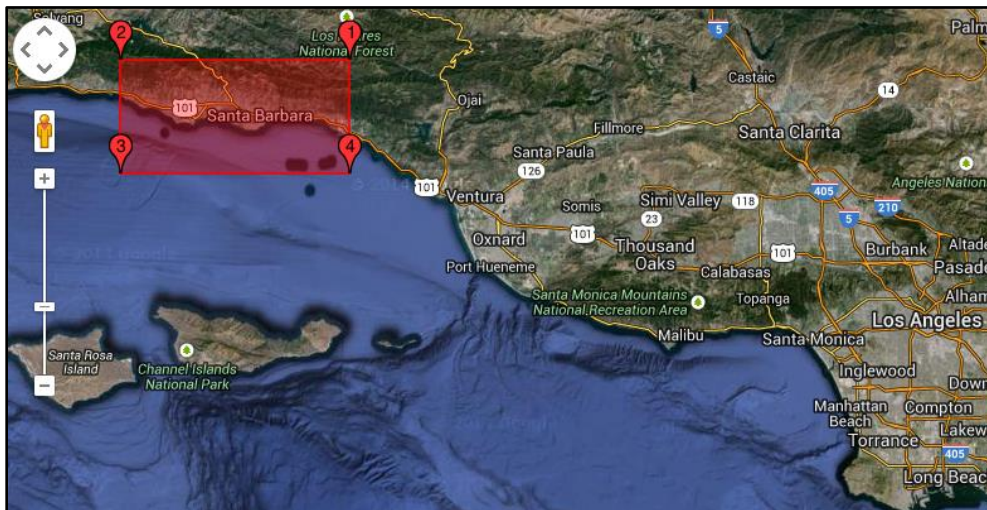


Figure 5.15. Screenshot showing one part of the area definition functionality of the open geodata distribution service called EarthExplorer. (United States Geological Survey 2015)

Some map services provide open geodata in predefined areas, see an example in figure 5.16. The user is often able to select a region or a block to define the extent of the download.

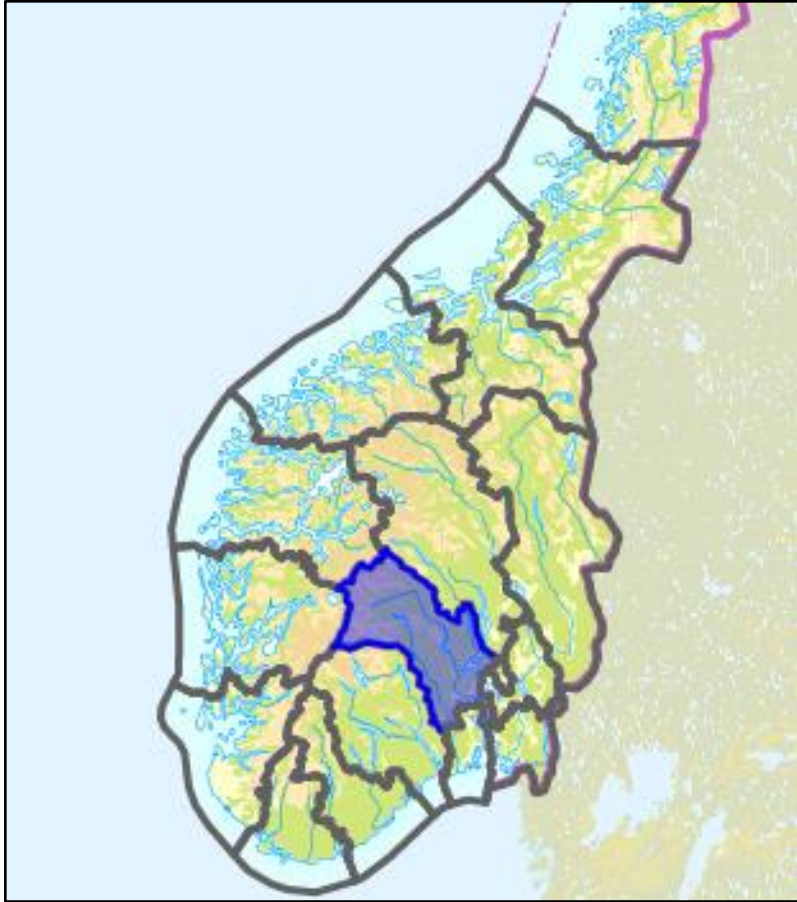


Figure 5.16. Screenshot showing an example of a predefined area from the open geodata distribution service of Norwegian Kartverket. (Kartverket 2015)

Figure 5.17 shows an example of additional user parameters, in this case file format and layers. The same data set is sometimes presented as different possible downloads depending on the different combinations of additional parameters, see figure 5.18.

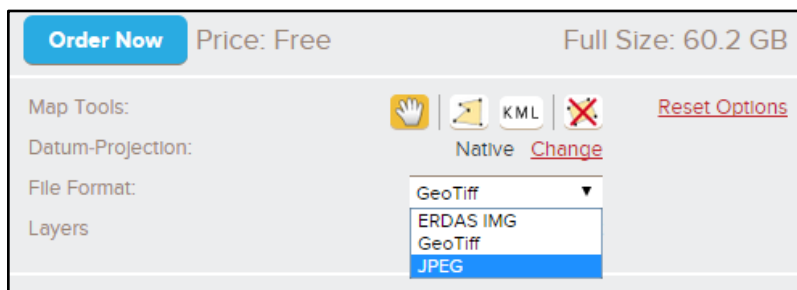


Figure 5.17. Screenshot showing an example of additional parameters from the open geodata distribution service called Trimble Data Marketplace. (Trimble Data Marketplace 2015)

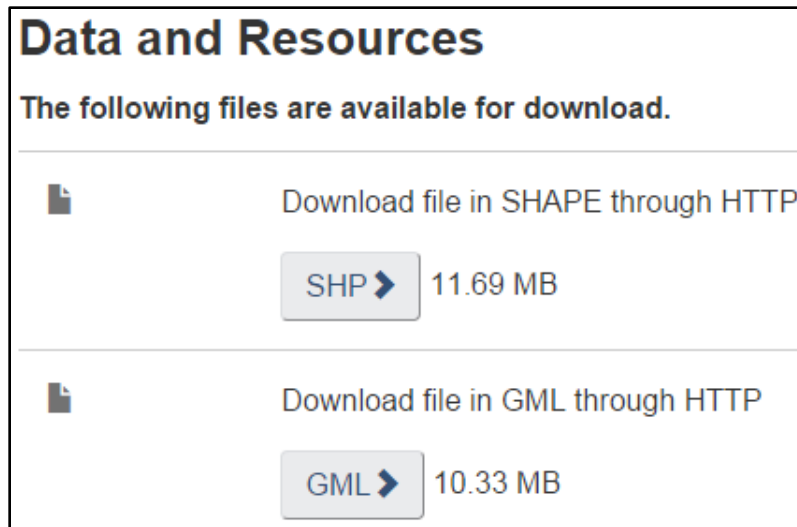


Figure 5.18. Screenshot showing an example of additional parameters from the open geodata distribution service called *GeoGratis*. (Government of Canada 2015)

In table 5.3 below, 17 different open geodata web map services have been compared based on different user parameters. The web sources of the studied open geodata distribution services can be found in table 5.1.

Table 5.3. *A comparison of 17 different open geodata distributors based on different user parameters.*

Name	Search Options	Area Definition	Other Parameters
<i>Baltic Sea Hydrographic Commission, Baltic Sea Bathymetric Database (Commercial data)</i>	Not possible to perform any type of text based search, but there are only four data sets available.	You can specify the area by drawing a rectangle on the map.	You can choose file format.
<i>City of Vancouver, Open Data Catalogue, Canada (Authority data)</i>	It is not possible to search for data. The data sets are ordered alphabetically in a list.	Not possible to choose map extent. All data sets are for Vancouver city or smaller areas within.	You can choose format, different options available for different data sets.
<i>Danish Geodata Agency, Kortforsyningen, Denmark (Authority data)</i>	<p>Not possible to perform a text based search for a data set or an area.</p> <p>Possible to filter data with four drop down menus, for example which type of data that should be shown in the list.</p> <p>It is possible to search for a place name in the map, which can be useful when you have access to a preview of the data or need to download a certain area of the map.</p>	<p>Different options for different data sets. Most of the data sets are available for the whole country (Denmark), and you are able to download the whole set in one piece.</p> <p>Some data sets come with predefined areas, and you may choose to download one or more specific blocks or regions.</p> <p>In a few cases, it is possible to draw your own area.</p>	<p>You can choose format and coordinate system, different options of these are available for different data sets.</p> <p>UTM32-ETRS89 is the most common coordinate system.</p> <p>TAB, SHP, GML and GeoTIFF are common formats.</p>

Table 5.3 A comparison of 17 different open geodata distributors based on different user parameters. (continued)

Name	Search Options	Area Definition	Other Parameters
<p><i>European Environment Agency, European Union Open Data Portal</i> (Authority data)</p>	<p>Text based search possible for keywords that are in the title of a data set, could be a place name or the type of data that you are looking for.</p> <p>You can browse the complete catalogue, which can be sorted based on topic and type of data.</p>	<p>Not possible for the user to define area on a map. You will have to download the complete extent of the data set.</p>	<p>You can choose format, different options available for different data sets.</p>
<p><i>Federal Geographic Data Committee, The Geospatial Platform, USA</i> (Authority data)</p>	<p>Possible to filter by place name and several other parameters, e.g. format and topic.</p> <p>You can specify geographic location by drawing on a map.</p> <p>It is also possible to search for a data set.</p>	<p>The areas of the data sets are predefined.</p>	<p>You can choose format, different options available for different data sets.</p>
<p><i>Geological Survey of Sweden, Kartgeneratoren, Sweden</i> (Authority data)</p>	<p>Possible to search for place names, but not for data sets.</p> <p>You can filter available data sets based on theme and map to find what you are looking for.</p>	<p>User chooses size of download (A4, A3 or A1) and specify center of area by clicking on the map.</p>	<p>You can choose map scale and size, different options available for different data sets.</p>

Table 5.3 A comparison of 17 different open geodata distributors based on different user parameters. (continued)

Name	Search Options	Area Definition	Other Parameters
<i>Geospatial Information Authority of Japan, Global Map Japan, (Authority data)</i>	It is not possible to search for data. The data sets are available in a list.	The areas of the data sets are predefined.	You can choose format, different options available for different data sets.
<i>Government of Canada, GeoGratis, Canada (Authority data)</i>	<p>Possible to switch between <i>basic search</i> and <i>advanced search</i>.</p> <p>In the basic search, it is possible to enter keywords and/or filter by product type. Possible to search based on data set names and/or place names.</p> <p>In the advanced search, it is possible to specify geographic location in three different ways, enter keywords and/or filter by for example product type and author.</p> <p>It is also possible to browse for data sets in their catalogue.</p>	The areas of the data sets are predefined.	You can choose format, different options available for different data sets.

Table 5.3 A comparison of 17 different open geodata distributors based on different user parameters. (continued)

Name	Search Options	Area Definition	Other Parameters
<i>Kartverket, Norway</i> (Authority data)	Not possible to perform any type of text based search. Possible to filter data with four drop down menus, and with those specify for example which type of data that should be shown in the list.	The data sets are available as predefined areas, either as the whole country or a specific block/region.	You can choose format and coordinate system, different options of these are available for different data sets. UTM32-WGS84 and UTM33-WGS84 are common coordinate systems.
<i>Linköping kommun, Sweden</i> (Authority data)	It is not possible to search for data. The data sets are ordered alphabetically in a list.	Not possible to choose map extent. All data sets are for Linköping city or smaller areas within.	You can choose between a WMS and a WFS service.
<i>Natural Earth</i> (VGI)	It is not possible to search for data. Data is sorted by scale level, and then by three different themes <i>Cultural</i> , <i>Physical</i> or <i>Raster</i> .	Not possible to choose map extent. The areas of the data sets are predefined. Not possible to preview extent of map. Not always obvious what area the data set cover.	You can choose between three different scale levels, 1:10,000,000, 1:50,000,000 and 1:110,000,000. Not all data sets are available at all scale levels.

Table 5.3 A comparison of 17 different open geodata distributors based on different user parameters. (continued)

Name	Search Options	Area Definition	Other Parameters
<i>OpenStreetMap, USA (VGI)</i>	Search for a place name and/or zoom to the extent you want.	Area is defined by the zoom extent. You can also specify the area by drawing a polygon on the map.	You can choose between different layers, e.g. <i>Transportation</i> .
<i>Stockholms Stad, Open Stockholm Portal, Sweden (Authority data)</i>	Possible to search for data sets, but not for place names. You can filter available data sets based on topic and publisher to find what you are looking for.	The data sets are available as predefined areas, either Stockholm county or a specific region within.	You can choose format, different options available for different data sets.
<i>Trimble Data Marketplace, USA (Commercial data)</i>	It is possible to search based on place names, and acquire information about what data that is available in that region. It is also possible to zoom to a specific area, and search for a data set to see if it is available in that region. You can also search for a specific data set.	You can order full size (the whole map extent) or specify your own area by drawing a polygon. It is possible to select a KML file with coordinates that specifies your area, drag and drop it on the map.	You can choose format, different options available for different data sets. For some data sets, it is possible to choose between different spatial resolutions and different layers. Other parameters might also be available.

Table 5.3 A comparison of 17 different open geodata distributors based on different user parameters. (continued)

Name	Search Options	Area Definition	Other Parameters
<p><i>United Nations Environment Programme, Environmental Data Explorer</i> (Authority data)</p>	<p>Possible to switch between <i>basic search</i> and <i>advanced search</i>.</p> <p>In the basic search, it is possible to enter keywords and/or select a data category.</p> <p>In the advanced search, it is possible to enter keywords and/or filter by for example data type, theme and region.</p>	<p>The areas of the data sets are predefined.</p>	<p>You can choose format, different options available for different data sets.</p>
<p><i>United States Geological Survey, EarthExplorer, USA</i> (Authority data)</p>	<p>When you have specified the area, it is possible to see what data sets that exist in that region.</p> <p>It is possible to search for a place name.</p> <p>You can zoom in to the extent you want, or specify bounding box coordinates. You can also choose search region by uploading a KML or SHP file.</p>	<p>The areas of the data sets are predefined.</p>	<p>Different options are available for different data types.</p> <p>For satellite imagery, it can for example be possible to choose year of acquisition, satellite type and cloud cover.</p>

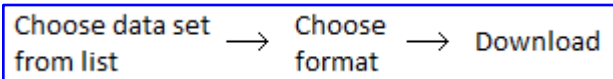
Table 5.3 *A comparison of 17 different open geodata distributors based on different user parameters. (continued)*

Name	Search Options	Area Definition	Other Parameters
<i>Washington State Department of Ecology, USA (Authority data)</i>	It is not possible to search for data. The data sets are ordered alphabetically in a list.	Not possible to choose map extent. All data sets are for Washington State or smaller areas within.	No other user parameters are available.

5.5 Comparative Study of Download Processes

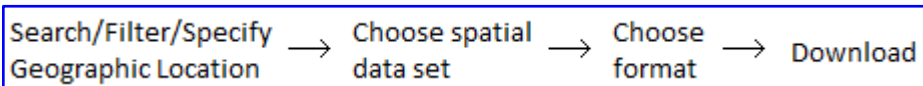
As we have seen, web map services offer different possibilities, and the user interfaces of the services all vary in some way. In this section, some different download processes are compared. What way of designing the user interface and deal with user input is the most user friendly?

Washington State Department of Ecology has the most simple download process of all web map services compared in this study, it is hard to imagine that an easier process exists. The only thing you need to do is to choose a data set from the list and press download. *Vancouver Open Data Catalogue* does also have a very straightforward download process, the only thing they have added compared to *Washington State* is that the user will need to choose data download format, see *Process 1*.



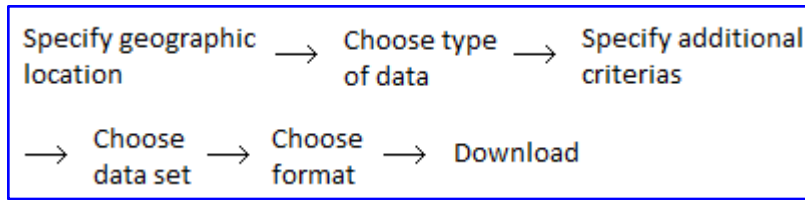
Process 1. Download process for example used by *Vancouver Open Data Catalogue*.

Web map services that provide more data sets than the *Vancouver Open Data Catalogue* will need to add a search or filter capability to the service, this to make it possible for the user to find data in an uncomplicated way, see *Process 2*. Some services allow the user to specify a geographic location or geographic area to filter data sets by, for example the *Geospatial Platform*.



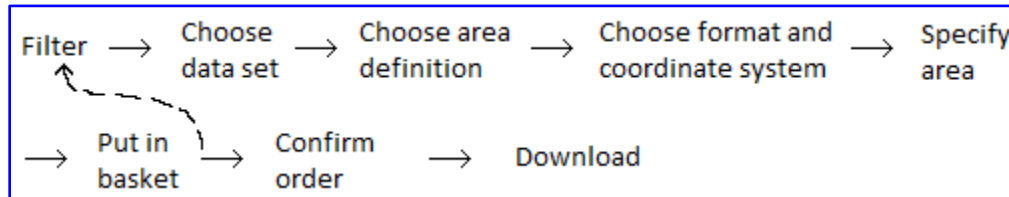
Process 2. Download process for example used by the *Geospatial Platform*, *Environmental Data Explorer*, *Open Stockholm Portal*, and *GeoGratis*.

Some services, for example *EarthExplorer*, will only allow the user to search or filter based on a geographic location or area, and do not allow the user to search for a specific data set. When location and data type have been established, and additional criteria have been specified, the user will be presented a list with all data sets available in that region, see *Process 3*.



Process 3. *Download process for example used by EarthExplorer.*

Some web map services, for example Danish *Kortforsyningen*, do not allow the user to perform text based searches. Data is sorted based on a number of filter options, see *Process 4*. Prior to a download from *Kortforsyningen*, the registered user will need to put the desired data set in the customer basket. This type of step allows the user to stay on the web page for a while and gather multiple data sets in the basket before downloading them.



Process 4. *Download process for example used by Kortforsyningen.*

All web map services compared in this study present their data catalogue as a list of data sets, but in different ways. Some services have chosen to list every version of a data set as an entry in the list, meaning that everything is predefined when you click on a list item, while other services have decided to show all data types in the list and make the user choose additional parameters in the next step. Considering the multiple versions of data sets that can exist, it is possible that the list will become long.

6 Design of the Generic User Interface

General design considerations of interactive products and a number of open geodata download services have been analyzed in previous chapters. In this chapter, the design of the generic open geodata user interface is discussed. Based on the studies in previous chapters, conclusions about a generic and efficient design are made.

6.1 Description of the Generic User Interface

The final design of the web map application depends on the purpose of it and what type of geodata that should be distributed. Any type of open geodata should be possible to include in the application, and a generic design is therefore required. A geodata distributor should also be able to add any user parameter to the service. Therefore, the design will need to be adaptable and not fixed. Main purposes of the web map application and user interface are that any type of open geodata should be possible to include and download, and that the open geodata distributor easily can alter what user parameters that are offered.

Even though the web map application should be applicable to most data, users and distributors, there are way too many different combinations of data types and purposes of using the service to satisfy them all. It is also hard to specify what type of users and distributors that benefit the most from the approach chosen for the implementation of the generic user interface in this study. As an example, some users might consider metadata the most important part of the application, while others won't even notice the absence of it.

6.2 General User Interface Design Considerations

Considerations regarding usability and user centered design have to be taken during the development phase of the system in this project to reach the goal of a user-friendly design. The

user interface should be developed and designed with the users in mind, to make the usage of the service as simple as possible.

The user interface and developed service should be possible to use by anyone with basic computer and web experience, hence it will need a simple and clear design, without distractions. The purpose of the application is for users to be able to download geodata, and that should be obvious from the moment you enter the application. With the help from features and components on the web page, such as buttons and user input forms, it should be clear to the user what he or she is supposed to do now, but also in the next step. The user interface should be designed in a uniform manner, components representing similar functions should be expressed in similar ways.

Users that enter this web application, and aim to use it, have a number of common needs and requirements. This is an important aspect to consider during the development to ensure an easy and efficient web service. All users want to be able to search for geodata, and to be presented with the search results in an understandable manner. If the wanted data is found, the user will expect to be able to download it. Some users will also expect to be able to adjust some parameters of the data set before proceeding with the download. Different users have different needs and requirements, and it is not necessary to satisfy them all.

Besides great functionalities, the application should have an aesthetically pleasant design. The user experience will be affected by the way the web page is structured, but also by the way it is colored, and the way the buttons and other components are placed and designed. The user should feel satisfied both by using the service and by just looking at it.

6.3 Specific User Interface Design Considerations

The components and processes offered by a web service can affect the usability and user experience profoundly. A user registration is not considered necessary or beneficiary for this web service, neither for the user nor the distributor of geodata. Some potential users of a service might choose not to if they are required to register, or if the registration process is too complicated.

It is often very convenient, and sometimes necessary, for the user to be presented a preview of the data set before making the decision to download or not. It can save both time and computer capacity/memory. In many cases, it might be enough with a preview of the extent of the map download. A preview might facilitate for a user that is uncertain of what he/she is looking for, or if it is unclear based on the name of the data set what the actual content is. Even though a preview of data sets can be of great value for the users, it is not considered essential for the purpose of this download service.

Metadata is another important aspect of the service, it could simplify significantly for the user if metadata about the data sets are easily available.

The download procedure used by Danish *Kortforsyningen* and Norwegian *Kartverket* is more complicated than many others since it requires you to put data in your customer basket and order it from there. This extra step ensures that you do not by accident download more data than you need. It is sometimes, in some services, unclear when and how the data download is triggered. If you click on the name of a data set, the data might automatically begin to download without further permission from the user. It could be the case that the user clicks on the name with the hope to receive more information about the data set, and ends up with more downloaded data than needed. This step, to include a customer basket, is considered user friendly since many people are used to this from the most common approach of web shops.

Even though the extra step used by Danish *Kortforsyningen* and Norwegian *Kartverket* is considered user friendly, it will not be used in the generic user interface developed in this project. As many other available geodata download services are constructed, the actual download will be performed directly through the web page to simplify the process. The absence of a customer basket will reduce the complexity of the download procedure, but it will also decrease the amount of work necessary to finish this time-limited project.

The user parameters offered by a service are also of significant value for the usability and user experience. It is convenient to be able to perform a text based search for a data set, but it could get troublesome if the user does not type in the exact match of a specific keyword or place name. The downside of filters is that it might be plenty of data sets left to browse through even after

filters have been applied. Hence, a combination of filter and search possibilities is to prefer. A user that does not know exactly what to search for might want to use a filter while a user that knows exactly what is wanted can use the text based search.

It is in this study, and for the purpose of this service, considered straightforward to use spatial search instead of keyword search. A keyword search does not always simplify the process for the user since it can be hard to know what keywords that are listed for the wanted data set. It can also become difficult to present the results from a keyword search in a comprehensive way, should they be sorted by relevance or something else? What should be included as a search result? By using a spatial search, you will receive a list of all data sets that intersects with that geographic region, and these data sets are preferably sorted alphabetically.

The area definition is another important user parameter. Predefined areas make the download process less complicated, the user won't need to specify anything, which in one way could be called user-friendly. On the other hand, it might mean that the user does not acquire exactly what is wanted, it might require the user to download a larger area than needed.

A possibility for the user to specify an own area could complicate the process for the geodata distributor but it offers more flexibility for the user, despite the extra work that could become necessary. Among the services examined in this study, it is more common that the user is offered the possibility to draw a polygon in the map rather than uploading a file with an area. When it is possible to upload a file with the wanted area, the user is able to obtain the exact area that is needed for the purpose of the download, possibly a spatial analysis where two layers of the same extent need to be combined. No pressure is put on the user to draw the correct area on the map, and there is no risk that the wrong area is defined and the data set need to be downloaded again.

It might be easy for both the user and the distributor with predefined areas, but that does not offer very much flexibility. A possibility for the user to define an own area can improve the usability of a service and the downloaded geodata. This possibility should be offered in the application developed in this project.

Services that do not offer the possibility to overlay the data on a background map could be dissatisfying if it is hard to precise the geographic location of the data. Regarding the background

map, it is important that it has an appropriate size and well expressed content. A good cartographic quality can ease the procedure, not only for the normal user but also for people with a color deficiency. A proper choice of background map will therefore be significant. *OpenStreetMap* is considered to be the best option for the purpose of the user interface in this project.

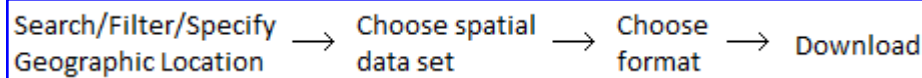
It is convenient for the users of a service that the same data set can become available for download in several different versions. More options and user parameters can, up to a certain limit, increase the usability of a service and the data sets. Too many possibilities for the user can make the download process complicated, and make the service less user friendly.

It is in this study considered more straightforward to list all data types and make the user set additional parameters in a later step. The list of available data would become too long if every version of a data set, with all combinations of parameter settings, were listed. A long list of data sets does not improve the efficiency for the user.

The downside of simple download processes like Process 1 in chapter 5.5 is that they do not allow for much user input. Furthermore, it is not possible to use this download process if there are many data sets in the database. This process will only work for web map services that provide a very limited number of data sets since there are no search or filter functionalities.

EarthExplorer was considered to be one of the more complicated web map services in this study. The download process is not obvious, it takes time to understand how the system works. The list of data types is presented after the location has been specified, but that does not mean that all data types in the list are available for that region. The complicated download process could probably be explained by the service's inhomogeneous data assets.

The application should be designed and developed to assist the users, and speed up their work. To accomplish that, the design of the user interface should leave no room for mistakes. The design and download procedure need to be clear and simple, and the service should work the way users' expect it to. *Process 2* described in section 5.5 above is in this study considered a clear and simple download procedure, and it allows for some user input.



Process 2. *Download process chosen for the generic user interface.*

6.4 Mockup

Before implementation of the system, a design proposal (mockup) was created. The mockup is developed to simplify the implementation phase, and make sure that all important functionalities will be developed properly. The design of the web page, together with the necessary functionality, is important for the usability of the service.

It is in the mockup phase of the project decided that:

- The background map should be acquired from *OpenStreetMap*.
- The background map should cover most of the view.
- No keyword or spatial search possibilities will be offered.
- Only user defined areas will be available for download.
- A panel with clear steps will allow the user to select what data to download and how this data should be altered according to user parameters.
- The HTML forms which allow for user input will populate dynamically depending on what data that exist and which user parameters the open geodata distributor has made available.
- The download will be done directly from a link on the web page.

7 User View of the Generic User Interface

The result from the implementation, which was done with all design considerations in mind, is shown in figure 7.1. The panel on the left encloses four steps that lead the user through the download procedure. The first step of the panel is expanded as soon as the user enters the application, as can be seen in figure 7.1, the following steps will become available when the user is done with previous steps.

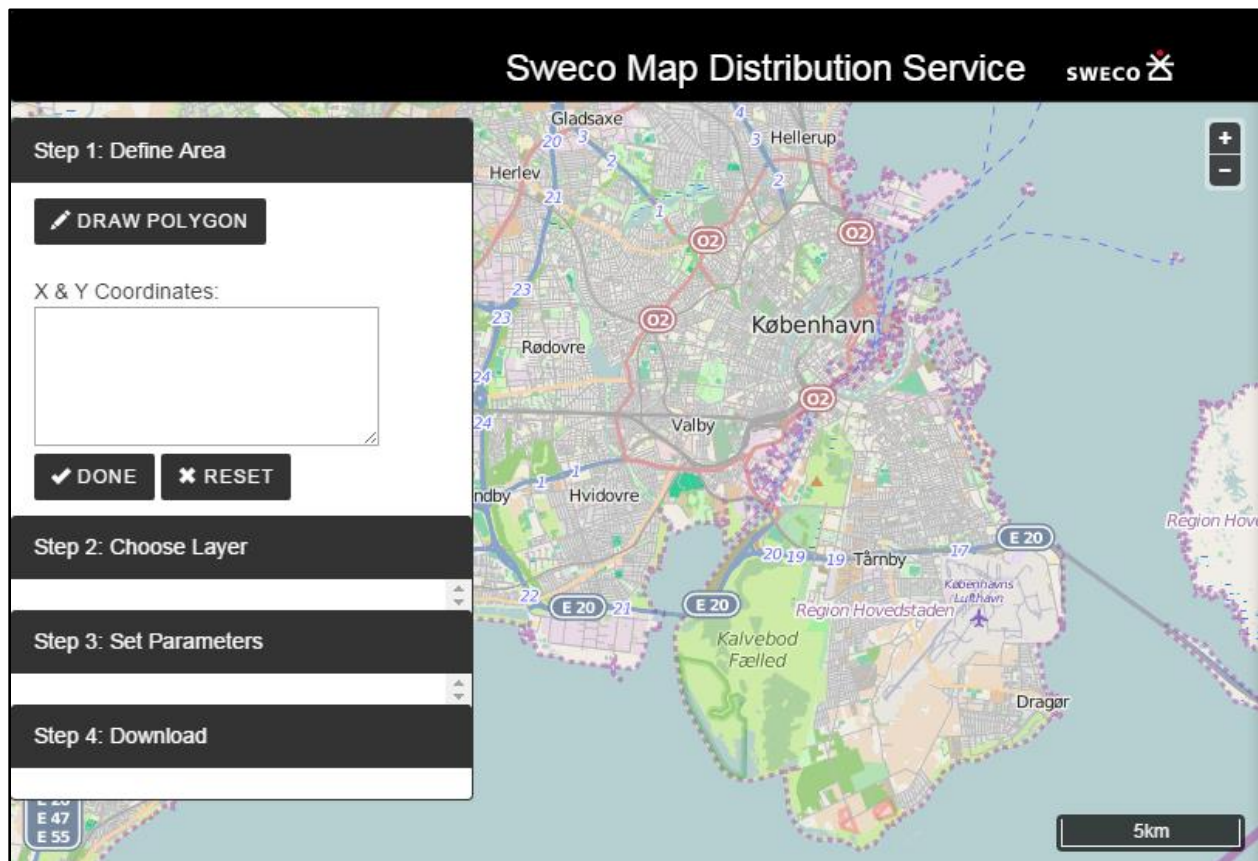


Figure 7.1. Screenshot of the generic user interface shown in a web browser.

The first step for the user is to define the area of interest for download, this is done by drawing a polygon on the map. The map can be dragged and dropped in order to find wanted geographic region. The user activates the drawing tool by pressing the *Draw Polygon* button. Drawing is ended by a double click, which will close the polygon, see figure 7.2. When drawing is ended, the line break coordinates will be shown in the coordinates text area, see figure 7.3.

When the user has finalized a polygon, she will need to decide whether she is satisfied with it or not. If not, user can press *Reset* button to remove the drawing and the coordinates in the coordinates text area of the panel. If satisfied, user will press *Done* button in step 1 of the panel to expand step 2 of the panel and continue with the download procedure.

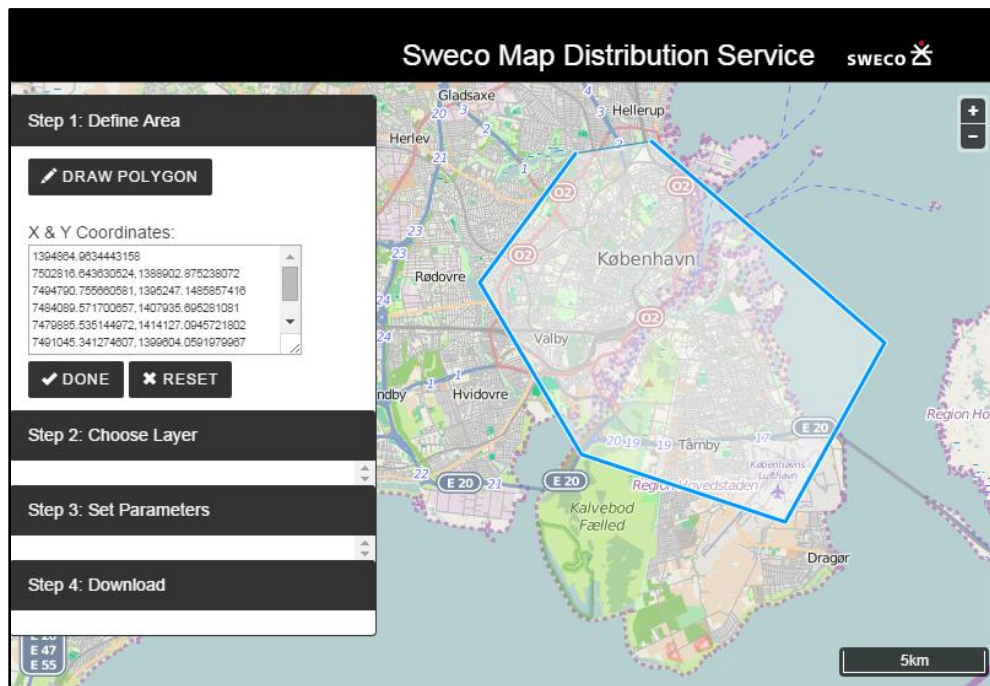


Figure 7.2. Screenshot of a user specified area in the generic user interface.

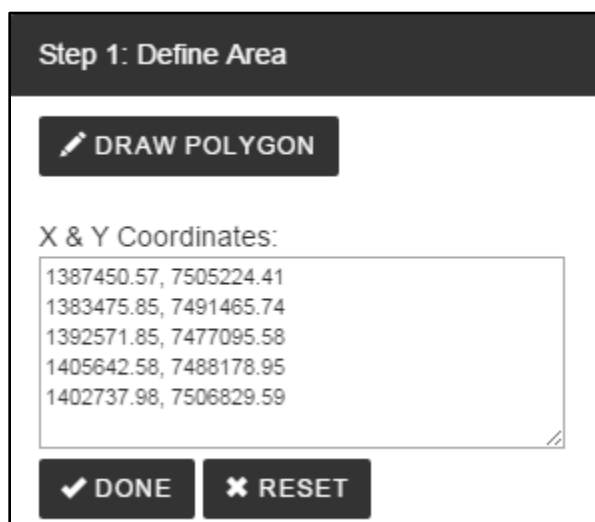


Figure 7.3. Screenshot of step 1 of the panel in the generic user interface after the first step of the download procedure (drawing a polygon) has been finalized.

There are three more steps that need to be finished, after the drawing has been finalized, before the user can acquire data. The panel of the application has a different appearance in different steps of the download procedure, one step at a time is expanded. Figure 7.1 and 7.2 show the look of the panel in step 1 of the download procedure and figure 7.4 shows the look of the panel after the user has pressed the *Done* button.

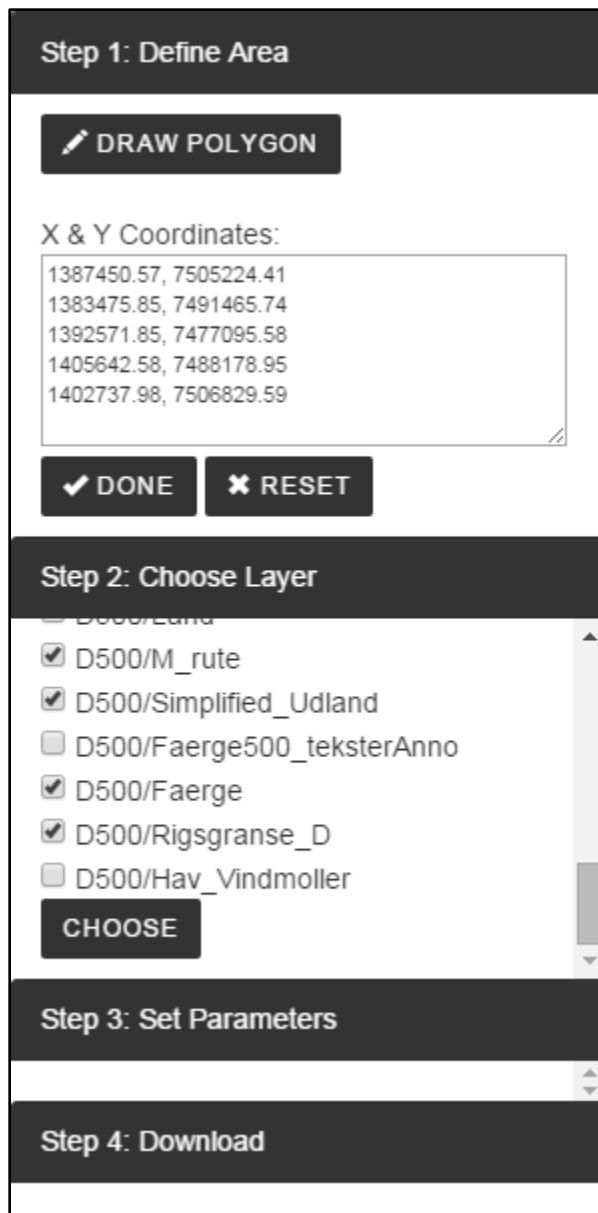


Figure 7.4. Screenshot of panel in generic user interface when step 2 of the download procedure has been expanded.

When the user presses *Done* button, and is satisfied with the specified area, step 2 will be populated with a list of different available layers, see figure 7.4. The list is populated dynamically depending on what data that exist within the user defined area. Each list item is associated with a checkbox, and the user can choose one or several layers by checking the corresponding checkbox. When the choice of layers has been made, the *Choose* button in step 2 of the download procedure is pressed. If the user changes her mind about the specified area or the chosen layers, she can press *Reset* button of step 1 to remove the polygon and reset the choice of layers.

Step 3 of the panel will dynamically be populated with a form depending on what user parameters that the open geodata distributor has made available, see figure 7.5 and 7.6. User parameters can for example be format and coordinate system. User specifies the desired value for all parameters and presses *Request* button. As this button is pressed, a pop-up message like the one shown in figure 7.7 will appear. User will have to confirm that she is ready to start the download. If the user changes her mind about the specified area, the chosen layers or the user parameter settings, she can press *Reset* button of step 1 to remove the polygon, reset the choice of layers, and reset the settings of the parameters.

Step 3: Set Parameters

Output Coordinate System:
WGS84 Lat/Long

Output Format:
ESRI Shape ▼

Geometry Source:
POLYGON((1387450. 571700653

Figure 7.5. Screenshot of upper part of step 3 of the panel in the generic user interface.

Step 3: Set Parameters

Geometry Source:
POLYGON((1387450. 571700653

Clip data: Yes ▼

Layers: D500/M_rute D500/Simplifi

REQUEST

Figure 7.6. Screenshot of lower part of step 3 of the panel in the generic user interface.

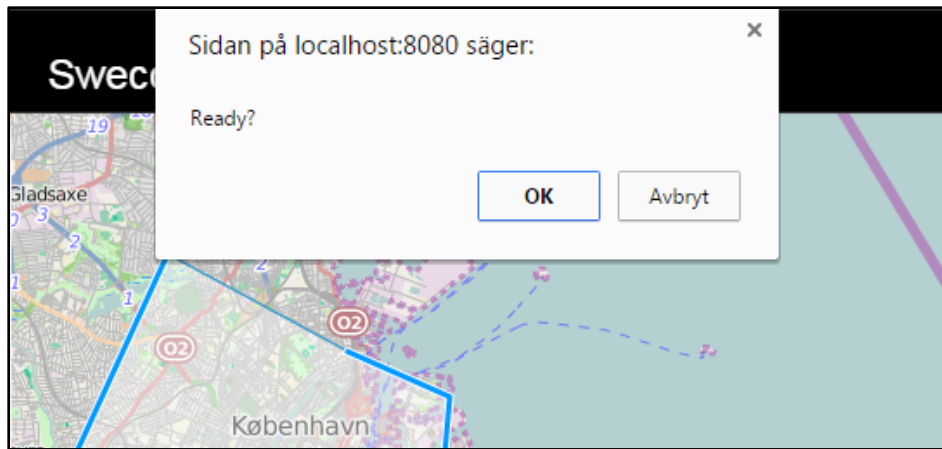


Figure 7.7. Screenshot of pop-up message that appear when user presses *Request* button of the application. User will have to confirm the she is ready to start the download.

As the user has confirmed that she is ready to start the download, step 4 of the panel will expand, see figure 7.8. In this step, the user will have to click the link *Start Download* in order to download data to her computer. Geodata will be downloaded as a zip file.

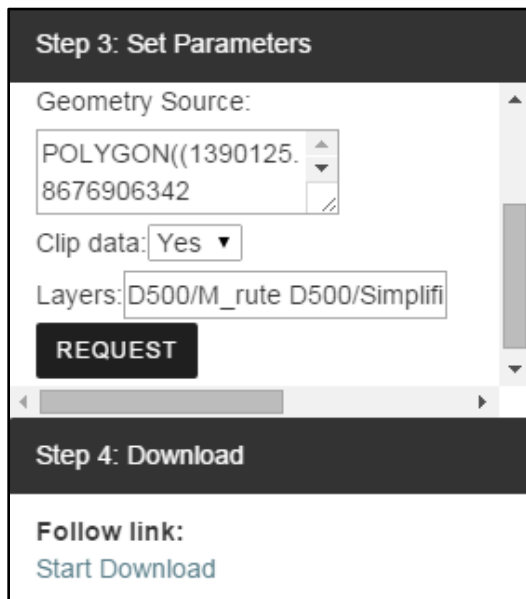


Figure 7.8. Screenshot of panel when user has altered the user parameters as wanted and is ready to download geodata. If *Start Download* link is pressed, the data will begin to download.

Fully extended panel, with all steps included, is shown in figure 7.9. This is the look of the panel when the user finally is able to download geodata.

Step 1: Define Area

DRAW POLYGON

X & Y Coordinates:

1387527.0087289382
7509887.088748898, 1375679.289344736
7485885.841865353, 1406254.0806588085
7472738.673000303, 1419095.501410716
7495975.529598997, 1387527.0087289382
7509887.088748898

✓ DONE

✕ RESET

Step 2: Choose Layer

☒ D500/Flyveplads
☐ D500/Kote
☐ D500/Simplified_Udland
☒ D500/Hjelpelinie
☒ D500/Rigsgranse_D
☐ D500/Hav_Vindmoller

CHOOSE

Step 3: Set Parameters

Geometry Source:

POLYGON((1387527.0087289382

Clip data: Yes ▼

Layers: D500/ALLE_blokke D500/k

REQUEST

Step 4: Download

Follow link:
[Start Download](#)

Figure 7.9. Screenshot of the fully extended panel of the generic user interface.

8 Implementation of the Generic User Interface

8.1 Background

Considering the expected future of open geodata and open geodata distribution services, it is of high importance for the society to be able to develop and establish numerous new download services in a short amount of time. A framework such as the one developed in this project can with slight modifications be used in several different types of open geodata distribution systems, making it easier to establish many new services.

All open geodata distribution services have the same main goal; that a user should be able to download the open geodata that is wanted or needed. The way this is executed, the download process, is often different, but will normally not affect the possibility for the service to reach its goal. The same thing applies to most differences found between the services, for example the search possibilities they offer or the design of the web pages, these factors will not hamper the possibility for the user to download the wanted data set.

The most important difference, which may affect the possibility for the service to reach its goal, found between the open geodata download services studied in this project is what user parameters they offer. More user parameters can increase the flexibility of the service, and make it more likely that the user is able to download exactly the geodata that is wanted.

The developed system will make it possible for the open geodata distributor to decide what user parameters that should be offered. The system should be able to cope with any combination of them. This possibility is expected to increase the number of services that this system is applicable for.

This chapter starts with a description of the software products and case data used for the implementation of the generic user interface. This is followed by descriptions of preparatory work and implementation details.

8.2 Software Products

8.2.1 *FME Workbench and FME Server*

FME consists of several software applications that can handle spatial data in different ways. FME Workbench is used for performing data translation and solving processing problems. Underlying functionality is in the Workbench exposed in an interface that does not require any programming. The Workbench can easily interact with other FME products such as FME Server. FME Workbench can be used to create a workspace, a data flow that transforms source data to destination data. A workspace created in the Workbench can be used for many types of tasks, for example data conversion or data validation. (Safe Software 2015a)

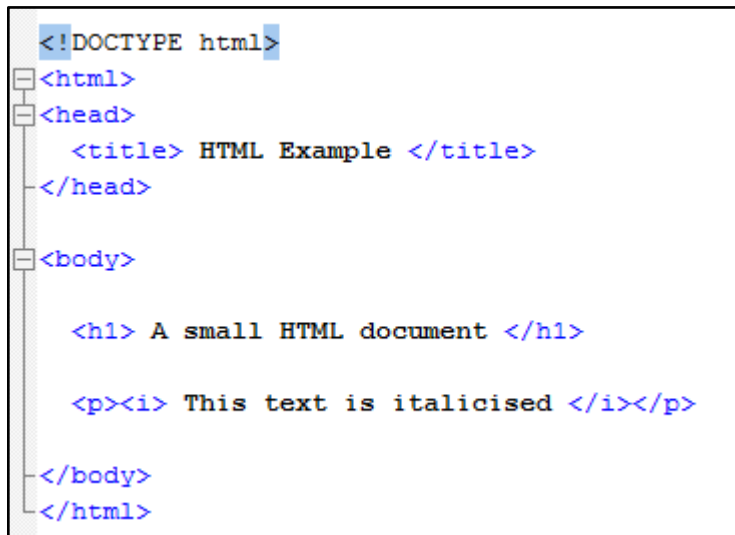
FME Server is a data transformation application with the same underlying technology as FME Desktop. FME Server is operated through a local-area network or the Internet. When a workspace has been created in FME Workbench, it can be uploaded to FME Server by clicking a button. This allows the user to manage and share workspaces, spatial data sets, and published parameters (Safe Software 2015b). Once a workspace has been published, it can be run through FME Server. In the interface of FME Server, it is possible to configure settings that specify when the workspace should run. No knowledge of coding will be required, neither for FME Workbench or FME Server (Safe Software 2014).

FME Server is a solution for integrating, transforming and sharing data. It is possible to send and receive data in real time, without delay. Data integration capabilities are for example: validation of data, handling of large data volumes, keeping data up-to-date, and automation of workflows. Data sharing capabilities are for example: possibility to distribute and stream data, and provide access to up-to-date information. FME Server is a product that can be used to provide users access to data when, where, and how they want it. A data distribution web site, for example a site allowing for map downloads, can be developed using FME Server. (Koning 2012)

8.2.2 HTML

HTML is an abbreviation of HyperText Markup Language and is a language used to describe web pages (Duncan 2014). *HyperText* is a method used to move around on the web. By clicking on “hyperlinks”, which is a special type of text, you can move around between pages. *Markup* is what the tags do to their content, they mark it as a specific type of text, for example as a title. (Shannon 2012)

Every web site contain one or more HTML files, and each of these files is a text file that can be edited in for example Notepad++, see example in figure 8.1 (Duncan 2014).



```
<!DOCTYPE html>
<html>
<head>
  <title> HTML Example </title>
</head>
<body>
  <h1> A small HTML document </h1>
  <p><i> This text is italicised </i></p>
</body>
</html>
```

Figure 8.1. A small example of a HTML document written in Notepad++.

An HTML file consists of a series of elements, each HTML element describes different content of the document (w3schools 2014). An element is specified within start and end tags, the tags differentiate simple text from HTML code. A tag is letters and symbols within angle brackets, it specifies how the text between the start and the end tag should be rendered. Tags allow for images and tables on the web page, as well as simple things such as text formatting. (Shannon 2012)

An HTML file is viewed through a web browser. The browser, for example Google Chrome or Mozilla Firefox, will read the HTML file, translate the text and visualize the content, see figure 8.2. (ibid.)



Figure 8.2. *HTML file in figure 8.1 visualized in a browser.*

8.2.3 JavaScript

HTML and JavaScript can be combined and written in the same file to create a web page. HTML code will define the static content of the web page and JavaScript is used to make the web page interactive and perform dynamic tasks (Chapman 2015).

JavaScript is a script language developed by Netscape. No special scripting program is necessary to develop the code, Notepad++ will work properly. JavaScript can be embedded in HTML files, or stand as separate files, and be interpreted by a web browser. JavaScript support is built into most web browsers (ibid.).

JavaScript can for example be used to create polls and questionnaires, make links appear in a popup window, cause page content such as text or images to transform when clicked on, or do mathematics based on user input. In the example below, see figure 8.3-8.5, HTML and JavaScript are used to show an image of a light bulb that alters color when you click on it.


```

<!DOCTYPE html>
<html>
<body>

<h1>JavaScript Can Change Images</h1>



<p>Click the light bulb to turn on/off the light.</p>

<script>
function changeImage() {
    var image = document.getElementById('myImage');
    if (image.src.match("bulbon")) {
        image.src = "pic_bulboff.gif";
    } else {
        image.src = "pic_bulbon.gif";
    }
}
</script>

</body>
</html>

```

Figure 8.3. A HTML document with embedded JavaScript code to make the web page interactive. (w3schools 2015)

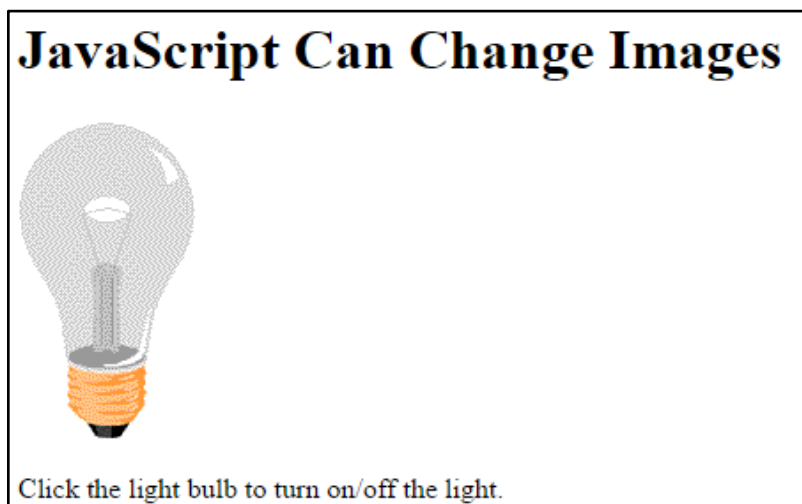


Figure 8.4. Result from code in figure 8.3 above, light bulb has not been clicked on. (w3schools 2015)

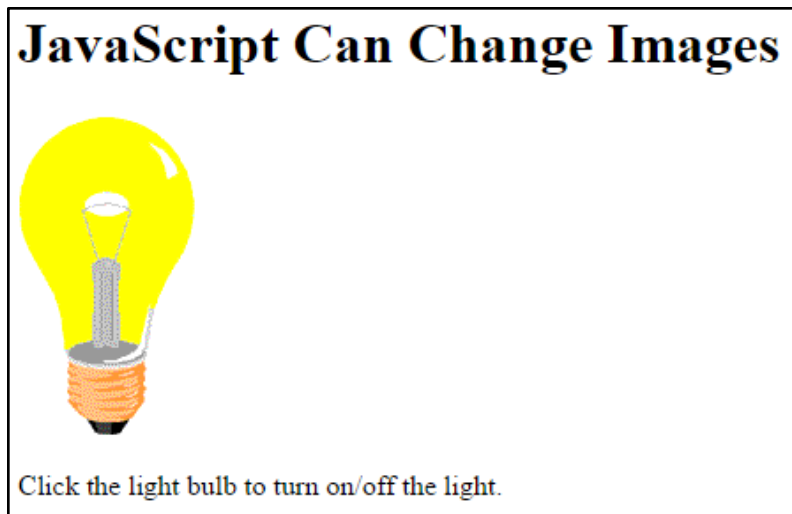


Figure 8.5. *Result from code in figure 8.3 above, light bulb has been clicked on. (w3schools 2015)*

8.2.4 Sweco Map

Sweco Map is a software application developed by Sweco Position AB. The application is heavily dependent on OpenLayers 3 and modern components such as Bootstrap and jQuery. OpenLayers is a JavaScript library that consists of functionalities for displaying map data in common web browsers (OpenLayers 2008). Sweco Map offers all functionalities made available by OpenLayers, but does also provide some additional ones. Sweco Map can be used for navigation, distance and area measurements, and other common web map functionalities.

8.2.5 Software Choice

The software products described above are used in this project to achieve the goal of a working system and user interface that can be used to establish open geodata distribution services in many future projects. With the help from HTML and JavaScript, it will be possible to create a web environment with the wanted functionalities and a user-friendly design. FME Server will make it possible to establish a connection between a FME workspace, which is developed by the open

geodata distributor, and the JavaScript code, hence make it possible for the distributor to decide what user parameters that should be available.

8.3 Case Data

I have chosen to work with open geodata from Danish Geodata Agency's service called *Kortforsyningen*. Any geodata should be applicable for the service but the open alternatives were considered the natural choice considering the aim of the project. I am in this project working with a topographic map in the scale of 1:500,000 that is covering the whole country of Denmark, without showing a lot of details. The primary content is cities and major roads (Danish Geodata Agency 2015a). Figure 8.6 shows a preview of the data set.

The data set consists of 30 different layers, for example airports, railways, coastline, lakes, and forests. In the developed service, it will be possible to choose one or more of these layers to download. Case data are locally stored during the development of this application.

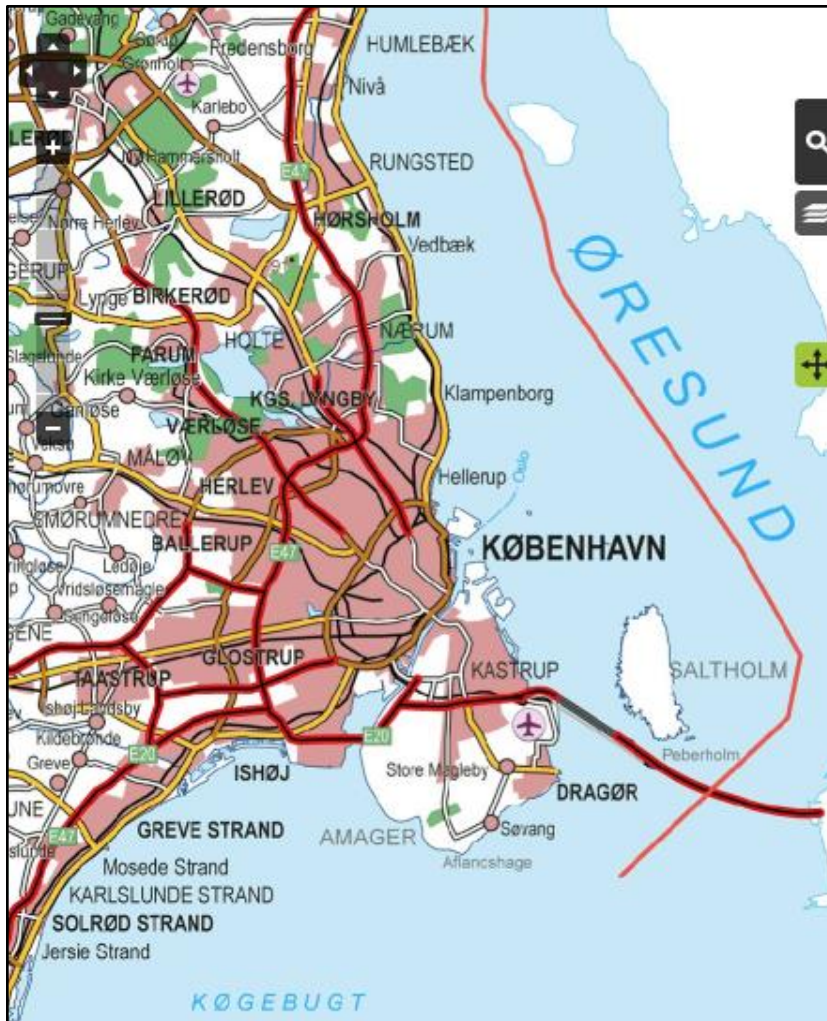


Figure 8.6. Preview of the data set Denmark 1:500 000 from Danish Kortforsyningen, which has been used as case data in this project. (Danish Geodata Agency 2015b)

8.4 Method

8.4.1 Preparation

FME Server is a key part of the developed system. Safe Software provides a JavaScript library that makes it possible to integrate JavaScript with FME Server (FME Server Developer Playground 2015a). A FME workspace that modifies data according to the user parameters is

published to the server, and hence possible to reach through the JavaScript code published by Safe Software.

The JavaScript provided by Safe Software is called *FMEServer.js* and can be found on their online Developer Playground. The script is a collection of wrapper methods for REST API calls common in a web page which is integrated with FME Server (FME Server Developer Playground 2015b). The FME Server REST API does for example allow you to manage workspaces through an open web interface. *FMEServer.js* makes it easier to connect web services with the functionality provided by FME Server and its REST Services. Numerous functions are available through the library, but I am in this project only interested in the functionalities that allow you to populate forms dynamically.

A workspace created in FME Workbench and published to FME Server is required to be able to modify data according to user input. The workspace determines what user parameters that should be available, and should therefore be created by the open geodata distributor. All parameters that are set as *Published Parameter* in the workspace are possible for the user to alter. To give an example, and be able to test the developed system, an example workspace have been created in this project, see figure 8.7.

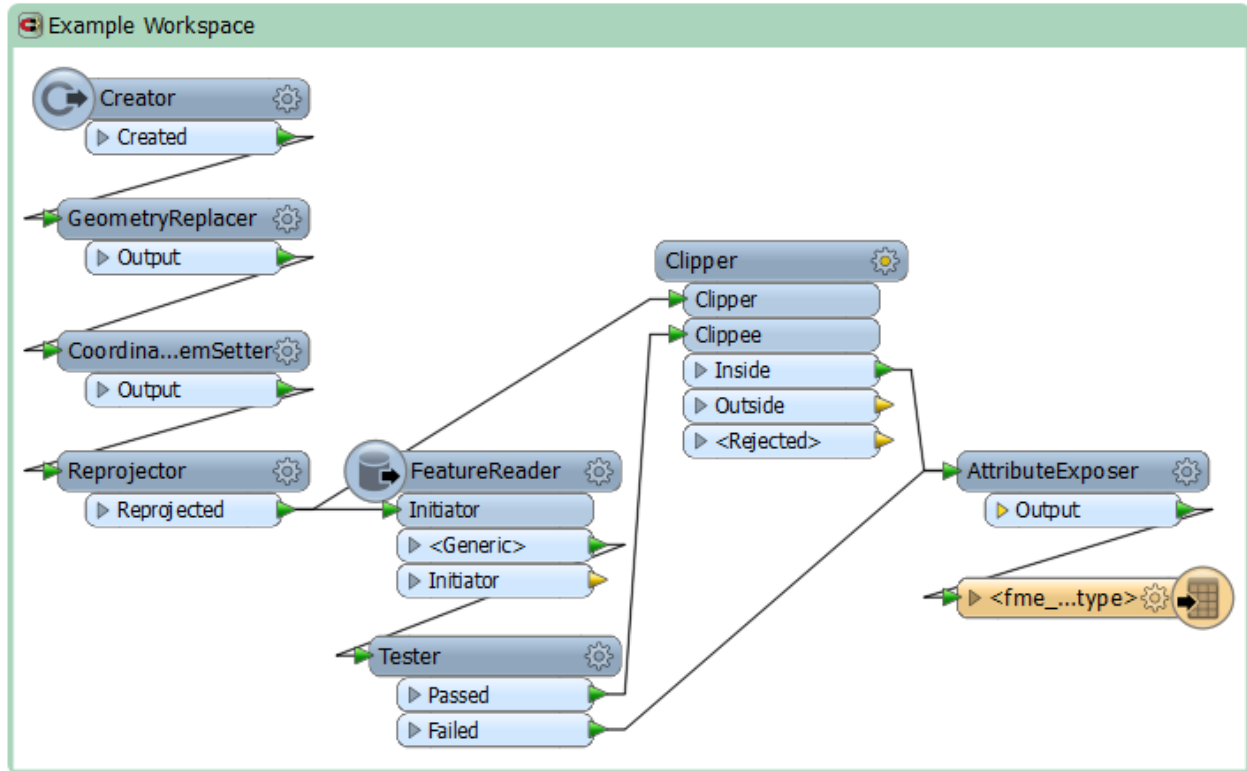


Figure 8.7. FME Workspace used to modify data according to user input prior to data download. The generic web application developed in this project can access the workspace through FME Server.

The first transformer of the workspace, the *Creator*, creates an empty geometry feature. This feature is in the next transformer replaced by the polygon created by the user. To make that possible, the *Geometry Source Parameter* in the *GeometryReplacer* transformer is set to a user parameter called GEOM.

CoordinateSystemSetter tags the geometry feature with the coordinate system it belongs to, which is the same coordinate system as Sweco Map, Spherical Mercator. The *Reprojector* transformer reprojects the user created geometry to the same coordinate system as the case data has, in this case ETRS89.UTM-32N. The user drawn polygon and the case data need to be in the same coordinate system to be able to clip the data according to the user specified area. The reprojected geometry feature proceeds to the *Clipper*, where it acts as the area against which all *Clippee* features will be processed.

The *FeatureReader* reads the case data from a local folder. The *Spatial Filter Parameter* in the transformer is set to *Intersects*, therefore only data that intersects with the user specified area is read. In the parameters of the transformer, it is possible to set which feature types the transformer should read. In this example, this is set to a user parameter called LAYERS, to make it possible for the user to determine what layers that are interesting.

Tester transformer looks at user parameter CLIPPER to see if the user has selected to clip or not to clip the data. If yes, the data will be sent to the *Clipper* and clipped according to the user specified area, all features that intersects with the clipper boundary are in this example treated as inside. If no, the data will not be processed by the *Clipper*. Note that the data already is clipped according to user defined polygon.

The attribute *fme_feature_type* is exposed by the *AttributeExposer* to make it possible to fan-out by this attribute when the new features are written. That means that every layer that the user has chosen will be written as separate features and files.

The terminative writer is a generic writer that allows the user to specify output format and coordinate system. These are therefore also listed as published parameters of this workspace. See complete list of published parameters in figure 8.8.

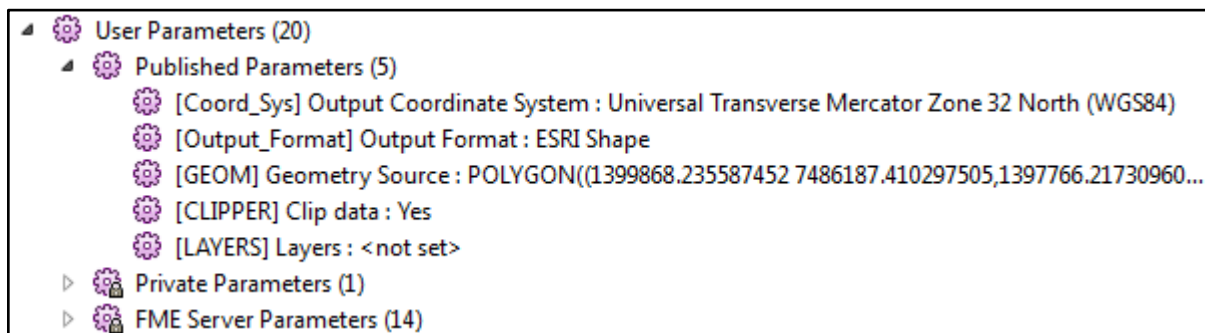


Figure 8.8. *Published parameters of the workspace in figure 8.7.*

The workspace in figure 8.7 was according to the tests performed in this study working properly for all data except for annotations, or text strings, shown in a map. These data were shown as polygons instead of rendered text strings.

A web browser is the client of a client-server application, and it will need to communicate with a server in order to display content and perform certain tasks. A local FME Server is used in this project, besides the services of a FME Server, it contains a web server with a number of web applications. The developed system is stored as a web application in a folder within the web server of the local FME Server and can thereby be sent to, and displayed by, a web browser.

The local FME Server is reached from the web browser by entering: `http://localhost:8080/` in the address bar of the web page. The web map application is sent to the web browser by using: `http://localhost:8080/unigisdataexport/`, where the italicized part should be altered based on the name of the folder in which the application is stored within the server.

8.4.2 Implementation

Early during the implementation phase it was discovered that some type of bounding box or extent feature of the data sets would be necessary to be able to populate the layer list dynamically. The list should depend on what data that intersects with the area specified by the user. It is not a possible solution to import all available data sets to the application and check if the user specified area intersects with any of these. It would slow down the whole process substantially.

The first thought of a solution was to use the bounding box or the convex hull of the data, and import these as a GEOJSON file to the application without visualizing them in the map. This would make it possible to quickly check if the user specified polygon did intersect with the bounding box of a specific layer. Though, this can cause problems if there are areas within the bounding box that do not contain any data. A point layer of data could possibly consist of only two points, but have a big bounding box. If the user would specify an area within the bounding box but without any data, an error would occur when the FME workspace tries to distribute data that does not exist.

The next thought was to make FME check if the user specified area did intersect with any data with the help of a workspace published to FME Server. This solution was also discarded when it was discovered that a lot of available data sets would make this step very time consuming.

A thought that was considered possible as a solution to this problem was to use zoom dependent TileCache of the data sets. All tiles would have an array attribute that contained the layers that intersect with the tile. It would be possible to check which tiles the user specified polygon intersects with, and thereby reach the available layers. Different zoom levels can indicate how big of an area the user intends to specify, and the size of the tiles should be determined based on that. When a user zooms in, the tiles will decrease in size to minimize the possibility for the user to select an area without any data. The TileCache could possibly be stored in a tileJSON file.

The TileCache approach was not fully implemented in this project, but instead a basic version of it using a fixed grid. The area of interest (Denmark) was converted into a 2D grid using FME Workbench, see figure 8.9. Each grid cell is assigned an array attribute with available layers in that specific cell. The TileCache approach is further discussed in chapter 10.

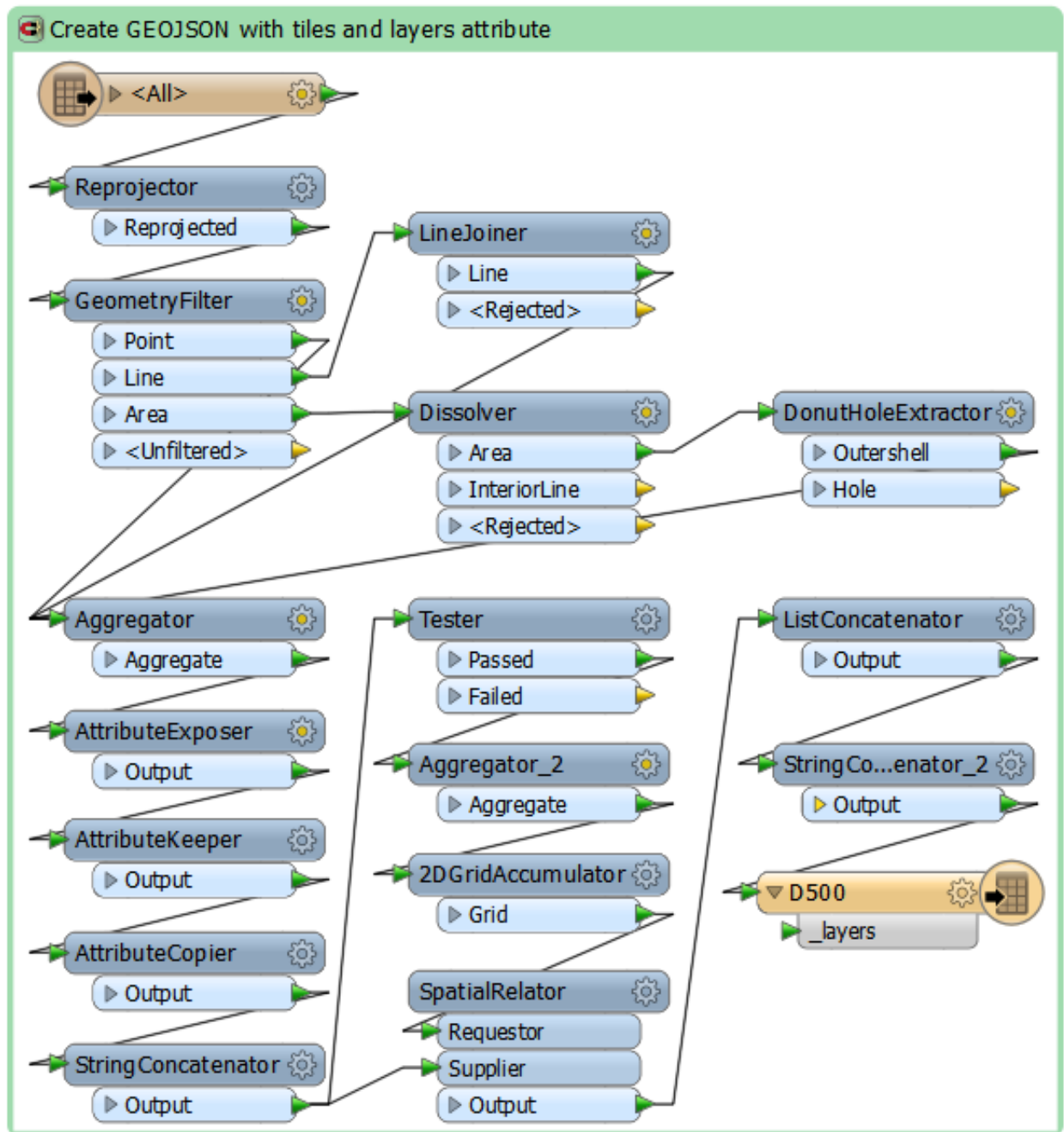


Figure 8.9. *FME Workspace used to write a GEOJSON file that holds a 2D grid over the area of interest. Each grid cell has a layers attribute that is used to determine what data sets that are available within user defined area.*

Every aspect of the workspace in figure 8.9 is not of importance for this project, and the workspace will therefore only be explained briefly. All data that are available for download are imported into the workspace in the *Reader* to be able to retrieve all possible feature types. The

input data are then reprojected to match the coordinate system of Sweco Map (Spherical Mercator). Different geometries in the data should be handled differently and are therefore filtered before all objects are aggregated grouped by feature type. A 2D grid is created over the area of interest which in this case is Denmark, and the *SpatialRelator* transformer is used to assign an array attribute to every grid cell that contains intersecting layers. The grid is finally written to a GEOJSON file called D500.

To complete the web application, I have been working with four JavaScript files and one HTML file. The HTML file and three of the JavaScript files are available as appendices to this report. The JavaScript provided by Safe Software is not included as an appendix. Some JavaScript code that belongs to Sweco Map was never edited in this project, and will therefore not be presented. Two JSON files are also provided as appendices to this report, one is the configuration file of the application and the other is the GEOJSON file containing the 2D grid with the layers attribute.

The system architecture is presented in figure 8.10. *Index.html* is the root file, and this file connects all other files in the system. The root file is linked to different file types: CSS, JavaScript, and GeoJSON. The different files of the system will be explained in the following paragraphs.

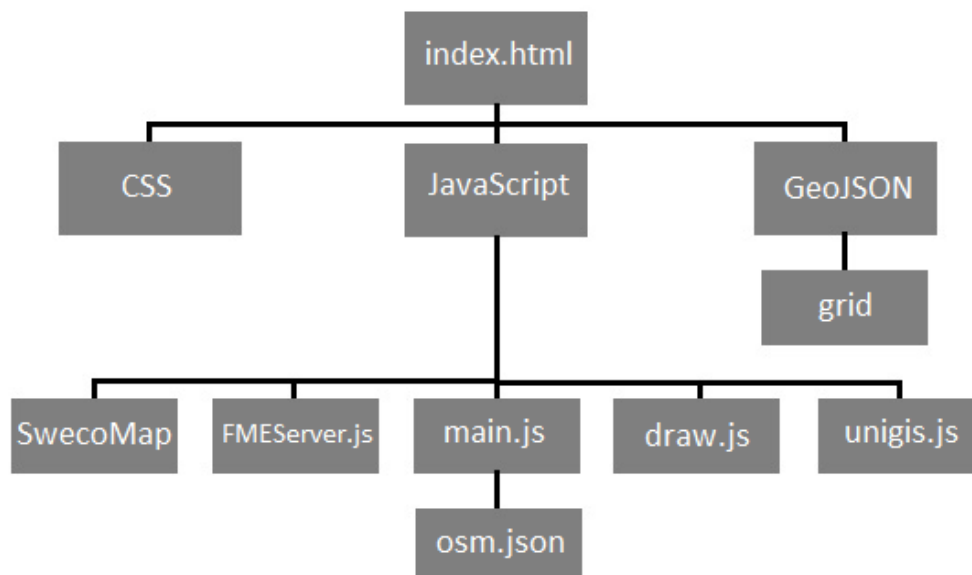


Figure 8.10. The architecture of the system developed in this project, *index.html* is the root file that communicates with all other files.

The configuration file *osm.json*, see appendix B, is used to configure the initial settings of the application. A background map from *OpenStreetMap* is chosen as a layer of the map application, and the initial view is set to be centered on Copenhagen and have zoom level 11.

The previously mentioned *TileCache* approach was considered too complicated for the time scope of this project, hence a basic version of it was developed instead. The foundation of the basic version is a 2D grid with a layers attribute (GeoJSON grid). This was constructed using the workspace in figure 8.9, and some example features from the result can be seen in appendix C.

The HTML file *index.html* determines the design of the web application and what JavaScript code that is integrated with it, see appendix D. The HTML code creates a title panel on the top of the page in which a title text and the company logo is placed. A panel is also created on the left side of the page. This is populated with forms and buttons to allow for user input. Buttons and panels are created with the help of Bootstrap, for a pleasant and uniform design. Some HTML elements of the web page are additionally styled with CSS (Cascading Style Sheets), for example to manage color and positioning of an element. Within a JavaScript tag inside the HTML file, a number of global variables are declared and the GEOJSON file with the 2D grid, appendix C, is imported.

The JavaScript *fmeserver.js* provided by Safe Software contains a lot of code that most often is difficult to understand. To use the script, it is important to understand what the different methods do, what input information they need and how to use them within your own script. Descriptions of the methods are provided as comments within the script, and it can also be helpful to look at the application examples found on FME Server Developers Playground.

There are numerous methods for REST API calls provided in *fmeserver.js*, most of them not of interest in this project. Four methods from the script have been used to create the generic open geodata distribution service, these are:

- *FMEServer.init()* - Initializes the FME Server connection object with help from the server URL and the token string.
- *FMEServer.getWorkspaceParameters()* - Retrieves all published parameters from a specific workspace and return these as json syntax.

- `FMEServer.generateFormItems()` - Generates a form based on form elements in input json.
- `FMEServer.runDataDownload()` - Runs a specific workspace with specified parameters, and returns a json object.

To improve the result of the methods, one line of code was added to the *generateFormItems* method in *fmeserver.js*. In this project, this method was used to create HTML form elements based on published parameters in the FME workspace shown in figure 8.7. The result of the method was not aesthetically pleasant since no line breaks were used between the different form elements. Line breaks were added after every form element by adding this line of code: *span.innerHTML += '
';*

One of the scripts created for this project is called *main.js* and is used to initialize the Sweco Map client and set configuration file of the application, see appendix E. The system developed in this project is built as an extra feature for Sweco Map version 1.2.1, and should be possible to integrate seamlessly. *Main.js* does also specify that the *initdraw* method should be executed when the page is initialized, this function can be found in *draw.js* and appendix F.

The JavaScript *draw.js*, see appendix F, contains the *initdraw* method which is executed when the page is loaded. This method creates a draw interaction, and activates it when the *Draw Polygon* button is pressed. The *initdraw* method does also manage what happens when a drawing is ended, when a user resets a drawing, and when a user is satisfied with the polygon and presses *Done*.

When a drawing is ended, the polygon that the user has created should be stored as a geometry. The geometry is stored both as a Well-known text (WKT) object and as a geometry object. The WKT object is later sent as a parameter to the workspace shown in figure 8.7 while the geometry is used to test intersection with tiles (grid cells).

As the user press the *Reset* button, everything that has been specified so far will need to be reset to its original value. The draw interaction is removed, the polygon is cleared, and all elements added to the panel are emptied and removed.

When the user is pleased with a drawing, and presses *Done* button, the user specified geometry should be compared to all tiles in the GEOJSON file, see appendix C, to see which tiles it intersects with. If the geometry intersects with one or more tiles, a checkbox form that allows the user to choose between different layers should be created. The layer names that populate the form originate from the layers attribute of the tiles. A specific layer should only appear once in the form even if it exists in several tiles that the geometry intersects with. If the user specified geometry does not intersect with any tile, an error message will appear.

To be able to use the JavaScript library provided by Safe Software, the JavaScript file *fmeserver.js* was downloaded from their Developer Playground and added to the working folder. To integrate the script with the rest of my system, it was included in the head of my web application and initialized with three configuration object properties, see appendices D and G. The URL of the FME Server and a token to provide access to it are claimed to be the only two configuration objects properties you need to initialize the library (FME Server Developer Playground 2015b), but one extra had to be added to make it work properly, see appendix G.

The JavaScript *unigis.js*, see appendix G, contains all interaction with FMEServer. The JavaScript *fmeserver.js* provided by Safe Software is integrated and initialized in this script. The initialization is done by specifying the server URL and a token to provide access to that specific server.

Two methods in *unigis.js* are used to generate the form elements of step 3 in the panel. In step 3, the user is able to specify different user parameters, based on published parameters in the workspace, see figure 8.7 and 8.8. Method *processParameterForm* monitors what layers that have been chosen by the user and saves these as a string object. Within this method, there is another method that originates from Safe Software's JavaScript library, this method retrieves all published parameters of a workspace and calls another method that can generate a form based on those. Method *generateParaForm* uses the method *generateFormItems* from the JavaScript library to create a form based on json object retrieved by *getWorkspaceParameters*. The GEOM parameter is assigned the value of the WKT object, and the LAYERS parameter is assigned the value of the Layers string.

When the *Request* button is pressed, the workspace in figure 8.7 should run. This is made possible with the method *runDataDownload* from the JavaScript library provided by Safe Software. This method needs four input elements, the server repository, the workspace name, the parameters string, and a callback method. The parameters string is created by looping through the form elements of step 3 to check their value. The parameter names and values are concatenated to a string with the correct syntax.

The callback method *showResults* uses the json object retrieved by *runDataDownload* to create a URL object that links the user to the download of wanted data.

9 Feedback on the Generic User Interface

9.1 Questionnaire to Acquire Comments on the Generic User Interface

It is common to measure usability by letting some test users use the system and perform certain tasks. The same system can get different critique from different users depending on performed tasks. Users and their requirements are very different, and it is therefore important to consider all usability measures instead of a mean value of them. (Nielsen 1993)

The system developed in this project has not been tested in a proper way, with a big and diverse test group. The limited time scope of this project eliminated the possibility to perform an extensive verification and evaluation of the application. But three people have tried the generic open geodata distribution application in order for me to be able to obtain some feedback on the application. All of the testers are men working at Sweco Position in Malmö, ages between 25 and 35. All of them are also used to computers and web environments, and also web based geodata download services. The feedback on the system is acquired from a very low number of testers, and the testers have very similar previous knowledge and experiences. The comments made by the few testers are although valuable for future development of the application.

The test persons in this study were asked a number of questions after testing the application, these are listed below:

1. Is the application easy to use? Did it work the way you wanted?
2. How is the usability of the application affected by the absence of text based search/metadata/previews?
3. What are the pros and cons with the way the area is defined?
4. What are the pros and cons with the way the data download is done?
5. Other comments?

9.2 Comments on the Generic User Interface

All people that tested the application considered it easy to use and self-explanatory. The steps to follow were clear and easy to interpret. According to the test persons, the application is user friendly. One tester considered the amount of buttons unnecessary, it would according to this person be easier if some buttons were removed, e.g. the *Done* button, the layer list could possibly be populated automatically as soon as user has finished drawing the polygon. However, another tester pointed out that the finite steps, with the same type of button to proceed from step to step, made the download process even more straightforward.

Most test persons thought the application would benefit from an addition of search possibilities. It would be great if there was a possibility to search for a place name, and the application would zoom in to that region on the map. As for now, the user has to pan the map in the search of the area of interest. The process of finding the area of interest would be more efficient with a place name search available, but not all testers are disturbed by the fact that it is absent. The test persons indicated that it would be convenient with a possibility to perform a text based search in the layer list, but one tester mentioned that this extra step could complicate the download procedure a bit. A search function in the layer list would only be necessary if the list becomes very long.

One test person specifically mentioned that the geography filter is very convenient for the user. Without it, the user would have to browse through a long list of layers that most of the time are not geographically relevant. Users do most often have a specific area of interest in mind when browsing for geodata.

The absence of metadata about the data sets does not hamper the usability of the web map application, but it could possibly hamper the usability of the downloaded data. The testers of the application emphasized that additional information always is of value, but that the absence of it does not affect the actual application in this project. If metadata would be provided, the test persons would have wanted it as an extra text file integrated in the download, not as an extra feature within the application.

Some sort of preview of the data sets would have improved the usability of the service according to the testers. One way of displaying previews would be to show the layers (those selected in the layer list of step 2) inside the user specified area on top of the background map. But it could sometimes, according to some test persons, be convenient with a complete preview of a specific layer.

All test persons considered the way to define area of interest to be easy and user friendly. To be provided the possibility to specify your own area is considered better and more user friendly than to only be provided predefined areas. However, some mentioned that it would have been of interest to be provided some regions, e.g. municipalities, as predefined areas. One tester pointed out that predefined areas of specific regions could impose problems since these areas would have to be up to date and accurate at all times.

If you are used to web environments and downloads from different web pages, there should according to the test persons be no problem to understand the download procedure of this application. Some test persons mentioned that it could be convenient to receive an email with the download link instead, if the data download is big and FME Server needs a lot of time to process the request. An email with a link instead of a link directly in the application would mean that the user can proceed with other tasks while waiting for the request to be processed, this could possibly improve the efficiency of the application.

10 Discussion

The main goals of the project, specified in chapter 1, have been reached. Developed application is working properly, and the system can be used to establish many new open geodata distribution services in the future because of its generic nature. The design of the application is simple and user-friendly according to a number of test persons. Some currently available open geodata distribution services have been analyzed and different countries and organizations have been examined regarding their open geodata, everything to be able to draw some conclusions regarding the best way to manage and distribute open geodata.

The generic user interface developed in this project is heavily dependent on FME technology. This hampers and limits the usability of the system since FME is an expensive software, not openly available for anyone to install and use. However, if FME technology (and knowledge) is available, there should be no problem recreating the generic user interface. All HTML and JavaScript code is available as appendices to this report, and the FME Workspaces used in the system are all presented as figures with a description.

Like any software product, the application developed in this project does currently have some advantages and disadvantages that should be considered in further developments of it. The most relevant of these will be discussed in the following paragraphs.

As mentioned in chapter 4, usability is traditionally associated with the following usability attributes (Nielsen, 1993, p. 26):

- Learnability - the system should be easy to learn
- Efficiency - the system should be efficient to use
- Memorability - the system should be easy to remember
- Errors - the system should have a low error rate
- Satisfaction - the system should be pleasant to use.

Developed web application is considered easy to learn and remember, the download procedure is clearly presented and no unnecessary functionality that may distract the user is offered. It is also

considered efficient, the download procedure is fast and download is done directly from the web page. The application does at the moment have an error rate that can be reduced by implementing the TileCache approach described in chapter 8. If the user is in need of an efficient open geodata download service with no special functionalities or features, the application should also be pleasant to use. Satisfaction is always influenced by user requirements and needs, and will not be on the same level for every user.

The open geodata distribution service developed in this project does not offer a lot of functionality, it is a simple and intuitive service that offers what the user wants, to download geodata. The expected use of the system has been considered in the process of development, the users' needs and requirements are of high importance and the user interactions are simple and effective. This is an advantage of the final product, no unnecessary functionality will distract the user when trying to use the application for its primary purpose. However, it is not possible to satisfy the needs of every user, some users might want the extra functionality.

Icons and buttons of the application are readable, simple and easy interpretable. No hints appear when mouse pointer moves over the icons or buttons since these are considered self-explanatory, they properly represent their functionality. Some buttons might be unnecessary, however they do not decrease the usability of the application.

The map of the open geodata distribution application is big, it covers most of the screen. A larger map will keep the user more focused on the actual task, without being too occupied with map interaction or extra functionality settings. The map, designed by *OpenStreetMap*, is made for visualization on a computer screen, it is simple and clear.

The loading time of the application page is short, the user can start using the application immediately when entering the page. Everything on the start page is visualized at once, no extra features or functionality can be found by scrolling. Thereby, all information is available for the user directly. This is also true for smaller computer screens, the user interface is suitable and adaptable for most screens.

No registration is required to use the developed application. In certain aspects, it could be beneficiary with a registration, the distributor could gather information about downloads and the

user could possibly store information on her account. In this project, a registration is not considered necessary or beneficiary for the purpose of the service. The registration procedure would slow down the download process and thereby decrease the efficiency for the user. The distributor will also need to manage account information in an efficient and secure way. Most of the open geodata distribution services compared in chapter 5 of this report distribute their geodata without making the user register beforehand, which makes it easy to believe that this strategy is possible and most probably also considered user friendly.

The open geodata distribution application does not provide any previews of data. A possibility to inspect a data set before download could add value to the service, and make it easier for a user to find wanted data. Previews were considered unnecessary in this part of the development, but should be considered as an additional feature in further development of the system. It is common among open geodata distribution services to provide preview of available geodata, but some services manage without it. The services will work without previews, but the usability will be decreased.

An alternative to previews of data would be to provide extensive metadata for all data sets. Detailed metadata could possibly give the user all the information that is needed. Metadata is at the moment not supported by the generic application, but must according to the Inspire directive be easily available and should therefore be a prioritized improvement. Metadata is provided by many of the services compared in this report, and most of these provide metadata within the application, e.g. as a pop-up window. If metadata access is added to the generic user interface, it should be possible to reach within the application, since that is what most users are used to.

Data download is done directly through the application, like most of available download services do it. To ensure the user has specified the parameters as wanted, she is prompted before the data download request is executed. The link that leads to the download does clearly say that it will start the download to minimize number of unnecessary downloads. A data download procedure that instead sends the download link to the user by email would be to prefer if the data download is big and FME Server needs some time to process the request.

No search options are available in the developed application, it is not essential for it to work. The area of interest is located by zooming and panning in the map. For future refinements of the system, at least a geographic search should be added to aid the user in finding a specific location. Since this service does not provide any search possibilities, the list of data sets in step 2 can become long, and it can take time for the user to find wanted data set. A search possibility for the layer list in step 2 would be convenient for the user. According to the comparative study in chapter 5, it is common for an open geodata distribution service to have some sorts of filter or search possibilities, but it depends on the number of available data sets. If a service provides many different data sets, it will be of high value for the user to be able to browse through these in an easy way.

Different area definition options can increase the usability of a service. The developed application does only offer one type of area definition, hence not a lot of flexibility. Predefined areas are not supported by the system, meaning that the user always will have to specify her own area. The usability is thereby decreased, some users might not want to use the drawing tool. This decrease is considered manageable in this project since the download process is very effective, and time loss because of the drawing step is not substantial. Most services of the comparative study have each chosen one way to define area, but some make it possible for the user to choose between several area definition options. The open geodata distribution services that provide the user with the opportunity to define an own area are considered more generic and flexible than the ones only providing predefined areas.

This application is considered generic since it can handle most data types and formats, but most important that it can handle any data conversion workspace, with any published parameters, instead of the workspace in figure 7.7. The user interface form elements will adapt depending on the published parameters of the workspace.

The download procedure is divided into four simple and clear steps according to *Process 2* in chapter 5.5. The four steps are visualized immediately, from the moment the user enter the page, she will know what is expected of her. Area, layers, and parameters must be specified prior to download. This process was chosen because of the simplicity of it, but also because it offers some flexibility for the user. More flexibility does not necessarily mean that the process has to

become more complicated, but one needs to be observant during the development not to forget about the user experience. Increased flexibility could mean an improved user experience, but only as long as the process is not too complicated.

At the moment, the web map application does not work exactly as wanted. A fixed grid is used instead of zoom dependent TileCache of the data sets. The basic approach that was implemented can result in some errors during the download procedure. The size of the tiles (grid cells) is fixed and does not depend on the zoom level, meaning that they almost certainly are too big on large scales. A tile too big means that a user can draw a polygon within a tile, and the layer list will populate according to available layers in the tile, but the user defined area does not contain any information about selected layer, see figure 10.1. The user might for example be interested in downloading forest information, but draws a polygon that is not within any forest area. The forest layer will still be available in the layer list as a choice, and an error will occur when the user tries to download the data that does not exist. This will happen similarly when using TileCache, but not as frequently. The size of the tiles should be as small as possible to minimize the risk that the user can select a layer that does not exist in specified area, but a high number of tiles could decrease the efficiency of the service.

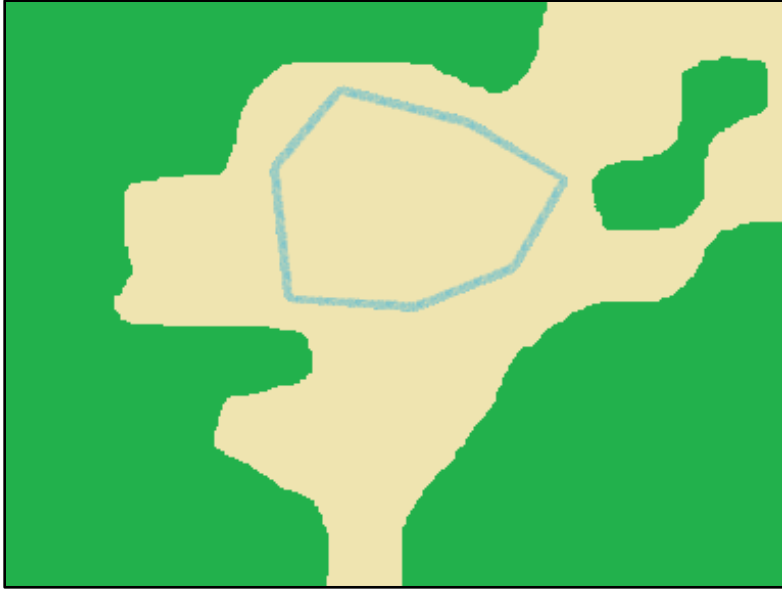


Figure 10.1. *Example of a user defined area with no geodata within. The layer list of the application will tell the user that the forest layer is available within the polygon, since the polygon is within a certain tile that contains the forest layer, but the user has managed to draw a polygon outside of the forest region.*

In order to fully implement the TileCache approach, one needs to find the critical zoom levels when the tiles should change in size. When a user zooms in (large scale), the tiles will decrease in size in order to minimize the possibility for the user to select an area without any data. It will require some work to find out what tile sizes that are appropriate for each zoom level, which is the minimum/maximum tile size needed? The tileJSON format has not been closely studied in this project, but could probably be helpful in further developments of the TileCache approach.

The fixed grid that was used as a basic approach of zoom dependent TileCache consists of cells that are too big for the application to work properly. The layer list will sometimes be populated with layers that do not exist within the user specified area. Adding zoom dependency to this problem can decrease the number of errors of this sort. Finding the critical zoom levels, when tiles should change in size, is probably the most difficult part of this work.

The workspace in figure 7.7 is working properly for all data except for annotations. These data are displayed as polygons instead of rendered text strings. To manage this problem, the workspace should be edited to handle annotations separately. FME Desktop provides a

transformer called *EsriAnnotationRenderer* that should be useful in order to solve this. This transformer extracts the line information from *EsriAnnotation* and creates the geometry required to visualize it.

One inaccuracy was found in the JavaScript *fmeserver.js* provided by Safe Software. An additional configuration object property had to be added in order to initialize the FME JavaScript library. The inaccuracy was possible to avoid by adding an extra line of code in the initialization of the library. There is a chance that more inaccuracies occur in this script, it is provided “as it is”, and care should therefore be taken when including it in your development.

Even though the application is developed as an extra feature for Sweco Map, it could probably quite easily be integrated with other systems that depend on OpenLayers. It could be harder to integrate it with other web map services, but some parts of the code should be applicable.

Lastly, improvements can always be done to both the JavaScript code and the FME workspaces to make them more efficient and generic. The download process is currently not very time consuming, but some of the steps take a few seconds. Enhancements of the code and the workspaces could cut some time and make the download process even more efficient. During the development of this application, drawbacks of Sweco Map have been found, and fixing these problems could also increase the satisfaction of the service.

11 Conclusions

The amount of open geodata in the society is increasing. The trend is clear, openness is favorable for everyone. Both positive and negative consequences of a release of open geodata have been expressed but most people and organizations consider the positive ones to exceed the negative. Open geodata can among other things stimulate growth and efficiency in the society, and lead to new inventions that can have a positive impact on for example the environment.

For anyone to be able to access open geodata in an easy way, we are in need of user-friendly web based distribution services. The services that are available today are most often very different regarding *how* they provide the user with data. Some of the services are easier to interpret and use while others might seem too complex for the normal user. It is of high importance to keep the users in mind when developing the services in order to improve their efficiency.

For a smooth transition to a complete openness in the society, a generic user interface for open geodata distribution could be of great significance. A generic user interface that is applicable to most data types can be used to establish numerous new download services in a short amount of time. The purposes of the services are the same, to provide the user with the possibility to download open geodata, so there should be no need to start the development from the beginning every time a new distribution service is established. There might not be one optimal way of designing the user interface, user needs and requirements are often different depending on what type of data that is distributed, who the distributor is, and what purposes the user has. But if keeping the design as simple as possible, the system should be applicable in most cases.

According to the results from this study, the best way to distribute open geodata is to keep it simple and minimize the number of extra features. Additional functionality will increase the usability, but only up to a certain limit. The key to a successful open geodata distribution service would be to find this limit and implement the application with the user in mind. The service should offer the functionality that the users want, but additional ones will increase the complexity and decrease the user satisfaction. Different users have different needs and requirements, but only the general user should be considered during implementation of an application like the one developed in this project.

Features and functionalities offered by the application should be simple and intuitive. The general user is probably used to computers, but possibly not to geodata distribution applications. Anyone with computer experience should be able to use the application, meaning that icons and buttons must be self-explanatory. But most importantly, the download procedure must be easy to follow.

A lot can be done to aid the user during the download procedure. The first thing would be to provide a map that covers most of the screen to keep the user focused on the task. A smaller map would increase the need of user interaction in order to find and discover area of interest. Another aspect that can decrease the need of user interaction is to make all features and functionalities visible immediately when opening the application. If scrolling is necessary to find everything on the page, a number of users might lose some information. It can also be distracting and troublesome not to be able to see everything at once.

User registration will seldom be necessary in order to satisfy the purpose and goals of an open geodata distribution service. Despite that, both distributors and users could possibly find it beneficiary. The conclusion made about this matter is simply that a registration rarely affects the usability.

Applications offering previews of available data sets would probably obtain higher user satisfaction than other services since previews make it easier for the user to know beforehand what data to download. It could be complicated to integrate previews in the application in a way that helps the user rather than making the download procedure more complex. Previews should also be kept simple, in some applications it might be enough with an example preview that not necessarily covers the user specified area.

Metadata about each available data set should be easily accessible for the user. The best way to provide metadata has not been studied in this project, but as with everything else it should be kept as simple as possible. A pop-up window with information about the data would be one way to deal with it that does not intrude on the actual application page information. Metadata could also be included in the download, as some test persons of the application proposed.

Whether to keep the actual data download simple or not is a complex question. A simple download like the one implemented in this project, download directly through the web application, will speed up the work of the user, and improve the efficiency. On the other hand, a download that is too simple and fast might make the user download unintended data by accident. This was avoided by adding a second step to the download in which the user has to reassure the application that the data request was intended. The user should be well aware when the download happens, it should not be possible to download data with only one mouse click.

Search and filter options might not be necessary for an open geodata distribution service to function, but it can greatly improve the usability, especially if the service offers many data sets. A geography filter was used in the application developed in this project, only data sets intersecting with the user specified area were displayed in the layers list. If this approach is used, it would be convenient for the user with a geographic search in order to find the region that is of interest, it can be hard to know exactly where in a country that a specific town is located.

Different possible ways of specifying the area can increase the usability of a service. One user might prefer predefined areas while another prefers to specify the area by hand. A possibility for the user to specify an area increases the flexibility of the service without complicating the download process too much.

The open geodata distributor is provided the opportunity to decide what user parameters that should be available by modifying the workspace in figure 7.7. Any parameters should be possible to include, but the more that are added, the more caution must be taken to ensure the workspace is managing the data in a correct way. More data types might have to be separately handled in order to obtain a good result. The most common user parameter is the format, it is of great importance to be able to alter this to maximize the usability of the data.

References

- Aditya T. & Kraak M-J. (2005) *Reengineering the Geoportal: Applying HCI and Geovisualization Disciplines*. In Proceedings of the 11th EC-GI & GIS Workshop, Alghero, Italy, 29 June–1 July 2005.
- Baltic Sea Hydrographic Commission (2015). *Baltic Sea Bathymetric Database* data download web site, <http://data.bshc.pro/#2/58.6/16.2> [2015-06-01].
- Belda, K. (2014). GIS Engineer at the City of Stockholm (Stockholms stad). E-mail 5 December.
- Butler J., Holden K. & Lidwell W. (2003). *Universal Principles of Design*. Rockport Publishers, Inc.
- Chapman, S. (2015). *What is JavaScript?*
<http://javascript.about.com/od/reference/p/javascript.htm> [2015-01-09].
- City of Vancouver (2015). *Open Data Catalogue* data download web site,
<http://data.vancouver.ca/datacatalogue/index.htm> [2015-06-01].
- Danish Geodata Agency (2013). *The effects of open geographic basic data*.
<http://eng.gst.dk/about-the-danish-geodata-agency/the-effects-of-open-geographic-basic-data/#>
[2015-01-13].
- Danish Geodata Agency (2014a). *Frie data - Danmarks digitale råstof* (in Danish).
<http://gst.dk/emner/frie-data/> [2015-01-20].
- Danish Geodata Agency (2014b). *Hvordan får jeg fat i data?* (in Danish).
<http://gst.dk/emner/frie-data/hvordan-faar-jeg-fat-i-data/> [2015-01-20].
- Danish Geodata Agency (2014c). *The impact of the open geographical data*.
<http://eng.gst.dk/media/gst/2626131/GST%20The%20impact%20of%20the%20open%20geographical%20data.pdf> [2015-01-13].

Danish Geodata Agency (2015a). *Kortforsyningen: Danmark 1:500.000* data download page (in Danish). <http://download.kortforsyningen.dk/content/danmark-1500000> [2015-04-16].

Danish Geodata Agency (2015b). *Kortforsyningen: Geodataprodukter* data download web site (in Danish). <http://download.kortforsyningen.dk/content/geodataprodukter> [2015-06-01].

Doldirina, C. (2013). *Interpretation of the “full and open” access to and use of (geographic) data: existing approaches*. Living paper of the GEO Data Sharing Working Group.

Duncan, R. (2014). *A Simple Guide to HTML*. <http://www.simplehtmlguide.com/whatishtml.php> [2015-01-08].

United States Geological Survey (2015). *EarthExplorer* data download web site, <http://earthexplorer.usgs.gov/> [2015-06-01].

Eriksson, J. (2014). Stockholms Stad. *Stockholms Stads öppna geodata* (in Swedish). http://www.uli.se/images/stories/geoinfo2014/Presentationer/geoinfo2014_2a_eriksson.pdf [2015-01-14].

European Commission (2014). *About INSPIRE*. <http://inspire.ec.europa.eu/index.cfm/pageid/48> [2014-11-20].

European Environment Agency, European Union (2014). *Mid-term evaluation report on INSPIRE implementation*. Luxembourg. Publications Office of the European Union. (EEA Technical report No. 17/2014, Report EUR 91574 EN).

European Environment Agency (2015). *European Union Open Data Portal* data download web site, <http://open-data.europa.eu/data/publisher/eea/> [2015-06-01]

European Parliament and Council (2007). *Establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)*. Strasbourg. (Directive 2007/2/EC of the European Parliament and of the Council).

Federal Geographic Data Committee (2015). *The Geospatial Platform Dataset Catalogue* data download web site,

https://www.geoplatform.gov/node/201/%26fq%3Dmetadata_type%3A%22geospatial%22%2BAND%2B [2015-06-01].

FME Server Developer Playground (2015a). *Javascript Library*.

<http://playground.fmeserver.com/javascript-library> [2015-04-21].

FME Server Developer Playground (2015b). *Server Library Documentation*.

<http://playground.fmeserver.com/javascript-library/server-documentation/> [2015-04-21].

Garrett, J.J. (2003) *The Elements of User Experience: User Centered Design for the Web*. Easy Riders.

Geodata (2011a). *Coordination*. <https://www.geodata.se/en/What/Infrastructure-for-geodata2/Co-ordination/> [2015-02-05].

Geodata (2011b). *Regulation of the Swedish implementation of Inspire*.

<https://www.geodata.se/en/What/INSPIRE/INSPIRE--legislation/> [2015-01-09].

Geodata (2014a). *Inspire* (in Swedish). <https://www.geodata.se/sv/Vad/Inspire/> [2014-11-20].

Geodata (2014b). *The Geodata Advisory Board*. <https://www.geodata.se/en/What/Infrastructure-for-geodata2/Geodata-Advisory-Board/> [2015-02-05].

Geological Survey of Sweden (2015). *Öppna data* (in Swedish).

<http://www.sgu.se/produkter/geologiska-data/oppna-data/> [2015-05-06].

Geological Survey of Sweden (2015). *Kartgenerator* data download web site, (in Swedish).

http://apps.sgu.se/kartgenerator/maporder_sv.html [2015-06-01].

Geospatial Information Authority of Japan (2015). *Global Map Japan* data download web site,

http://www.gsi.go.jp/kankyochiri/gm_japan_e.html [2015-06-01].

Government of Canada (2013). *Statistics Canada Open Licence Agreement*.

<http://www.statcan.gc.ca/pub/92-160-g/2011001/app-ann/app-anne-eng.htm> [2015-05-22]

Government of Canada (2015). *Free Data - GeoGratis* data download web site, <https://www.nrcan.gc.ca/earth-sciences/geography/topographic-information/free-data-geogratis/11042> [2015-06-01].

He X., Persson H. & Östman A. (2012) *Geoportal usability evaluation*. International Journal of Spatial data Infrastructures Research. Vol. 7, 88–106.

ISO (2014). *International Organization for Standardization standard "Geographic information - Metadata - Part 1: Fundamentals" ISO 19115-1:2014*.

http://www.iso.org/iso/home/store/catalogue_tc/catalogue_detail.htm?csnumber=53798 [2014-11-27].

Kartverket (2015). *Geodataprodukter* data download web site, (in Norwegian).

<http://data.kartverket.no/download/content/geodataprodukter> [2015-06-01].

Koning, A. (2012). *FME Server Overview*. Safe Software.

<https://www.youtube.com/watch?v=glCllXOMcfM&index=15&list=PL85CF81EC874F1F01> [2015-01-09].

Lantmäteriet (2014). *Öppna geodata* (in Swedish). <http://www.lantmateriet.se/sv/Om-Lantmateriet/Samverkan-med-andra/Kommunsamverkan/Oppna-geodata/> [2015-01-14].

Lantmäteriet (2015). *Lantmäteriet släpper småskalig kartinformation fri* (in Swedish). <http://www.lantmateriet.se/sv/Pressrum/Pressmeddelande/lantmateriet-slapper-smaskalig-kartinformation-fri/> [2015-05-04].

Leckström, M. (2014). Sveriges Kommuner och Landsting. *Enkät till kommunerna om öppna geodata* (in Swedish). http://www.lantmateriet.se/globalassets/om-lantmateriet/var-samverkan-med-andra/kommunsamverkan/oppna-geodata/2014/kommunenkat_m_leckstrom_skl.pdf [2015-01-14].

Linköping kommun (2015). *Geodata* data download web site, (in Swedish).

<http://www.linkoping.se/open/Oppna-data1/Geodata/> [2015-06-01].

- Moody, G. (2015). *Italy's Great Leap Forward for Openness?*.
<http://www.computerworlduk.com/blogs/open-enterprise/italys-great-leap-forward-for-openness-3569346/> [2015-05-22]
- Natural Earth (2015). *Downloads* data download web site,
<http://www.naturalearthdata.com/downloads/> [2015-06-01].
- Nielsen, J. (1993). *Usability Engineering*. Academic Press.
- Nivala A-M., Brewster S. & Sarjakoski T. (2008) *Usability evaluation of web mapping sites*. The Cartographic Journal. Vol. 45 No. 2, pp. 129–138.
- Open Definition (2015). *The Open Definition*. <http://opendefinition.org/> [2015-01-14].
- OpenLayers (2008). *What is OpenLayers?* <http://docs.openlayers.org/> [2015-05-04].
- Stockholms Stad (2015). *Open Stockholm Portal* data download web site, (in Swedish).
<http://dataportalen.stockholm.se/dataportalen/> [2015-06-01].
- OpenStreetMap (2015). *OpenStreetMap* data download web site,
<https://www.openstreetmap.org/> [2015-06-01].
- Preece J., Rogers Y. & Sharp H. (2007). *Interaction Design*, 2nd Edition. John Wiley & Sons, Ltd.
- Regev, H. (2005). *JavaScript*. <http://searchsoa.techtarget.com/definition/JavaScript> [2015-01-09].
- Resch B. & Zimmer B. (2013). *User Experience Design in Professional Map-Based Geo-Portals*. ISPRS International Journal of Geo-Information. 2, 1015-1037.
- Safe Software (2014). *FME Desktop*. <http://www.safe.com/fme/fme-desktop/> [2015-01-09].
- Safe Software (2015a). *FME Components*.
http://docs.safe.com/fme/html/FME_Workbench/FME_Workbench.htm#Workbench/FME_Components.htm%3FTocPath%3DFME%2520Workbench%7CAbout%2520FME%7C____1
 [2015-04-23].

Safe Software (2015b). *Working with FME Server*.

http://docs.safe.com/fme/html/FME_Workbench/FME_Workbench.htm#Workbench/fme_server_about.htm%3FTocPath%3DFME%2520Workbench%7CAbout%2520FME%7C_____3 [2015-04-23].

Shannon, R. (2012). *What is HTML?* <http://www.yourhtmlsource.com/starthere/whatishtml.html> [2015-01-08].

Skarlatidou A. & Haklay M. (2006) *Public Web Mapping: Preliminary Usability Evaluation*. In Proceedings of GIS Research UK Conference, Nottingham, UK, 5–7 April 2006.

Stockholms Stad (2014a). *Om Open Stockholm* (in Swedish).

http://open.stockholm.se/Open_Stockholm/ [2014-12-09].

Stockholms Stad (2014b). *About the competition*.

<http://www.openstockholmaward.se/competitions/open-stockholm-award-2014/pages/the-competition> [2014-12-09].

Svan Colding, T. (2014). Danish Geodata Agency.

http://www.uli.se/images/stories/geoinfo2014/Presentationer/geoinfo2014_3a_colding.pdf [2015-01-20].

Sveriges Kommuner och Landsting, SKL (2014). *Öppna geodata* (in Swedish).

<http://skl.se/samhallsplaneringinfrastruktur/planerabyggabo/geodatalantmater/oppnageodata.4234.html> [2015-01-14].

Sveriges Riksdag (2010). *Lag (2010:566) om vidareutnyttjande av handlingar från den offentliga förvaltningen* (in Swedish). [http://www.riksdagen.se/sv/Dokument-](http://www.riksdagen.se/sv/Dokument-Lagar/Lagar/Svenskforfattningssamling/Lag-2010566-om-vidareutnytt_sfs-2010-566/)

[Lagar/Lagar/Svenskforfattningssamling/Lag-2010566-om-vidareutnytt_sfs-2010-566/](http://www.riksdagen.se/sv/Dokument-Lagar/Lagar/Svenskforfattningssamling/Lag-2010566-om-vidareutnytt_sfs-2010-566/) [2014-12-09].

Tait, M. (2005) *Implementing geoportals: Applications of distributed GIS*. Computers, Environment and Urban Systems 29 (2005) 33–47.

Trimble Data Marketplace (2015). *Trimble Data Marketplace* data download web site, <http://data.trimble.com/market/index.html> [2015-06-01].

United Nations Environment Programme (2015). *Environmental Data Explorer* data download web site, <http://geodata.grid.unep.ch/> [2015-06-01].

W3schools (2014). *HTML introduction*. http://www.w3schools.com/html/html_intro.asp [2015-01-08].

W3schools (2015). *JavaScript Introduction*. http://www.w3schools.com/js/tryit.asp?filename=tryjs_intro_lightbulb [2015-01-09].

Washington State Department of Ecology (2015). *GIS Data* data download web site, <http://www.ecy.wa.gov/services/gis/data/data.htm> [2015-06-01].

Appendices

Appendix A - Screenshots of important design details from different open geodata distribution services

Appendix B - Configuration file: osm.json

Appendix C - GEOJSON file: D500.json ¹

Appendix D - HTML code: index.html

Appendix E - JavaScript code 1: main.js

Appendix F - JavaScript code 2: draw.js

Appendix G - JavaScript code 3: unigis.js

¹ Only a few example features are included in the appendix.

Appendix A - Screenshots of important design details from different open geodata distribution services

This appendix contains screenshots from the open geodata distribution services compared in chapter five of this report. The appendix is divided into six parts that each contains screenshots from one important design detail (component or user parameter). All distribution services of the comparative study are not presented completely, meaning that not all important design details of all services are included in this appendix (although all distributions services of the comparative study are represented in at least one screenshot to give the reader an idea of their design).

A.1 Preview

This part of the appendix consists of a number of screenshots from open geodata distribution services that captures what a preview of geodata can look like. Figure A.1.1 and A.1.2 show examples of previews of geodata visualized in pop-up windows. In both of these examples, the whole extent of the data set is shown when the preview is opened, but in the example in figure A.1.1, the user is allowed to further explore the content by zooming and panning in the map.

Figure A.1.3 shows an example of a geodata preview overlaid on a background map. Geodata is visualized in the area that the user has chosen, i.e. within the current zoom extent. Some open geodata distribution services do not provide preview of the actual data set, but of the extent of it. Figure A.1.4 is an example of a data set extent preview. Other services do not provide a preview of the data set within an area specified by the user, they might only provide an example preview within a predefined area, see figure A.1.5.

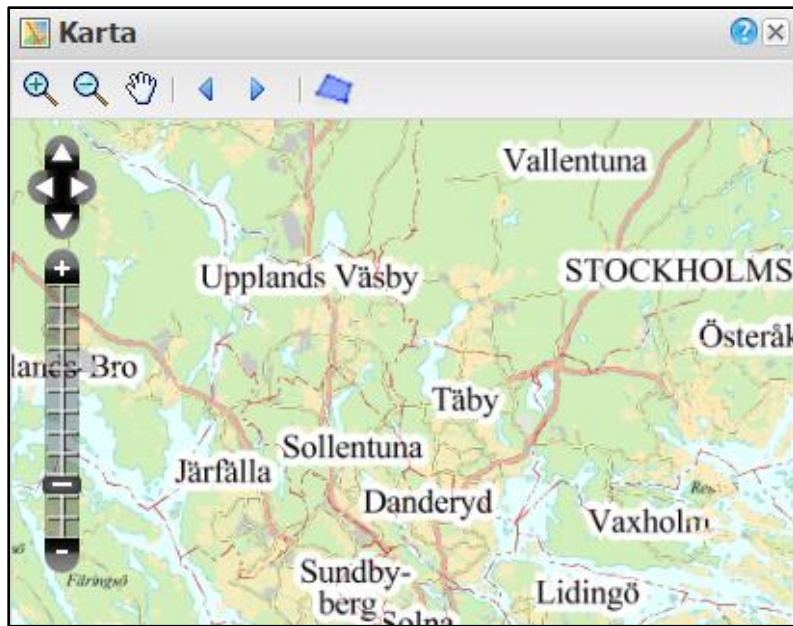


Figure A.1.1. Screenshot showing an example of the data preview functionality of the open geodata distribution service called *Open Stockholm Portal*. (Stockholms Stad 2015)

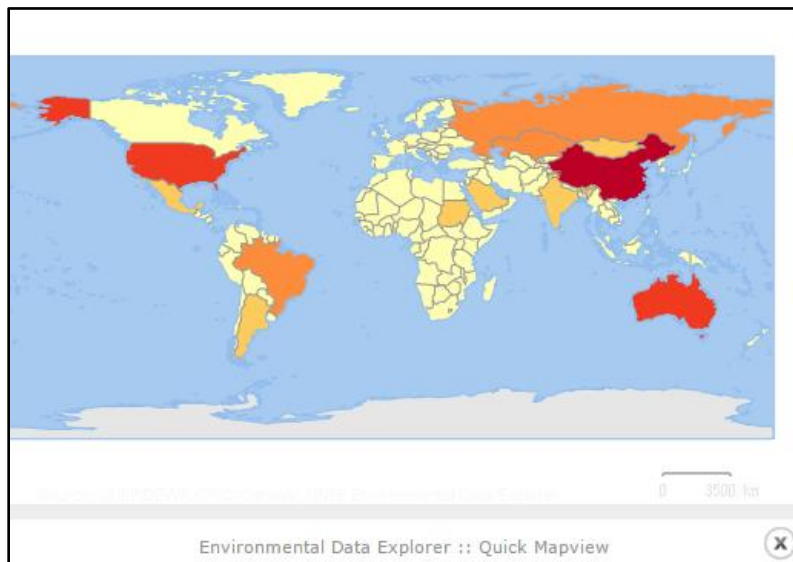


Figure A.1.2. Screenshot showing an example of the data preview functionality of the open geodata distribution service called *Environmental Data Explorer*. (United Nations Environment Programme 2015)

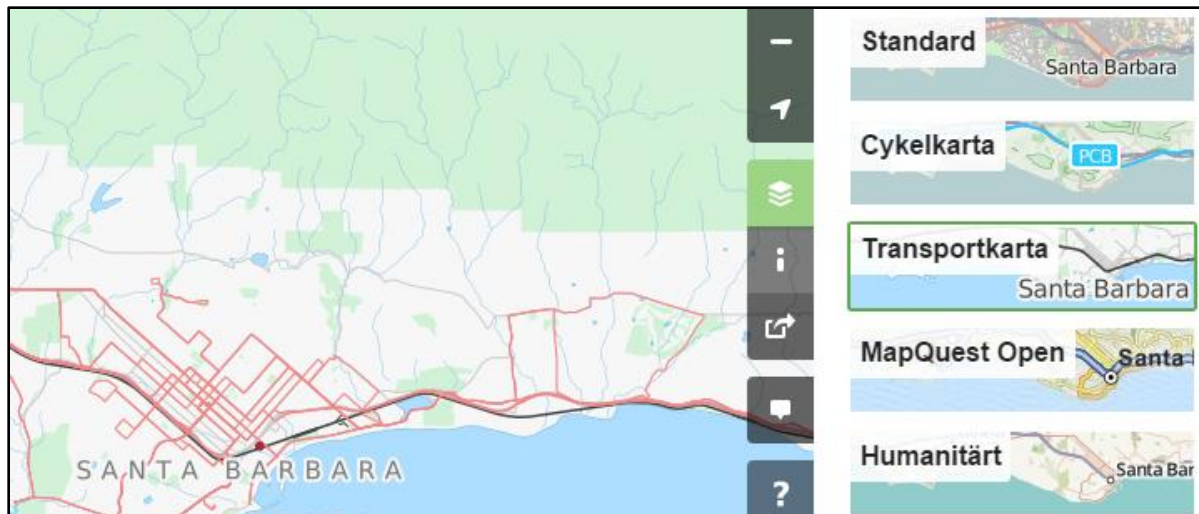


Figure A.1.3. Screenshot showing an example of the data preview functionality of the open geodata distribution service called *OpenStreetMap*. (OpenStreetMap 2015)

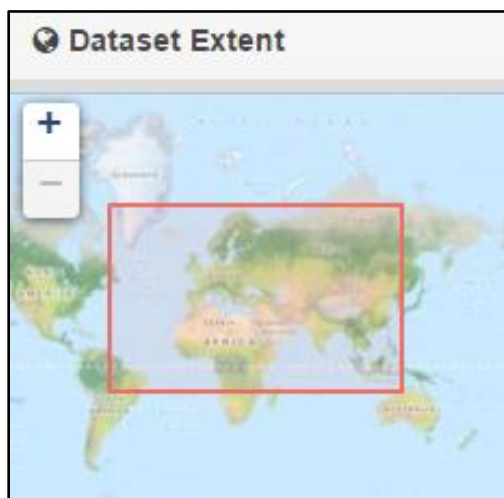


Figure A.1.4. Screenshot showing an example of the data set extent preview functionality of the open geodata distribution service called the *Geospatial Platform*. (Federal Geographic Data Committee 2015)

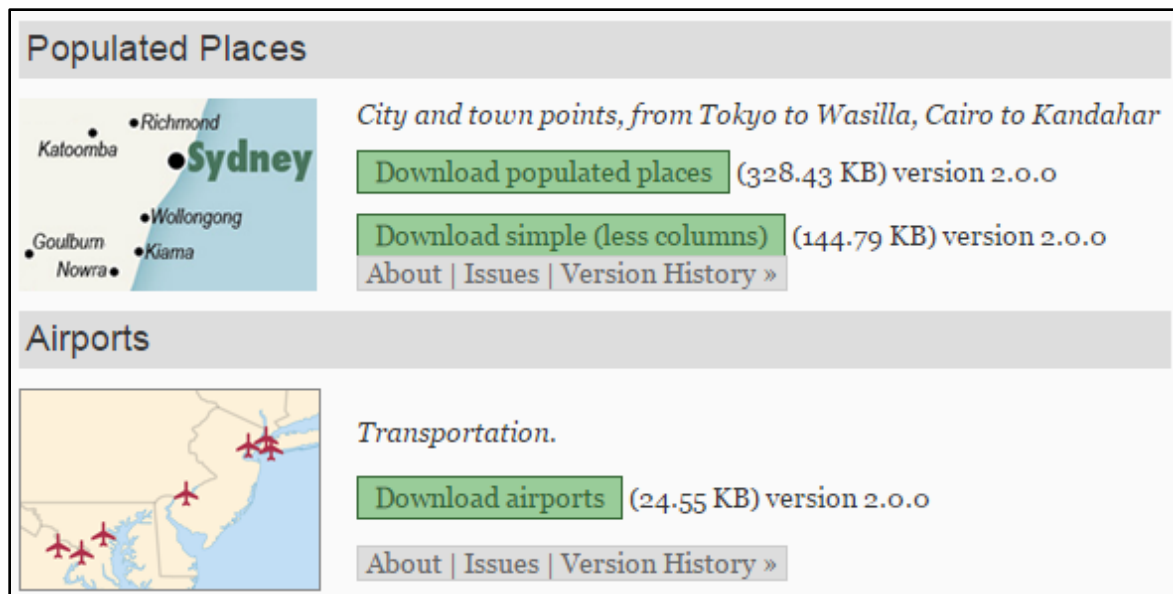


Figure A.1.5. Screenshot showing an example of the data preview functionality of the open geodata distribution service called Natural Earth. This screenshot does also show how geodata is accessed through this service. (Natural Earth 2015)

A.2 Metadata

In this part of the appendix, some screenshots of metadata and metadata access are presented. In figure A.2.1, the link to metadata is placed right next to the preview of geodata. If user clicks the link, the content of the current browser window will be replaced by the metadata.

In the download services represented by figure A.2.2, A.2.3 and A.2.4, metadata can be reached directly in the list of available data sets. Figure A.2.2 and A.2.3 shows examples of when metadata is displayed in a pop-up window (in figure A.2.3 by clicking one of the symbols underneath the data set). When working with *Vancouver Open Data Catalogue* as in figure A.2.4, metadata is accessed by clicking on the name of a data set. The metadata is visualized in the current browser window.

Some open geodata distribution services display metadata of geodata directly in the browser window as a data set has been chosen, see figure A.2.5, while other services add it as an optional step of the download procedure, see figure A.2.6.

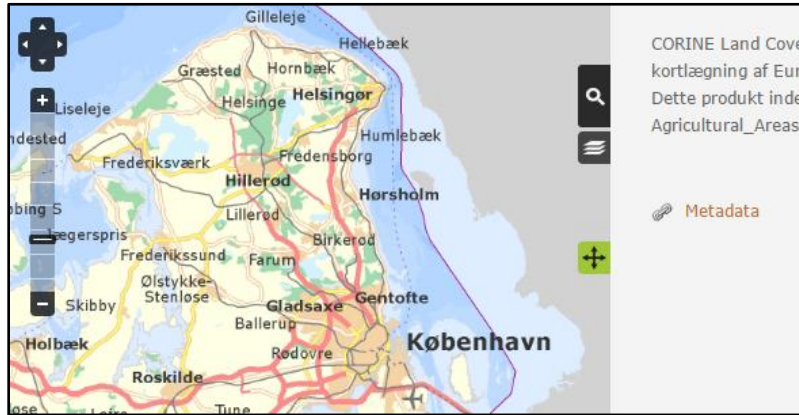


Figure A.2.1. Screenshot showing an example of metadata access from the open geodata distribution service called *Kortforsyningen*. This screenshot does also visualize the preview functionality of the service. (Danish Geodata Agency 2015b)

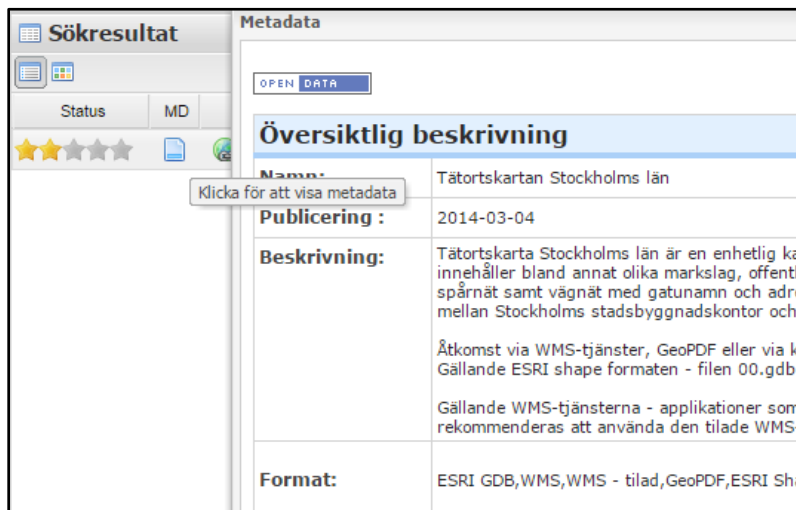


Figure A.2.2. Screenshot showing an example of metadata access from the open geodata distribution service called *Open Stockholm Portal*. (Stockholms Stad 2015)

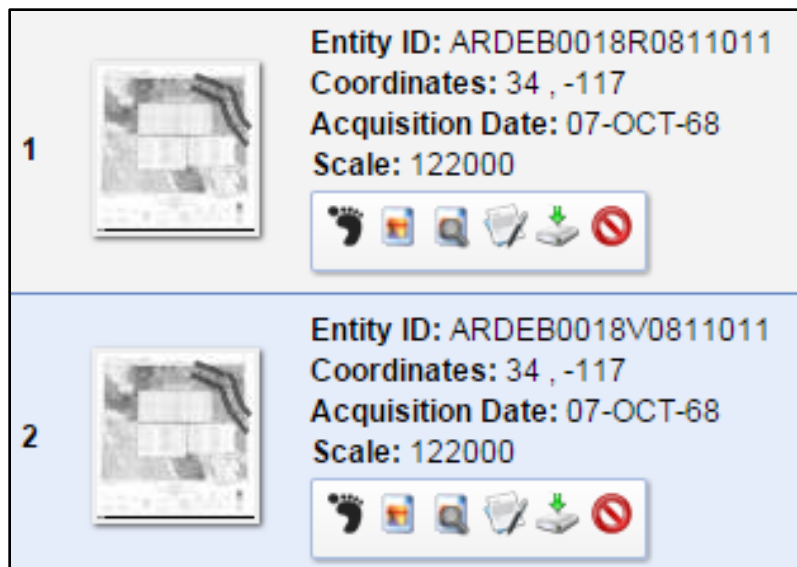


Figure A.2.3. Screenshot showing an example of metadata access from the open geodata distribution service called *EarthExplorer*. (United States Geological Survey 2015)

B									
Bike racks	✓ CSV	✓ XLS							
Bikeways			✓ DWG	✓ KML	✓ SHP			G	b
Block numbers			✓ DWG	✓ KML	✓ SHP			G	b

Figure A.2.4. Screenshot showing an example of metadata access from the open geodata distribution service called *Vancouver Open Data Catalogue*. This screenshot does also visualize how the geodata is distributed to the user (by choosing a format) and the preview functionality of the service (in Google or Bing maps). (City of Vancouver 2015)

Additional Information

Date published	June 18, 2001
Keywords	Earth sciences, Cartography, Geography, Geographic data... show more
Series	National Topographic Data Base (NTDB) 12,506
Issue	030M11
Purpose	The NTDB provides a base of properly structured vector data (segmentation connection and sharing between entities... show more
Author	Government of Canada; Natural Resources Canada; Earth Sciences Sector Mapping and Earth Observation
Language	This product is available in English and French
Product type	Data 92,642


Full metadata

[View full metadata \(formatted NAP\)](#) | [North American Profile](#)

Figure A.2.5. Screenshot showing an example of metadata access from the open geodata distribution service called GeoGratis. (Government of Canada 2015)

Select an option


Draw Map



Display the selected data set as a map, dynamically drawn by the Environmental Data Explorer Internet Map Server.

display as ...
Map

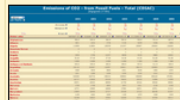
Draw Graph



Display the selected data set as a graph and compare different countries.

display as ...
Graph


Show Table



Display the selected data set with multiple analysis & display options in HTML format on a web site.

display as ...
Table

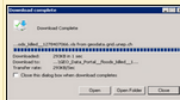
Show Metadata



Display the information about this dataset, such as definition, source, and other details.

display as ...
Metadata

Download Data



Download the selected data dynamically from the Environmental Data Explorer server in different formats.

download as ...
Comma Separated File
HTML
Microsoft Excel
ESRI Shapefile

Figure A.2.6. Screenshot showing an example of metadata access from the open geodata distribution service called Environmental Data Explorer. (United Nations Environment Programme 2015)

A.3 Data Delivery

In this chapter, six screenshots of design details associated with data delivery are presented. Some of the open geodata distribution services compared in this report deliver the geodata by email (or at least the link to download of data), while other services distribute the data directly through the web page. As for the distributions service represented by figure A.3.1, the user is asked to enter her email before the order of geodata can be processed. Figure A.3.2 shows an example of what an email with a download link might look like.

Figure A.3.3-A.3.6 show examples of when geodata are downloaded directly through the web page. Download of geodata can sometimes be done directly in the list of available data sets, as in figure A.3.3 and A.3.6. But the user will most often have to choose a data set, and enter the specific browser window for that, before the download/order button is visualized. Some services provide the user with other parameters, such as format, in the list of possible downloads. The same data set can be listed several times but in different versions (different combinations of additional parameters), see figure A.3.5 and A.3.6.



The screenshot shows a web form with a light blue background. At the top, it says "Du har valt:" (You have chosen:). Below this, there are four rows of selected parameters: "Karta" (Map) with the value "Jordartskarta, 1:25 000-1:100 000", "Skala" (Scale) with "100 000", "Storlek" (Size) with "A3", and "Koordinater (väst,syd)" (Coordinates (west,south)) with "632820, 6627350". Below these parameters is a section labeled "E-post:" (E-mail:) with a white text input field. At the bottom right of the form is a button labeled "Beställ karta" (Order map).

Du har valt:	
Karta	Jordartskarta, 1:25 000-1:100 000
Skala	100 000
Storlek	A3
Koordinater (väst,syd)	632820, 6627350

E-post:

Beställ karta

Figure A.3.1. Screenshot showing an example of how geodata is downloaded from the open geodata distribution service called Kartgeneratorn. (Geological Survey of Sweden 2015)

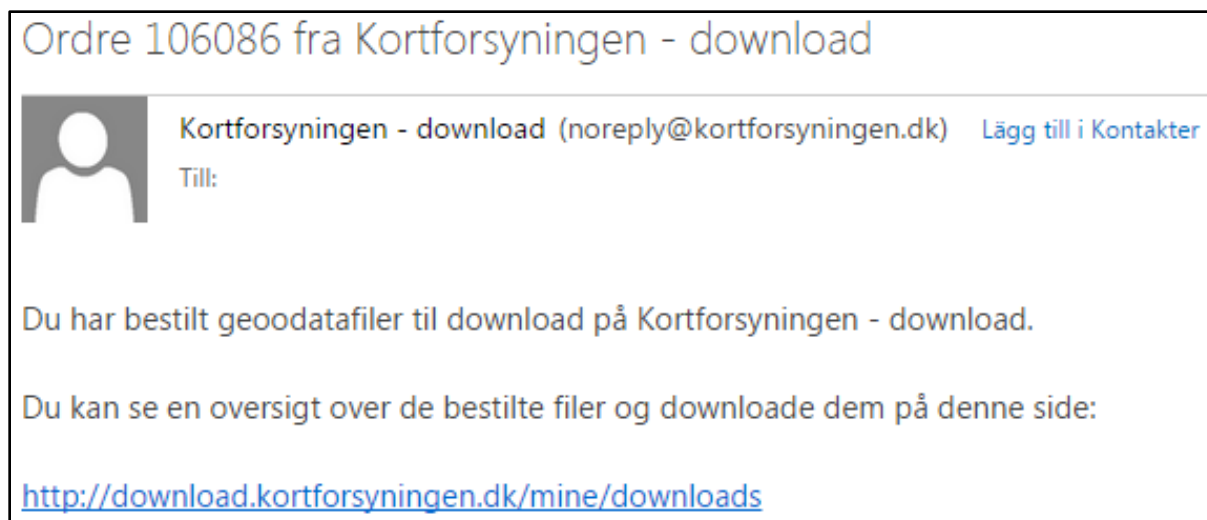


Figure A.3.2. Screenshot showing an example of how geodata is downloaded from the open geodata distribution service called Kortforsyningen. (Danish Geodata Agency 2015b)

Typ	Beskrivning	Hämta data
Karta	Kartbild över Linköpings kommun.	WMS
Flygfoto	Ortofoto från satellit- och flygbilder över Linköpings kommun (från hösten 2010).	WMS

Figure A.3.3. Screenshot showing an example of how geodata is downloaded from the open geodata distribution service of Linköping kommun. (Linköping kommun 2015)

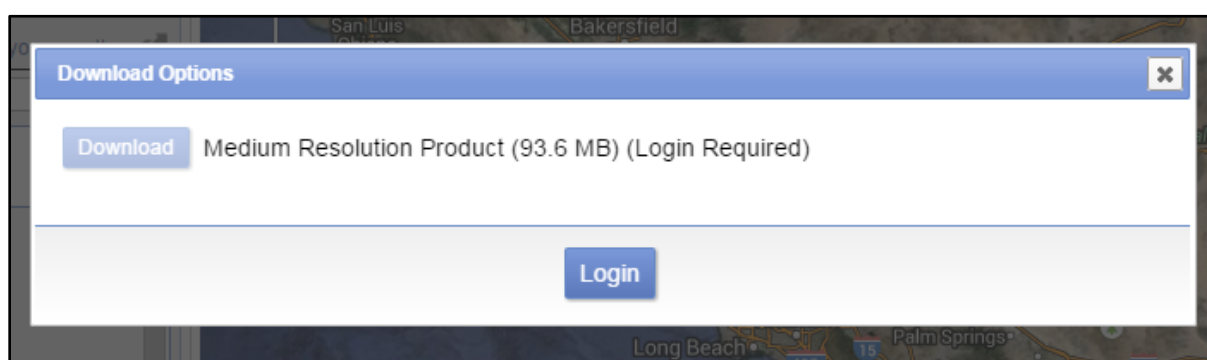


Figure A.3.4. Screenshot showing an example of how geodata is downloaded from the open geodata distribution service called EarthExplorer. (United States Geological Survey 2015)

Rubrik	Hela Stockholms län
Tätortskartan Stockholms län (ESRI personlig geodatabas version 10.2)	Ladda ner
Tätortskartan Stockholms län (ESRI shape)	Ladda ner
Tätortskartan Stockholms län (MapInfo TAB)	Ladda ner

Figure A.3.5. Screenshot showing an example of how geodata is downloaded from the open geodata distribution service called Open Stockholm Portal. This screenshot does also show how additional parameters are set. (Stockholms Stad 2015)

• Global Map Japan version 2 Vector data (Released in 2011)		
Layer	GML	Shape file
All	gm-jpn-all 2.zip	gm-jpn-all u 2.zip
Boundary	gm-jpn-bnd 2.zip	gm-jpn-bnd u 2.zip
Drainage	gm-jpn-hydro 2.zip	gm-jpn-hydro u 2.zip
Population	gm-jpn-pop 2.zip	gm-jpn-pop u 2.zip
Transportation	gm-jpn-trans 2.zip	gm-jpn-trans u 2.zip
• Legend (Global Map Specifications version 2.2)		

Figure A.3.6. Screenshot showing an example of how geodata is downloaded from the open geodata distribution service called Global Map Japan. This screenshot does also show how additional parameters are set. (Geospatial Information Authority of Japan 2015)

A.4 Search options

This section contains screenshots of search and filter possibilities made available by some of the open geodata distribution services compared in chapter 5 of this report. Some services give users the opportunity to perform a text based search, see figure A.4.1, while others provide the user with a number of filter options, for example *Kortforsyningen* in figure A.4.2. Many services allow a combination of search and filter options, see figure A.4.3 and A.4.4.

To simplify for the user, some services allow the user to search for a location in the map, one example of this is displayed in figure A.4.5. This does not always affect the download procedure, it might simply decide where the background map is centered. It is in some cases possible to filter by location, and perform a text based search “within” the filtered area, see figure A.4.6.

A number of open geodata distribution services compared in this study do not provide any type of filter or search possibilities, sometimes because there are not very many data sets available, and search functionality is unnecessary. A very minimalistic version of search options can be seen in figure A.4.7, data is stored alphabetically and the user can browse through the data catalogue by choosing a specific letter.



Figure A.4.1. Screenshot showing an example of the search functionality of the open geodata distribution service called *European Union Open Data Portal*. (European Environment Agency 2015)

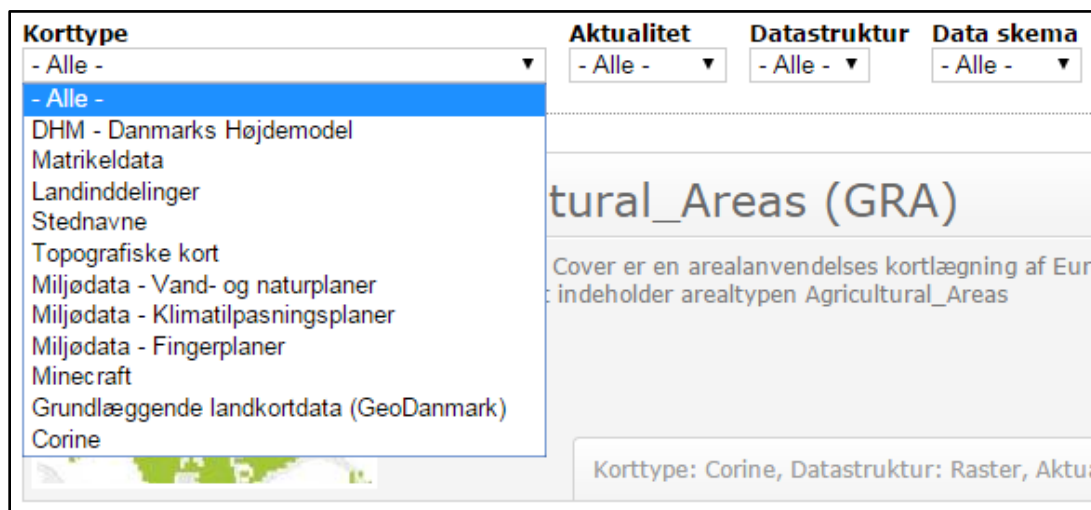


Figure A.4.2. Screenshot showing an example of the filter functionality of the open geodata distribution service called *Kortforsyningen*. (Danish Geodata Agency 2015b)

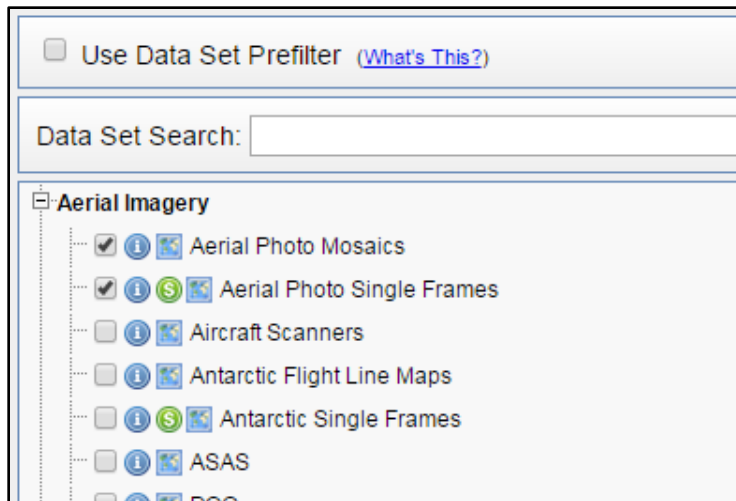


Figure A.4.3. Screenshot showing an example of the search and filter functionality of the open geodata distribution service called *EarthExplorer*. (United States Geological Survey 2015)

1 - Geographic Location: ?

Place Name or Postal FSA (K1G) or National Topographic System

2 - Subject Keywords: ?

Title, Theme, Author, Product, etc...

3 - Product Type: ?

☐ Maps (published maps)
☐ Data (vector, tabular, etc.)
☐ Remotely Sensed Data (satellite, airborne, sonar, etc.)
☐ Elevation Data (elevation models)
☐ Publications (geoscience research and others)
☒ All Product Types

[Advanced Search ?](#)
 ?

Figure A.4.4. Screenshot showing an example of the search and filter functionality of the open geodata distribution service called *GeoGratis*. (Government of Canada 2015)

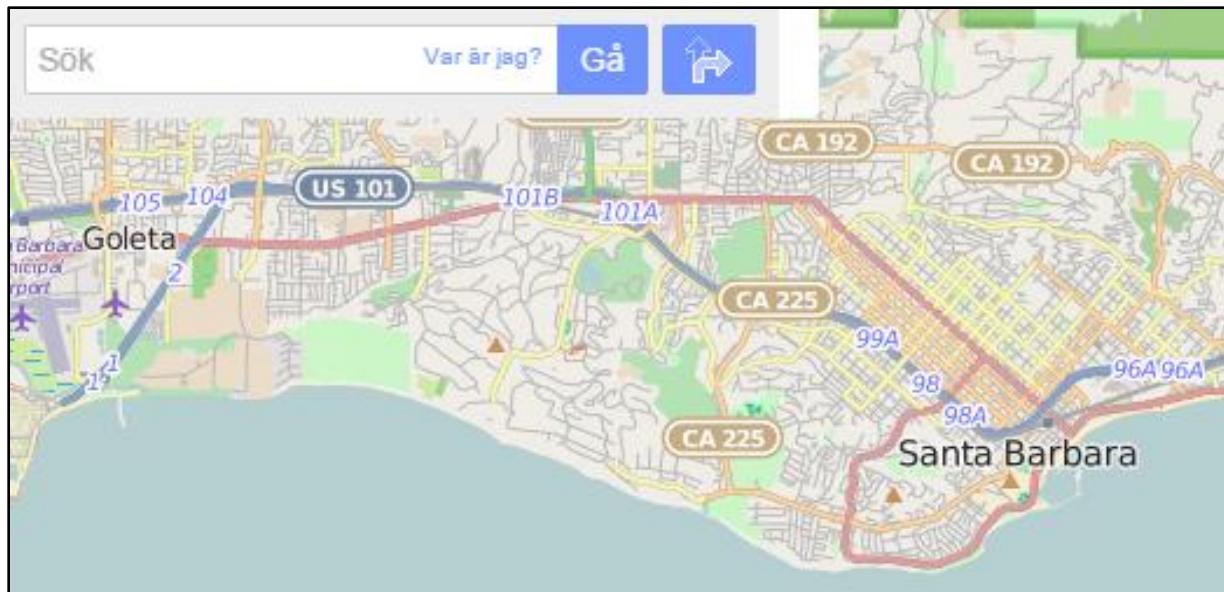


Figure A.4.5. Screenshot showing an example of the location search functionality of the open geodata distribution service called OpenStreetMap. (OpenStreetMap 2015)

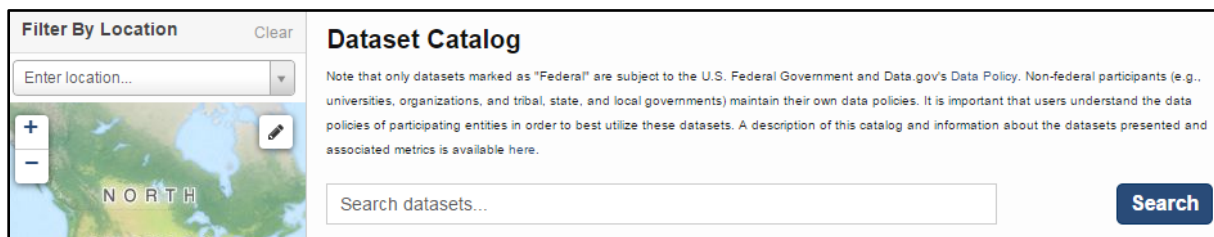


Figure A.4.6. Screenshot showing an example of the location filter and keyword search functionality of the open geodata distribution service called the Geospatial Platform. (Federal Geographic Data Committee 2015)



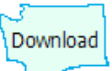


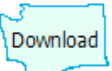


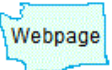
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z																													
DATA LAYER NAME																								VIEW FGDC METADATA		VIEW IMAGE		DOWNLOAD ZIP FILE	
Ambient Water quality monitoring stations																													
Baseflow Stations Baseflow characteristics of Washington streams																													
Washington Public Beach Access Points A detailed GIS database of public access locations (point features) with attributes along the coastal shorelines.																													

Figure A.4.7. Screenshot showing an example of the alphabetic search functionality of the open geodata distribution service of Washington State Department of Ecology. (Washington State Department of Ecology 2015)

A.5 Area definition

This part of the appendix consists of a number of screenshots from open geodata distribution services that captures how the extent of the data download is defined. It will often only be possible for the user to download the complete extent of a data set, but it is sometimes possible for the user to download geodata within a predefined area, e.g. within a city limit, and sometimes possible for the user to draw her own polygon that specifies the extent of download.

Danish *Kortforsyningen* does sometimes give users the choice of drawing an own area or downloading geodata within a predefined area, see figure A.5.1. When downloading geodata from the *Geological Survey of Sweden*, the user sets the size of download extent based on options in a drop-down menu and clicks the center of wanted area on the map, a red square that visualizes the chosen extent will then show on the map as in figure A.5.2. Figure A.5.3, A.5.4 and A.5.5 are other examples of screenshots from services that allow the user to specify her own area by drawing a polygon on the map.

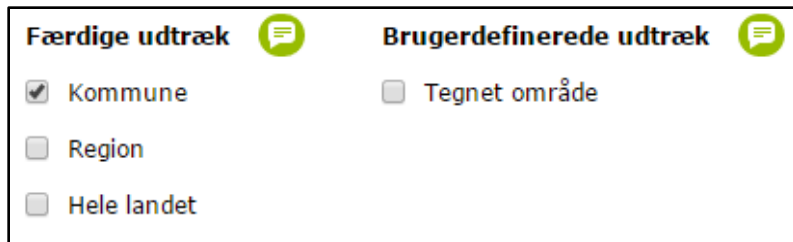


Figure A.5.1. Screenshot showing an example of the area definition functionality of the open geodata distribution service called *Kortforsyningen*. (Danish Geodata Agency 2015b)

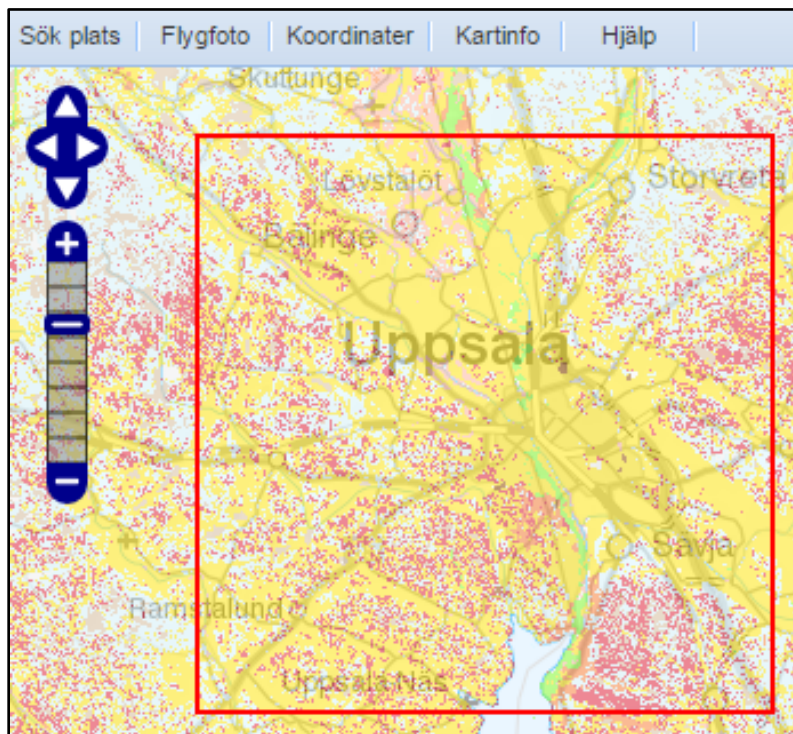


Figure A.5.2. Screenshot showing an example of the area definition functionality of the open geodata distribution service called *Kartgeneratorn*. This screenshot does also visualize the preview functionality, metadata access (*Kartinfo*) and location search possibilities (*Sök plats*) of the service. (Geological Survey of Sweden 2015)

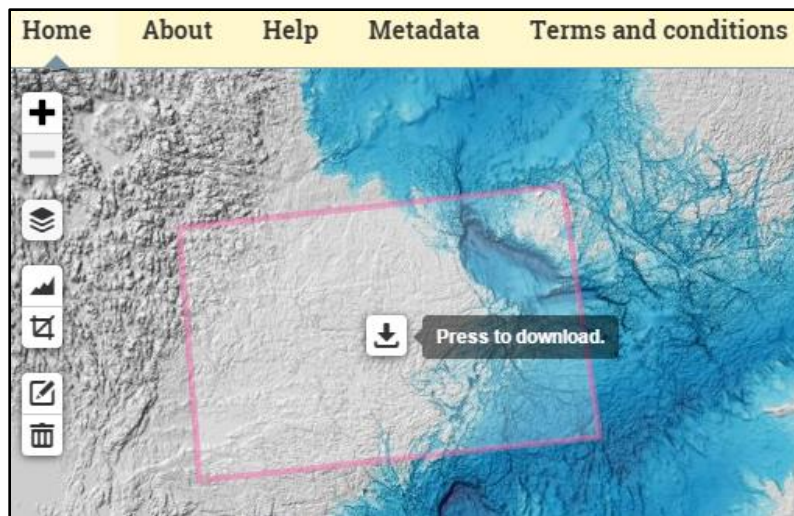


Figure A.5.3. Screenshot showing an example of the area definition functionality from the open geodata distribution service called the Baltic Sea Bathymetric Database. This screenshot does also visualize the preview functionality, metadata access and how geodata is downloaded from the service. (Baltic Sea Hydrographic Commission 2015)

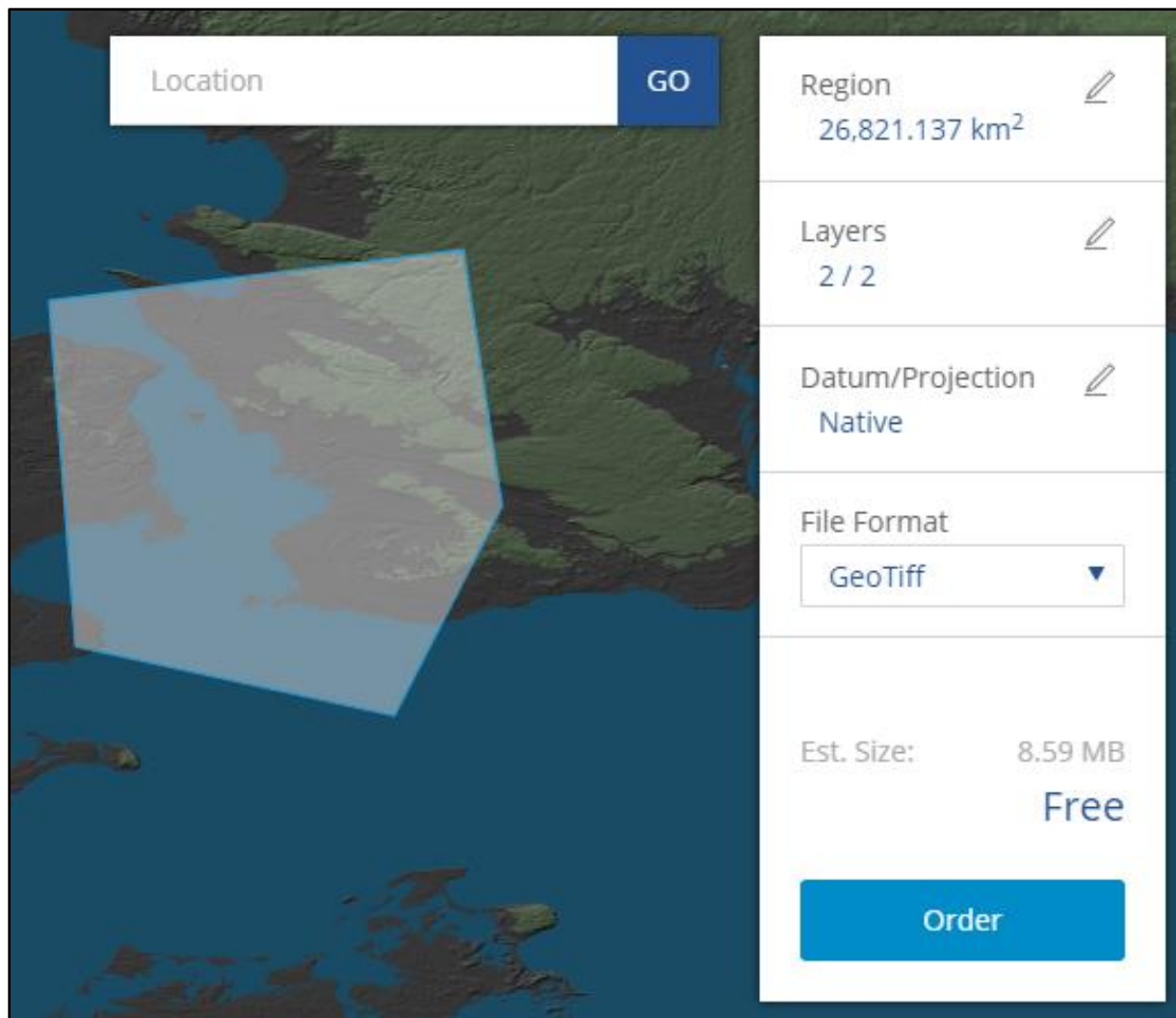


Figure A.5.4. Screenshot showing an example of the area definition functionality of the open geodata distribution service called Trimble Data Marketplace. This screenshot does also visualize the preview functionality and how additional parameters are modified. (Trimble Data Marketplace 2015)

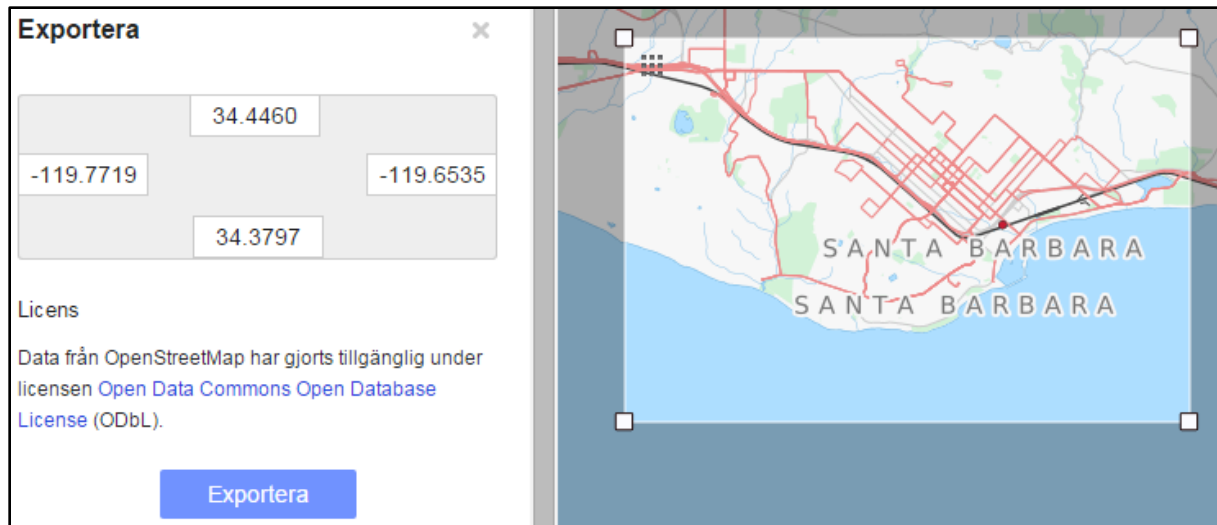


Figure A.5.5. Screenshot showing an example of the area definition functionality of the open geodata distribution service called OpenStreetMap. This screenshot does also show how geodata is downloaded from the service. (OpenStreetMap 2015)

A.6 Other parameters

Another important design detail of the open geodata distribution services compared in this report is how additional parameters are displayed and altered. Sometimes, the user will need to choose a specific data set before additional parameters are displayed and possible to modify, examples of this can be found in figure A.6.1-A.6.5. As for the distribution services represented in figure A.6.4 and A.6.5, the user parameter format is chosen at the same time as the download is started.

Figure A.6.6 and A.6.7 present examples of when additional parameters like area, scale and theme, are set as the user chooses a data set. The parameters are part of the list of available geodata.

The screenshot shows a web interface for the Danish Geodata Agency's 'Kortforsyningen' service. At the top, there are three steps: '1. Udtræksmetode', '2. Format og koordinatsystem' (highlighted in green), and '3. Vælg område på kort'. Below the steps, there are two main sections: 'Format' and 'Koordinatsystem'. Under 'Format', a dropdown menu is set to 'SHP (ArcGIS)'. Below this, a text block explains that the SHAPE format is a vector format for GIS systems like ArcGIS and QGIS, and provides a link 'Læs mere'. Under 'Koordinatsystem', a dropdown menu is set to 'UTM32-ETRS89'. Below this, a text block explains that UTM/ETRS89 is the primary map projection in Denmark for data exchange and processing, and provides a link 'Læs mere'.

Figure A.6.1. Screenshot showing an example of additional parameters of the open geodata distribution service called *Kortforsyningen*. (Danish Geodata Agency 2015b)

The screenshot shows the 'Kartbeställning' (Map ordering) interface of the 'Kartgenerator' service from the Geological Survey of Sweden. It features four dropdown menus for selecting map parameters: 'Tema' (Theme) with 'Välj tema', 'Karta' (Map) with 'Välj karta', 'Skala' (Scale) with 'Välj skala', and 'Storlek' (Size) with 'Välj storlek'. At the bottom left, there is a button labeled 'Fortsätt' (Continue). A back arrow button is located at the top right of the interface.

Figure A.6.2. Screenshot showing an example of additional parameters of the open geodata distribution service called *Kartgeneratorn*. This screenshot does also visualize the filter possibilities of the service. (Geological Survey of Sweden 2015)

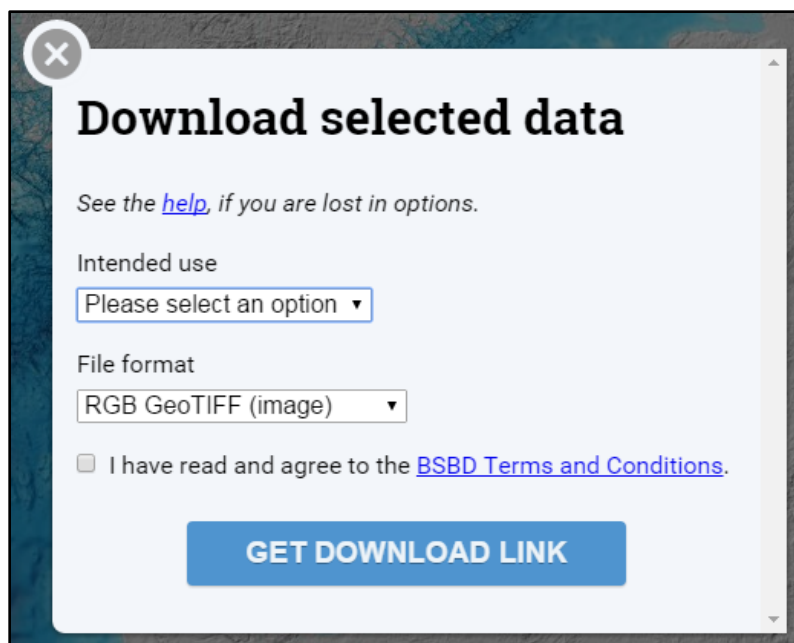


Figure A.6.3. Screenshot showing an example of additional parameters from the open geodata distribution service called the Baltic Sea Bathymetric Database. (Baltic Sea Hydrographic Commission 2015)

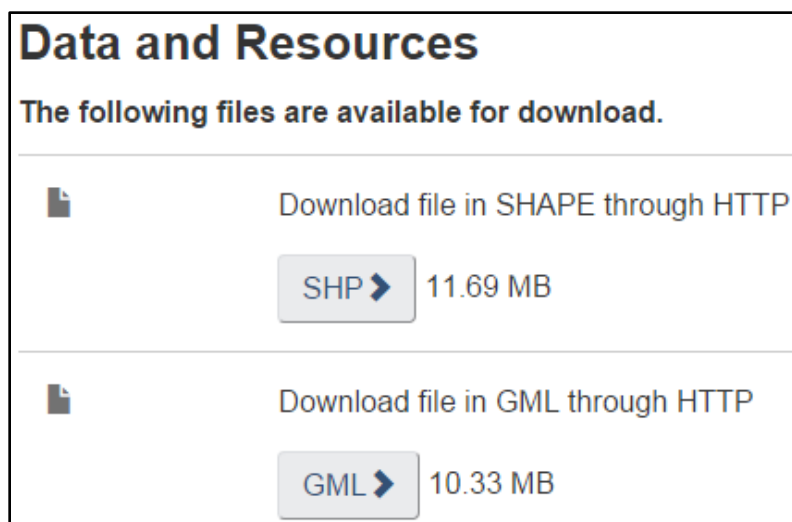


Figure A.6.4. Screenshot showing an example of additional parameters of the open geodata distribution service called GeoGratis. (Government of Canada 2015)

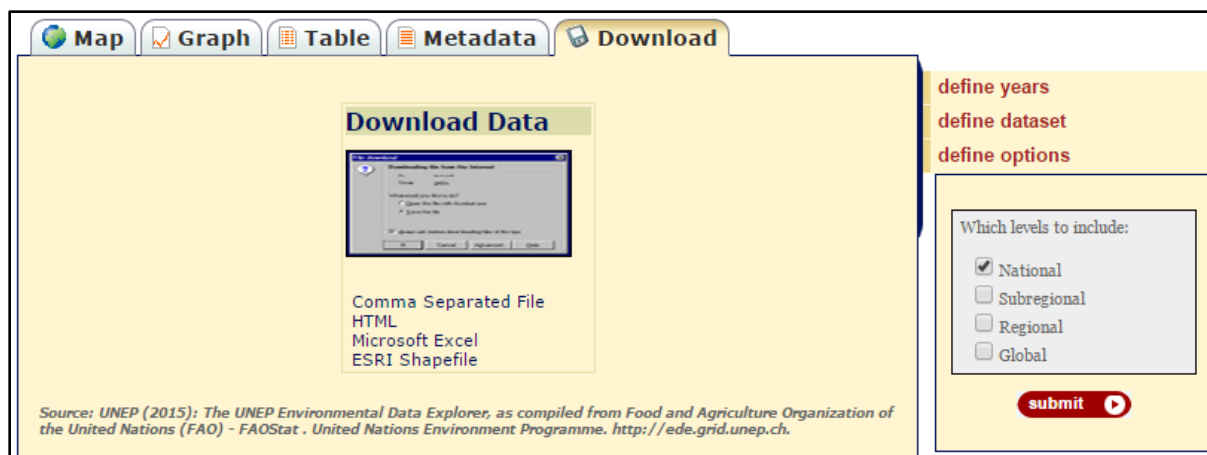


Figure A.6.5. Screenshot showing an example of additional parameters of the open geodata distribution service called Environmental Data Explorer. This screenshot does also show how geodata is downloaded from the service (by choosing a format) (United Nations Environment Programme 2015)



Figure A.6.6. Screenshot showing an example of additional parameters of the open geodata distribution service of Norwegian Kartverket. This screenshot does also visualize the preview and area definition functionality of the service. (Kartverket 2015)

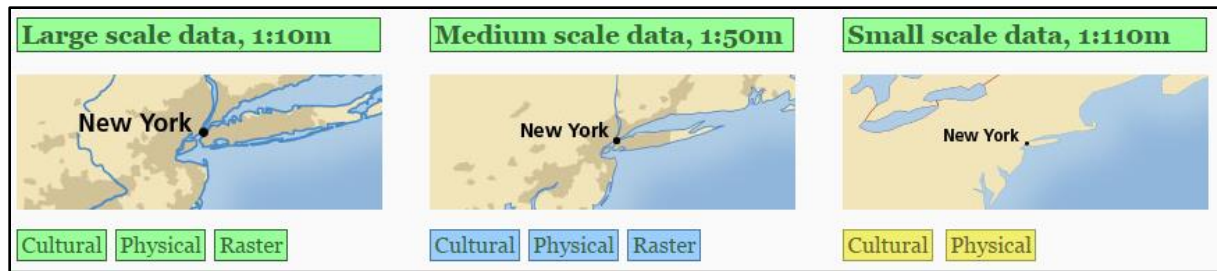


Figure A.6.7. Screenshot showing an example of additional parameters of the open geodata distribution service called *Natural Earth*. (Natural Earth 2015)

Appendix B - Configuration file: osm.json

```
{
  "target": "body",
  "layers": [{
    "type": "Tile",
    "name": "Sverigekarta",
    "source": {
      "type": "OSM"
    }
  }],
  "view": {
    "center": [1399069, 7495708],           // centered on Copenhagen
    "zoom": 11
  },
  "toolbar": {
    "drawtools": true
  },
  "toc": {
  },
  "navbars": {
    "north": {
      "visible": false
    },
    "south": {
      "visible": false
    }
  },
  "print": {
  }
}
```


Appendix C - GeoJSON file: D500.json

```
{ "name": "D500", "type": "FeatureCollection"
, "crs": { "type": "name", "properties": { "name": "EPSG:900913" } }
, "features": [
, { "type": "Feature", "geometry": { "type": "Polygon", "coordinates": [[[1498371.03782984, 7576690.23741211], [1498371.03782984, 7626690.23741211], [1548371.03782984, 7626690.23741211], [1548371.03782984, 7576690.23741211], [1498371.03782984, 7576690.23741211]]]], "properties": { "_layers": ["D500/Simplified_Udland", "D500/ALLE_blokke", "D500/FLYTTET_yderramme", "D500/HAV_til_DAGI_kyst", "D500/Yderramme", "D500/MAX_yderramme"] } }
, { "type": "Feature", "geometry": { "type": "Polygon", "coordinates": [[[1498371.03782984, 7626690.23741211], [1498371.03782984, 7676690.23741211], [1548371.03782984, 7676690.23741211], [1548371.03782984, 7626690.23741211], [1498371.03782984, 7626690.23741211]]]], "properties": { "_layers": ["D500/Simplified_Udland", "D500/ALLE_blokke", "D500/FLYTTET_yderramme", "D500/HAV_til_DAGI_kyst", "D500/Yderramme", "D500/MAX_yderramme"] } }
, { "type": "Feature", "geometry": { "type": "Polygon", "coordinates": [[[1498371.03782984, 7676690.23741211], [1498371.03782984, 7726690.23741211], [1548371.03782984, 7726690.23741211], [1548371.03782984, 7676690.23741211], [1498371.03782984, 7676690.23741211]]]], "properties": { "_layers": ["D500/Simplified_Udland", "D500/ALLE_blokke", "D500/FLYTTET_yderramme", "D500/HAV_til_DAGI_kyst", "D500/Yderramme", "D500/MAX_yderramme"] } }
] }
```


Appendix D - HTML code: index.html

```
<!DOCTYPE html>
```

```
<!--
```

Written by: Magdalena Nyberg, May 2015

Version: 1.0

This HTML document determines the basic design of a generic user interface for open geodata distribution. -->

```
<html lang="sv" class="no-js">
```

```
<head>
```

```
  <meta charset="utf-8">
```

```
  <meta http-equiv="X-UA-Compatible" content="IE=edge">
```

```
  <meta http-equiv="Content-Language" content="sv">
```

```
  <meta http-equiv="clear-type" content="on">
```

```
  <meta http-equiv="image-toolbar" content="no">
```

```
  <title>Sweco Map</title>
```

```
  <meta name="description" content="">
```

```
  <meta name="viewport" content="width=device-width, initial-scale=1, maximum-scale=1, user-scalable=0">
```

```
  <meta name="apple-mobile-web-app-status-bar-style" content="black">
```

```
  <meta name="apple-mobile-web-app-capable" content="yes">
```

```
  <link rel="shortcut icon" href="favicon.ico">
```

```
  <link rel="stylesheet" href="swecomap-1.2.1/css/style.css">
```

```
  <style type="text/css">
```

```
    #titleText {
```

```
      color: white;
```

```
      font-size: 170%;
```

```
      position: absolute;
```

```
      left: 320px;
```

```
      top: 20px;
```

```
      z-index: 1000;}
```

```
    #swecoheading {
```

```
      background-color: black;
```

```
      position: absolute;
```

```
      left: 0;
```

```
      top: 0px;
```

```
      width: 100%;
```

```
      height: 60px;
```

```

        z-index: 1000;}

#mainpanel {
    max-height: 90%;
    position: absolute;
    left: 0;
    top: 70px;
    width: 300px;
    z-index: 10;}

#step1 {
    max-height:230px;
    overflow-y: auto;}

#step2, #step3 {
    max-height:180px;
    overflow-y: scroll;}

#coords {
    font-size: 80%;
    font-family: arial;}

.ol-gps {
    z-index: 0;}

.ol-zoom.ol-unselectable.ol-control {
    top: 70px;}

</style>
</head>
<body>
    <!-- Sweco Map scripts -->
    <script src="swecomap-1.2.1/lib/openlayers/ol.min.js"></script>
    <script src="swecomap-1.2.1/lib/proj4/proj4.js"></script>
    <script src="swecomap-1.2.1/lib/jquery/jquery.min.js"></script>
    <script src="swecomap-1.2.1/lib/bootstrap/bootstrap.min.js"></script>
    <script src="swecomap-1.2.1/lib/bootstrap-select/bootstrap-select.min.js"></script>
    <script src="swecomap-1.2.1/lib/bootstrap-switch/bootstrap-switch.min.js"></script>
    <script src="swecomap-1.2.1/lib/typeahead.js/typeahead.jquery.min.js"></script>
    <script src="swecomap-1.2.1/lib/spin.js/spin.js"></script>
    <script src="swecomap-1.2.1/swecomap.min.js"></script>

    <!-- FME Server Rest API methods -->

```

```

<script src="fmeserver.js" type="text/javascript"></script>
<script type='text/javascript' >
    // Global variables
    var tiles = null;
    var wkt = "";
    var formlayers = [];
    var stringLayers = "";
    var countChoose = 0;
    var countRequest = 0;

    // Load JSON file containing tiles
    $.getJSON("D500.json", function(json) {
        var format = new ol.format.GeoJSON();
        tiles = format.readFeatures(json);
    });

</script>
<script src="main.js" type="text/javascript"></script>
<script src="draw.js" type="text/javascript"></script>
<script src="unigis.js" type="text/javascript"></script>

<!-- Title panel -->
<div id="swecoheading" class="panel panel-primary">
    <div class="panel-body">
        <p id="titleText">Sweco Map Distribution Service</p>
        </img>
    </div>
</div>

<!-- Download panel -->
<div id="mainpanel" style="overflow-y: auto;">
    <div class="panel panel-primary">
        <div class="panel-heading">Step 1: Define Area</div>
        <div class="panel-body" id="step1">

            <button type="button" class="btn btn-primary btn-sm" id="draw">

```

```

        <span class="glyphicon glyphicon-pencil" aria-hidden="true"></span>
        Draw Polygon
    </button><br><br>
    X & Y Coordinates:<BR>
    <TEXTAREA NAME="coords" id = "coords" COLS=40 ROWS=6
    readonly></TEXTAREA><br>

    <button type="button" class="btn btn-primary btn-sm" id="done">
        <span class="glyphicon glyphicon-ok" aria-hidden="true"></span> Done
    </button>
    <button type="button" class="btn btn-primary btn-sm" id="reset">
        <span class="glyphicon glyphicon-remove" aria-hidden="true"></span> Reset
    </button>
</div>

<div class="panel-heading">Step 2: Choose Layer</div>
<div class="panel-body" id="step2">
    <form id="form-layers"></form>
</div>

<div class="panel-heading">Step 3: Set Parameters</div>
<div class="panel-body" id="step3">
    <form id="form-parameters"></form>
</div>

<div class="panel-heading">Step 4: Download</div>
<div class="panel-body" id="step4"></div>
</div>
</body>
</html>

```


Appendix E - JavaScript code 1: main.js

```
/******  
* Written by: Magdalena Nyberg, May 2015  
* Version: 1.0  
* This script initializes the Sweco Map client and sets config file of application.  
*****/  
  
var init = function(client) {  
    initdraw(client);  
};  
  
var loader = new swecomap.config.Loader();  
loader.loadConfig(function(config) {  
    new swecomap.Client({  
        config: config,  
        callback: init  
    });  
}, "osm.json");
```


Appendix F - JavaScript code 2: draw.js

```
/******  
* Written by: Magdalena Nyberg, May 2015  
* Version: 1.0  
* This script manages the draw interaction of the application.  
*****/
```

```
function initdraw(client) {  
  
    var coordString = "";  
    var countDone = 0;  
    var drawing = false;  
  
    // Creates draw interaction  
    var drawin = new ol.interaction.Draw({  
        source: client.drawLayer.getSource(),  
        type: 'Polygon'  
    });  
  
    // Draw polygon when draw button is pressed  
    $('#draw').on('click', function(e) {  
        drawReset();  
        client.map.addInteraction(drawin);  
    });  
  
    // When drawing is ended  
    drawin.on('drawend', function(e) {  
        // Notes coordinates as wkt  
        var feature = e.feature;  
        var format = new ol.format.WKT();  
        wkt = format.writeFeature(feature);  
  
        // Send wkt to coords textarea  
        var coordString = "";  
        var tempgeom = e.feature.getGeometry();
```

```

tempcoords = tempgeom.getCoordinates()[0];

for (i=0; i < tempcoords.length-1; i++) {
    for (j=0; j < tempcoords[i].length; j++) {
        tempcoords[i][j] = tempcoords[i][j].toFixed(2);
        coordString += tempcoords[i][j] + ", ";
    }
    coordString = coordString.substr( 0, coordString.length - 2 );
    coordString += " " + "\n";
}

document.getElementById( "coords" ).value = coordString;

// Save polygon geometry
geometry = feature.getGeometry();

// Remove interaction after 50 milliseconds
setTimeout(function(){ client.map.removeInteraction(drawin); }, 50);
drawing = true;
});

// Clear polygon layer when reset button is pressed
$('#reset').on('click', function(e) {
    drawReset();
});

// Clear polygon layer
function drawReset() {
    client.map.removeInteraction(drawin);
    drawing = false;
    client.drawLayer.getSource().clear();
    coordString = "";
    document.getElementById( "coords" ).value = coordString;

    // Remove all step 2 elements but add form again
    $('#step2').empty();

```

```

document.getElementById('step2').innerHTML = '<form id="form-layers"></form>';

// Remove values in step 3 textareas
$('#step3').children().find('text,textarea').each(function(){
    $(this).val("");
});
// Remove all step 3 elements but add form again
$('#step3').empty();
document.getElementById('step3').innerHTML = '<form id="form-parameters"></form>';

// Remove all step 4 elements
$('#step4').empty();

// Reset chosen layers
stringLayers = "";
// Reset layer array
formlayers = [];
// To make it possible to press Done a second time after Reset
countDone = 0;
// To make it possible to press Choose a second time after Reset
countChoose = 0;
// To make it possible to press Request a second time after Reset
countRequest = 0;
}

// Generate step 2 elements
$('#done').on('click', function(e) {
    var countLayers = 0;
    var name = "";
    var intersection = false;

    // Only executed if a polygon has been specified, but not twice
    if (drawing == true && countDone == 0) {
        countDone = countDone+1;
        // Check if polygon geometry intersects with json tiles extents.
        // If so, a checkbox and label should be created for every layer that exists in that tile

```

```

for (i=0; i < tiles.length; i++) {
    if(geometry.intersectsExtent(tiles[i].getGeometry().getExtent())){
        intersection = true;

        for (j=0; j < tiles[i].getProperties()._layers.length; j++) {
            name = tiles[i].getProperties()._layers[j];

            // No duplicates of layers
            if($.inArray(name, formlayers) == -1) {

                idCB = name + "CB";
                idLabel = name + "Label";

                addEl("checkbox",idCB,"form-layers");

                document.getElementById("form-layers").innerHTML += " ";
                addLayerLabel(idLabel,name,name,"form-layers")

                document.getElementById("form-layers").innerHTML += "<br>";

                formlayers[countLayers] = name;
                countLayers = countLayers + 1;
            }
        }
    }
}

if (intersection == false){
    // Alerts user if no data exists in specified area.
    window.alert("Sorry, no data exist in the area you have specified.\nPlease
construct a new polygon.");
} else {
    // Append Choose button to step 2 div
    addEl("button","Choose","form-layers");
    // Process parameter form when clicking Choose button

```

```

        document.getElementById("Choose").setAttribute("onclick",
"processParameterForm()");
    }
} });

// Add form element
// type = button, checkbox,...
function addEl(type,id,formid){
    var element=document.createElement("input");
    element.setAttribute("type",type);
    element.setAttribute("id",id);
    element.setAttribute("value",id);
    element.setAttribute("name",id);
    element.setAttribute("class","rwr");

    if (type == "button"){
        element.setAttribute("class","btn btn-primary btn-sm");
    }
    var foo=document.getElementById(formid);
    foo.appendChild(element);
}

// Add layer label
function addLayerLabel(labelId,name,labelText,formId){
    var label = document.createElement("label");
    label.setAttribute("id",labelId);
    label.setAttribute("class","rwr");
    label.htmlFor = name;
    label.appendChild(document.createTextNode(labelText));
    layerform = document.getElementById(formId);
    layerform.appendChild( label );
}
}

```


Appendix G - JavaScript code 3: unigis.js

```
/*
*****
* Written by: Magdalena Nyberg, May 2015
* Version: 1.0
* This script contains the application's interaction with FME Server.
*****
*/

var repository = "exjobb";

window.onload = function() {
    FMEServer.init({
        server : "http://localhost:8080/",
        token : "fadb81f86df60b98a4057f9c82e70bf88279892d",
        detail : "low&token=fadb81f86df60b98a4057f9c82e70bf88279892d"
    });
};

// Process parameter form
function processParameterForm() {

    var checkedLayer = false;

    for(i = 0; i<document.getElementById("form-layers").elements.length; i++){
        var element = document.getElementById("form-layers").elements[i];

        if( element.type == "checkbox" && element.checked) {
            checkedLayer = true;
            // Save names of chosen layers in a string
            stringLayers += formlayers[i] + " ";
        }
    }

    // Remove last spacing from stringLayers
    stringLayers = stringLayers.substr( 0, stringLayers.length - 1 );
}
```

```

// You should not be able to run this twice by clicking twice on the Request button.
// One or more checkboxes have to be checked to be able to click Request
if(checkedLayer == true && countChoose == 0) {
    countChoose = countChoose + 1;

    var workspace = "clipship.fmw";

    // Get the workspace parameters from workspace
    FMEServer.getWorkspaceParameters( repository, workspace, generateParaForm );
}

}

// Generate Parameters form
function generateParaForm( json ) {
    var form = document.getElementById( "form-parameters" );

    // Build the form items using the API
    FMEServer.generateFormItems( "form-parameters", json );

    // Loop through all form elements
    for(i = 0; i<form.elements.length; i++){
        element = form.elements[i];

        // Show wkt in GEOM text area
        if(element.name == "GEOM"){
            element.value = wkt;
        }

        // Show chosen layers in LAYERS text area
        if(element.name == "LAYERS"){
            element.value = stringLayers;
        }

        // Make textareas not editable
        if(element.type == "textarea" || element.type == "text"){
            element.setAttribute("readonly", "readonly");
        }
    }
}

```

```

    }
}

// Create the Request Data Button
addEl("button","Request","form-parameters");

// Run Data Download
document.getElementById("Request").setAttribute("onclick", "runDataDownload()");
}

function runDataDownload() {
    // Should not be possible to click twice on Request button
    if (countRequest == 0){
        countRequest = countRequest + 1;
        // Confirms with user that she's ready to request the specified data
        var start = confirm("Ready?");
        if (start == true) {

            var workspace = "clipship.fmw";
            var form = document.getElementById( "form-parameters" );
            var params = "";

            // Loop through unique parameters and build the parameters string
            for(i = 0; i<form.elements.length-1; i++){
                var element = form.elements[i];
                if( element.type == "select" ) {
                    params +=
element.name+"="+element[element.selectedIndex].value+"&";
                } else if( element.type == "checkbox" ){
                    if( element.checked ) {
                        params += element.name+"="+element.value+"&";
                    }
                } else { params += element.name+"="+element.value+"&";}
            }

            // Remove trailing & from params
            params = params.substr( 0, params.length - 1 );
            // Use the FME Server Data Download Service

```

```

        FMEServer.runDataDownload( repository, workspace, params, showResults );
    }
}

// Show Data Download URL
function showResults( json ) {
    // This extracts the download link to the clipped data
    var url = json.serviceResponse.url;

    // Alerts user if the url is undefined.
    if (url == undefined) {
        window.alert("Sorry, something went wrong!\nTry drawing a new polygon or selecting
another layer.");
    } else {
        $( "#step4" ).append("<b>Follow link:</b><br>");
        $( "#step4" ).append('<a href="'+url+'"> Start Download </a>');
    }
}

// Add form element
// type = button, checkbox,...
function addEl(type,id,formid){
    var element=document.createElement("input");
    element.setAttribute("type",type);
    element.setAttribute("id",id);
    element.setAttribute("value",id);
    element.setAttribute("name",id);
    element.setAttribute("class","rwr");

    if (type == "button"){
        element.setAttribute("class","btn btn-primary btn-sm");
    }

    var foo=document.getElementById(formid);
    foo.appendChild(element);
}

```


Institutionen av naturgeografi och ekosystemvetenskap, Lunds Universitet.

Student examensarbete (Seminarieuppsatser) i geografisk informationsteknik. Uppsatserna finns tillgängliga på institutionens geobibliotek, Sölvegatan 12, 223 62 LUND. Serien startade 2010. Hela listan och själva uppsatserna är även tillgängliga på LUP student papers och via Geobiblioteket (www.geobib.lu.se)

Serie examensarbete i geografisk informationsteknik

- 1 *Patrik Carlsson och Ulrik Nilsson* (2010) Tredimensionella GIS vid fastighetsförvaltning.
- 2 *Karin Ekman och Anna Felleson* (2010) Att välja grundläggande karttjänst – Utveckling av jämförelsemodell och testverktyg för utvärdering
- 3 *Jakob Mattsson* (2011) Synkronisering av vägdatabaser med KML och GeoRSS - En fallstudie i Trafikverkets verksamhet
- 4 *Patrik Andersson and Anders Jürisoo* (2011) Effective use of open source GIS in rural planning in South Africa
- 5 *Nariman Emamian och Martin Fredriksson* (2012) Visualisering av bygglovsärenden med hjälp av Open Source-verktyg - En undersökning kring hur man kan effektivisera ärendehantering med hjälp av en webbapplikation
- 6 *Gustav Ekstedt and Torkel Endoff* (2012) Design and Development of a Mobile GIS Application for Municipal Field Work
- 7 *Karl Söderberg* (2012) Smartphones and 3D Augmented Reality for disaster management - A study of smartphones ability to visualise 3D objects in augmented reality to aid emergency workers in disaster management
- 8 *Viktoria Strömberg* (2012) Volymberäkning i samhällsbyggnadsprojekt
- 9 *Daniel Persson* (2013) Lagring och webbaserad visualisering av 3D-stadsmodeller - En pilotstudie i Kristianstad kommun
- 10 *Danebjer Lisette och Nyberg Magdalena* (2013) Utbyte av geodata - studie av leveransstrukturer enligt Sveriges kommuner och landstings objekttypskatalog
- 11 *Alexander Quist* (2013) Undersökning och utveckling av ett mobilt GIS-system för kommunal verksamhet
- 12 *Nariman Emamian* (2014) Visning av geotekniska provborrningar i en webbmiljö
- 13 *Martin Fredriksson* (2014) Integrering av BIM och GIS med spatiala databaser – En prestandaanalys
- 14 *Niklas Krave* (2014) Utveckling av en visualiseringsapplikation för solinstrålningsdata