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Implementation of a Geoserver application for GIS data distribution and manipulation

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Preface

This Master's thesis is Karteek Kommana's degree project in Physical Geography and Quaternary Geology at the Department of Physical Geography and Quaternary Geology, Stockholm University. The Master's thesis comprises 45 credits (one and a half term of full-time studies).

Supervisors have been Göran Alm at the Department of Physical Geography and Quaternary Geology, Stockholm University and Stefan Ene, Department of Human Geography, Stockholm University. Examiner has been Peter Schlyter at the Department of Physical Geography and Quaternary Geology, Stockholm University.

The author is responsible for the contents of this thesis.

Stockholm, 12 June 2013

Lars-Ove Westerberg
Director of studies

Abstract

Accessibility and Interactivity are keywords of information today and that is equally important in science as anywhere else. When scientists share information it benefits if it is intuitive, informative and simple and does not demand expert skills in complicated formats. This master thesis has the aim to investigate open source software tools to design a web map application that can be used by any institute or NGO to distribute their data over internet.

The Java platform to be implemented is the open source *OpenLayers* which allow users to view and potentially manipulate GIS map data through a web map application. Whatever GIS data made available on the *Geoserver* (the host site for the application) can be shared to users worldwide. The user can then: add from a list of available data layers, choose background (e.g. Google Earth, Open Street Map, etc.), zoom in and out, pan, change symbols and colors, add their own data on top and start animation (if applicable).

The data distributed from the Geoserver can also be viewed and accessed from smartphones which opens the possibility to make the public part of the larger data gathering task of specific scientific inventories like observations of migrating birds, or whatever indicator a specific scientist is interested in. Data is uploaded to the Geoserver and can then be analyzed and the result is distributed to the public.

Keywords: OpenLayers, Java, Geoserver

Table of Content

Introduction

Data sharing and distribution over the internet may seem to be difficult and expensive for persons representing e.g. NGO's or local folklore societies etc. There is still an increasing need to share their data to the public. For example, statistical geospatial data are difficult to understand if it is presented as tables or graphs. The users' understanding can be improved by showing the data on a map. The process of showing data on a map over the web is termed as "Web Mapping" or "Internet Mapping". Showing the data on a map requires geospatial coordinates of the data. The use of internet mapping has been getting vast popularity for past few years. By the end of 1999 there were about 40 million maps were produced over the Internet per day and two years later almost reached over 200 million per day (Schütze, 2007). This tremendous increase of the use of internet mapping shows the importance of showing/sharing spatial information over internet. On February 2005 the release of Google maps created a revolutionary change in the concept web mapping. Google maps were introduced with dynamic mapping with more user interface tools that made it successful (Ramsey).

Continues development of GIS technology and in special web mapping can provide smart and self-service applications. Municipalities in England has successfully implemented web mapping applications to improve the citizen services and recognize savings (Directions Staff, 2009). Web mapping applications come with menus and functions easy to understand and users can browse or search for information through the web. The level of information provided can be varied according to the intended user and the access to data can be regulated through the use of login and password if so desired. With easy access to information via the internet, there has been increased participation from the communities on issues relating to community (Majid, Haron, & Rafee, 2007). With the introduction of Google Maps and Bing Maps people are exposed to the GIS solutions in their smartphones, tablets and computers. This widespread use increases the familiarity of reading information from web maps. Municipalities using this web map technology have the tool to provide and spread large quantities of information online. This gives citizens 24/7 access to information which vastly reduces phone calls to government offices. Some of examples of map services that government agencies provide are:

1. A web map application that can be used for crime complains by pointing location.
2. Providing information about the construction projects that are ongoing which can cause traffic delays.

Through web map service, users can also process and manipulate spatial data online such as doing simple analyses using the spatial data. This analysis can be done by customizing the user interface with simple analysis functions. One example is the Slaithwaite Web GIS (Carver et al., 2005) which provides the community with markup functions on the web that lets the user to comment on the data directly on the map. In planning, web mapping applications can also support the concept of e-governance through the internet, the two-way interactions between government and citizens, government and government as well as government and NGO's (Montagna, 2005).

The use of web map applications is increasing in both public and private sectors. These web based GIS projects often face challenges like: lack of financial resources, lack of technical expertise, and lack of documentation about how non-technical users can make use of web based GIS. It is difficult to evaluate whether these advantages of technology can really lead to the improvements suggested by their proponent's: improve public participation, transparency in government, literacy in Web GIS, better data driven decision making by community based organizations.

In recent times use of internet has improved greatly with no doubt geospatial information has become a part of people's day to day life. Online street maps like Google maps, Google Earth and Yahoo maps are popular and are combined with social networking sites like blogs, wiki, personal publishing. This trend has increased in recent times. One popular site states that, it has more than 40 million unique visitors per month (Nivala, Brewster, & L, 2008) which clearly show the popularity of web mapping technology in the public. The biggest advantage of adapting web for developing applications includes:

1. No local installations required.
2. Automatic upgrade of new features for all users.
3. Worldwide access from any device connected to the internet.

The aim of this project is to see if it is possible to design a web map application by using open sources so that the end user does not need technical skills to work with it. The outcome of this project will in that case be a web map application that can be used by any institute or NGO. The data of any individual person can be shared over the internet with no or low cost and with only basic technical knowledge.

Objectives:

The specific objective of this project is to design a web based mapping application suitable for a university department or NGO that should be able to:

1. Supply maps from the research activities to the public.
2. Supply maps to the restricted users (e.g.: other research groups, different organizations).
3. Data on the map should be selectable, editable, zoomable, pannable etc. on Google Maps.
4. Animate the map layers of an application.
5. Users own data should be possible to superimpose on the map object in the application.
6. To validate how useful is a system like this for e.g. NGO's and other local society or private person.

To test suitable methods for implementing the above objectives an already existing data set was used. This data comes from an earlier project at the department and it deals with the effects of a change in shoreline due to the isostatic uplift that has its origin in the melting of the ice cover over Scandinavia during the last stages of the last glaciation and is briefly discussed below.

Case study: The Land Uplift

To describe change during the last 7000 years in shoreline configuration in northern Uppland, southeast Sweden, 17 overgrown lakes have been interpreted by diatom analysis and AMS radiocarbon dates on terrestrial macrofossils. Also 20 archaeological sites expected to be shore bound were dated and their locations measured. The sites studied are spread c. 60 km in east-west and c. 70 km in north-south direction. From these 37 sites a multi-linear regression was performed and used to determine the expected elevation of the Baltic shoreline for a given age and a given position in the map coordinate system. The data analysis showed that the rate of isostatic uplift was faster the further to the north you are and faster the further back in time you look. The radio-carbon dating of the archaeological and lake sediment samples were between 5000 BC to 2000 BC. As a result from the analysis it is possible to produce maps of the position of the shoreline from a given age, so called paleogeographic maps. A set of maps separated by 500 years from 5000 BC and extrapolated to 1500 AD were constructed. These maps are now used to illustrate the web map application in this exam project work (Risberg, Alm, & Goslar, 2005).

Web Mapping

Presented Spatial data as a map over the internet is termed *Internet Mapping*, *Web Mapping*, *net-based* etc. showing data on the map over the internet is not only a simple web mapping, along with presenting the data it should also provide simple tools like zoom bar and panning over the map.

Classification of web mapping:

Web mapping is divided into *static* and *interactive* maps. Static maps are simply mapped pictures that can be fit into the web page with no user interaction, whereas interactive maps are more advanced maps which allow users to interact with the data on the map. The only interaction that the user can have in static maps is panning around the map which does not alter anything on the map.

Architecture of Interactive mapping

Map object on the web page communicate with the web server to display data on the map which are stored on a web server. For example when the user is zooming in the map, the map client requests map tiles from map server and are displayed on the map. The server will generate new maps corresponding to the zoom level. The newly generated maps will be sent to the map object and the web map client displays it on the map that is integrated in the web page. The picture below shows the architecture of web mapping.

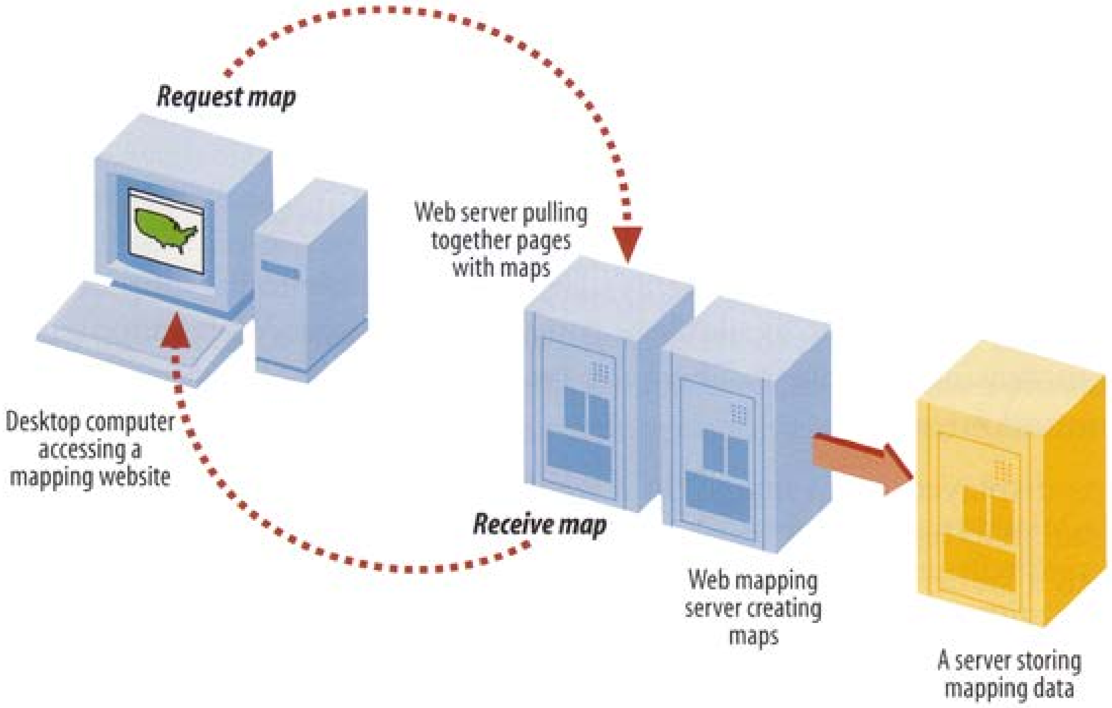

Request map
Web server pulling together pages with maps
Desktop computer accessing a mapping website
Receive map
Web mapping server creating maps
A server storing mapping data

Figure 1. Client-Server Architecture (Mitchell, 2005)

Data types

A web browser can usually be able to display various types of raster data on the map in PNG or JPG format, but browsers are still not able to support a variety of vector formats.

Web server

A web server is the place where map data are stored. It is usually installed in a separate machine. Popular free web servers include Geoserver, Tomcat, MapServer etc. Later in the report we focus on Geoserver which is used especially to store Geo-referenced data.

Tiling

Tiling is a fairly new development - it is the process of dividing a large map into small pieces in the form of square tiles and send these separately from the server which improves the performance of the web map. Map tiling can be done in two ways, client-side or server-side. The map can be pre-tiled in the server before the map is loaded into the web page. This will improve the loading time of the map but the main drawback of this is that, it is a time consuming process. But once the tiles are made in the server the tiles can instead directly be sent from the server. There is also a possibility to tile the map at different zoom levels on the server. On the client-side, the user selects the interested area and map client requests the tiles from the server. The size of map tile increase twice in height and width for each increasing zoom level on the map.

When the user zooms in or out into the place of interest the server will generate the map for that particular area. At zoom to maximum extent on the map the user may not recognize the map tiles but when zooming in repeatedly it is possible to see the map appear in the form of squares.

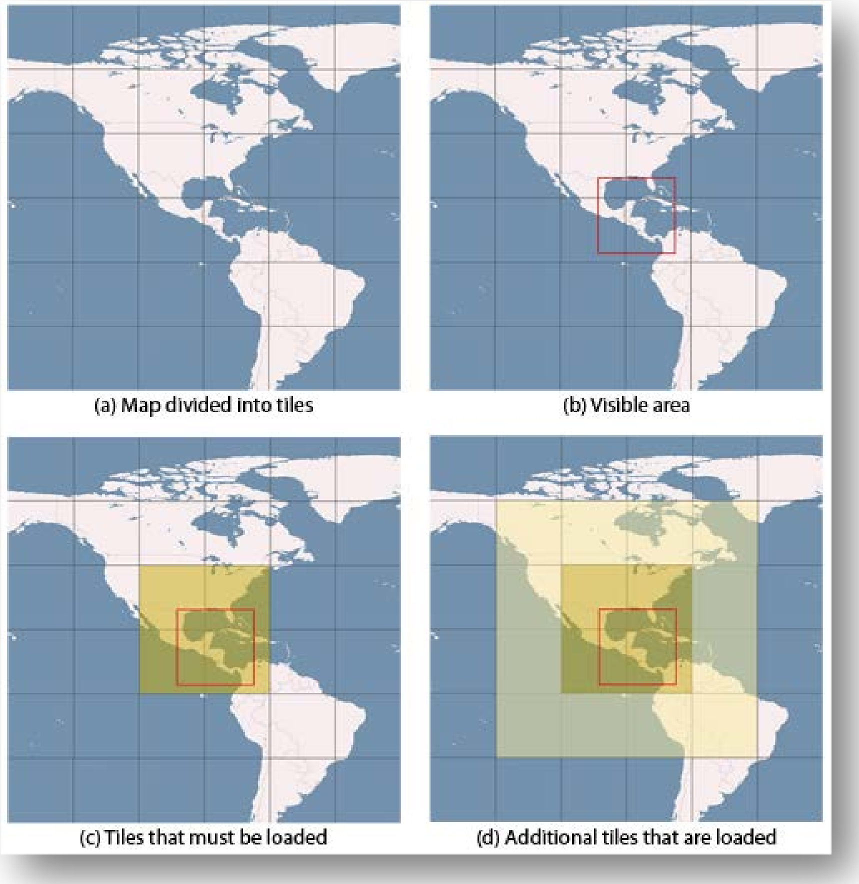

(a) Map divided into tiles
(b) Visible area
(c) Tiles that must be loaded
(d) Additional tiles that are loaded

Figure 2. Determination of Tiles to be loaded (Schütze, Web Mapping, 2007)

Open Geospatial Consortium

The Open Geospatial Consortium (OGC) was formed in 1994 from the Open GRASS Foundation (OGF). It is a non-profit organization working in collaboration with more than 480 companies (by 2013) government organizations and universities all over the world. The major objective of the OGC is to develop international standards for geospatial data and to set standards for public use. OGC standards come with a technical documentation and encodings. OGC® and OpenGIS® are the trademarks of OGC standards. The standards allow the developers to create complex spatial information and make it accessible to public and can be useful in different kinds of applications (Open Geospatial Consortium).

Web Map Service

The fundamental component of web mapping application is its map image. The Web Map Service (shortly as WMS) is the standard process of accessing map data from the server where map data are stored. When user interacts with the map, map tiles will be generated on the server and be sent back to the map. WMS generates map data in the form of image whether it is a vector or raster data. A simple WMS request can look like below.

http://localhost:8080/geoserver/topp/wms?service=WMS&version=1.1.0&request=GetMap&layers=topp:tasmania_cities&styles=&bbox=145.19754,-43.423512,148.27298000000002,-40.852802&width=512&height=427&srs=EPSG:4326&format=image/png

A quick explanation of the above WMS is:

1. Server details (a WMS 1.1.0 request)
2. Request type (WMS GetMap)
3. Layer name (topp:tasmania)
4. Projection (EPSG:4326)
5. Bounding box (in this case, latitude/longitude coordinates)
6. Image size and format (512x427 PNG)

OGC- WMS

The OpenGIS® Web Map Service Interface Standard (WMS) provides a simple HTTP interface for requesting geo-registered map images from one or more distributed geospatial databases. A WMS request defines the geographic layer(s) and area of interest to be processed. The response to the request is one or more geo-registered map images (returned as JPEG, PNG, etc.) that can be displayed in a browser application. The interface also supports the ability to specify whether the returned images should be transparent or not so that layers from multiple servers can be combined.

When a Web Map Service fulfills the WMS specifications of the OGC, it is referred to as an OGC conforming WMS. This means that requests to and responses from the WMS must be done according to a specific standard. The following three queries fall under current OGC specifications (with the third being optional).

1. *GetCapabilities*
   queries the WMS' capabilities.
2. *GetMap*
   requests a specific map.

3. *GetFeatureInfo*
   requests information on individual map objects.

The figure below illustrates the relationships between some OGC web services, as well as the main operators (as defined by the OGC web services).

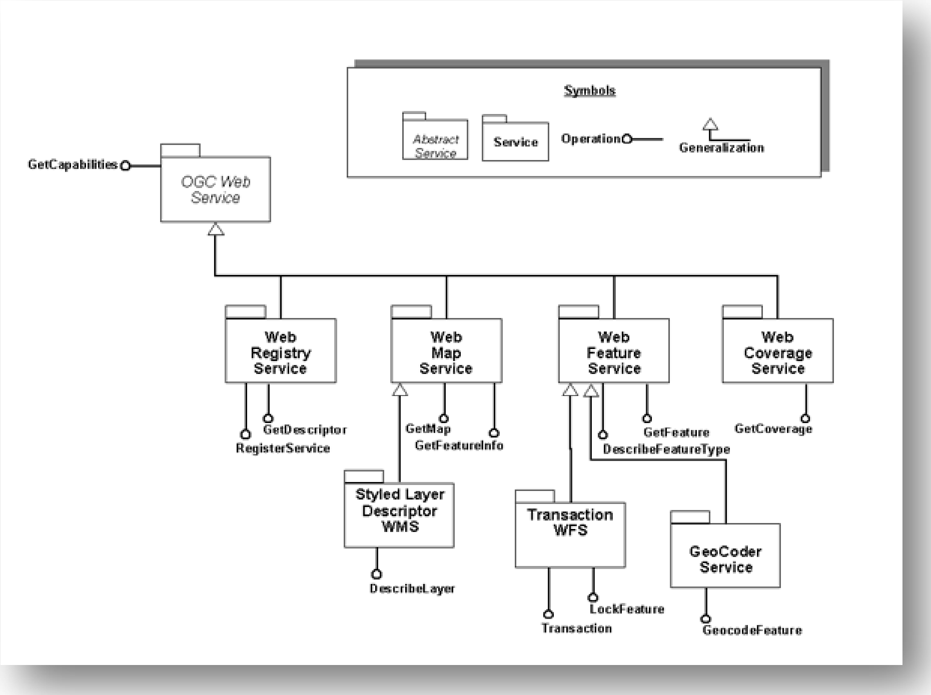


Figure 3. OGC Web Services Architecture (Hazzard E. , 2011)

EPSG:

Geographic coordinates describing the position of an object on the earth's surface refer as an earth model rather than the Earth itself. There are many ways to represent objects in the model with different coordinates. The European Petroleum Survey Group (EPSG) designed a model with geodetic parameters in 1985 for internal use in their company. In 1995 they make the data public to their Petro Technical Open Software Corporation data model. In 2005 EPSG was reformed to the International Association of Oil and Gas Producers (OGP). OGP is a group of companies working on exploration and mining world-wide. The dataset includes coordinate systems, datum transformations, projections, units and other related information. The information was gathered from various petroleum companies, government agencies that are responsible for geodetic in that specific country. EPSG dataset is available for free download and are worldwide accepted coordinate system and transformation information. Data will be frequently updated at least 2-6 times in a year depending on the data they get (EPSG, 2012).

OpenLayers:

OpenLayers (OL) is a Java script library running on the client side. It is completely open source and can be freely accessed. Having programming knowledge will make it easier to work with OL but even non-programmers can be able to handle it as everything is stored in the OL library. It is not owned by any company and it is been developed by group of developing communities. It is possible to download the Java script library locally or on the server and edit the library according to the user need. It works in almost all the modern web browsers and some older like IE6.

Client-side:

OL works on the local machine of the user, it particularly runs on the user's web browser.

OL library:

OL is a Java script library which is developed by a group of brilliant people and can be either downloaded from the OL website or accessed from the repository on the OL website (www.openlayers.org). OL library is an API (Application Programming Interface) which provides tools to build web mapping applications. When a web mapping application is made from scratch, mapping part of the application can be used from OL library. For example if you want to setup a blog, it is not necessary to build it from scratch instead existing sources like WordPress or Blogger can be used to build an application on top of it. The same for web mapping, it can be created from scratch or use examples from the OL library which has been built and tested by a strong community.

Web map application:

Web map application could simply be any application of internet that uses maps. For example, showing the population density in different regions of a city on map which are geo-referenced or it could be showing water bodies (geo-referenced) on a particular area in a map

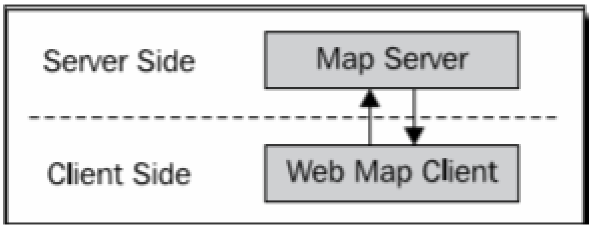


Figure 4. Server Client model (Hazzard E. , 2011)

The core process of any web application called "Server/Client Model". In the case of web mapping OL acts as a web map client which request map data from the map server (E.g.: WMS server).

Web map client:

The primary duty of the client is to get a map from the map server. When the user interacts with the map by panning, zooming or looking at a particular area on the map, the client should request that particular map from the server and display it on the map. OL does all client work by using asynchronous JavaScript (AJAX).

Web map server:

A map server simply provides maps to the web map client. There are many different map servers that are available; WMS examples are Google Maps, Bing Maps. Yahoo Maps etc. these map servers allow the client to select different parts of the map. With OL it is possible to use multiple back end servers like Yahoo, Google, Bing etc.

Google/Yahoo/Bing/ and other APIs:

Google, Yahoo and other APIs provide their map service on the map objet as background map (OL does the same). These APIs works on client side like OL. Google maps are very powerful which can allow GIS tools on the map (which can also be done with OL). The biggest disadvantage of using Google is there will be no access to its backend server. As there is not possible to access the backend server there is high rick that something can happen in Google server. To solve this problem OL recommend downloading the OL library and save it locally instead of accessing it from OL server.

OpenLayers Layer:

As mentioned earlier, OL allow multiple map servers or backend map servers that can deliver data to the map. These different map servers will be added to the map as layers using OL. Each layer on the map will add on top of each other just like the desktop GIS applications. Google or Yahoo map servers etc., can be used as background maps and on top of it any kind of raster or vector data can be displayed. The advantage of using vector data is that it allows user to add GIS tools to the map on top of it.

Map Controls:

In general a simple web map should have the following components:

Main Map:

This is the major component of the map. On top of the map raster or vector data can be projected.

Overview Map:

It's also a main map but with navigation window. It will act as a reference map. The zoomed portion of the main map can be seen on the whole map with a rectangle box highlighted the zoomed area.

Pan/Zoom Bar:

It is a zoom slider to select the zooming level of the map.

Layer Overview:

This portion of the map contains the data present in layers. Layers can be selected or unselected here.

Toolbar:

This portion of the map contains GIS tools like panning button, zoom button etc. The tool box can be placed on the map or outside the map.

Scale Bar:

Scale bar shows the current scale of the map.

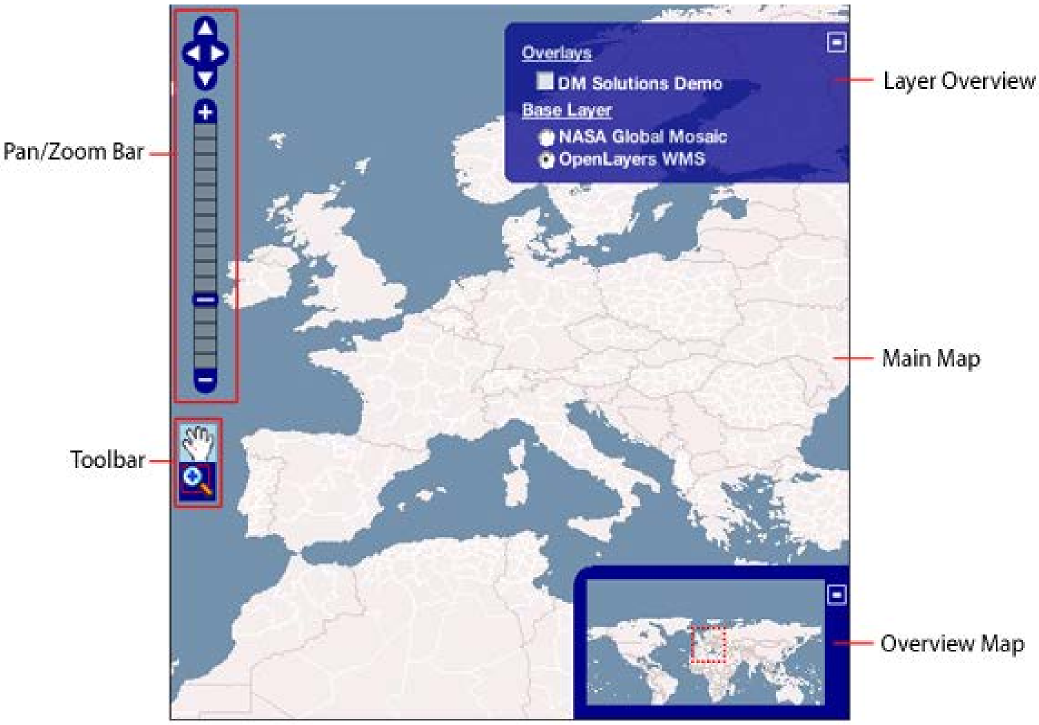


Figure 5. Components of Web Mapping Application OpenLayers (Schütze, Web Mapping, 2007)

Controls in detail

With the rapid growth of the internet and web mapping the concept of map interaction has gained greater importance. In modern web mapping applications user has more specific interactive tools on the map. It is possible to display data on the map in any region of the world. Pan /zoom bar can be used to pan the map in any direction and the zoom bar can be used to zoom the map from global to local level. Layer overview of the map allows the user to select the specific data on the map which will be very useful to compare different data on the map. GIS tools can also be added to the map in the tool box which will allow the user to create points, lines or even polygons on the map. For a more advanced web mapping Ajax has been used to connect the map with the other objects on the web page.

Web page design:

In order to build a web page some basic things are required:

1. Page construction(e.g. HTML)
2. Styling(e.g. CSS)
3. Page interaction (e.g. JQuery)

HTML is the standard and universally accepted markup language used to construct the web page. HTML stands for “Hyper Text Markup Language”. HTML defines the structure of the web page using standard tags which are enclosed in angle brackets (e.g.: <html>) and attributes. All the HTML tags are coming up with pair i.e., beginning tag and ending tag (<html>,</html>). The closing tag looks exactly same as beginning tag with extra back slash “/” before the tag name. There are several hundreds of HTML tags are available in the language, all the tags are not required to construct a web page. Two basic tags are necessary to construct a web page web without those pages cannot be build (W3Schools, HTML Tutorial).

<!DOCTYPE html> this tag defines the page as HTML

<html> starting the script with. All the script lies under this tag.(Beginning tag)

<body> content of the page resides under this tag. (Beginning tag)

<h1>My First Heading</h1> this tag is for heading on the web page (Both tags)

<p>My first paragraph. </p> this tag is for a paragraph on the web page. (Both tags)

</body> this tag in the script closes the beginning tag <body> (Close tag)

</html> this tag in the script closes the beginning tag <html> (Close tag)

CSS standards for "Cascading Style Sheet". It defines the style of HTML objects on the web page. Using CSS, it is possible to display or adjust the position of different objects like table, paragraph, heading, copyright etc. on the web page. A simple style for a paragraph in a web page below (W3Schools, CSS Tutorial).

<p style="**color:sienna;margin-left:20px**">This is a paragraph.</p>

Defines color of the paragraph. It defines the paragraph should be 20 pixels distant from the left margin.

JQuery is a client side JavaScript library that can be used to create dynamic web pages. With JQuery it is possible to navigate to the web page and to e.g. create animations on the page. The simple JQuery script shows below.

```
$(document).ready(function() {
 $("#p").click(function() {
  $("h1").css("background-color","red");
 });
});
```

When user click on the paragraph on the page, JQuery triggers background color to red for h1 heading on the web pagen (W3Schools, JQuery Tutorial).

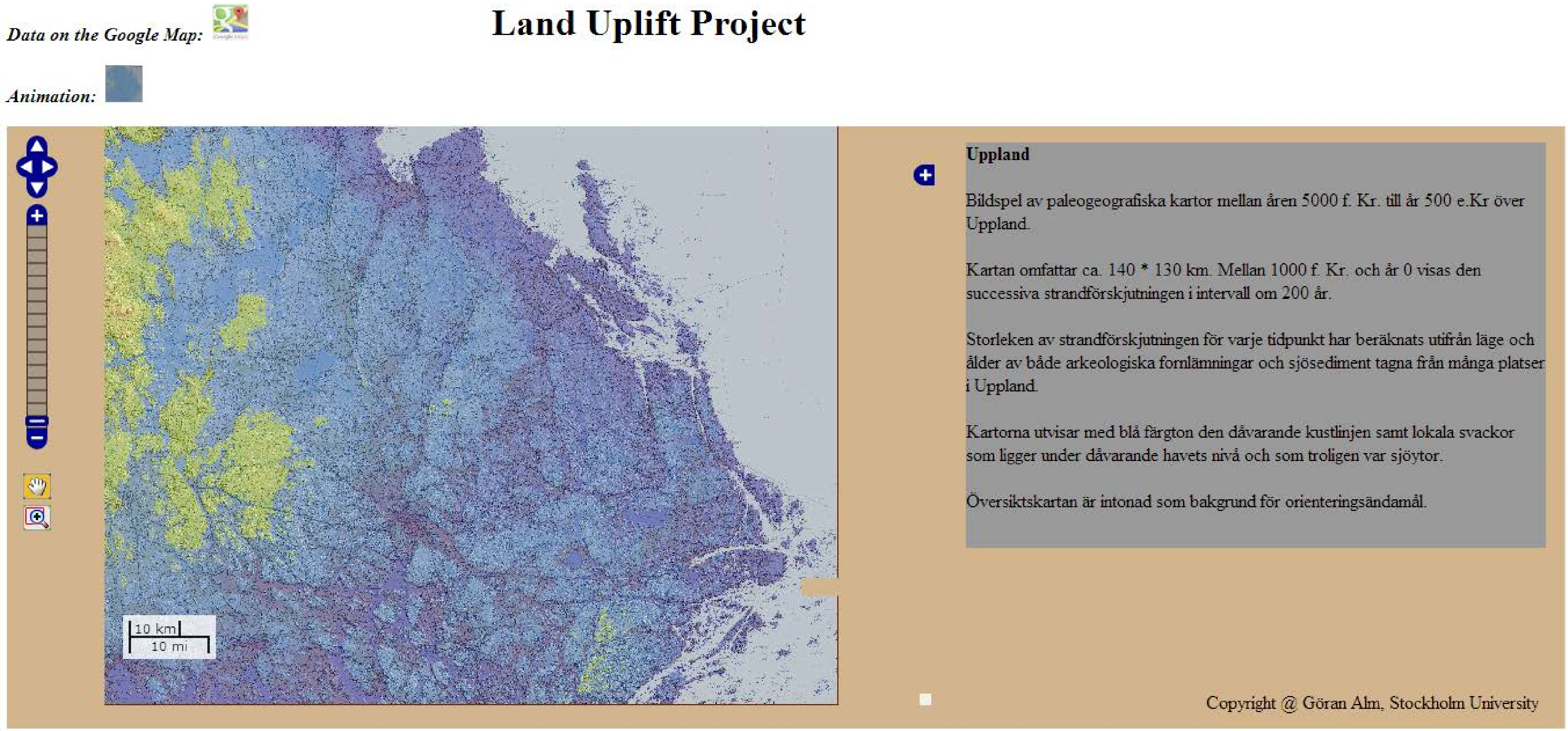
Geoserver:

Geoserver is a Java based server that can allow map creating and data sharing. It is completely open source and work under OGC standards. It can allow display/sharing the well-spatial data to the world through the web. Geoserver comes with a WMS that can fit into other Java applications like OpenLayers and can create maps of different formats. It comes with inbuilt "Geotools" which is an open source Java GIS toolkit that allows GIS operations on the map. Geoserver can display data on the any popular modern mapping applications like "Google Maps", "Google Earth", "Yahoo Maps" etc.; even it can connect to the traditional desktop GIS tools like ESRI ArcGIS. Complete instruction of the Geoserver installation is provided in the appendix of this report (Geoserver).

Results:

To create the dynamic web page HTML, CSS and JQuery have been used in this project. Tiff files were produced for 500 year intervals from 5000BC to 1500AD using traditional desktop GIS tool ArcMap. After the production of the layers they were imported to the Geoserver in order to display them on the modern map servers like Google Maps, Google Earth, and Open Street Map etc.

On the web page data were projected in two different map projection systems. Swedish map projection system SWEREFF99 TM and used for world mapping WGS84 lat/long system. When the page load map with data projected on the Swedish projection system will be shown. In Swedish projected map data includes a background map from "lantmateriet". So, there will be only data layers without any background map like Google Maps. Other map can be shown by pressing the button "Show/Hide data on World Map". Data projected on the world map were semi-transparent in order to see the background map to know the difference between the past and present. User can see both maps on the page or can hide one by clicking on buttons on the web page. On the right side of the page description of the data has been given in Swedish (target people on this project are comfortable with Swedish language). Finally the biggest challenge of the project is to animate the layers in a series to show how the land has been raised and this was done by using the Giff animator tool. Layers were imported to the Giff animator in order 5000 BC to 1500 AD and produce animated Giff image. The animated image has placed in the server and displayed with HTML tags. The HTML script that has used to create the web page can be shown in **Script**.



Land Uplift Project

Uppland

Bildspel av paleogeografiska kartor mellan åren 5000 f. Kr. till år 500 e.Kr över Uppland.

Kartan omfattar ca. 140 * 130 km. Mellan 1000 f. Kr. och år 0 visas den successiva strandförskjutningen i intervall om 200 år.

Storleken av strandförskjutningen för varje tidpunkt har beräknats utifrån läge och ålder av både arkeologiska fornlämningar och sjösediment tagna från många platser i Uppland.

Kartorna utvisar med blå färgton den dåvarande kustlinjen samt lokala svackor som ligger under dåvarande havets nivå och som troligen var sjöytor.

Översiktskartan är intonad som bakgrund för orienteringsändamål.

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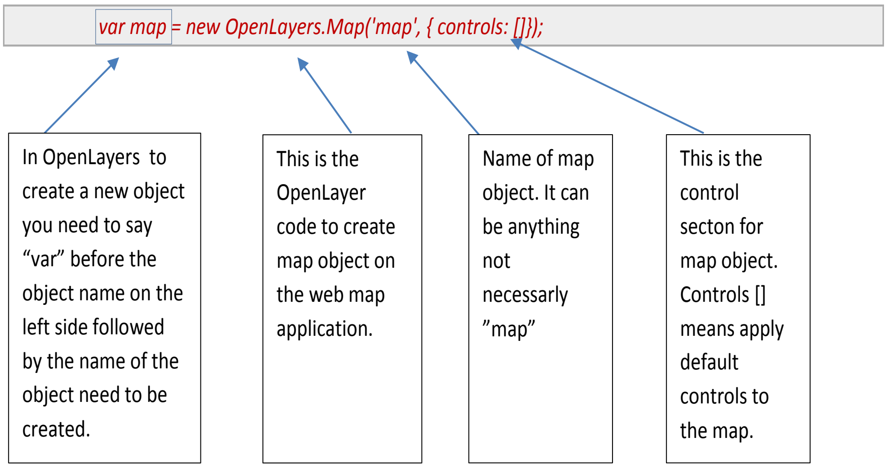
Figure 6. Screenshort of the designed web map application (Result)

Detail explanation of Script:

The web map application is designed by using HTML, CSS and Jquery. In this section a detailed explanation of the script will be given.

<div id="map" style="height:500px;width:500px;float:left;">

The above block tag will create the “Map Object “on the web application. Inside this “div” element Java scripting was written using OpenLayers library. When creating the map object it is required to define the map controls. There are two ways to define controls to the map object one way is to give basic default controls to the map object controls like zooming and panning around the map. The second way is to define user specific controls to the map, only controls that are defined will apply to the map object. In this project map object were given default controls in the beginning to make sure that it contains minimum controls and later specific controls were defined like “Scalebar”, “Panel”, “Layer”, “Mouse Position” etc. map object with default controls can be created like below.



```
var map = new OpenLayers.Map('map', { controls: []});
```

In OpenLayers to create a new object you need to say “var” before the object name on the left side followed by the name of the object need to be created.

This is the OpenLayer code to create map object on the web map application.

Name of map object. It can be anything not necessarly ”map”

This is the control secton for map object. Controls [] means apply default controls to the map.

Note: it is very important to keep an eye on comma, colon and apostpie in the script. They are very important and without them the script won’t work.

After the map object created layers need to be added to the map. There is no limit to the number, any number of vector data or raster data or even both together can be added to the map. Similar like creating the map object, layers follow the same rules as below. For better understanding the script was written in different rows.

var wms_layer_0_Kr = newOpenLayers.Layer.WMS

('0_Kr','http://130.237.175.39:8080/geoserver/wms/land_upplift',

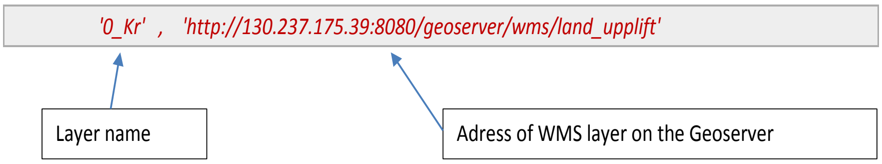
{layers: '0_Kr', transparent: "true", format: "image/png"}

,{maxExtent: new OpenLayers.Bounds(585000, 6600000, 740000, 6722500), maxResolution: 'auto',

projection:"EPSG:3006", units: "m"},{isBaseLayer: false},{visibility: true});

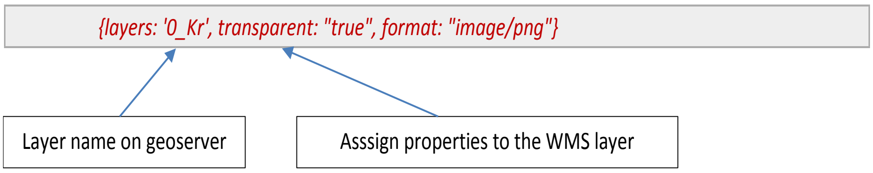
“var wms_layer_0_Kr” creates a new WMS layer “wms_layer_0_Kr”.

“newOpenLayers.Layer.WMS” defines that the object created will be a “WMS layer” that can be displayed on the background map. This is the Java script to add WMS layers on the map object on the web map application.



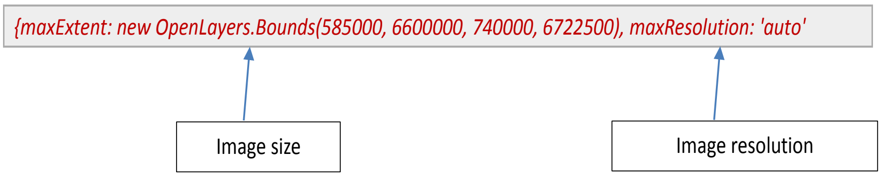
'0_Kr' , 'http://130.237.175.39:8080/geoserver/wms/land_upplift'

The layer name is the one that can be seen on the layer list on the map object. It is possible to give any kind of name to the layer depends on the user interest and the data type. Each layer on the geoserver has a specific address for easily identification and it is not allowed to have the same address for more than one layer.



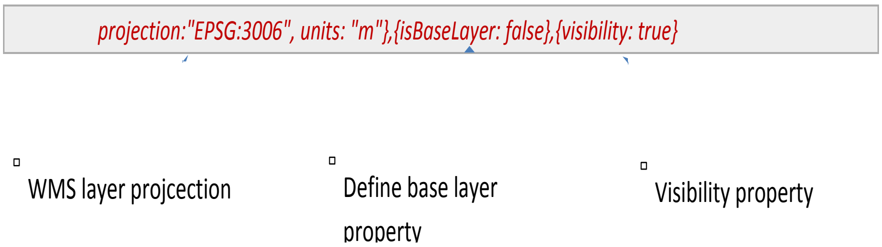
{layers: '0_Kr', transparent: "true", format: "image/png"}

When a WMS layer is imported to the goeserver it is necessary to give it a unique name. It is possible to assign different properties to the layer. “Transparent: true” means the WMS layer is allowed to make transparent if needed. And “format: image/png” defines that the layer superimposed on the map is a png image that is generated by the geoserver.



{maxExtent: new OpenLayers.Bounds(585000, 6600000, 740000, 6722500), maxResolution: 'auto'

“OpenLayer. Bounds” defines the position of the layer on the world map. The values will be obtained in geoserver in both “meters” and “degrees”. Values can be used in maps with different coordinate system. By setting the resolution of the map to “auto” makes it automatically adjust according to the zoom level on the map.



projection:"EPSG:3006", units: "m"},{isBaseLayer: false},{visibility: true}

It is not necessary to define the projection of the WMS layer but if needed It is possible to specify the projection system of the WMS layer.” isBaseLayer” property defines the layer time weather it is a baselayer or background layer on the map or overlay layer on top of baselayer. By setting “visibility:true” when the webpage open the layer will be seen on the map. It can also be set to “false” which restricts the WMS layer to show on the map automatically but can be seen by selecting on the layer list over the map object.

In the above way all the layers were created. Then all the layers need to be added to the map object. This can be done using the block script below:

map.addLayers([wms_layer_5000_fKr, wms_layer_4500_fKr, wms_layer_4000_fKr, wms_layer_3500_fKr, wms_layer_3000_fKr, wms_layer_2500_fKr, wms_layer_2000_fKr, wms_layer_1500_fKr, wms_layer_1000_fKr, wms_layer_500_fKr, wms_layer_0_Kr, wms_layer_500_eKr, wms_layer_1000_eKr, wms_layer_1500_eKr, wms_layer_Point_Data]);

“map.addLayers” will add the created WMS layers to the map object. After adding the WMS layers to the map object it is possible to create controls on the map for user interaction with the map. For example “scale” on the map can be created like below.

```
        var scalebar = new OpenLayers.Control.ScaleLine();
```

Tip: in the traditional desktop GIS tools top layer on the list will be visible on the map but in case of OpenLayers it doesn’t follow such rules. There is a way to define the layer order by defining a control to layer list as below.

```
        var layer = new OpenLayers.Control.LayerSwitcher({'ascending':false});

                map.addControl(layer);
```

by setting the ‘ascending:false’ the top layer on the layer list always appears on the map other layers will be added below it.

Conclusion:

The aim of this project is to investigate open source software tools that can be used to design a web map application that can be used by any institute or NGO to distribute their data over internet. The case study that was undertaken shows clearly that it is possible to share spatial data with minimum technical skills and low or no cost. In the case study the performance of the web map application was tested with raster and vector data to compare its performance. Raster data requires little more time to fetch data from the map server than vector data. Raster images used in the case study are high resolution and have large size (around 250 MB each layer) gives decent performance, which shows that the application can be used for sharing even high resolution satellite images. In the case study data was displayed on both Google Maps and as a map specifically for Swedish data using SWEREF99 TM projection. The reason for using Google Maps is its popularity worldwide. There are four different Google base maps: “Google Hybrid”, “Google Streets”, “Google Physical” and “Google Satellite”. User can select anyone in the list, for better understanding and if the layers are half transparent it is possible to see the background map though it. Data that needs to be projected on the Google Maps should be prepared in WGS 84 projection system.

On a Swedish specific map object, data that have a Swedish projection system can be superimposed. Data on both maps objects are pannable, zoomable and select/unselect on the layer list over the map object. The animation was done earlier at the department using the Gif animator tool. The animation provided on the web map application was taken from the department site http://ww2.ink.su.se/living_maps/.

For the specific users who want to superimpose their data on the map object in the application this can be done in two ways. Data can be sent to the Stockholm university department where data will be superimposed by them or the users need to install the geoserver software (open source) and run it on his/her own computer. After the successful installation of the geoserver data need to be imported into it. Users are able to run the web map application on their own server by adding their data to the map object.

Problems during project:

During the project the biggest problem that has faced is with Geoserver. The problem was related to extensive loading times for map layers on the page. The performance of the geoserver was compared with the existing geoserver on the other department in the university. After many tries the problem was detected to be data itself. A new set of data layers was produced and imported to geoserver and test the performance and after that it works fine. Another problem we have noticed is with Java Runtime Environment (JRE). In the project latest version of JRE was used version JRE 7 that created problems by giving high load on the server and degrades the performance of geoserver. To solve this problem JRE 6 version instead is used which works fine. Finally the whole project feels like very challenging as it related to IT technologies which makes little difficult to understand the tools and work on them.

Future work:

In the current web map application it is not possible to see the details of the data that are displayed on the map. It will be much better if the user can select any data on the map that display its attribute information. It will be more advanced application if there is possible to add data directly on the application instead of installing another geoserver or sending data to Stockholm university department.

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Appendix 1-Geoserver Instructions:

Note: Before installing the geoserver you have to install JRE on the server the reason for this is geoserver runs on the Java Runtime Environment (JRE). Without this geoserver will not work.

Geoserver can be installed on a physical server or as a virtual server. Geoserver is used to store layers on the server in order to make them available on the internet. Here are instructions for installing geoserver on a standalone machine.

1. Download the geoserver application from their website (www.geoserver.org). You need to select the latest version which will usually be on the top of the list.
2. After downloading, follow the instructions for installation.
3. During the installation you need to select the type of installation as “Install as service” which makes it run on the server.
4. Geoserver runs default on port 8080. It is possible to change the port according to the user requirement. It is important to know that two geoserver applications cannot run on the same port, they must run on different ports.
5. Default credentials for geoserver are “admin” and “geoserver”. It is highly recommended to change the password for the reason to avoid others to login and change or delete the data.
6. After successful installation, geoserver is ready to use.

Web administration interface:

This is the place where you will do the entire configuration for geoserver including importing data, editing layers, delete layers etc. This web administration can be accessed via a web page which is by default “localhost: <port>/geoserver/web”. The port number can vary according to the user need. You need to login with the credentials to access the administration page. After successful login to the page you will see different sections on the left side of the page which will be briefly described below.

Server:

In this section there will find information about the configuration tools for geoserver, contact information for the public in a WMS capability document and importantly this section will use for debug the server problems.

Data:

Here you have the possibility to add data to the server. First you need to create a work space to store the data. In case of large data it will be very useful to have a separate workspace for different data. In geoserver there is a possibility to store three different types of Geo data, vector, raster and WMS. There is also a possibility to connect PostGIS database to geoserver. In this project we will be discussing extensively about vector and raster type data and more specifically in vector type our focus will be importing shape files. There is a specific procedure to import data into the geoserver which will be described below.

1. You need to create a workspace for your data. Give it a suitable name which should make sense. It is recommended to separate the data by storing them in separate workspace to avoid confusion in the longtime.
2. Data will be imported into geoserver by creating a store. A store can be a vector, raster or WMS.

3. After adding the data it is possible to preview the data on a map using the “Layer preview” option. To do that go to layer preview on the list of the lawyers find your layer and press on OpenLayers to see it on the map or you can download KML format of the data to view it on Google Earth.

Layer group:

This is a very useful feature that can help to combine different layers in the geoserver. Here you can create a single layer by selecting multiple layers that already exist in the geoserver. The important thing to know is that you can only combine different layers that are in the same workspace. It is not possible to combine layers in different workspaces.

Services:

Data presentation in geoserver can be served to the web in three different types WCS, WFS and WMS. Web coverage service (WCS) is the data type that provides available information in a specific format that can be used in the scientific modeling. Web feature service (WFS) is a service that renders data including feature geometry and its attributes. This type of data supports data query on the web. This WFS service is available for vector data. Finally and most common data service that are widely used is a web map service (WMS) which provides the data in map tiles. This service is typically for raster data.

Tile catching:

As we discuss above geoserver provides raster data in the form of map tiles. When the user interact with zooming or panning around the map server needs to generate the tiles. In case of large raster data, the server takes a long time to render image into the web page which makes the user inconvenient, to reduce this rendering time it is possible to catch the map tiles and store in geoserver before the user interact with the map. By doing this server does not have to generate tiles instead it will use the already generated tiles that are stored in “Tiles Layer” section.

Map projections:

It is possible to use different projections for different countries. This feature will help the user to display his data on specific projection. It is possible to create EPSG projections and use that projection when tiling the layer.