# 6.2 Getting Data For Assessing Ecosystem Services

You have learned about different ecosystem assessment tools available in InVEST. We will now go in depth with water yield to assess the hydropower production from reservoirs service.

Hydropower accounts for 20% of worldwide energy production, most of which is generated by reservoir systems. InVEST estimates the annual average quantity and value of hydropower produced by reservoirs, and identifies how much water yield or value each part of the landscape contributes annually to hydropower production.

The model has three components: water yield, water consumption, and hydropower valuation. The first two components use data on average annual precipitation, annual reference evapotranspiration and a correction factor for vegetation type, root restricting layer depth, plant available water content, land use and land cover, root depth, elevation, saturated hydraulic conductivity, and consumptive water use. The valuation model uses data on hydropower market value and production costs, the remaining lifetime of the reservoir, and a discount rate.

Upon completion of this exercise, participants should be able to:

A) Install InVEST package and choose a specific ecosystem services model
B) Identify the input data needed to run the InVEST model: Water Yield
C) Define a specific location for a case study
D) Find this data on the Internet and download it

## A) Install InVEST and choose your model

First, we search for the InVEST model on the NatCap website at : http://www.naturalcapitalproject.org/invest

Once identified, you can download the latest version of the package **without** the tutorial data. The InVEST package is a standalone software that will run on Windows or Mac operating systems.

## B) Identify the geospatial data inputs

As described in the InVEST User manual under the Water Yield model the data needed for this model (http://data.naturalcapitalproject.org/nightly-build/invest-users-guide/html) is presented below:

1. **Precipitation (required).** A geographic information System (GIS) raster dataset with a non-zero value for average annual precipitation for each cell. The precipitation values should be in millimeters.

2. **Average Annual Reference Evapotranspiration (required).** A GIS raster dataset, with an annual average evapotranspiration value for each cell. Reference evapotranspiration is the potential loss of water from soil by both evaporation from

the soil and transpiration by healthy alfalfa (or grass) if sufficient water is available. The reference evapotranspiration values should be in millimeters.

3. **Root restricting layer depth (required).** A GIS raster dataset with an average root restricting layer depth value for each cell. Root restricting layer depth is the soil depth at which root penetration is strongly inhibited because of physical or chemical characteristics. The root restricting layer depth values should be in millimeters.

4. **Plant Available Water Content (required).** A GIS raster dataset with a plant available water content value for each cell. Plant Available Water Content fraction (PAWC) is the fraction of water that can be stored in the soil profile that is available for plants' use. PAWC is a fraction from 0 to 1.

5. **Land use/land cover (required).** A GIS raster dataset, with an LULC code for each cell. The LULC code should be an integer.

6. **Watersheds (required).** A shapefile, with one polygon per watershed. This is a layer of watersheds such that each watershed contributes to a point of interest where hydropower production will be analyzed.

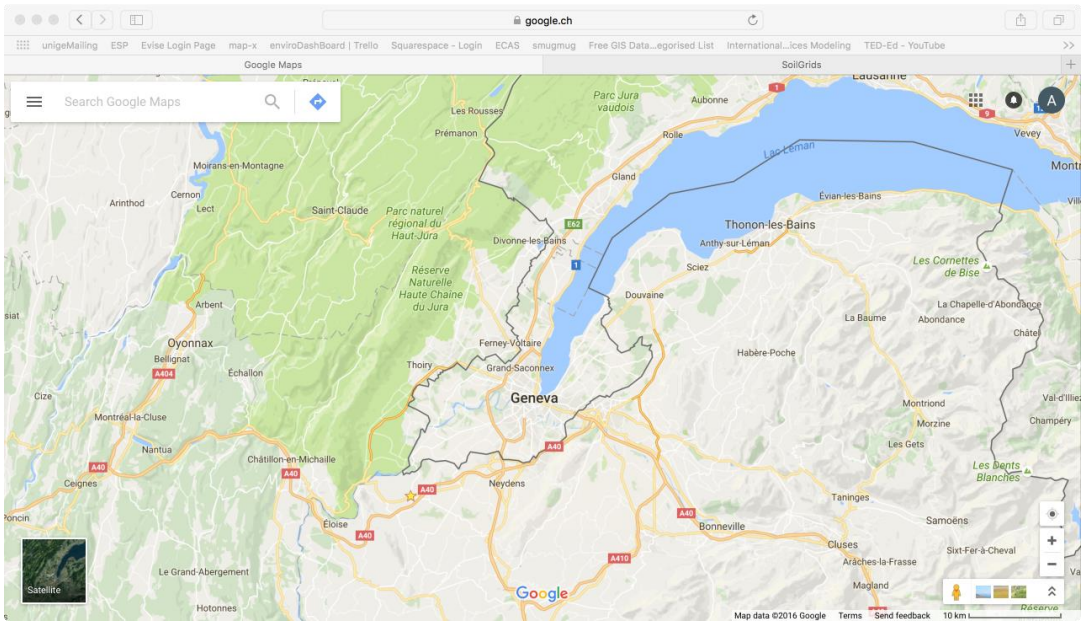
7. **Subwatersheds (required).** A shapefile, with one polygon per subwatershed within the main watersheds specified in the Watersheds shapefile.

The standard GIS raster file formats should be used (e.g., ESRI GRID, TIF or IMG) or vector formats (ESRI shapefiles). The necessary GIS files can be named anything, but no spaces in the name and less than 13 characters if an ESRI GRID. If a TIF or IMG, the name may be longer. We will learn how to pre-process this data in the next exercise (part 6.3). More details on the data needed for the Water Yield model can be found at: http://data.naturalcapitalproject.org/nightly-build/invest-users-guide/html/reservoirhydropowerproduction.html#data-needs

## C) Decide on case study location

Choose a location where you would like to assess water yield with InVEST. We have chosen our hometown of Geneva in Switzerland.

We first need to find the geographic coordinates for the extent of the area of interest (AOI). We suggest using Google Map for this with http://maps.google.com, and clicking on the lower left and upper right corners of your AOI, and then writing down the coordinates.




In the case of Geneva it could be:
Lower left corner: 46.109818 N, 5.940873 E
Upper right corner: 46.444043 N, 6.421520 E

These coordinates will be useful to select our input data in the next steps and to clip the data to the useful extent if needed.

## D) Navigate to websites and download your data

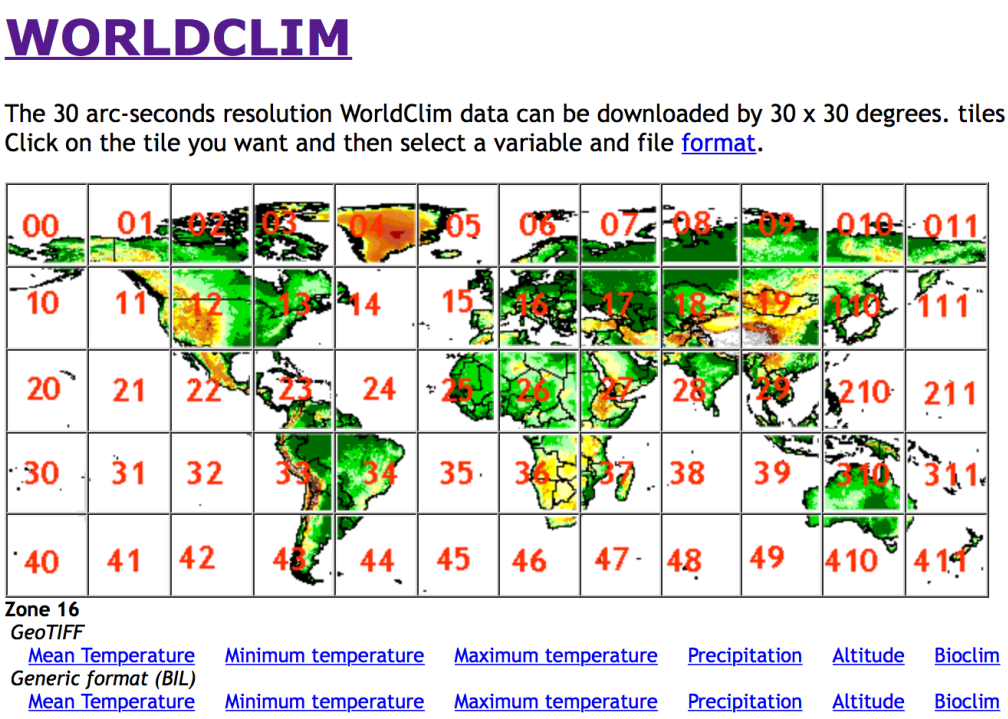
The following are websites where you will be able to find the necessary input data for any place in the World.

Once you have downloaded the required files you will have to pre-process them in the open source QGIS software in the next exercise. Each dataset must be in the right format with the correct spatial extent and the same geographic projection.

Details on the data requirements are available at:

http://data.naturalcapitalproject.org/nightly-build/invest-users-guide/html/reservoirhydropowerproduction.html#appendix-a-data-sources

1. Global annual precipitation data can be obtained from the WorldClim dataset at 1km resolution: http://www.worldclim.org/tiles.php. For Geneva we selected the tile 16 and downloaded Precipitation in Geotiff format.




Alternatively select your tile from the following table:

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 010 | 011 |
| 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 110 | 111 |
| 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 210 | 211 |
| 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 310 | 311 |
| 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 410 | 411 |

Citation: Fick, S.E. and R.J. Hijmans, 2017. Worldclim 2: New 1-km spatial resolution climate surfaces for global land areas. International Journal of Climatology.

2. Global annual reference evapotranspiration may be obtained from the CGIAR CSI dataset (based on WorldClim data): http://www.cgiar-csi.org/data/global-aridity-and-pet-database. The Annual Global-PET dataset is provided for non-commercial use in standard ARC/INFO Grid format, at 30 arc seconds (~ 1km at equator), to support studies contributing to sustainable development, biodiversity and environmental conservation, poverty alleviation, and adaption to climate change globally, and in particular in developing countries.

Global PET and Aridity Index de Ivy Romero (IFPRI)

| Nom | Taille |
|---|---|
| ET_SolRad.rar | 14,12 Mo |
| Global Aridity - Annual.zip | 271,69 Mo |
| Global PET - Annual.zip | 164,13 Mo |
| Global PET - Monthly.zip | 622,55 Mo |

Citation: *Zomer RJ, Bossio DA, Trabucco A, Yuanjie L, Gupta DC & Singh VP, 2007. Trees and Water: Smallholder Agroforestry on Irrigated Lands in Northern India. Colombo, Sri Lanka: International Water Management Institute. pp 45. (IWMI Research Report 122).*

3. Depth to root restricting layer can be derived from The FAO global soil data in their Harmonized World Soil Database (HWSD): http://www.iiasa.ac.at/Research/LUC/External-World-soil-database/HTML/. The HWSD is a 30 arc-second raster database with over 16000 different soil mapping units that combines existing regional and national updates of soil information worldwide (SOTER, ESD, Soil Map of China, WISE) with the information contained within the 1:5'000'000 scale FAO-UNESCO Soil Map of the World.


**Harmonized World Soil Database**

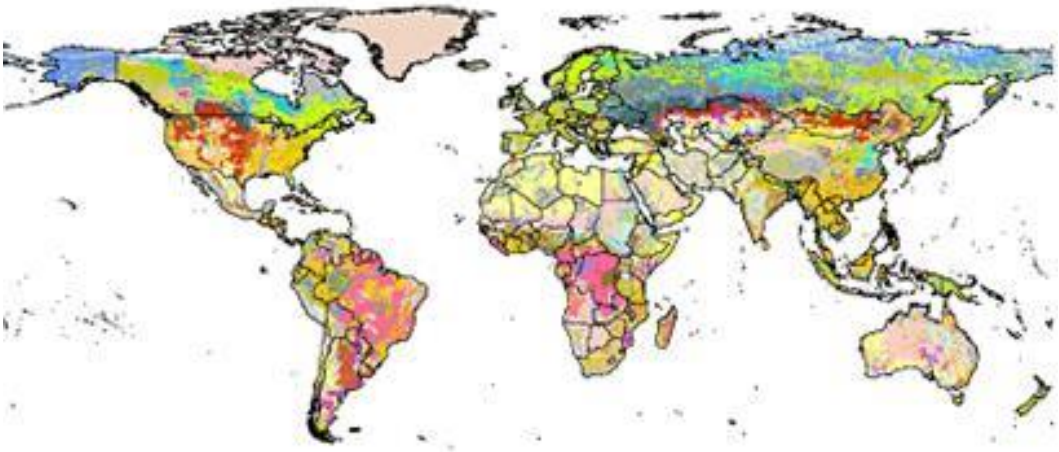
## HWSD Database

**HWSD Home**
Documentation
Download Viewer and Data
Download Data Only

**Supplementary data**
Terrain Data Description
Terrain Data
Land Cover Data Description
Land Cover Data
Soil Qualities Description
Soil Quality Data

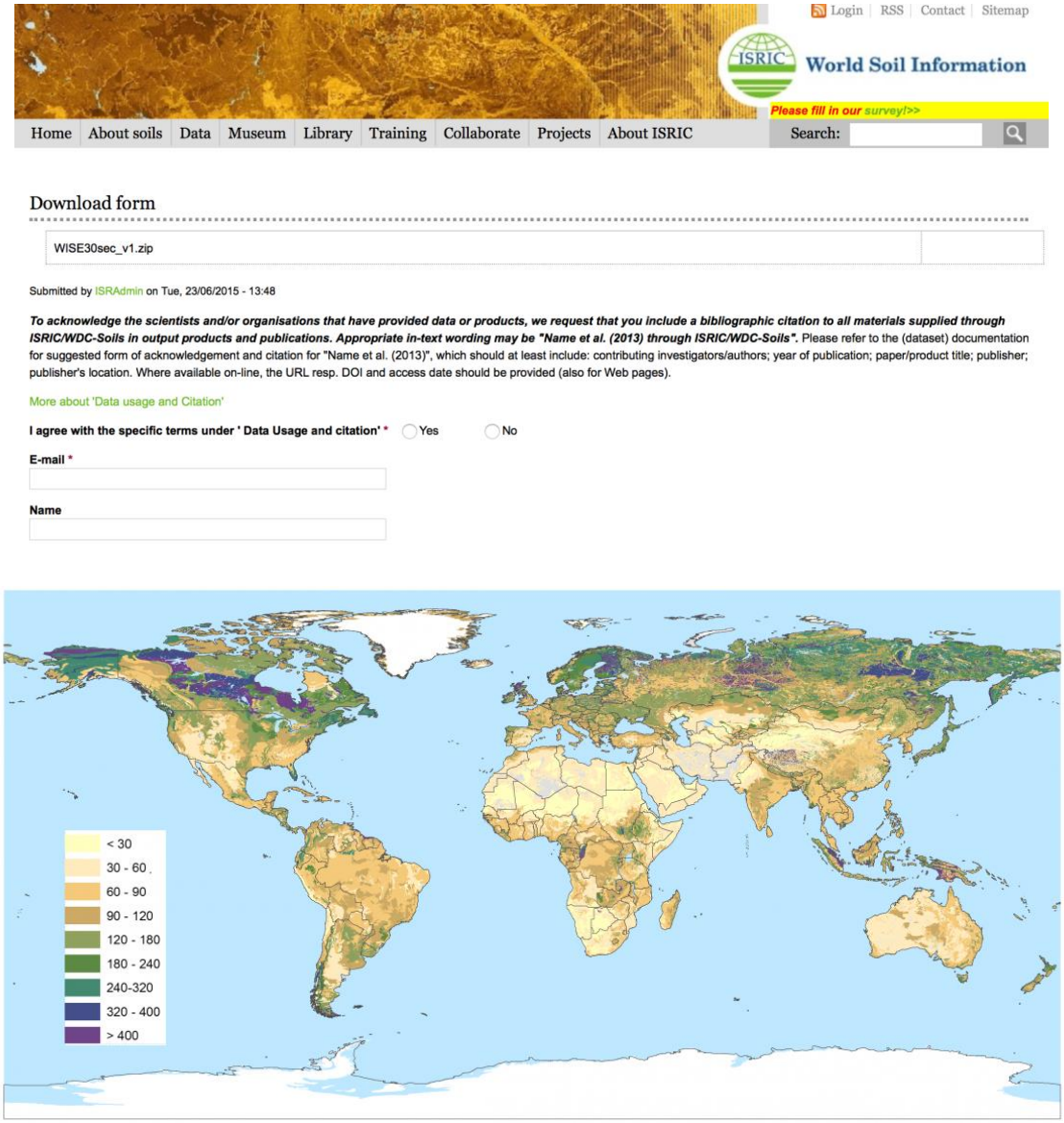
The data available on this page is automatically installed with the HWSD Viewer, in a subdirectory called "Data" of the installation directory. The data is duplicated here for those who do not wish to install the viewer, or already have the viewer and only want to update or repair the database. If updates to the database are necessary and created, they will be documented here.

| DATA FILES | DESCRIPTION | DATE |
|---|---|---|
| HWSD_RASTER.zip | Raster soil map in .bil file format | 07.03.12 |
| HWSD.mdb | Soil Attribute Database (MS Access) | 07.03.12 |
| HWSD_META.mdb | Soil Attribute Database metadata | 07.03.12 |



*Citation: FAO/IIASA/ISRIC/ISSCAS/JRC, 2012. Harmonized World Soil Database (version 1.21). FAO, Rome, Italy and IIASA, Laxenburg, Austria.*

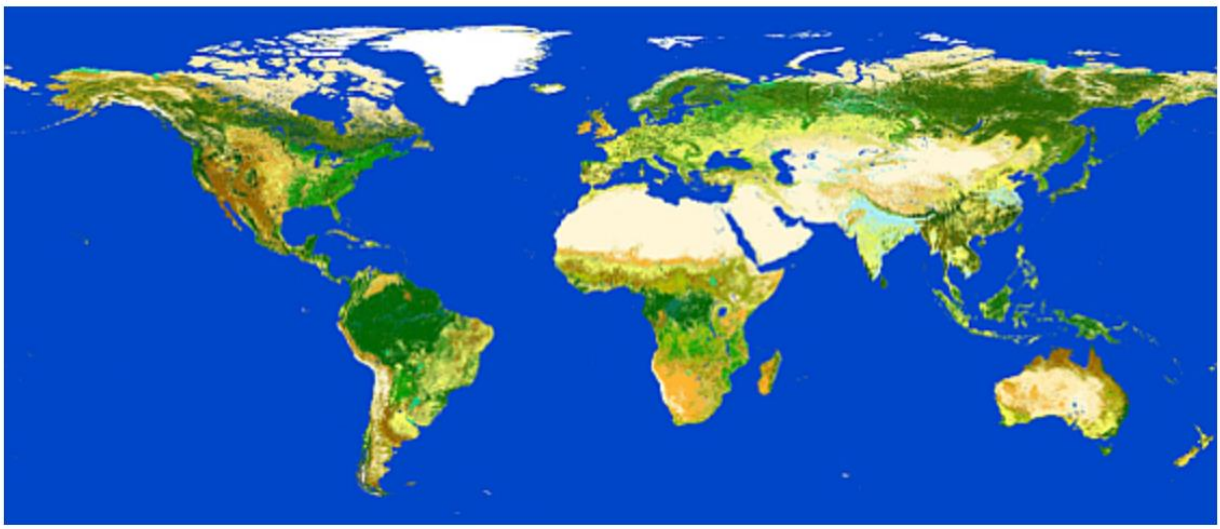
4. Plant available water fraction can be found in the ISRIC Soil Information system at: http://data.isric.org/geonetwork/srv/eng/catalog.search#/metadata/82f3d6b0-a045-4fe2-b960-6d05bc1f37c0. This harmonized dataset of derived soil properties for the World was created using: (1) the soil distribution shown on the 1:5 million scale FAO-Unesco Soil Map of the World (DSMW 1995) and (2) soil parameter estimates derived from ISRIC's global WISE soil profile database. The dataset considers 19 soil variables that are commonly required for agro-ecological zoning, land evaluation, crop growth simulation, modeling of soil gaseous emissions, and analyses of global environmental change.




*Citation: Batjes NH 2016. Harmonised soil property values for broad-scale modelling (WISE30sec) with estimates of global soil carbon stocks. Geoderma 2016(**269**), 61-68 (doi: 10.1016/j.geoderma.2016.01.034), with supplemental information*

5. Land use: Global land use data for 2009 is available at 300m resolution from: the European Space Agency: http://due.esrin.esa.int/page_globcover.php. GlobCover is an ESA initiative that began in 2005 in partnership with JRC, EEA, FAO, UNEP, GOFC-GOLD and IGBP. The aim of the project was to develop a service capable of delivering global composites and land cover maps using as input observations from the 300m MERIS sensor on board the ENVISAT satellite mission.

**Welcome to the European Space Agency GlobCover Portal**

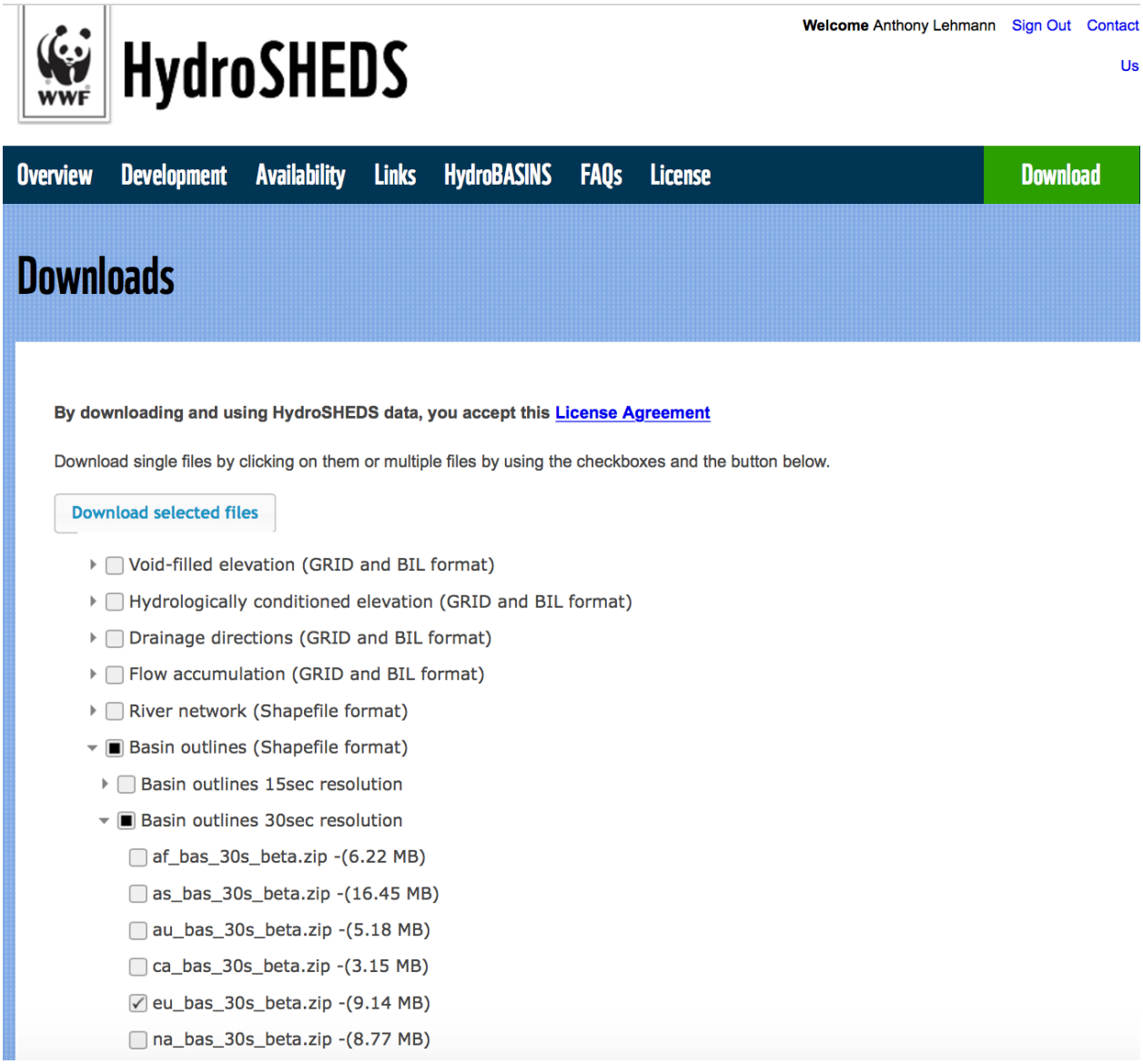


**GlobCover Land Cover Maps**
Use the links below to download the map.

GlobCover 2009 (Global Land Cover Map) **RELEASED ON 21st December 2010**
Here you can find:
1) The zip file Globcover2009_V2.3_Global_.zip (information can be found in the Globcover2009_ReadMe.pdf which is included),
2) Updated Product Description and Validation Report (files/GLOBCOVER2009_Validation_Report_2.2.pdf)
3) A coloured version of the map in GeoTIFF format (CLICK HERE)

*Citation: Arino O., J. Ramos, V. Kalogirou, P. Defourny and F. Achard. GlobCover 2009. ESA Living Planet Symposium, 27 June . 2 July 2010, Bergen, Norway*

6. Watersheds and subwatersheds: http://hydrosheds.org/page/hydrobasins. HydroBASINS is a series of polygon layers that depict watershed boundaries and sub-basin delineations at a global scale. The goal of this product is to provide a seamless global coverage of consistently sized and hierarchically nested sub-basins at different scales (from tens to millions of square kilometers), supported by a coding scheme that allows for analysis of watershed topology such as up- and downstream connectivity. The HydroBASINS product has been developed on behalf of World Wildlife Fund US (WWF), with support and in collaboration with the EU BioFresh project, Berlin, Germany; the International Union for Conservation of Nature (IUCN), Cambridge, UK; and McGill University, Montreal, Canada.




*Citation : Lehner, B., Grill G. (2013): Global river hydrography and network routing: baseline data and new approaches to study the world's large river systems. Hydrological Processes, 27(15): 2171–2186. Data is available at www.hydrosheds.org.*