

Open Data Sources & Software for Water Resources

One Week Customized Course on
Remote Sensing & GIS Technology

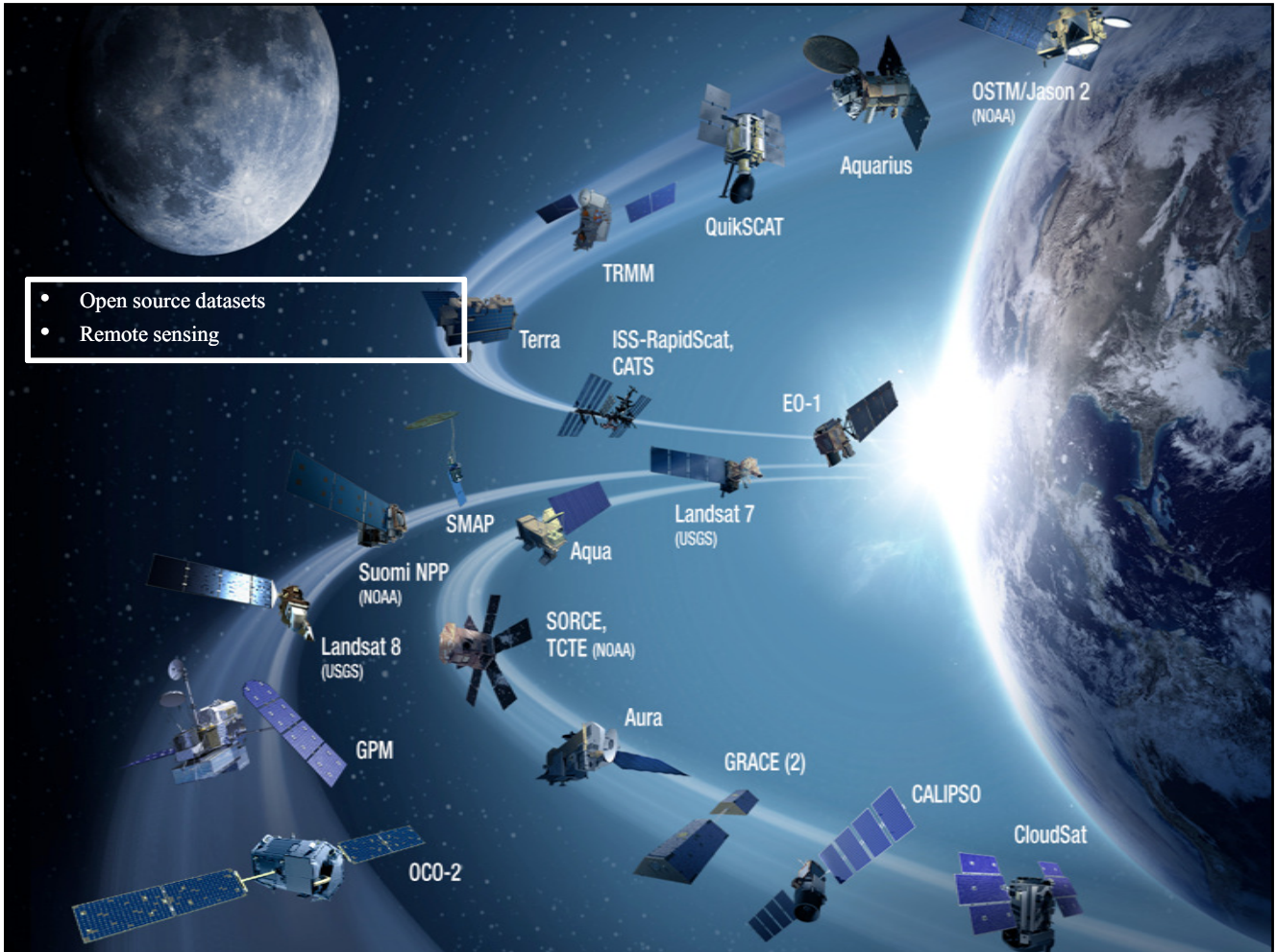
Saksham Joshi

WRAD/WRG/RSAA
National Remote Sensing Centre
Hyderabad - 500037, India
saksham_joshi@nrsc.gov.in
040-23884547

04th February 2021



nrsc



Global Datasets

Global Datasets

Precipitation

- TRMM
- CHIRPS
- GPM
- CMORPH
- PERSIANN
- CPC
- ARC
- GPCC

Soil Moisture

- GLDAS
- ASCAT
- SMAP

Evapotranspiration

- MOD16
- GLEAM
- ET-Monitor
- LANDSAF
- METRIC/EEFLUX
- ALEXI
- CMRSET
- SEBS
- SSEBop

MODIS

- LAI – MOD15
- GPP – MOD17
- NPP – MOD17

Land Use Land Cover

- NRC-250k LULC
- GLOBCOVER
- IWMI
- GMIA
- MICRA
- WDPA
- JRC
- GRAND
- MODIS
- WORLD POP
- GLOBAL SURFACE WATER

Others

- Grey Water Footprint
- Environmental Water Flow
- Elevation – HydroSHEDS
- GRACE

Global Datasets

**Glacier & Snow
Monitoring**

- Mountain Geoportal (ICIMOD)
- Mountain Geoportal (ICIMOD)
- GLIMS Glacier Viewer (NSIDC)
- Swiss GMN
- Arctic SDI Geoportal

DEM

- SRTM
- ASTER
- CARTOsat
- GTOPO

**Irrigation
Informatics**

- Water Watch
- CIMIS
- WaterNSW
- IWMI
- DEWS
- Global surface water explorer

Others

- National water information system :Web Interface
- AQUASTAT
- Giovanni
- Environmental Data Explorer
- Joint Research Centre
- Water Portal
- LAADS DAAC
- DIVA-GIS

Global Datasets

Precipitation

- TRMM
- CHIRPS
- GPM
- CMORPH
- PERSIANN
- CPC
- ARC
- GPCC

Soil Moisture

- GLDAS
- ASCAT
- SMAP

Precipitation: TRMM

- Tropical Rainfall Measuring Mission (TRMM)
- NASA & JAXA mission
- Spatial resolution: 0.25° ~27 km
- Temporal resolution: 3-hourly, daily, monthly
- From 1998 to April 2015

- Instruments
 - Precipitation radar
 - Microwave imager
 - Visible and Infrared Scanner (VIRS)
 - Lightning Image Sensor (LIS)

- Elevation – HydroSHEDS
- GRACE

Source: <http://trmm.gsfc.nasa.gov/>

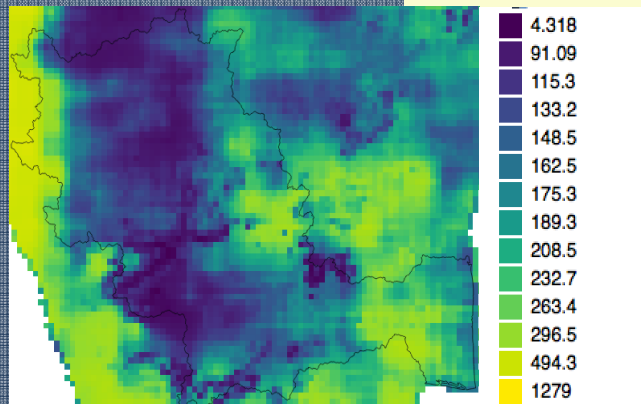
Global Datasets

Precipitation

- TRMM
- **CHIRPS**
- GPM
- CMORPH
- PERSIANN
- CPC
- ARC
- GPCC

Precipitation: CHIRPS

- Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS)
- Funded by USGS and USAID
- Spatial Extent: -180, 180, -50, 50°
- Temporal resolution: daily, monthly
- Initial date: 1981
- Spatial Resolution: 0.25°



- Environmental water flow
- Elevation – HydroSHEDS
- GRACE

Source: <http://chg.geog.ucsb.edu/data/chirps/>
<http://www.nature.com/articles/sdata201566>

Global Datasets

Precipitation

- TRMM
- CHIRPS
- **GPM**
- CMORPH
- PERSIANN
- CPC
- ARC
- GPCC

Precipitation: GPM

- Global Precipitation Measurement (GPM)
- NASA & JAXA Mission
- Spatial resolution: 0.1° ~11 km
- Temporal resolution: 30min
- Initial date: March 2015
- Instruments
 - Dual - Frequency Precipitation radar (DPR) x2
 - Microwave imager

Soil Moisture

- GLDAS
- ASCAT
- SMAP

- NPP – MOD17

- Environmental Water Flow
- Elevation – HydroSHEDS
- GRACE

Source: http://www.nasa.gov/mission_pages/GPM/main/index.html

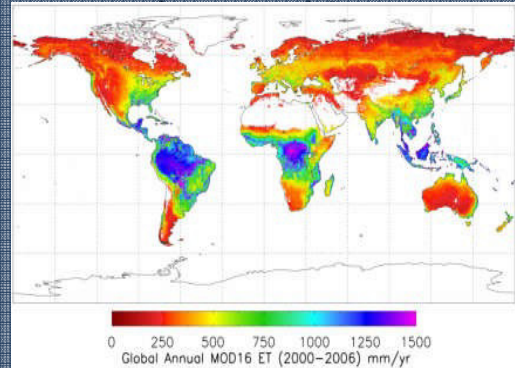
Global Datasets

Precipitation

- TRMM
- CHIRPS
- GPM
- CMORPH
- PERSIANN
- CPC
- ARC
- GPCC

Evapotranspiration

- MOD16
- GLEAM
- ET-Monitor
- LANDSAF
- METRIC/EEFLUX
- ALEXI
- CMRSET
- SEBS
- SSEBop



- MODIS
- WORLD POP
- GLOBAL SURFACE WATER

Others

- Grey Water Footprint
- Environmental Water Flow
- Elevation – HydroSHEDS
- GRACE

Evapotranspiration: MOD16

- Moderate Resolution Imaging Spectroradiometer (MODIS)
- Two satellites / 36 bands
- Spatial Resolution: 1km
- Temporal resolution: 8-day, monthly
- Initial date: 2000

Source: <http://www.ntsug.umd.edu/project/mod16>
<http://modis.gsfc.nasa.gov/data/dataproduct/>

Global Datasets

Precipitation

- TRMM
- CHIRPS
- GPM
- CMORPH
- PERSIANN
- CPC
- ARC
- GPCC

Evapotranspiration

- MOD16
- **GLEAM**
- ET-Monitor
- LANDSAF
- METRIC/EEFLUX
- ALEXI
- CMRSET
- SEBS
- SSEBop

Evapotranspiration: GLEAM

- Global Land Evaporation Amsterdam Model (GLEAM)
- VU - ESA
- Global, 0.25° ~27km
- Temporal resolution: daily, monthly
- From 2003 to 2012

Rainfall Interception Model

Gash analytical model driven by observed rainfall

Potential Evaporation Module

Priestley and Taylor eq. driven by satellite-observed meteorology

$$E = E_p \times S + E_i$$

Stress Module

Semi-empirical relationship to root-zone soil moisture and VOD

Soil Module

Multi-layer model driven by satellite precipitation and surface soil moisture

Source: <http://www.gleam.eu/>

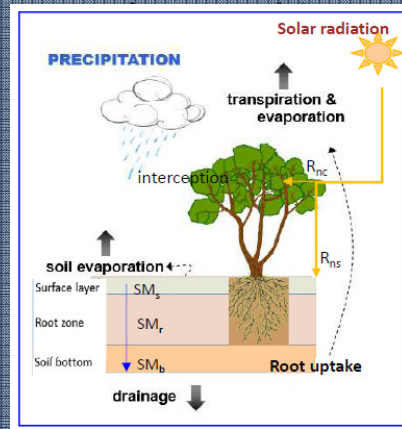
Global Datasets

Precipitation

- TRMM
- CHIRPS
- GPM
- CMORPH
- PERSIANN
- CPC
- ARC
- GPCC

Evapotranspiration

- MOD16
- GLEAM
- **ET-Monitor**
- LANDSAF
- METRIC/EEFLUX
- ALEXI
- CMRSET
- SEBS
- SSEBop



- GLOBAL SURFACE WATER

Others

- Grey Water Footprint
- Environmental Water Flow
- Elevation – HydroSHEDS
- GRACE

Evapotranspiration: ET - Monitor

- A process based model implementing processes of energy balance, plant physiology and soil water balance developed by EOWater Lab at RADL.

Global Datasets

Precipitation

- TRMM
- CHIRPS
- GPM
- CMORPH
- PERSIANN
- CPC
- ARC
- GPCC

Evapotranspiration

- MOD16
- GLEAM
- ET-Monitor
- LANDSAF
- METRIC/EEFLUX
- **ALEXI**
- CMRSET
- SEBS
- SSEBop

Land Use Land Cover

- NRC-250k LULC
- GLOBCOVER
- IWMI
- GMIA
- MICRA
- WDPA
- JRC
- GRAND
- MODIS
- WORLD POP
- GLOBAL SURFACE WATER

Evapotranspiration: ALEXI

- Atmosphere Land Exchange Inverse (ALEXI)
- $EF = \text{Latent Heat Flux} / (R_n - G)$
- Spatial Resolution – 0.027 degree ~ (3 km)
- Daily
- Data availability - 2007-2012

Others

Grey Water Footprint
 Environmental Water Flow
 Elevation – HydroSHEDS
 GRACE

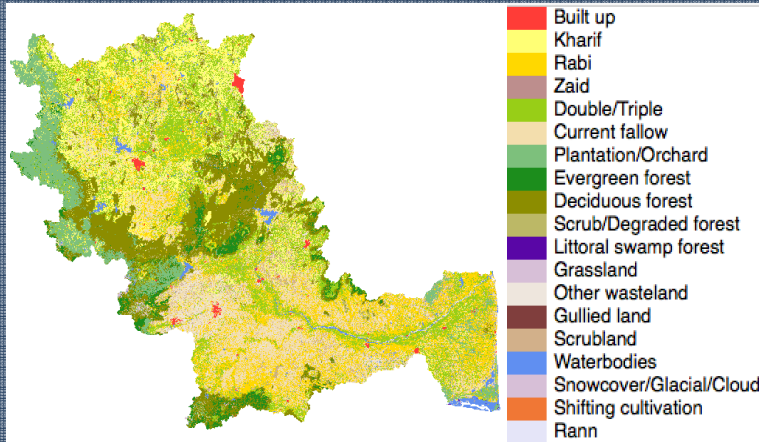
Global Datasets

Land Use Land Cover: NRC – 250k

- NRC – land cover
- Spatial resolution - 56 m
- Data Availability - 2004-05 to 2015-16
- ResourceSAT 2 – Advanced Wide Field Scanner (AWiFS)

• GRCC

• CIMRSET



Land Use Land Cover

- **NRC-250k LULC**
- GLOBCOVER
- IWMI
- GMIA
- MIRCA
- WDPA
- JRC
- GRAND
- MODIS
- WORLD POP
- GLOBAL SURFACE WATER

Others

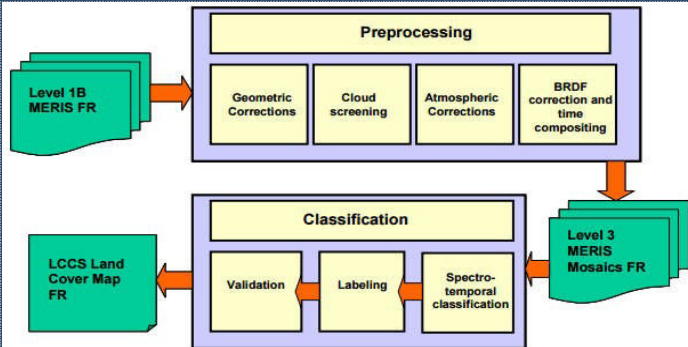
- Grey Water Footprint
- Environmental Water Flow
- Elevation – HydroSHEDS
- GRACE

Source: <http://bhuvan.nrsc.gov.in/>

Global Datasets

Land Use Land Cover: GLOBCOVER

- ESA – land cover
- Spatial resolution -- 300m
- Two periods -- December 2004 – June 2006
-- January – December 2009
- Meris mission
 - Land surface reflectance
 - Classification



Land Use Land Cover

- NRC-250k LULC
- **GLOBCOVER**
- IWMI
- GMIA
- MIRCA
- WDPA
- JRC
- GRAND
- MODIS
- WORLD POP
- GLOBAL SURFACE WATER

Others

- Grey Water Footprint
- Environmental Water Flow
- Elevation – HydroSHEDS
- GRACE

Source: http://due.esrin.esa.int/page_globcover.php

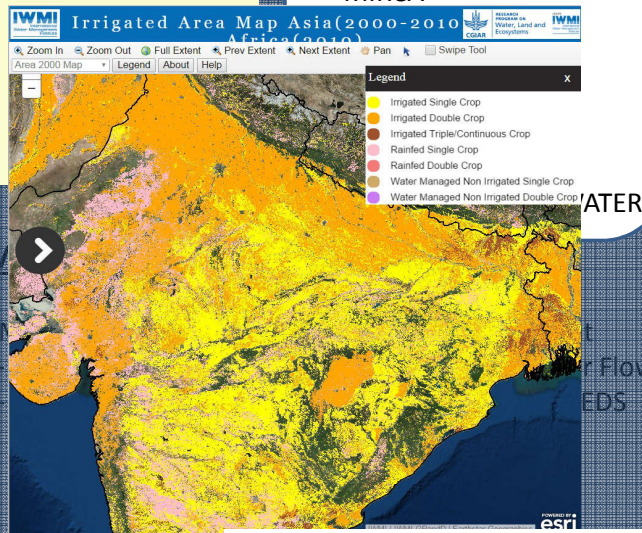
Global Datasets

Land Use Land Cover: IWMI

- International Water Management Institute (IWMI)
- Agricultural Areas
 - Irrigated
 - Rainfed
- Spatial extent: Africa and Asia
- Period: 2000
- Spatial resolution: 250m
- Based on MODIS NDVI data

Land Use Land Cover

- NRC-250k LULC
- GLOBCOVER
- IWMI
- GMIA
- MIRCA



Soil Moisture

- GLDAS
- ASCAT
- SMAP

- LAI - M
- GPP - M
- NPP - M

Source: http://waterdata.iwmi.org/applications/irri_area/

Global Datasets

Land Use Land Cover: GMIA

- Global Map of Irrigated Areas
 - area equipped for irrigation with surface water
 - area equipped for irrigation with groundwater
 - area equipped for total irrigation
- It is based on statistical data from various sources.

Land Use Land Cover

- NRC-250k LULC
- GLOBCOVER
- IWMI
- **GMIA**
- MIRCA
- WDPA
- JRC
- GRAND
- MODIS
- WORLD POP
- GLOBAL SURFACE WATER

Others

- GLDAS
- ASCAT
- SMAP
- LAI – MOD15
- GPP – MOD17
- NPP – MOD17
- Grey Water Footprint
- Environmental Water Flow
- Elevation – HydroSHEDS
- GRACE

Global Datasets

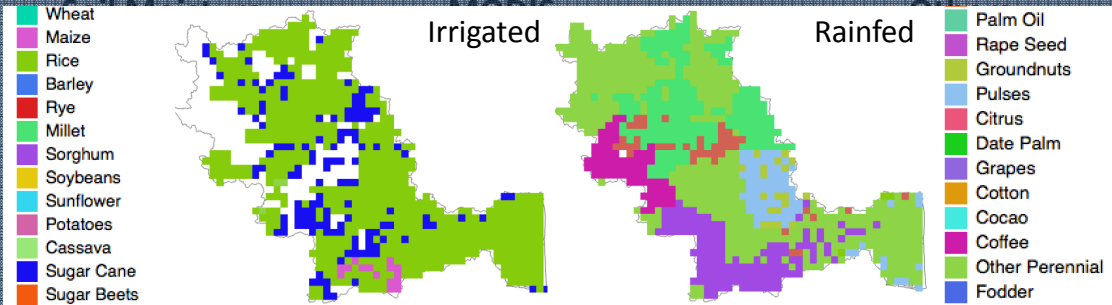
Land Use Land Cover: MIRCA

- Monthly growing area grids for 26 Dominant crop classes
 - Irrigated
 - Rainfed
- Spatial resolution - 10 km

- SEBS
- SSEBop

Land Use Land Cover

- NRC-250k LULC
- GLOBCOVER
- IWMI
- GMIA
- **MIRCA**
- WDPA
- JRC
- GRAND
- MODIS
- WORLD POP
- GLOBAL SURFACE WATER



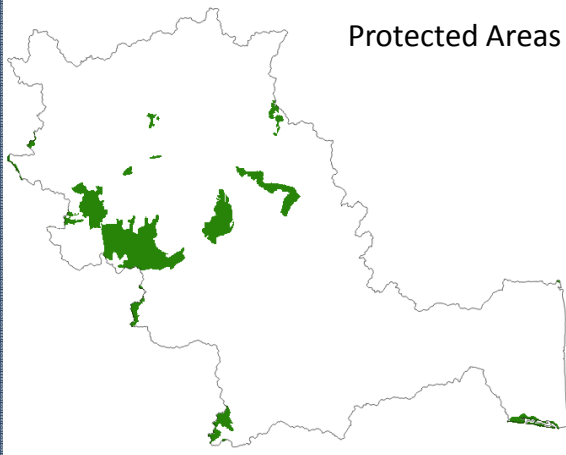
Global Datasets

Land Use Land Cover: WDPA

- World Database on Protected Areas
- Terrestrial and Marine protected areas
- Recognised as major tools in conserving species and ecosystem.

- ARC
- GPPC

- ALEXI
- CMRSET



Land Use Land Cover

- NRC-250k LULC
- GLOBCOVER
- IWMI
- GMIA
- MICRA
- **WDPA**
- JRC
- GRAND
- MODIS
- WORLD POP
- GLOBAL SURFACE WATER

Others

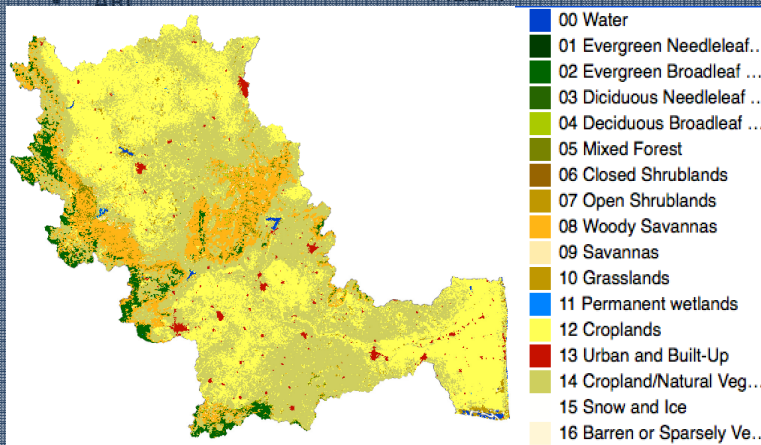
- Grey Water Footprint
- Environmental Water Flow
- Elevation – HydroSHEDS
- GRACE

Source: <https://www.iucn.org/theme/protected-areas>

Global Datasets

Land Use Land Cover: MODIS

- MCD12Q1
- Spatial resolution – 500 mtrs
- Temporal Coverage – 2001 -2013
- Total Classes – 17



Land Use Land Cover

- NRC-250k LULC
- GLOBCOVER
- IWMI
- GMIA
- MICRA
- WDPA
- JRC
- GRAND
- **MODIS**
- WORLD POP
- GLOBAL SURFACE WATER

Others

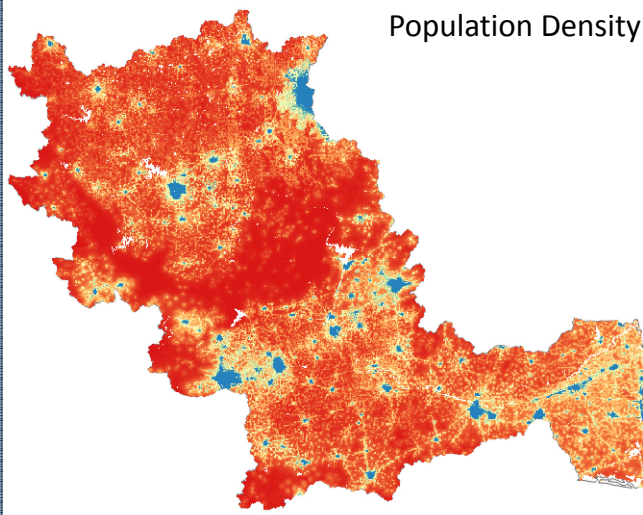
- Grey Water Footprint
- Environmental Water Flow
- Elevation – HydroSHEDS
- GRACE

Source : https://lpdaac.usgs.gov/dataset_discovery/modis/modis_products_table/mcd12q1

Global Datasets

Land Use Land Cover: World Population

- Random Forest Model
- Stevens, et al. (2015)
- Population density per Ha



Land Use Land Cover

- NRC-250k LULC
- GLOBCOVER
- IWMI
- GMIA
- MICRA
- WDPA
- JRC
- GRAND
- MODIS
- **WORLD POP**
- GLOBAL SURFACE WATER

Others

- Grey Water Footprint
- Environmental Water Flow
- Elevation – HydroSHEDS
- GRACE

Source : Stevens, F. R., Disaggregating Census Data for Population Mapping Using Random Forests with Remotely-Sensed and Ancillary Data. [doi:10.1371/journal.pone.0107042](https://doi.org/10.1371/journal.pone.0107042)

Global Datasets

Soil Moisture: ASCAT

- Advanced SCATterometer (ASCAT)
- EUMETSAT
- Spatial resolution: 12.5km
- Temporal resolution: daily
- Initial date: 2007
- SWI (Soil Water Index) at different depths

Land Use Land Cover

- NRC-250k LULC
- GLOBCOVER
- IWMI
- GMIA
- MICRA
- WDPA
- JRC
- GRAND
- MODIS
- WORLD POP
- GLOBAL SURFACE WATER

Soil Moisture

- GLDAS
- ASCAT
- SMAP

MODIS

- LAI – MOD15
- GPP – MOD17
- NPP – MOD17

Others

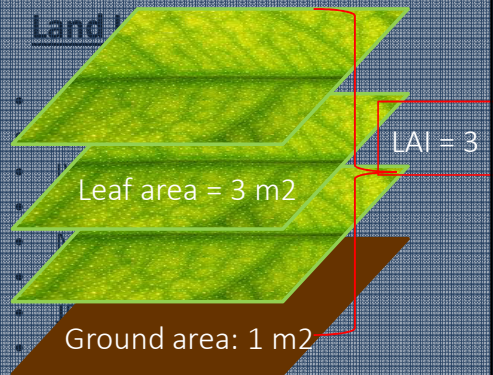
- Grey Water Footprint
- Environmental Water Flow
- Elevation – HydroSHEDS
- GRACE

Source: http://www.eumetsat.int/website/home/News/DAT_2633340.html
<http://land.copernicus.vgt.vito.be/PDF/portal/Application.html#Home>

Global Datasets

MODIS: LAI

- Leaf Area Index
- Dimensionless values to characterize canopy coverage [m²/m²]
- Application -
 - assess the growth of vegetation
 - parameterization of climate models
 - photosynthesis, respiration, transpiration, and interception



Soil Moisture

- GLDAS
- ASCAT
- SMAP

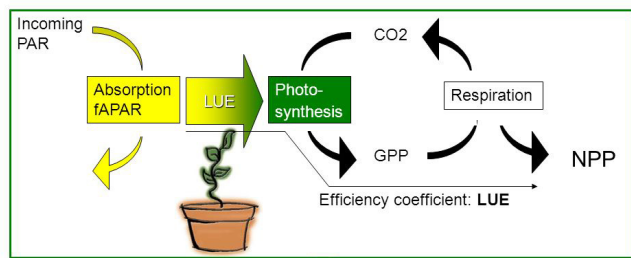
MODIS

- LAI – MOD15
- GPP – MOD17
- NPP – MOD17



Global Datasets

Light Use Efficiency models



$$NPP = LUE \cdot \sum_{day=1}^{365} fAPAR \cdot PAR$$

The LUE may depend on biome, soil moisture, temperature, nutrients, age,

Measured by satellites

Modeled or measured by satellites

Soil Moisture

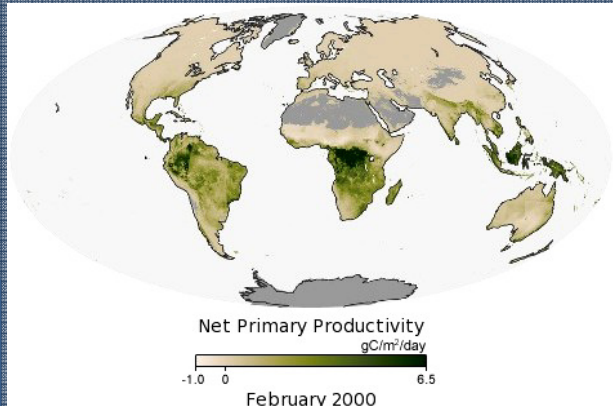
- GLDAS
- ASCAT
- SMAP

MODIS

- LAI – MOD15
- GPP – MOD17
- NPP – MOD17

MODIS: NPP/GPP

- Net Primary Production (NPP)
- Gross Primary Production (GPP)

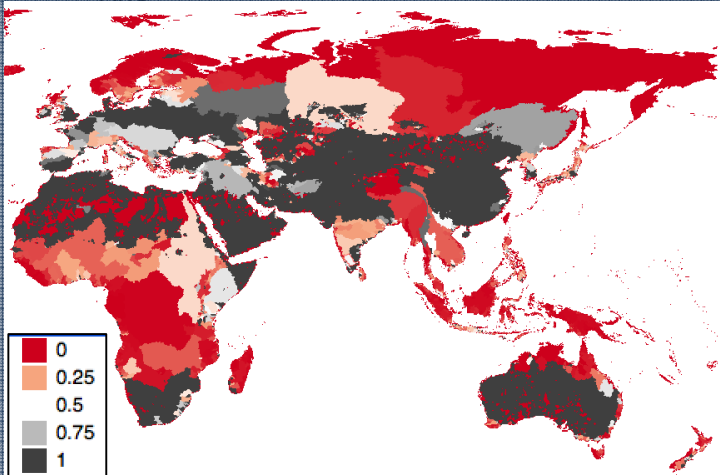


- Elevation – HydroSHEDS
- GRACE

Global Datasets

Others: Grey Water Footprint

- **Global anthropogenic phosphorous loads to fresh water**
- **5 * 5 min**
- **2002-2010**



Land Use Land Cover

- NRC-250k LULC
- GLOBCOVER
- IWMI
- GMIA
- MICRA
- WDPA
- IRC
- GRAND
- MODIS
- WORLD POP
- GLOBAL SURFACE WATER

Others

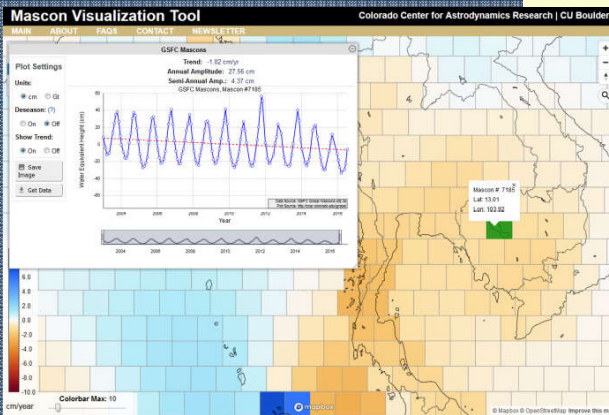
- **Grey Water Footprint**
- Environmental Water Flow
- Elevation – HydroSHEDS
- GRACE

Global Datasets



GRACE

- Gravity Recovery and Climate Experiment (GRACE) - NASA- JPL
- Measures changes in gravity
- Temporal resolution: ~ monthly
- Spatial resolution: ~3° (~300km)
- Initial date: April 2002
- Equivalent water depth – Groundwater, Root zone, Surface



• GLOBAL SURFACE WATER

Others

- Grey Water Footprint
- Environmental Water Flow
- Elevation – HydroSHEDS
- GRACE

Source: <http://ccar.colorado.edu/grace/gsfsc.html>

Global Datasets

**Glacier & Snow
Monitoring**

- Mountain Geoportal (ICIMOD)
- Mountain Geoportal (ICIMOD)
- GLIMS Glacier Viewer (NSIDC)
- Swiss GMN
- Arctic SDI Geoportal

**Irrigation
Informatics**

- Water Watch
- CIMIS
- WaterNSW
- IWMI
- DEWS
- Global surface water explorer

Others

- National water information system :Web Interface
- AQUASTAT
- Giovanni
- Environmental Data Explorer
- Joint Research Centre
- Water Portal
- LAADS DAAC
- DIVA-GIS

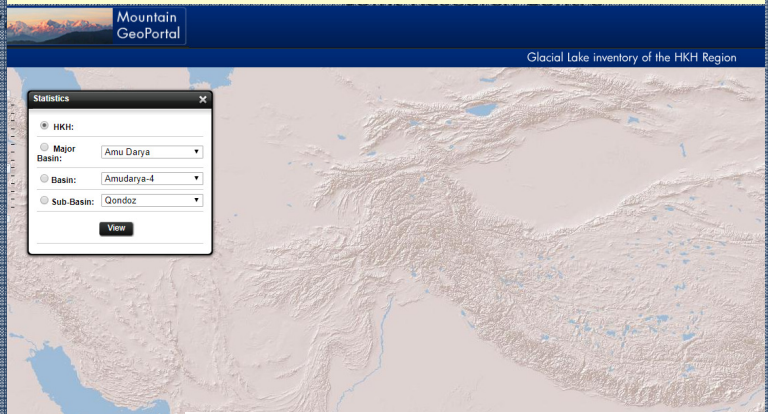
Global Datasets

Glacier & Snow Monitoring

- Mountain Geoportal (ICIMOD)
- Mountain Geoportal (ICIMOD)
- GLIMS Glacier Viewer (NSIDC)
- Swiss GMN
- Arctic SDI Geoportal

Glacial lake

- ICIMOD
- HKH Region
- Classification of Types of Glacial Lakes
- Contains Hydrological, Geometric, Lake, and Other Information
- Basin, Sub-basin, and Elevation wise Glacial Lake distribution, along with lake types



Source: <http://geoapps.icimod.org/glacierlakes/index.html>

Global Datasets

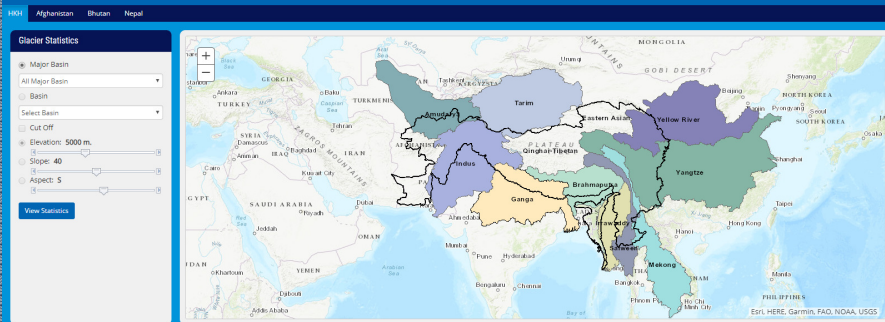
Glacier & Snow Monitoring

- Mountain Geoportal (ICIMOD)
- Mountain Geoportal (ICIMOD)
- GLIMS Glacier Viewer (NSIDC)
- Swiss GMN
- Arctic SDI Geoportal

Glacial

- ICIMOD
- HKH Region
- Categorized majorly based on its Primary Classification, Form, Frontal Characteristics, and Longitudinal Profile
- Areal distribution as per Basin, Sub-basin, and Elevation Range wise

Status of Glaciers in the HKH Region



Source: <http://geoapps.icimod.org/glacier/hkhglacier/>

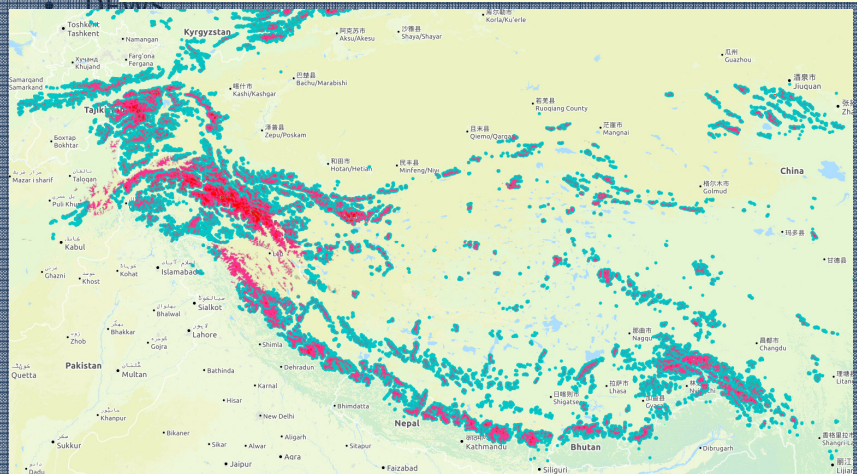
Global Datasets

Glacier & Snow Monitoring

- Mountain Geoportal (ICIMOD)
- Mountain Geoportal (ICIMOD)
- **GLIMS Glacier Viewer (NSIDC)**
- Swiss GMN
- Arctic SDI Geoportal

Glacial View

- HKH Region
- Includes glacier outline of RGI and WGI
- Glacier class defined by RGI
- Contains areal, hydrological and other information of Glacier



Source: <http://www.glims.org/maps/glims>

Global Datasets

Glacier & Snow Monitoring

- Mountain Geoportal (ICIMOD)
- Mountain Geoportal (ICIMOD)
- GLIMS Glacier Viewer (NSIDC)
- Swiss GMN
- Arctic SDI Geoportal

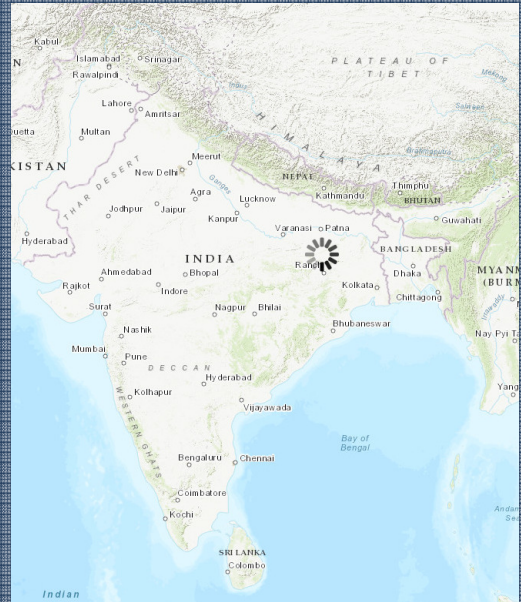
Irrigation Informatics

Water Watch

- CIMIS
- WaterNSW
- IWMI
- DEWS
- Global surface water explorer

Water for US

- Water Alert,
- Real-time stream flow
- Real-time flood data
- Real-time drought data
- Real-time groundwater levels



Source: <http://waterwatch.usgs.gov>

Global Datasets

Glacier & Snow Monitoring

- Mountain Geoportal (ICIMOD)
- Mountain Geoportal (ICIMOD)
- GLIMS Glacier Viewer (NSIDC)
- Swiss GMN
- Arctic SDI Geoportal

Irrigation Informatics

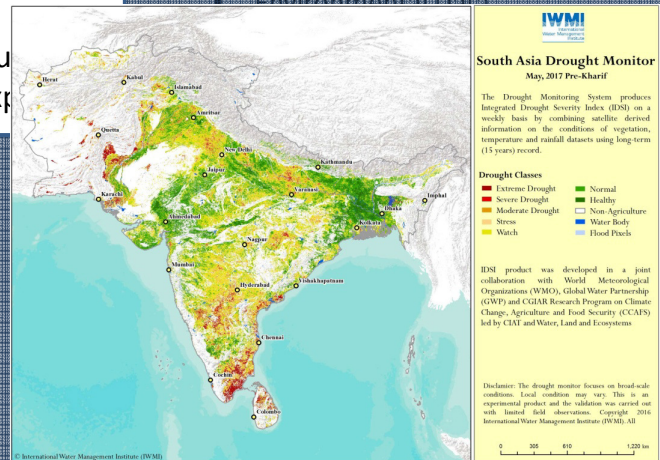
- Water Watch
- CIMIS
- WaterNSW
- IWM
- DEWS
- Global su water exp

Others

- National water information system -Web interface
- AQUASTAT
- Giovanni
- Environmental Data

IWMI

- Water accounting
- Water data portal
- Mapping drought pattern and impacts
- Irrigated area mapping
- Drought Monitor



Source: <http://www.iwmi.cgiar.org/>

Global Datasets

Glacier & Snow Monitoring

- Mountain Geoportal (ICIMOD)
- Mountain Geoportal (ICIMOD)
- GLIMS Glacier Viewer (NSIDC)
- Swiss GMN
- Arctic SDI Geoportal

Irrigation Informatics

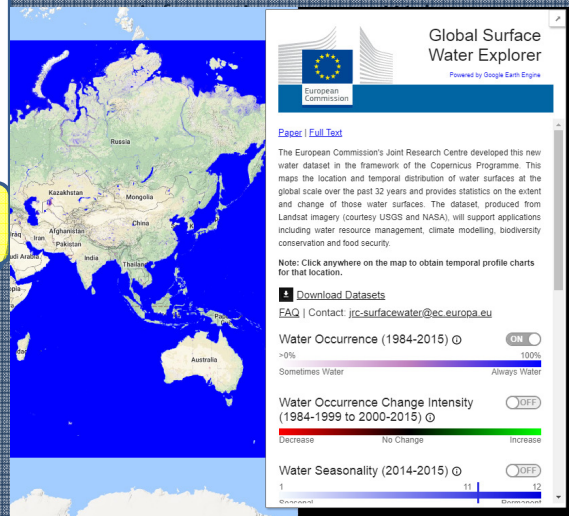
- Water Watch
- CIMIS
- WaterNSW
- IWMI
- DEWS
- **Global surface water explorer**

Others

- National water

Global Surface Water Explorer

- Landsat Imagery
- Temporal Distribution of Water Surface over past 32 years



Source: <https://global-surface-water.appspot.com/>

Global Datasets

AQUASTAT

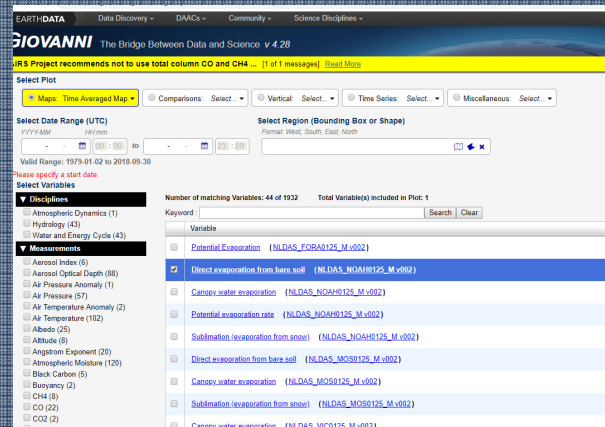
- Food and agricultural organization of the united nations
- Water resources
- Water uses
- Waste water
- Irrigation and drainage
- Global
- 1960 onwards

Others

- National water information system :Web Interface
- **AQUASTAT**
- Giovanni
- Environmental Data Explorer
- Joint Research Centre
- Water Portal
- LAADS DAAC
- DIVA-GIS

Source: <http://www.fao.org/nr/water/aquastat/main/index.stm>

Global Datasets



GIOVANNI

- Geospatial Interactive Online Visualization AND aNalysis Infrastructure
- Precipitation
- Evapotranspiration
- Soil moisture content layer
- Surface Runoff
- Global
- 1948-2018

Others

- National water information system :Web Interface
- AQUASTAT
- **Giovanni**
- Environmental Data Explorer
- Joint Research Centre
- Water Portal
- LAADS DAAC
- DIVA-GIS

Source: <https://giovanni.gsfc.nasa.gov/giovanni/>

Global Datasets

Glacier & Snow Monitoring

Irrigation Informatics

Others

UNEP DEWA GEO

United Nations Environment Programme
environment for development

Environmental Data Explorer

The Environmental Data Explorer is the authoritative source for data sets used by UNEP and its partners in the Global Environment Outlook (GEO) report and other integrated environment assessments. Its online database holds more than 500 different variables, as national, subregional, regional and global statistics or as geospatial data sets (maps), covering themes like Freshwater, Population, Forests, Emissions, Climate, Disasters, Health and GDP. Display them on-the-fly as maps, graphs, data tables or download the data in different formats.

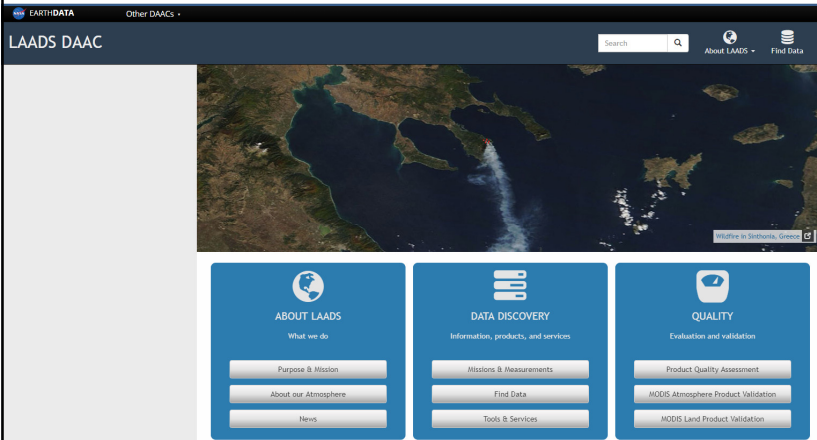
- Viewer (NSIDC)
- Swiss GMN
- Arctic SDI Geoportal
- DEWS
- Global surface water explorer

- National water information system :Web Interface
- AQUASTAT
- Giovanni
- Environmental Data Explorer**
- Joint Research Centre
- Water Portal
- LAADS DAAC
- DIVA-GIS

- Data Explorer**
- United Nation Environment programme
 - Environmental Data Explorer**
 - Precipitation
 - Temperature
 - DEM
 - River Networks
 - Watershed Boundaries
 - Irrigated areas
 - Global
 - 1970-2002

Source: <http://geodata.grid.unep.ch/>

Global Datasets



Others

- National water information system :Web Interface
- AQUASTAT
- Giovanni
- Environmental Data Explorer
- Joint Research Centre
- Water Portal
- **LAADS DAAC**
- DIVA-GIS

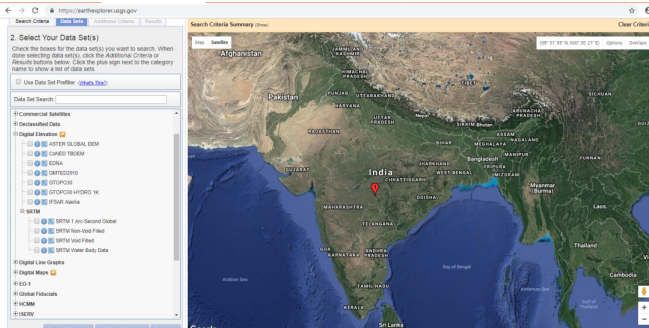
Data Explorer

The Level-1 and Atmosphere Archive & Distribution System (LAADS) Distributed Active Archive Center (DAAC)

- Level 0, Level 1 radiance data, reflectance data, albedo
- Atmospheric products (Aerosol, Water vapour, cloud mask)
- Annual water abstraction
- Global
- Since 1999

Source: <https://ladsweb.modaps.eosdis.nasa.gov/>

Global Datasets: DEM



ASTER GLOBAL Digital Elevation Model

Pixel Size	1 arc-second (30 m)
Geographic coordinates	Geographic latitude and longitude
DEM output format	GeoTIFF, signed 16 bits in units of vertical meters
Geoid reference	WGS84/EGM96
Special DN values	-9999 for void pixels, and 0 for sea water body
Tile volume	25 MB uncompressed, 4–5 MB compressed
Coverage	North 83 degrees to south 83 degrees, 22,702 tiles

CARTOSAT 1 Digital Elevation Model

Projection	Geographic
Horizontal Datum	WGS84
Vertical Units	Meters
Spatial Resolution	1 arc-second for global coverage (~30 meters)
Download	Bhuvan portal

- Global 30 Arc-Second Elevation (GTOPO30)
- Global Multi-resolution Terrain Elevation Data 2010 (GMTED2010)

Shuttle Radar Topography Mission (SRTM)

Projection	Geographic
Horizontal Datum	WGS84
Vertical Datum	EGM96 (Earth Gravitational Model 1996)
Vertical Units	Meters
Spatial Resolution	1 arc-second for global coverage (~30 meters) 3 arc-seconds for global coverage (~90 meters)
Raster Size	1 degree tiles
C-band Wavelength	5.6 cm

Source: <https://earthexplorer.usgs.gov/>

Open Sources Software for Water Resources

GIS Software

1. QGIS - <https://www.qgis.org/en/site/>

Image Processing

1. ORFEO Toolbox - <https://www.orfeo-toolbox.org/>
2. SNAP - <https://step.esa.int/main/toolboxes/snap/>
3. GRASS - https://docs.qgis.org/2.8/en/docs/user_manual/grass_integration/grass_integration.html

Data Visualization

1. Panoply - <https://www.giss.nasa.gov/tools/panoply/>
2. HDFview - <https://www.hdfgroup.org/downloads/hdfview/>

Hydrological Models

1. HEC-HMS - <https://www.hec.usace.army.mil/software/hec-hms/>
2. SWAT - <https://swat.tamu.edu/>
3. VIC - <https://vic.readthedocs.io/en/vic.4.2.c/Documentation/TechnicalNotes/Modes/>
4. sphy - <https://www.sphy.nl/>
5. CROPWAT - <http://www.fao.org/land-water/databases-and-software/cropwat/en/>
6. MODFLOW - https://www.usgs.gov/mission-areas/water-resources/science/modflow-and-related-programs?qt-science_center_objects=0#qt-science_center_objects

Thank you