

Open Data Sources & Software for Water Resources

One Week Customized Course on
Remote Sensing & GIS Technology

04th February 2021

Saksham Joshi

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



nrsc



Global Datasets

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

Soil Moisture

- GLDAS
- ASCAT
- SMAP

MODIS

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

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
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Soil Moisture

- GLDAS
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Precipitation: TRMM

- Tropical Rainfall Measuring Mission (TRMM)
- NASA & JAXA mission
- Spatial resolution: $0.25^\circ \sim 27$ 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: $0.1^\circ \sim 11$ 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

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Evapotranspiration

- MOD16
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- METRIC/EEFLUX
- ALEXI
- CMRSET
- SEBS
- SSEBop

MODIS
Global Annual MOD16 ET (2000–2006) mm/yr

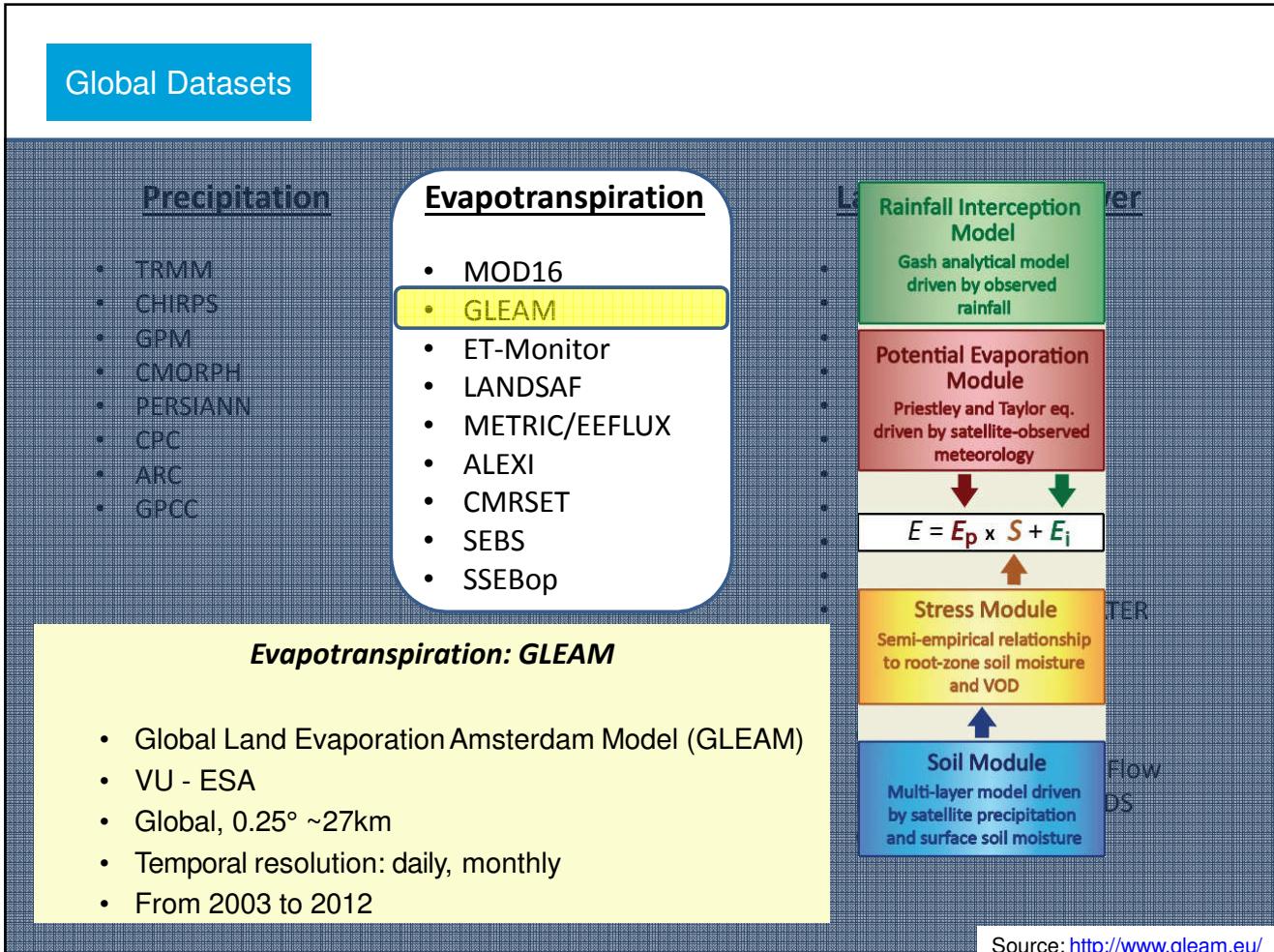
Evapotranspiration: MOD16

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

Others

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

Source: <http://www.ntsg.umt.edu/project/mod16>
<http://modis.gsfc.nasa.gov/data/dataprod/>



Global Datasets

<u>Precipitation</u>	<u>Evapotranspiration</u>	<u>Others</u>
<ul style="list-style-type: none"> • TRMM • CHIRPS • GPM • CMORPH • PERSIANN • CPC • ARC • GPCC 	<p>Evapotranspiration</p> <ul style="list-style-type: none"> • MOD16 • GLEAM • ET-Monitor • LANDSAF • METRIC/EEFLUX • ALEXI • CMRSET • SEBS • SSEBop 	<ul style="list-style-type: none"> • GLOBAL SURFACE WATER <p>Others</p> <p>Grey Water Footprint Environmental Water Flow Elevation – HydroSHEDS GRACE</p>

Evapotranspiration: ET - Monitor

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

Global Datasets

<u>Precipitation</u>	<u>Evapotranspiration</u>	<u>Land Use Land Cover</u>
<ul style="list-style-type: none"> • TRMM • CHIRPS • GPM • CMORPH • PERSIANN • CPC • ARC • GPCC 	<ul style="list-style-type: none"> • MOD16 • GLEAM • ET-Monitor • LANDSAF • METRIC/EEFLUX • ALEXI • CMRSET • SEBS • SSEBop 	<ul style="list-style-type: none"> • NRC-250k LULC • GLOBCOVER • IWMI • GMIA • MICRA • WDPA • JRC • GRAND • MODIS • WORLD POP • GLOBAL SURFACE WATER
<p><i>Evapotranspiration: ALEXI</i></p> <ul style="list-style-type: none"> • Atmosphere Land Exchange Inverse (ALEXI) • EF = Latent Heat Flux / (Rn – G) • Spatial Resolution – 0.027 degree ~ (3 km) • Daily • Data availability - 2007-2012 		<p><i>Others</i></p> <p>Grey Water Footprint Environmental Water Flow Elevation – HydroSHEDS GRACE</p>

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)

• GPCC • CMRSE

Built up
Kharif
Rabi
Zaid
Double/Triple Current fallow
Plantation/Orchard
Evergreen forest
Deciduous forest
Scrub/Degraded forest
Littoral swamp forest
Grassland
Other wasteland
Gullied land
Scrubland
Waterbodies
Snowcover/Glacial/Cloud
Shifting cultivation
Rann

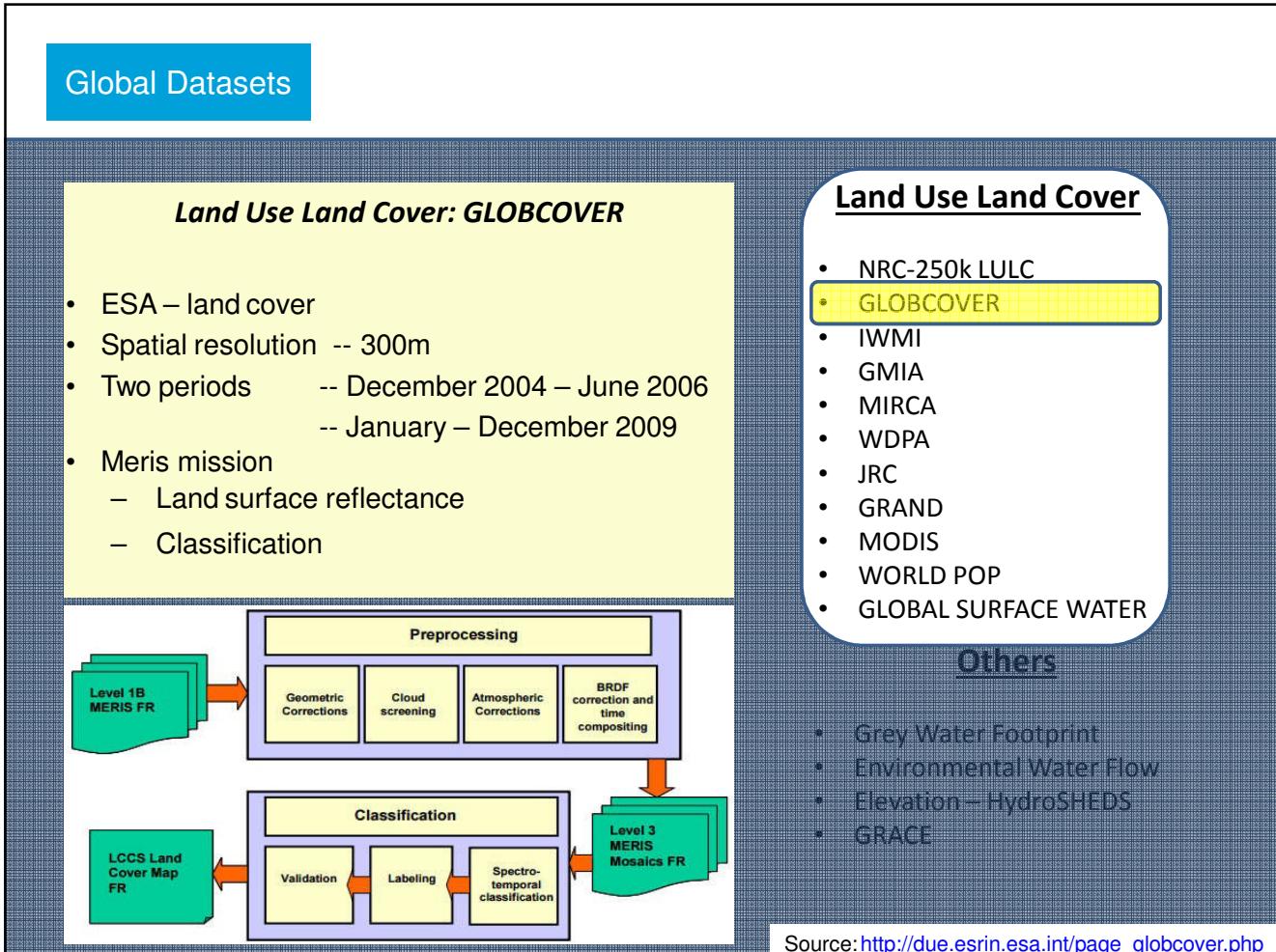
Land Use Land Cover

- 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/>



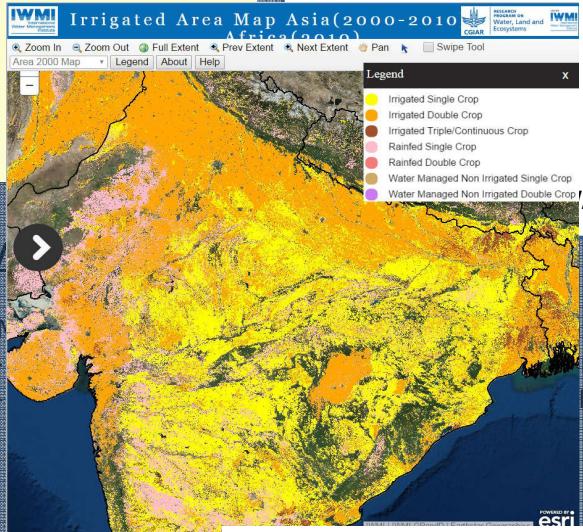
Global Datasets

Land Use Land Cover: 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



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

Soil Moisture

- GLDAS
- ASCAT
- SMAP

Modeling

- LAI – NPP
- GPP
- NPP

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
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Others

- | | |
|--|---|
| <ul style="list-style-type: none">• GLDAS• ASCAT• SMAP | <ul style="list-style-type: none">• LAI – MOD15• GPP – MOD17• NPP – MOD17 |
|--|---|

Global Datasets

Land Use Land Cover: MIRCA

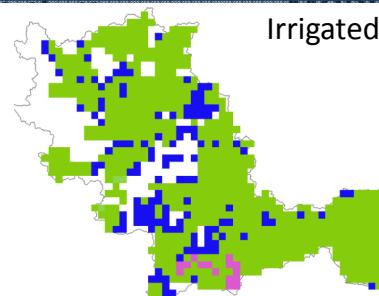
- Monthly growing area grids for 26 Dominant crop classes
 - Irrigated
 - Rainfed
- Spatial resolution - 10 km

- SEBS
- SSEBop

Land Use Land Cover

- NRC-250k LULC
- GLOBCOVER
- IWMI
- GMIA
- MIRCA
- WDPA
- JRC
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Wheat
Maize
Rice
Barley
Rye
Millet
Sorghum
Soybeans
Sunflower
Potatoes
Cassava
Sugar Cane
Sugar Beets



Irrigated

Rainfed

Palm Oil
Rape Seed
Groundnuts
Pulses
Citrus
Date Palm
Grapes
Cotton
Cocoa
Coffee
Other Perennial
Fodder

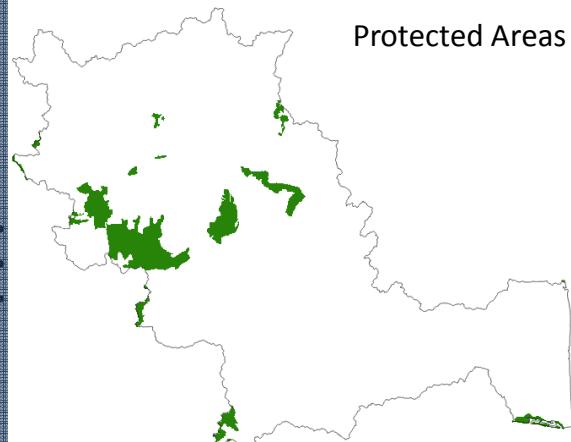
Global Datasets

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
- GRCC

- ALEAI
- CMRSET



Land Use Land Cover

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

Others

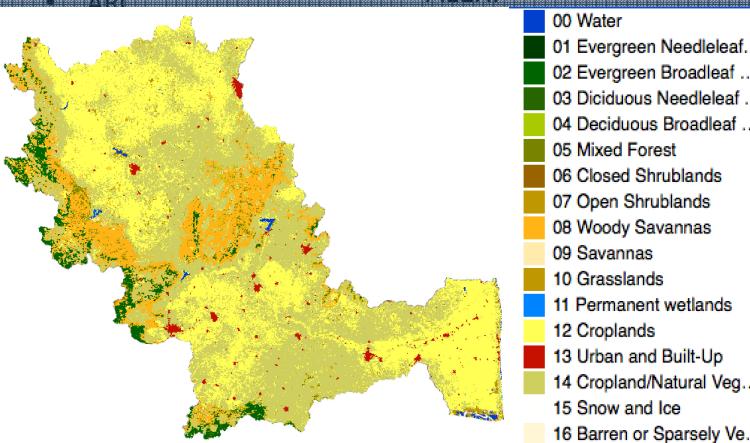
- Grey Water Footprint
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- GRACE

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



00 Water
01 Evergreen Needleleaf...
02 Evergreen Broadleaf ...
03 Deciduous Needleleaf ...
04 Deciduous Broadleaf ...
05 Mixed Forest
06 Closed Shrublands
07 Open Shrublands
08 Woody Savannas
09 Savannas
10 Grasslands
11 Permanent wetlands
12 Croplands
13 Urban and Built-Up
14 Cropland/Natural Veg...
15 Snow and Ice
16 Barren or Sparsely Ve..

Land Use Land Cover

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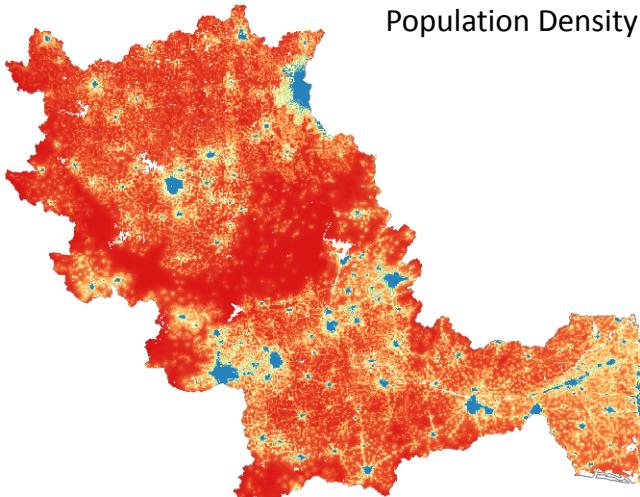
Source : https://lpdaac.usgs.gov/dataset_discovery/modis/modis_products_table/mcd12q1

Global Datasets

Land Use Land Cover: World Population

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

• PERSIANN
• GPC
• METRIC/EERFLUX



Population Density

Land Use Land Cover

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

• SSEBOP

Soil Moisture

- GLDAS
- **ASCAT**
- SMAP

MODIS

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

Land Use Land Cover

- NRC-250k LULC
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- GRAND
- MODIS
- WORLD POP
- GLOBAL SURFACE WATER

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 [m^2/m^2]
- 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

The diagram illustrates the LUE model. Incoming PAR is absorbed by the plant, with fAPAR representing the fraction of PAR absorbed. This leads to photosynthesis, which uses CO₂ and produces GPP (Gross Primary Production). A portion of GPP is used for respiration, while the remainder is NPP (Net Primary Production). The efficiency coefficient is LUE.

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

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

Measured by satellites

Modeled or measured by satellites

MODIS: NPP/GPP

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

Net Primary Productivity
gC/m²/day

February 2000

Elevation – HydroSHEDS

GRACE

Soil Moisture

- GLDAS
- ASCAT
- SMAP

MODIS

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

Global Datasets

Others: Grey Water Footprint

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

Land Use Land Cover

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Global Datasets



GRACE
Gravity Recovery and Climate Experiment

Mascon Visualization Tool
Colorado Center for Astrodynamics Research | CU Boulder

Plot Settings
 Units: cm
 Decade: 10
 Show Trend: Off
 Show Error: Off
 Get Data

GSFC Mascon
 Trend: -1.92 cm/yr
 Annual Amplitude: 27.56 cm
 Seasonal Amplitude: 1.97 cm
 GSPC Mascons: 47855

Year: 2004, 2006, 2008, 2010, 2012, 2014, 2016

Colorbar Max: 10 cm/year

GLOBAL SURFACE WATER

Others

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

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

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Irrigation Informatics

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

Others

- National water information system :Web Interface
- AQUASTAT
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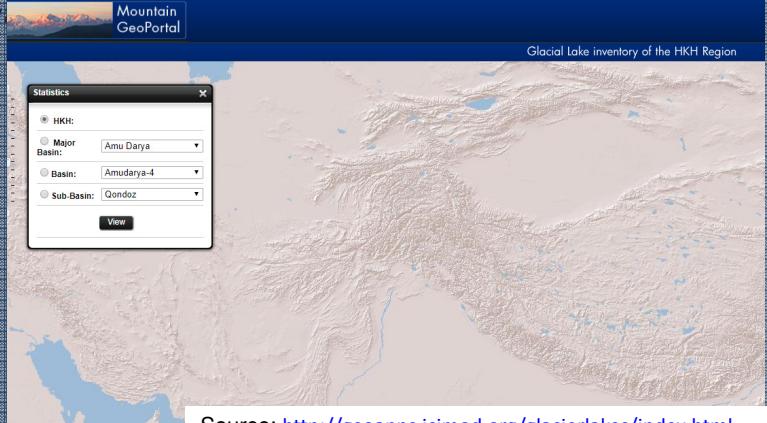
Global Datasets

Glacier & Snow Monitoring

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- 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>

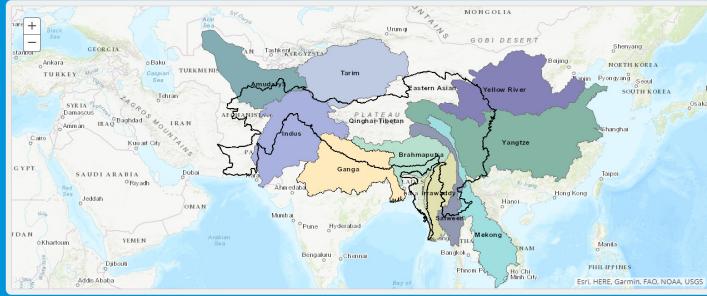
Global Datasets

Glacier & Snow Monitoring

- Mountain Geoportal (ICIMOD)
- Mountain Geoportal (ICIMOD) (highlighted)
- 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)
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- Swiss GMN
- Arctic SDI Geoportal

Water for US

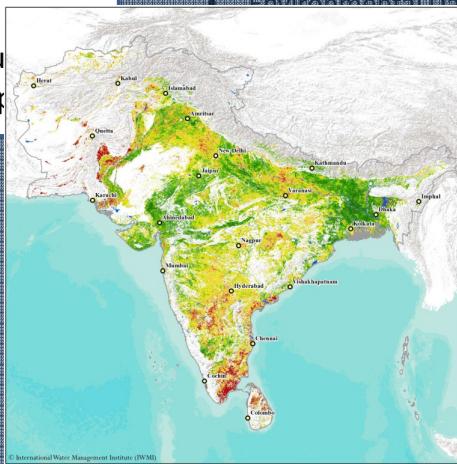
- Water Alert,
- Real-time stream flow
- Real-time flood data
- Real-time drought data
- Real-time groundwater levels

Irrigation Informatics

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

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

Global Datasets

<u>Glacier & Snow Monitoring</u>	<u>Irrigation Informatics</u>	<u>Others</u>										
<ul style="list-style-type: none"> • Mountain Geoportal (ICIMOD) • Mountain Geoportal (ICIMOD) • GLIMS Glacier Viewer (NSIDC) • Swiss GMN • Arctic SDI Geoportal 	<ul style="list-style-type: none"> • Water Watch • CIMIS • WaterNSW • IWMI • DEWS • Global surface water ex 	<ul style="list-style-type: none"> • National water information system :Web interface • AQUASTAT • Giovanni 										
IWMI		Environmental Data										
<ul style="list-style-type: none"> • Water accounting • Water data portal • Mapping drought pattern and impacts • Irrigated area mapping • Drought Monitor 		 <p>IWMI International Water Management Institute</p> <p>South Asia Drought Monitor May, 2017 Pre-kharif</p> <p>The Drought Monitoring System produces Integrated Drought Severity Index (IDS) on a weekly basis by combining satellite derived information on the conditions of vegetation, temperature and rainfall datasets using long-term (15 years) record.</p> <p>Drought Classes</p> <table border="1"> <tr> <td>Extreme Drought</td> <td>Normal</td> </tr> <tr> <td>Severe Drought</td> <td>Healthy</td> </tr> <tr> <td>Moderate Drought</td> <td>Non Agriculture</td> </tr> <tr> <td>Stress</td> <td>Water Body</td> </tr> <tr> <td>Watch</td> <td>Flood Pixels</td> </tr> </table> <p>IDS product was developed in a joint collaboration with World Meteorological Organization (WMO), Global Water Partnership (GWP) and FAO's Regional Program on Climate Change, Agriculture and Food Security (CCAFS) led by CIAT and Water, Land and Ecosystems</p> <p>Disclaimer: The drought monitor focuses on broad-scale conditions. Local conditions may vary. This is an experimental product and its validation was carried out with limited field observations. Copyright 2018 International Water Management Institute (IWMI). All rights reserved.</p> <p>0 300 600 1,200 km</p>	Extreme Drought	Normal	Severe Drought	Healthy	Moderate Drought	Non Agriculture	Stress	Water Body	Watch	Flood Pixels
Extreme Drought	Normal											
Severe Drought	Healthy											
Moderate Drought	Non Agriculture											
Stress	Water Body											
Watch	Flood Pixels											

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

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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

The screenshot shows a world map with blue areas representing water surfaces. Overlaid on the map are several controls and labels. At the top right is the European Commission logo and the text "Global Surface Water Explorer Powered by Google Earth Engine". Below this is a "Paper | Full Text" link. A note states: "The European Commission's Joint Research Centre developed this new water dataset in the framework of the Copernicus Programme. This maps the location and temporal distribution of water surfaces at the global scale over the past 32 years and provides statistics on the extent and change of those water surfaces. The dataset, produced from Landsat imagery (courtesy USGS and NASA), will support applications including water resource management, climate modeling, biodiversity conservation and food security." A note below says: "Note: Click anywhere on the map to obtain temporal profile charts for that location." There are three main filter sliders: "Water Occurrence (1984-2015)" with a range from 0% to 100%, currently set to "Sometimes Water"; "Water Occurrence Change Intensity (1984-1999 to 2000-2015)" with a range from "Decrease" to "Increase", currently set to "No Change"; and "Water Seasonality (2014-2015)" with a range from 1 to 12, currently set to "1".

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

Global Datasets



AQUASTAT

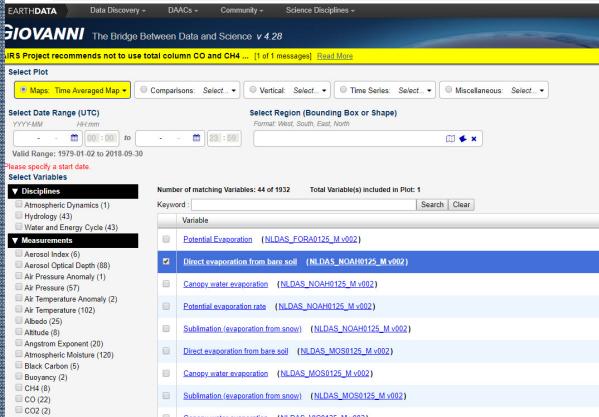
- Food and agricultural organization of the united nations
- Water resources
- Water uses
- Waste water
- Irrigation and drainage
- Global
- 1960 onwards

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 The Bridge Between Data and Science v 4.28

IRS Project recommends not to use total column CO and CH4 ... [1 of 1 messages] [Read More](#)

Select Plot

Map: Time-Averaged Map • Comparisons: Select... • Vertical: Select... • Time Series: Select... • Miscellaneous: Select...

Select Data Range (UTC)

From: 1979-01-02 to 2018-09-30

Please specify a start date

Select Variables

Number of matching Variables: 44 of 1932 Total Variable(s) included in Plot: 1

Keyword: Search Clear

Variable

- Potential Evaporation (NLADS_FORA0125_M_v002)
- Direct evaporation from bare soil (NLADS_NOAH0125_M_v002)
- Canopy water evaporation (NLADS_NOAH0125_M_v002)
- Potential evaporation rate (NLADS_NOAH0125_M_v002)
- Sublimation (evaporation from snow) (NLADS_NOAH0125_M_v002)
- Direct evaporation from bare soil (NLADS_MOS0125_M_v002)
- Canopy water evaporation (NLADS_MOS0125_M_v002)
- Sublimation (evaporation from snow) (NLADS_MOS0125_M_v002)
- Canopy water evaporation (NLADS_MOS0125_M_v002)

Others

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

GIOVANNI

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

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

Global Datasets

Glacier & Snow Monitoring

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.

- GLESPIS Viewer (NSIDC)
- Swiss GMN
- Arctic SDI Geoportal

Irrigation Informatics

- DEWS
- Global surface water explorer

Data Explorer

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

Others

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

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

Global Datasets

Data Explorer

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

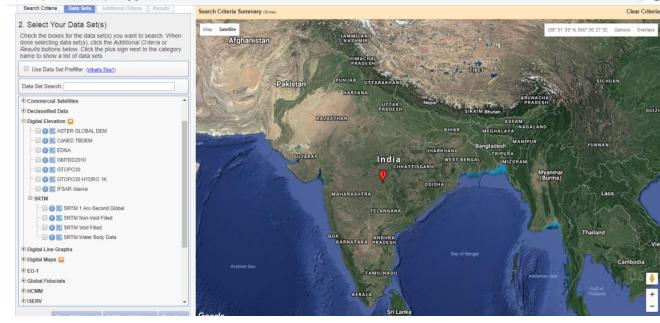
- Level 0, Level 1 radiance data, reflectance data, albedo
- Atmospheric products
- (Aerosol, Water vapour, cloud mask)
- Annual water abstraction
- Global
- Since 1999

Others

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

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

Global Datasets: DEM



Search Criteria Summary (None)

2. Select Your Data Set(s)
Check the boxes for the data sets you want to search. When done selecting data sets, click the Additional Criteria or Results button to see a list of data sets.

Use Data Set Filter ([What's This?](#))

Data Set Search:

- Commercial Satellites
- Declassified Data
- Digital Elevation
- Digital Line Graphs
- Digital Maps
- Elevation
- Global Fiducials
- HGM
- IERS

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

Shuttle Radar Topography Mission (SRTM)	
Projection	Geographic
Horizontal Datum	WGS84
Vertical Units	Meters
Spatial Resolution	1 arc-second for global coverage (~30 meters)
Raster Size	1 degree tiles
C-band Wavelength	5.6 cm

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)**

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