Open Data Sources for Water Resources

Remote Sensing & GIS Technologies for Water Resources Applications

Saksham Joshi

WRAD/WRG/RSAA
National Remote Sensing Centre
Hyderabad - 500037, India
saksham_joshi@nrsc.gov.in
040-23884529

24th June 2021

ISRO

NHP

nrsc

- Open source datasets
- Remote sensing

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

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

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)
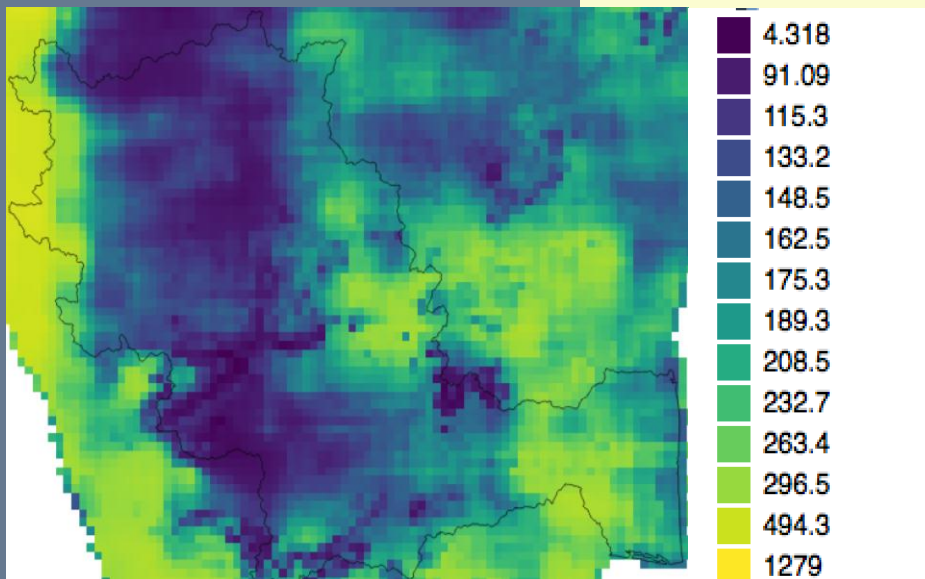 - Lightning Image Sensor (LIS)

- Elevation – HydroSHEDS
- GRACE

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

	4.318
	91.09
	115.3
	133.2
	148.5
	162.5
	175.3
	189.3
	208.5
	232.7
	263.4
	296.5
	494.3
	1279

Precipitation

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

Soil Moisture

- GLDAS
- ASCAT
- SMAP

- NPP – MOD17

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

- Environmental Water Flow
- Elevation – HydroSHEDS
- GRACE

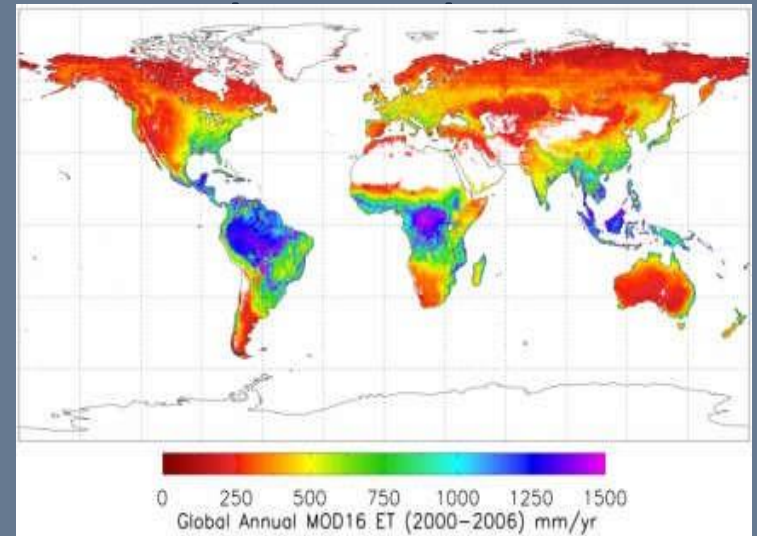Source: http://www.nasa.gov/mission_pages/GPM/main/index.html

Precipitation

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

Evapotranspiration

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

Global Annual MOD16 ET (2000−2006) mm/yr

- MODIS
- WORLD POP
- GLOBAL SURFACE WATER

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/

Precipitation

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

Evapotranspiration

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

Laver

-
-
-
-
-
-
-
-
- TER

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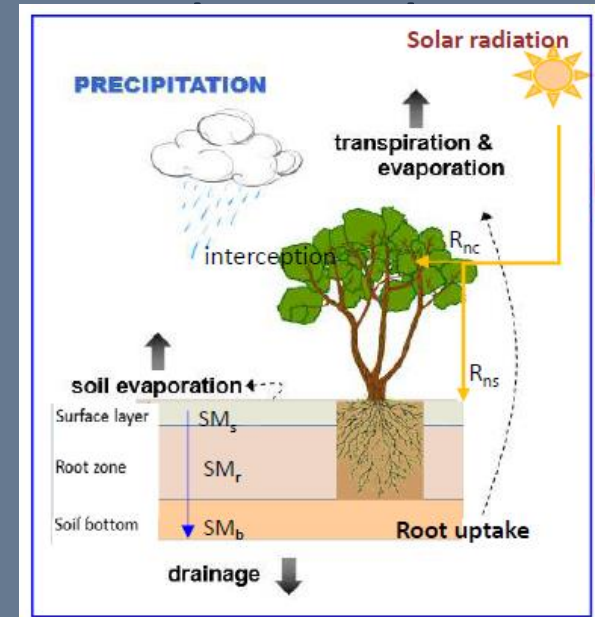Semi-empirical relationship to root-zone soil moisture and VOD

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

Evapotranspiration: GLEAM

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

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

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 processess of energy balance, plant physiology and soil water balance developed by EOWater Lab at RADI.

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

Others

Grey Water Footprint
Environmental Water Flow
Elevation – HydroSHEDS
GRACE

Evapotranspiration: ALEXI

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

Global Datasets

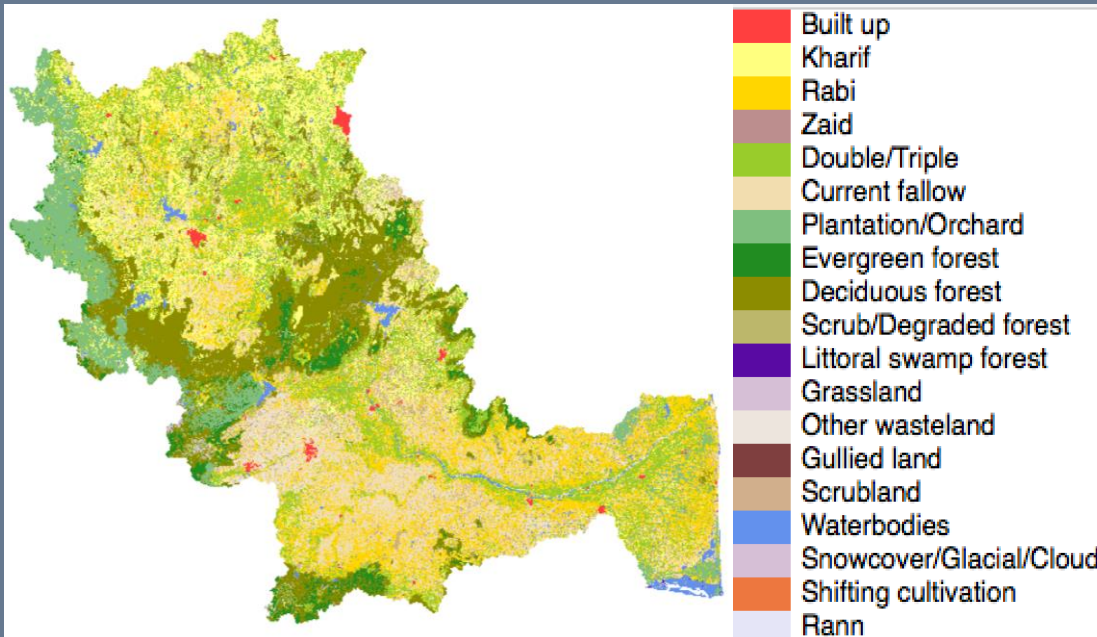## Land Use Land Cover: NRC – 250k

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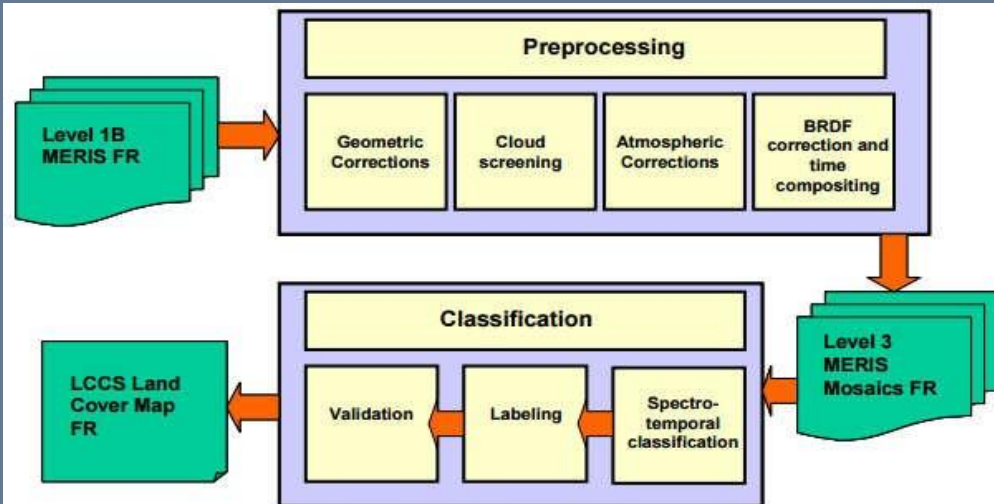
- GPCC
- CMRSET

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

Legend:
- 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

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

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
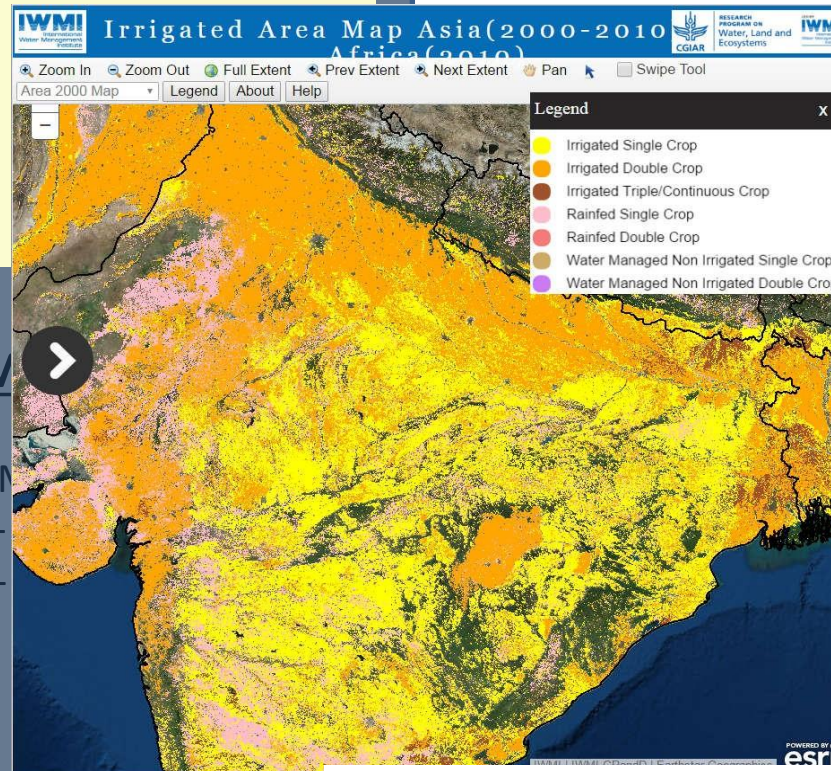- GRAND
- MODIS
- WORLD POP
- GLOBAL SURFACE WATER

Others

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

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

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

IWMI Irrigated Area Map Asia(2000-2010) Africa(2010)

Zoom In   Zoom Out   Full Extent   Prev Extent   Next Extent   Pan   Swipe Tool

Area 2000 Map   Legend   About   Help

Legend   x

- Irrigated Single Crop
- Irrigated Double Crop
- Irrigated Triple/Continuous Crop
- Rainfed Single Crop
- Rainfed Double Crop
- Water Managed Non Irrigated Single Crop
- Water Managed Non Irrigated Double Crop

ATER

Soil Moisture

- GLDAS
- ASCAT
- SMAP

M

- LAI –
- GPP –
- NPP –

r Flow
EDS

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
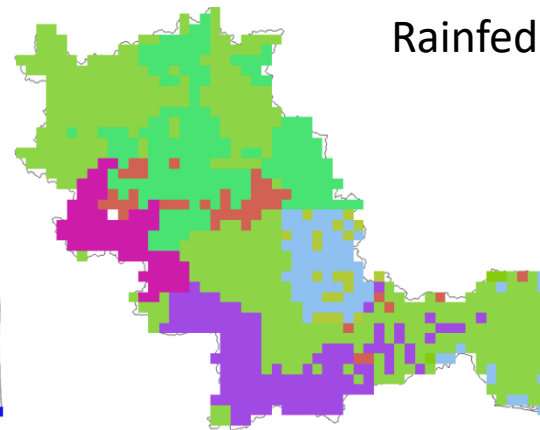   - Rainfed

- 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

Legend:
Wheat, Maize, Rice, Barley, Rye, Millet, Sorghum, Soybeans, Sunflower, Potatoes, Cassava, Sugar Cane, Sugar Beets
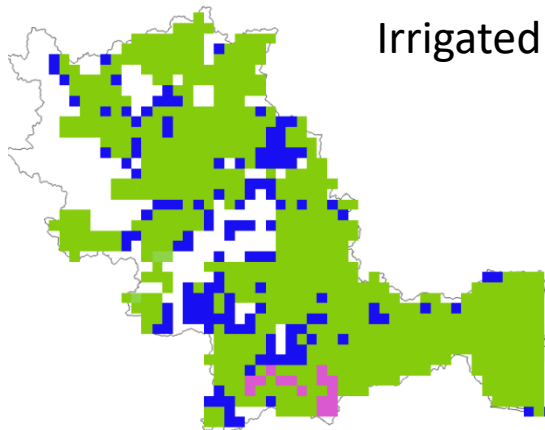
Irrigated   Rainfed
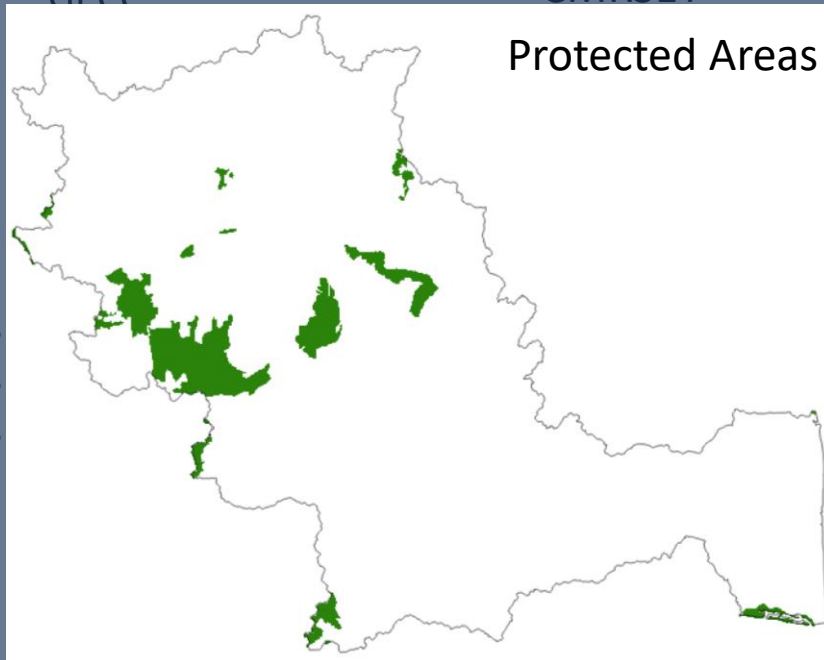
Palm Oil, Rape Seed, Groundnuts, Pulses, Citrus, Date Palm, Grapes, Cotton, Cocao, Coffee, Other Perennial, Fodder

Land Use Land Cover: WDPA

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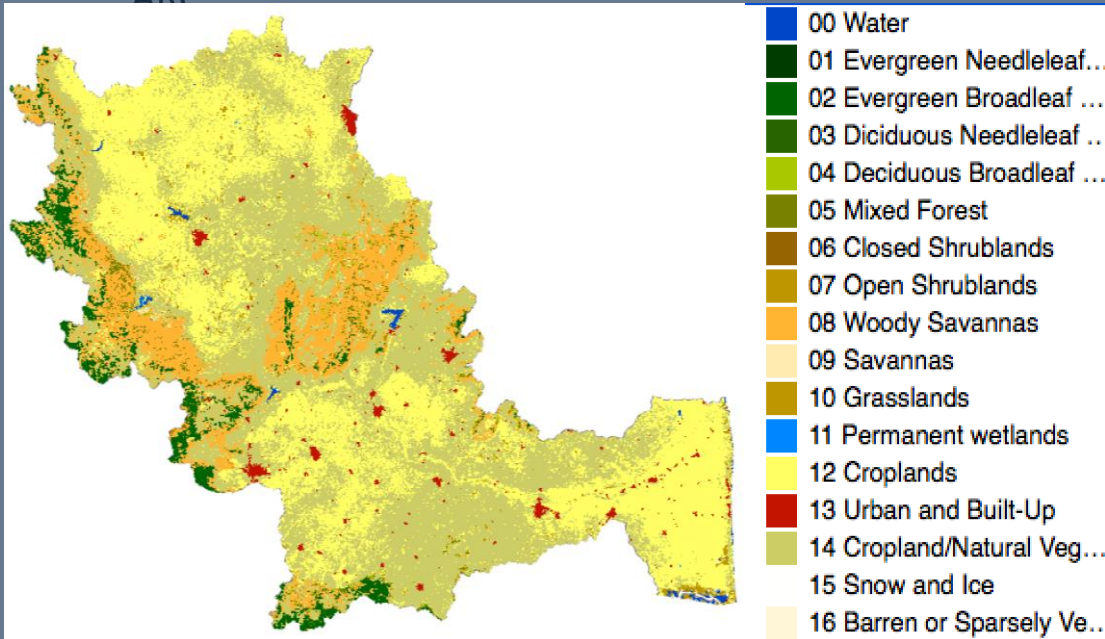
- ARC
- GPCC

- 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

Protected Areas

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

Global Datasets

Land Use Land Cover: MODIS

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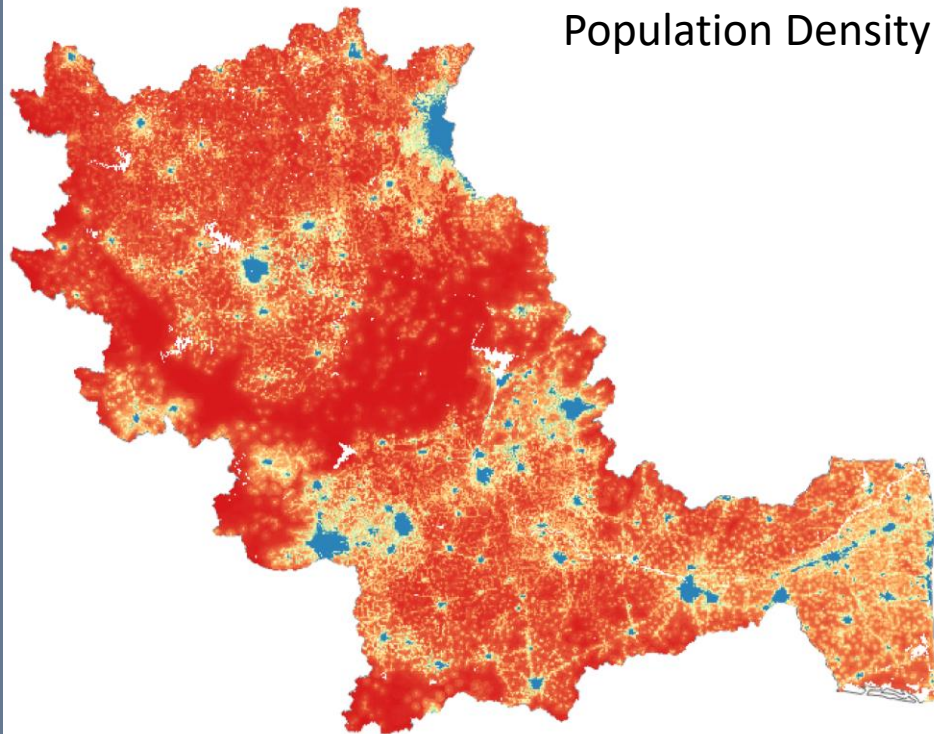- Total Classes – 17

- ARC
- ALEXI

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

00	Water
01	Evergreen Needleleaf…
02	Evergreen Broadleaf …
03	Diciduous 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…

Global Datasets

Land Use Land Cover: World Population

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

PERSIANN
CPC

LANDSAT
METRIC/EEFLUX

Population Density

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

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

SSEBop

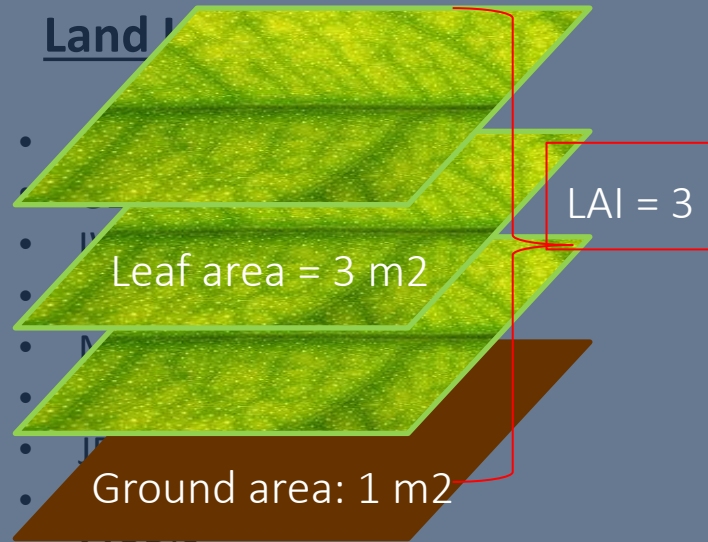## Soil Moisture

- 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

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
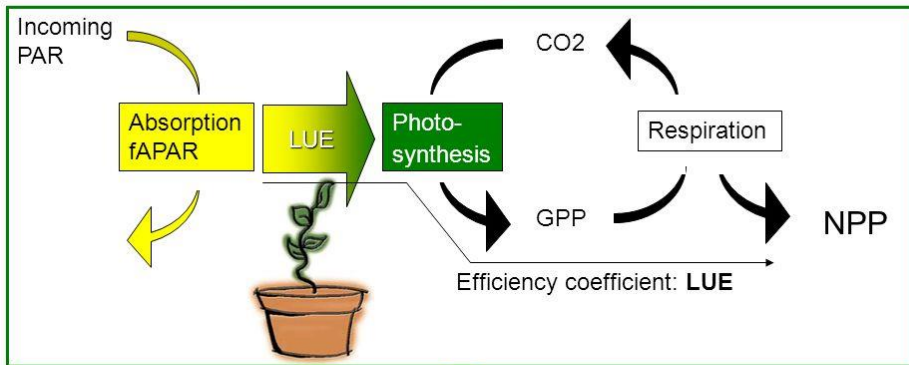
Land Use

LAI = 3

Leaf area = 3 m2

Ground area: 1 m2

MODIS
WORLD POP

Soil Moisture

- GLDAS
- ASCAT
- SMAP

MODIS

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

Light Use Efficiency models

Incoming PAR

Absorption fAPAR → LUE → Photo-synthesis → CO2

Respiration

GPP → NPP

Efficiency coefficient: **LUE**

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

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

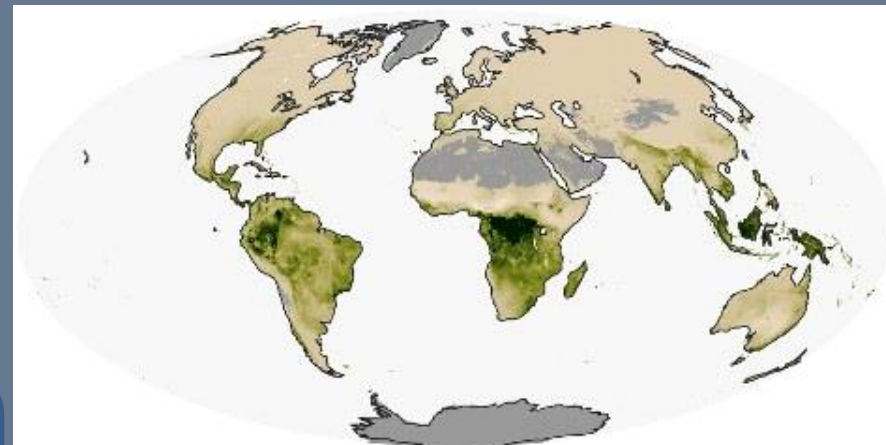Measured by satellites

Modeled or measured by satellites

MODIS: NPP/GPP

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

Net Primary Productivity
gC/m²/day

-1.0   0   6.5
February 2000

Soil Moisture

- GLDAS
- ASCAT
- SMAP

MODIS

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

- Elevation – HydroSHEDS
- GRACE

Precipitation **Evapotranspiration**

Others: Grey Water Footprint

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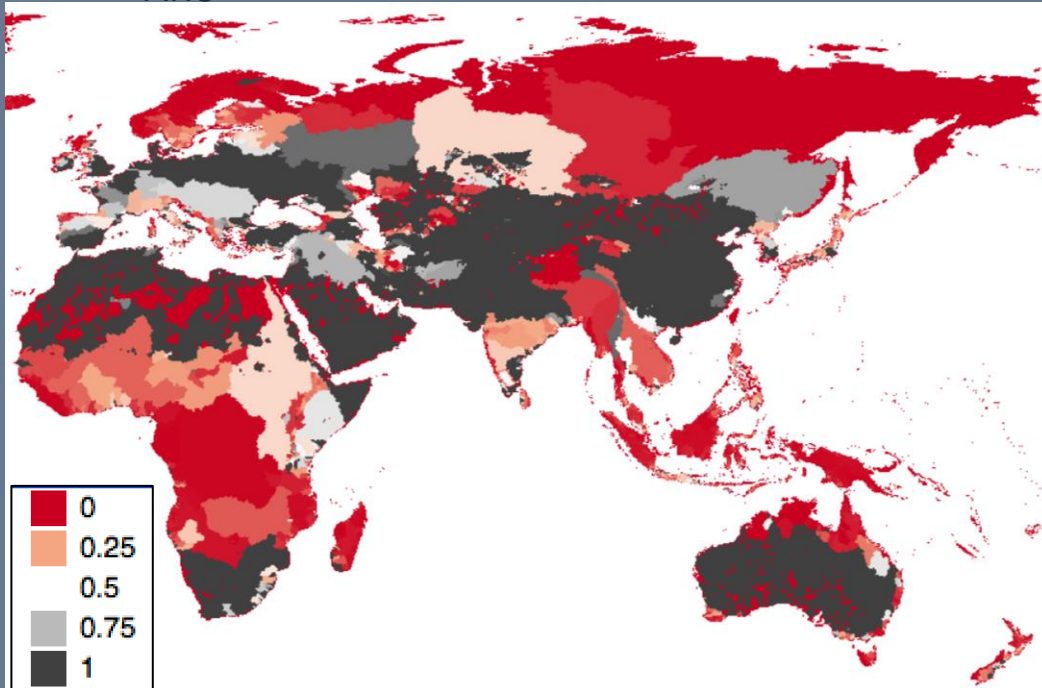
ARC

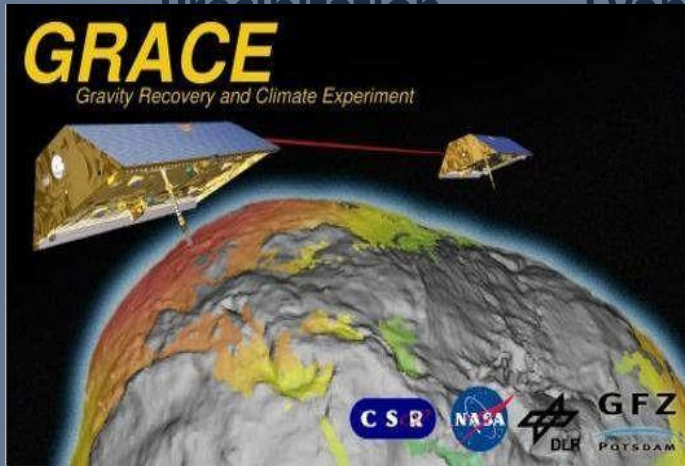|	
0	(dark red)
0.25	(light orange)
0.5	(white)
0.75	(grey)
1	(black)

Land Use Land Cover

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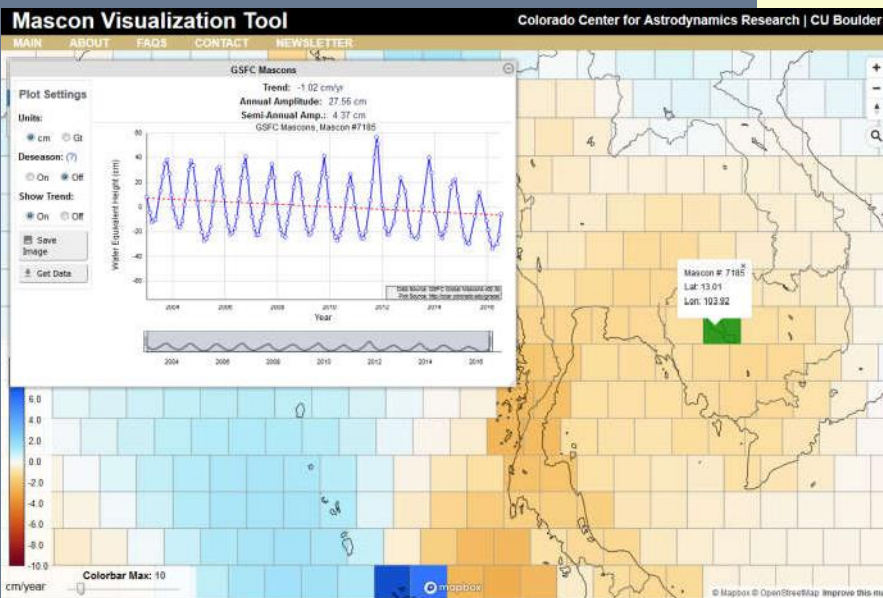- GRAND
- MODIS
- WORLD POP
- GLOBAL SURFACE WATER

Others

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

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/gsfc.html

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
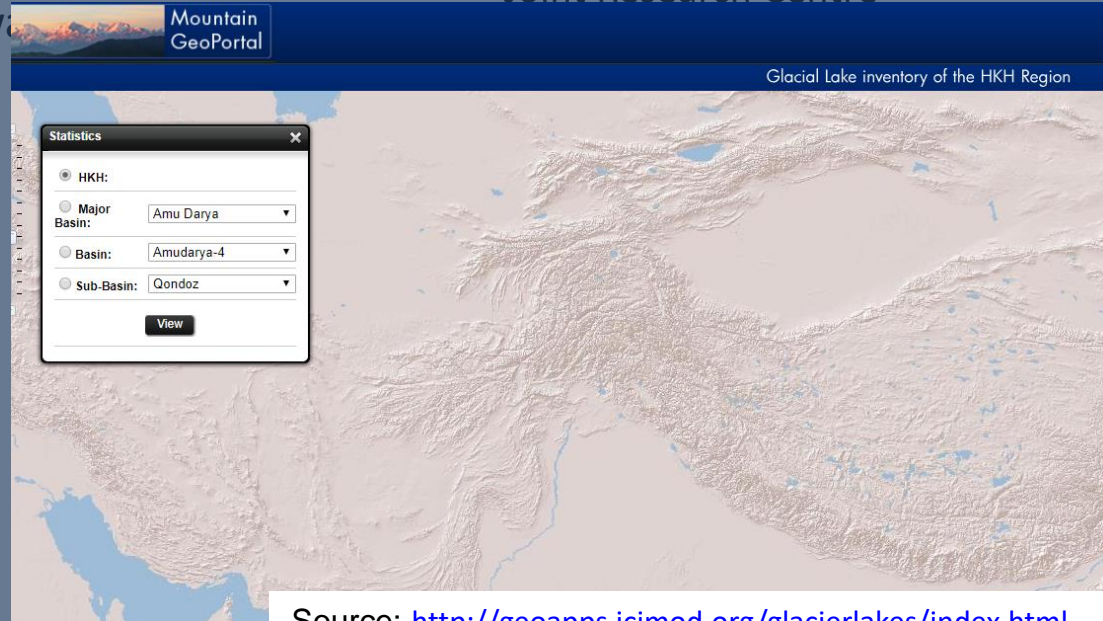- Global surface water explorer

Others

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

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
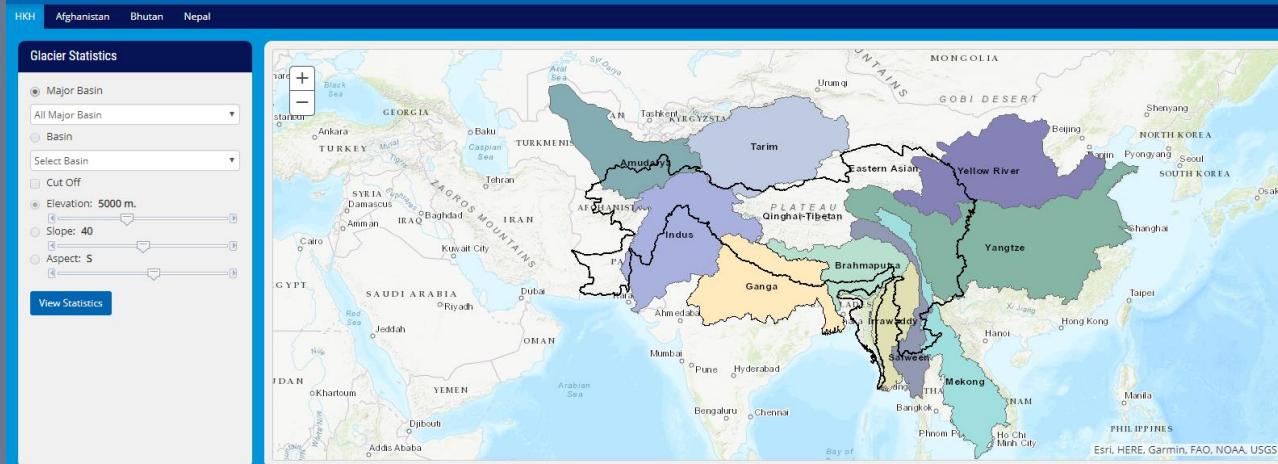
Mountain GeoPortal

Glacial Lake inventory of the HKH Region

Statistics

- HKH:
- Major Basin: Amu Darya
- Basin: Amudarya-4
- Sub-Basin: Qondoz

View

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

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

HKH   Afghanistan   Bhutan   Nepal

Glacier Statistics

- Major Basin

All Major Basin

- Basin

Select Basin

- Cut Off
- Elevation: 5000 m.
- Slope: 40
- Aspect: S

View Statistics
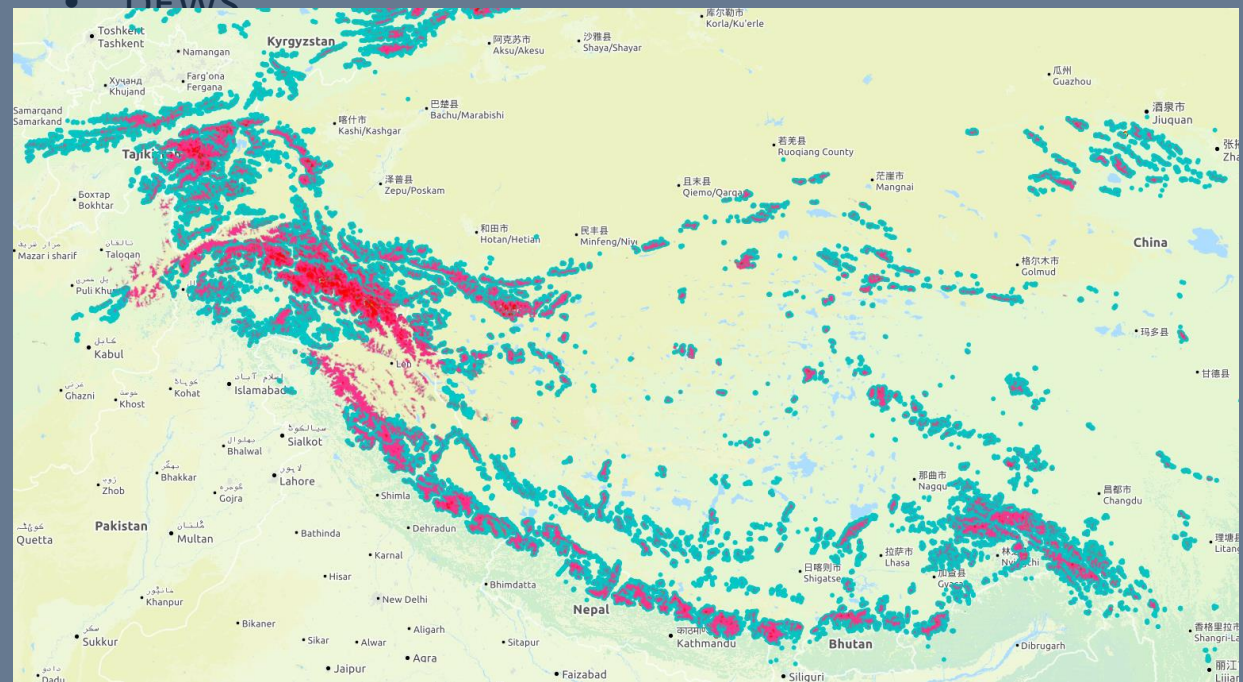
Source: http://geoapps.icimod.org/glacier/hkhglacier/

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
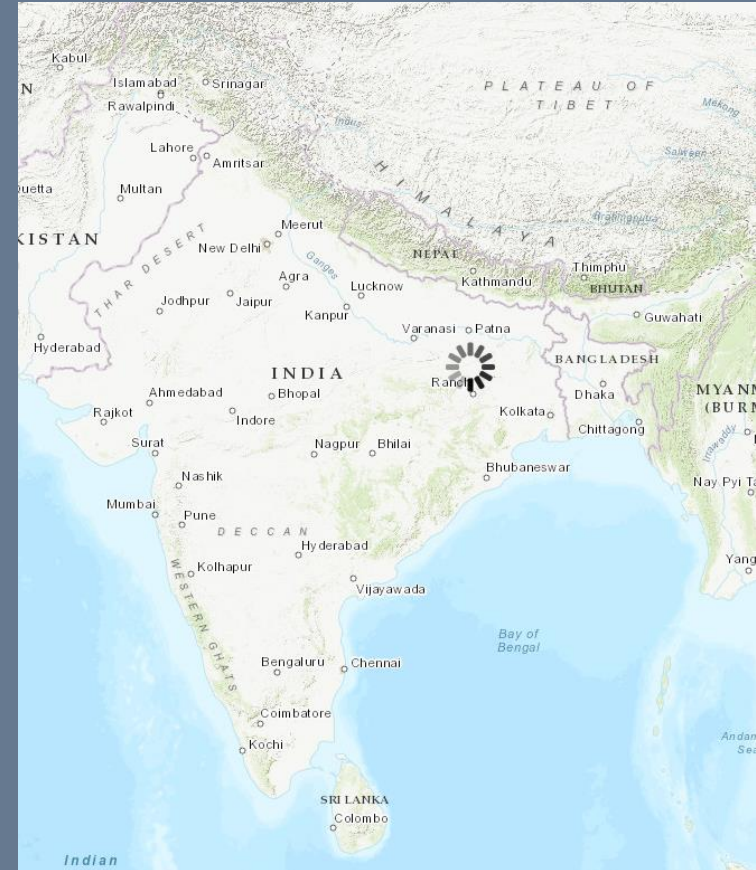
Glacier & Snow Monitoring

- 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
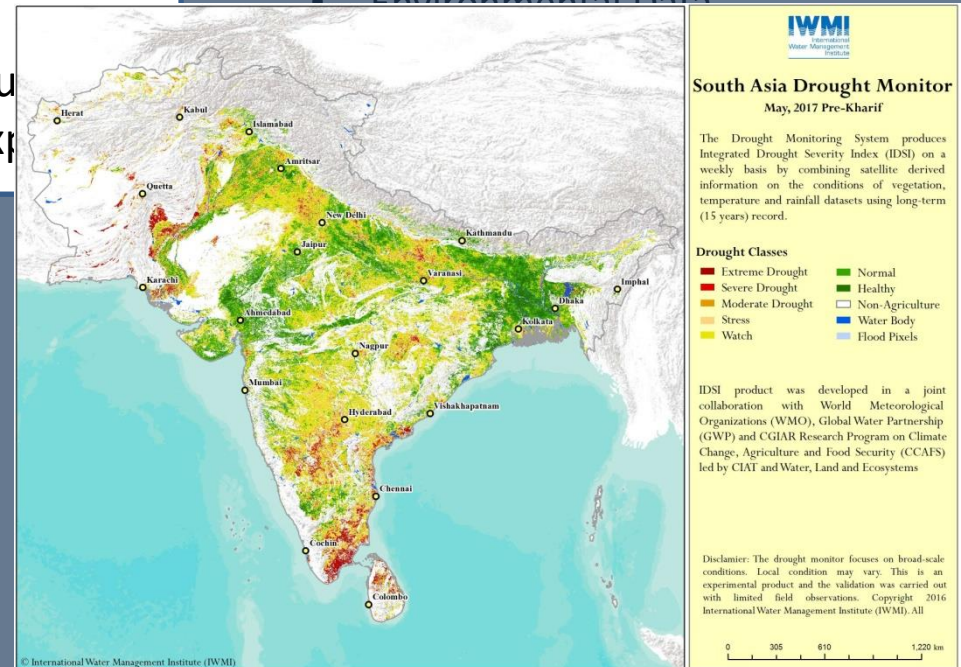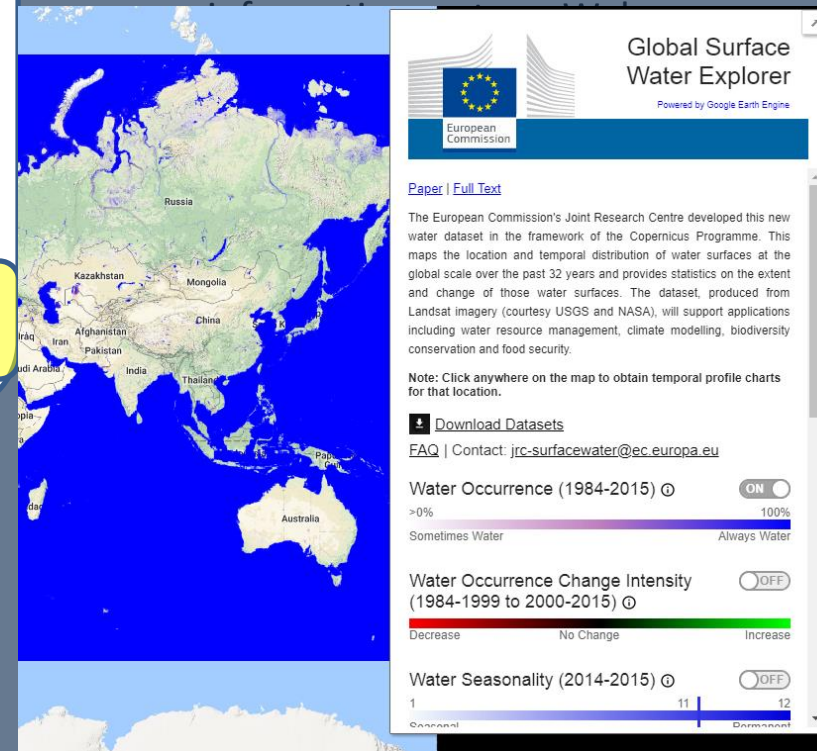
Irrigation Informatics

- Water Watch
- CIMIS
- WaterNSW
- IWMI
- 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

IWMI

South Asia Drought Monitor

May, 2017 Pre-Kharif

The Drought Monitoring System produces Integrated Drought Severity Index (IDSI) on a weekly basis by combining satellite derived information on the conditions of vegetation, temperature and rainfall datasets using long-term (15 years) record.

Drought Classes

- Extreme Drought
- Severe Drought
- Moderate Drought
- Stress
- Watch
- Normal
- Healthy
- Non-Agriculture
- Water Body
- Flood Pixels

IDSI product was developed in a joint collaboration with World Meteorological Organizations (WMO), Global Water Partnership (GWP) and CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) led by CIAT and Water, Land and Ecosystems

Disclamier: The drought monitor focuses on broad-scale conditions. Local condition may vary. This is an experimental product and the validation was carried out with limited field observations. Copyright 2016 International Water Management Institute (IWMI). All

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

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

Global Surface Water Explorer

Powered by Google Earth Engine

European Commission

Paper | Full Text

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 modelling, biodiversity conservation and food security.

Note: Click anywhere on the map to obtain temporal profile charts for that location.

Download Datasets
FAQ | Contact: jrc-surfacewater@ec.europa.eu

Water Occurrence (1984-2015) ⓘ   ON
>0%   100%
Sometimes Water   Always Water

Water Occurrence Change Intensity
(1984-1999 to 2000-2015) ⓘ   OFF
Decrease   No Change   Increase

Water Seasonality (2014-2015) ⓘ   OFF
1   11   12
Seasonal   Permanent

Global Datasets

AQUASTAT

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

Irrigation informatics

- ...ter Watch
- ...MIS
- ...terNSW
- ...MI
- ...WS
- ...bal surface
- ...ter explorer

Others

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

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/

Glacier & Snow Monitoring

United Nations Environment Programme
environment for development
UNEP

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.

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

Irrigation Informatics
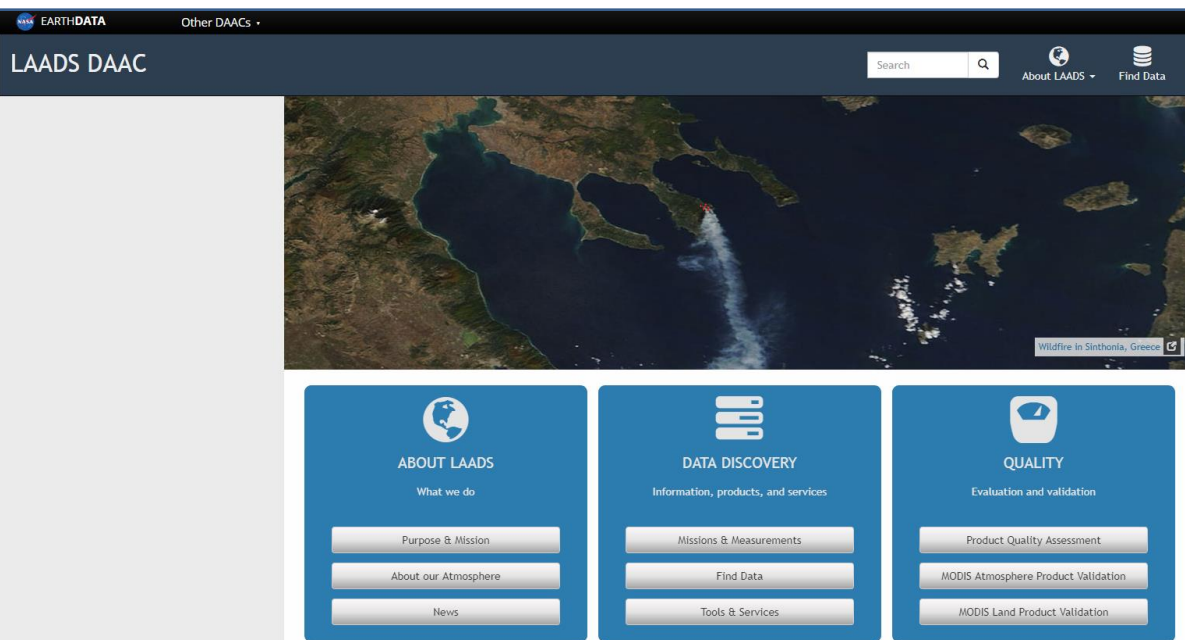
- DEWS
- Global surface water explorer

Others

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

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
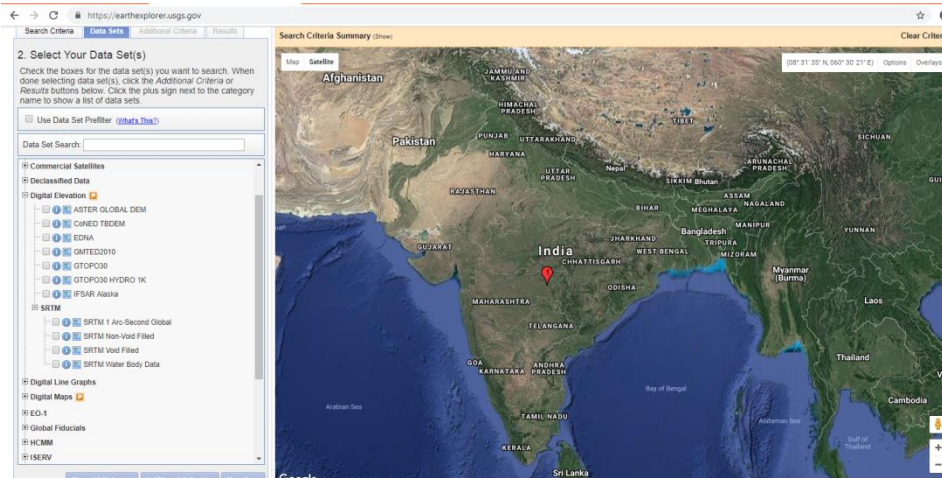- LAADS DAAC
- DIVA-GIS

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

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