

Overview of SRTM and ASTER DEM Data

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Learning Objectives

- Understand SRTM and ASTER Digital Elevation Modeling (DEM) data
- Access DEM Data



Outline

- SRTM and ASTER DEM Data
- SRTM and ASTER DEM Data Access
 - Global Data Explorer (GDEx)
 - Consultative Group for International Agricultural Research (CIGAR)
- Demonstration of GDEx





SRTM and ASTER DEM

What is SRTM?

<https://www2.jpl.nasa.gov/srtm/mission.htm>

- A C-band (5.6 cm) radar mission
- On NASA Space Shuttle Endeavour
- Completed February 2000
- 176 orbits around Earth in 11 days
- Acquired digital terrain elevation data of all land between 60°N- 56°S latitude
- ~80% of Earth's total land mass

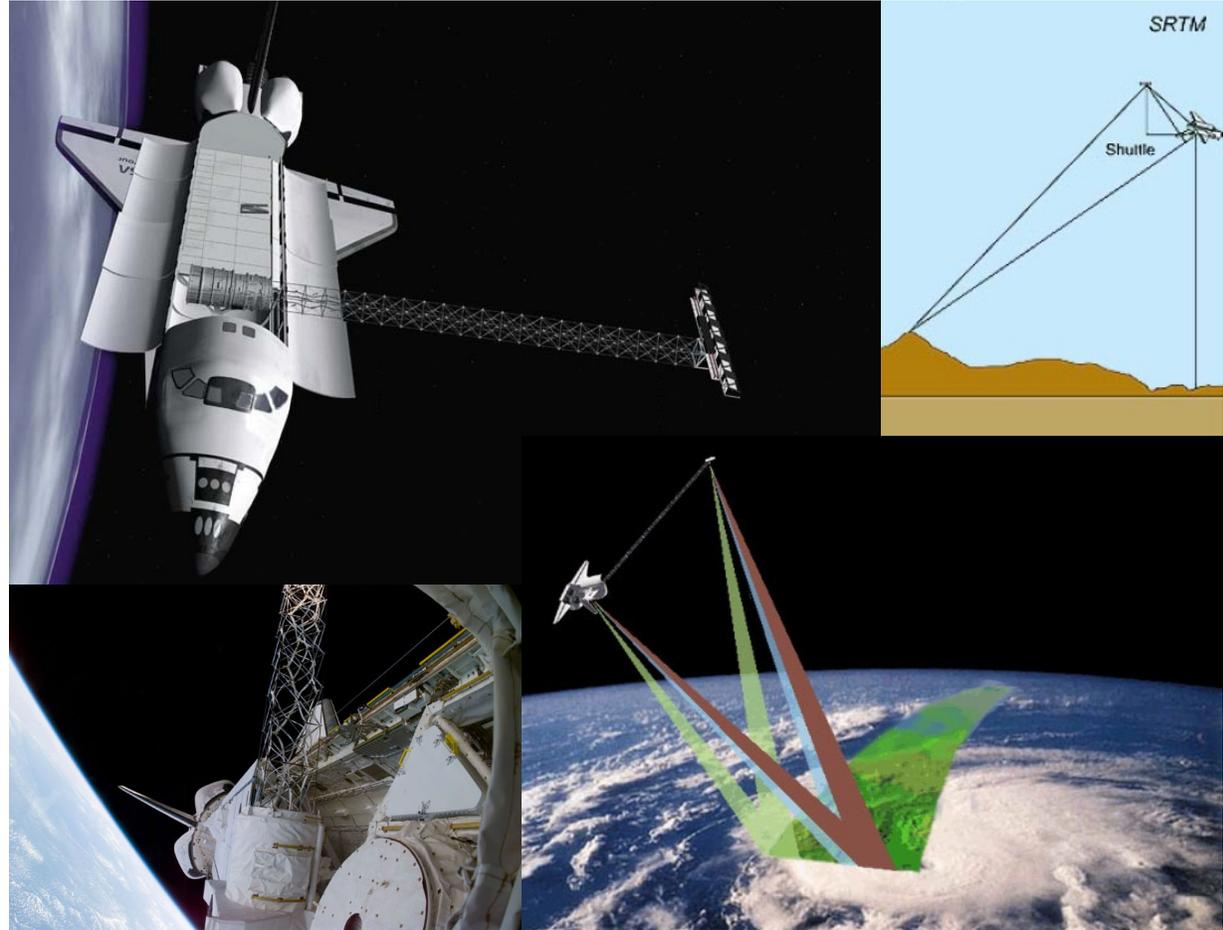


Image Credit (Top Right): DLR

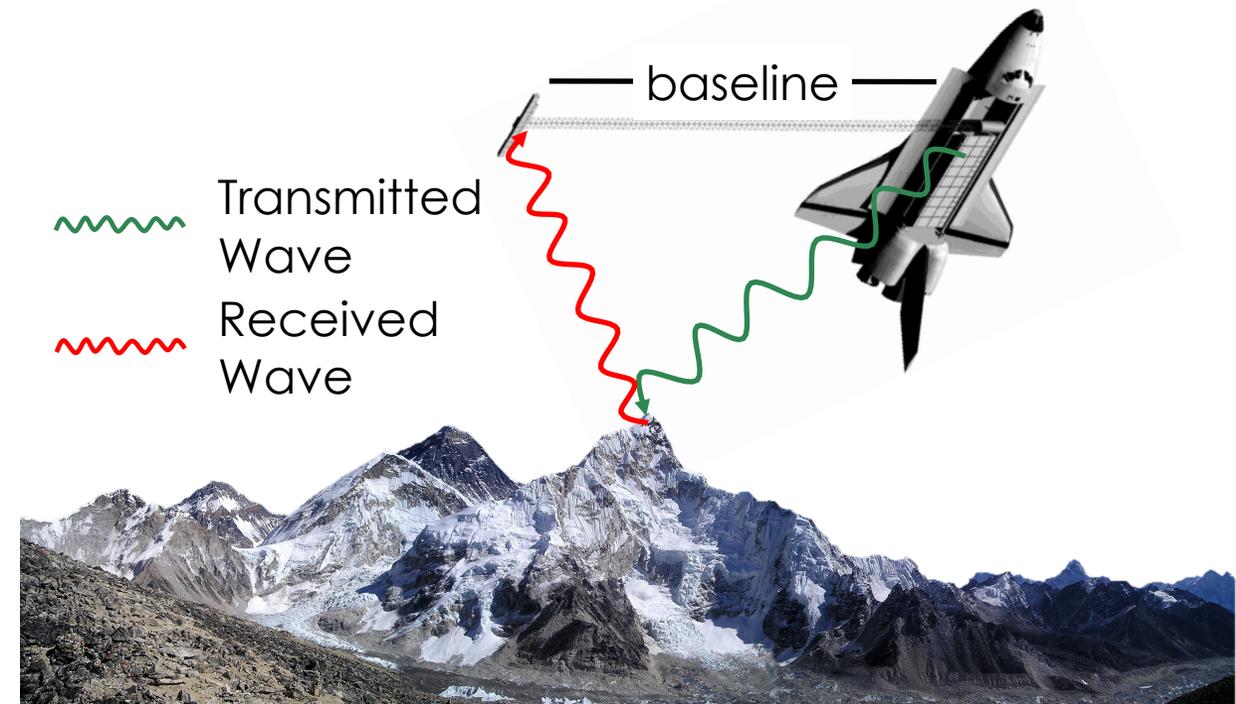


SRTM Digital Terrain Data

<http://www2.jpl.nasa.gov/srtm/instr.htm>

- SRTM used interferometry to gather topographic (elevation) data
- Interferometry:
 - two radar images of the same area are taken from different views
 - the difference in the two images determines the height of the surface in the digital elevation model (DEM)

Radar signals being transmitted and received on the SRTM mission (not to scale)



Based on a JPL graphic: <http://www2.jpl.nasa.gov/srtm/instrumentinterferometry.html>



NASA SRTM Version 3.0 (SRTM Plus)

- As of 2015, terrain data are available at 1 arc second or 30 m spatial resolution
- Eliminated voids in SRTM data by filling it with:
 - ASTER GDEM2
 - USGS GMTED2010
 - USGS National Elevation Dataset (NED)

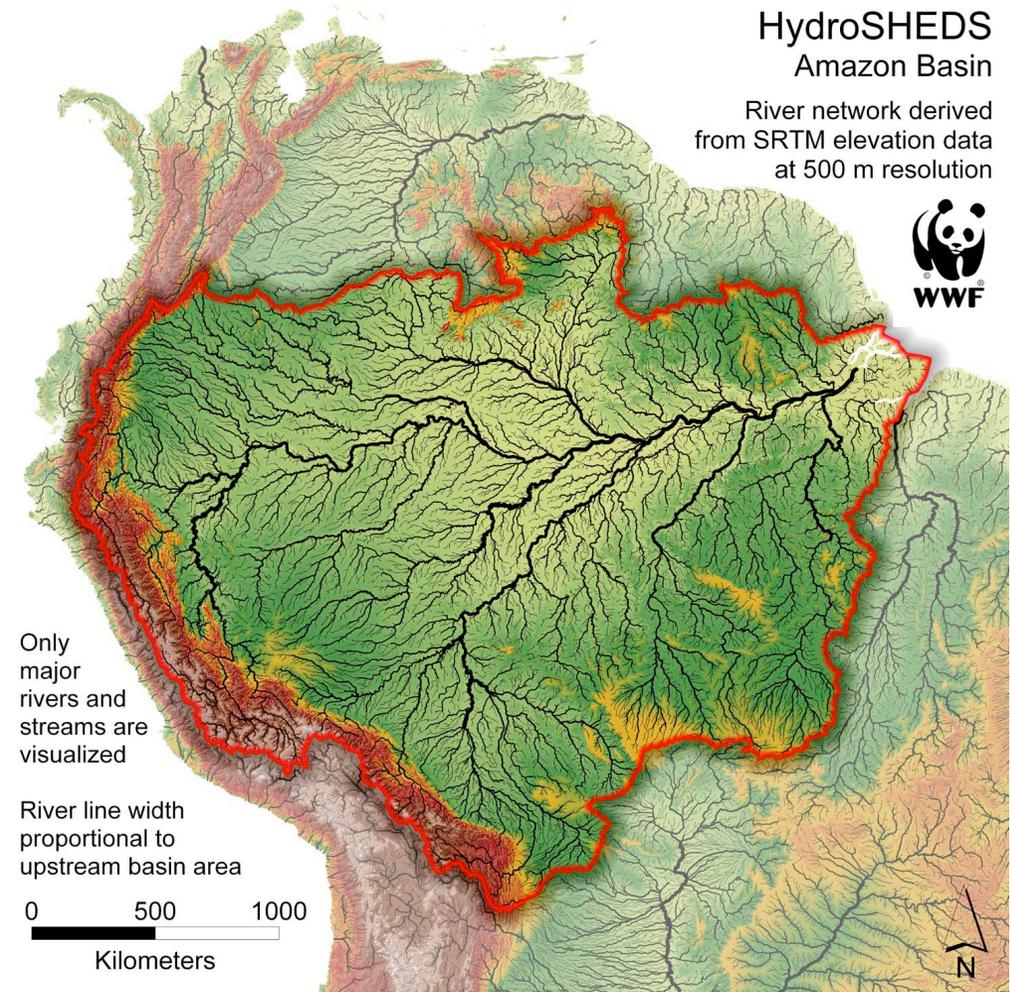


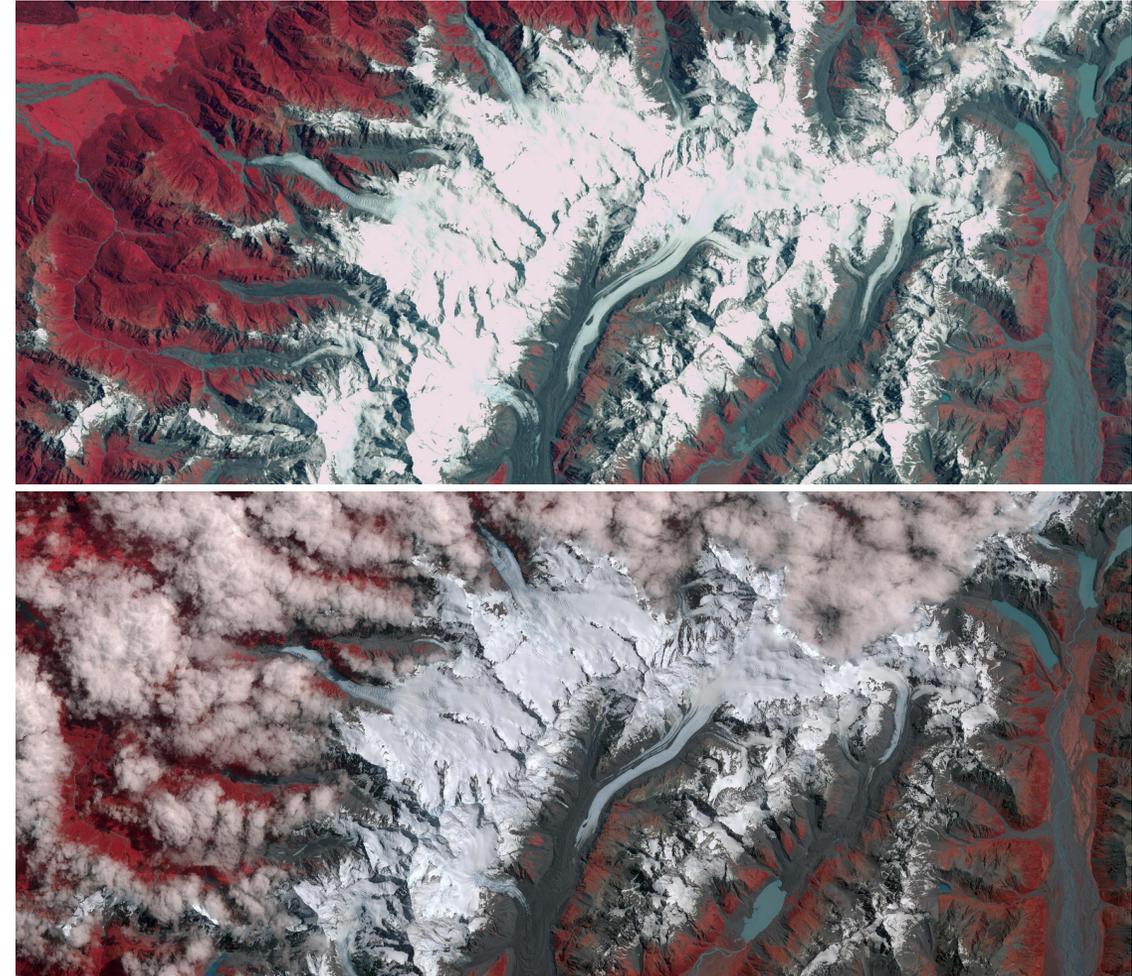
Image Credit: WWF, Text Reference: <https://earthdata.nasa.gov/community/community-data-system-programs/measures-projects/nasadem>



Advanced Spaceborne Thermal and Reflection Radiometer (ASTER)

<http://asterweb.jpl.nasa.gov/>

- Onboard Terra
 - Polar orbiting satellite launched Dec 1999
- Spatial Coverage and Resolution
 - Global
 - Swath Width: 60 km
 - Spatial Resolution Varies:
 - 15 m
 - 30 m
 - 90 m



Images of New Zealand glaciers in 1990 (Top: Landsat; Bottom: ASTER)

Advanced Spaceborne Thermal and Reflection Radiometer (ASTER)

<http://asterweb.jpl.nasa.gov/>

- Spectral Bands
 - **14 bands** (visible to thermal IR bands)
 - Bands 1-3: 15 m (VNIR)
 - Bands 4-9: 30 m (SWIR)
 - Bands 10-14: 90 m (TIR)
- Status alert: ASTER SWIR data acquired since Apr 2008 not usable

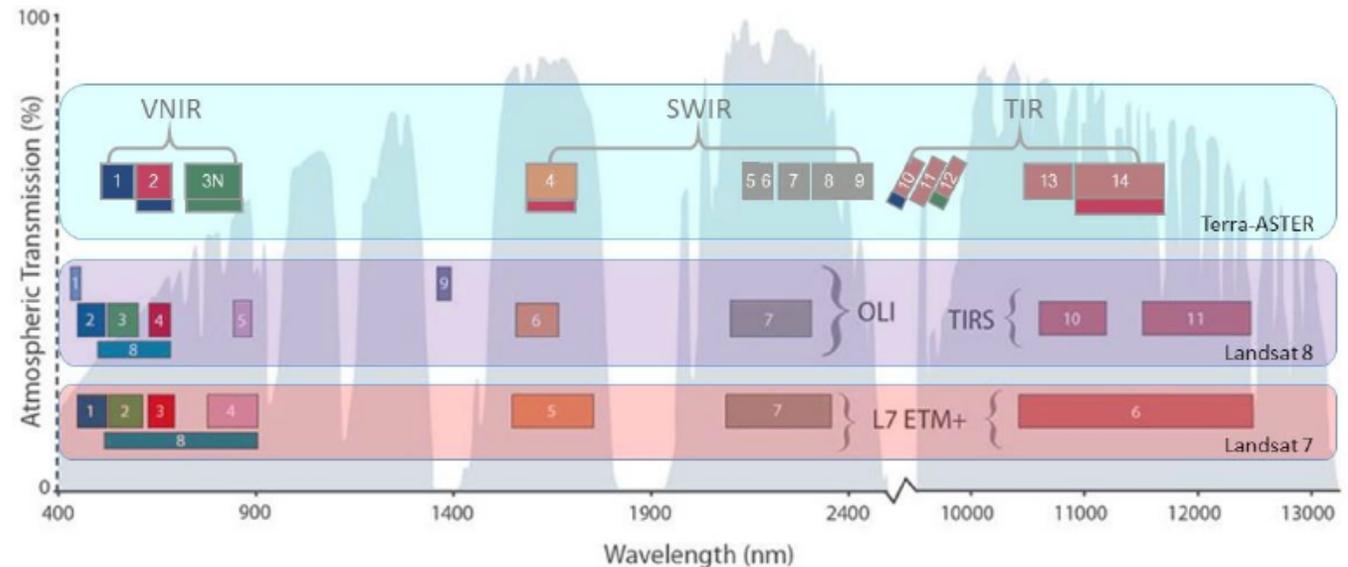


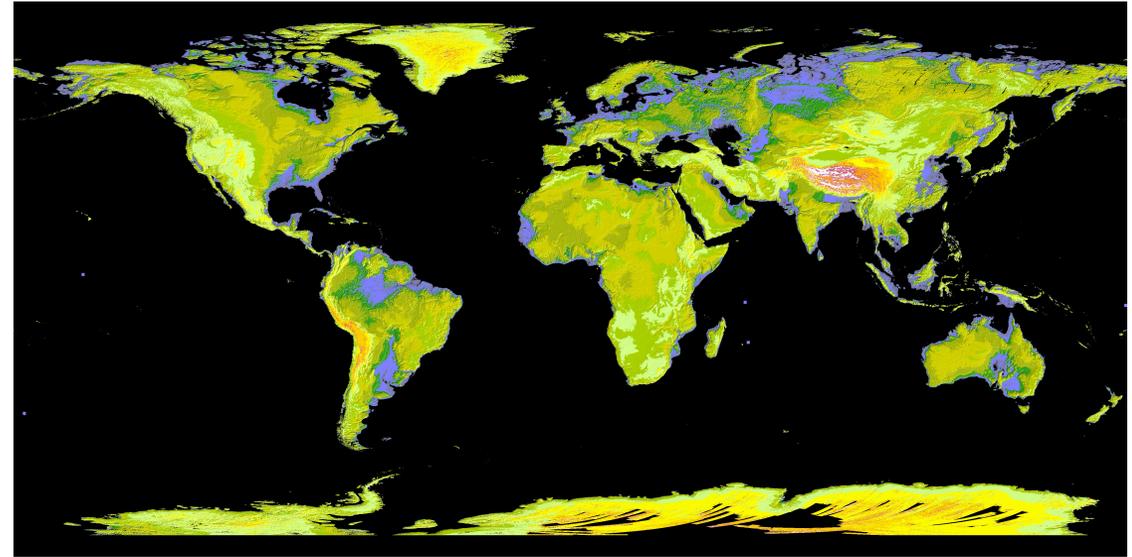
Image Credit: Vincheh, Z.H. and Arfania, R. (2017) Lithological Mapping from OLI and ASTER Multispectral Data Using Matched Filtering and Spectral Analogues Techniques in the Pasab-e-Bala Area, Central Iran. Open Journal of Geology, 7, 1494-1508.



ASTER Global Digital Elevation Model (GDEM V2)

<https://asterweb.jpl.nasa.gov/gdem.asp>

- A joint product developed by NASA and the Ministry of Economy, Trade, and Industry (METI) of Japan
- Uses ASTER VNIR stereo pair images to derive DEM
- GDEM version 2 is available since 2011, based on all available ASTER stereo images
- Covers land surfaces between 83°N – 83°S and is composed of 22,600 1° by 1° tiles of 30 m resolution



SRTM and GDEM2 Accuracy

Results from the CONUS Absolute Vertical Accuracy Assessment (in meters)

DEM	Minimum	Maximum	Mean	Standard Deviation	RMSE	LE95
GDEM2	-137.37	64.80	-0.20	8.68	8.68	17.01
NED	-46.21	16.42	-0.33	1.81	1.84	3.61
SRTM	-28.67	28.58	0.73	3.95	4.01	7.86
GDEM1	-127.74	105.41	-3.69	8.58	9.34	18.31

- Based on comparison with 18,000 geodetic points over the U.S.
- “...the GDEM validation team recommends the release of the GDEM2 to the public, acknowledging that, while vastly improved, some artifacts still exist which could affect its utility in certain application” - ASTER GDEM team [<https://pubs.er.usgs.gov/publication/70005960>]

RMSE: Root Mean Square Error

LE95: Linear error at 95% Confidence Level



SRTM and GDEM2 Accuracy

DEM data accuracy depends on **location** and **land cover categories**

Land Cover	SRTM (rmse m)	GDEM2 (rmse m)
Grass & Shrub	12.36	16.6
Deciduous	25.49	20.79
Evergreen	24.76	22.23
Mixed	18.81	10.03

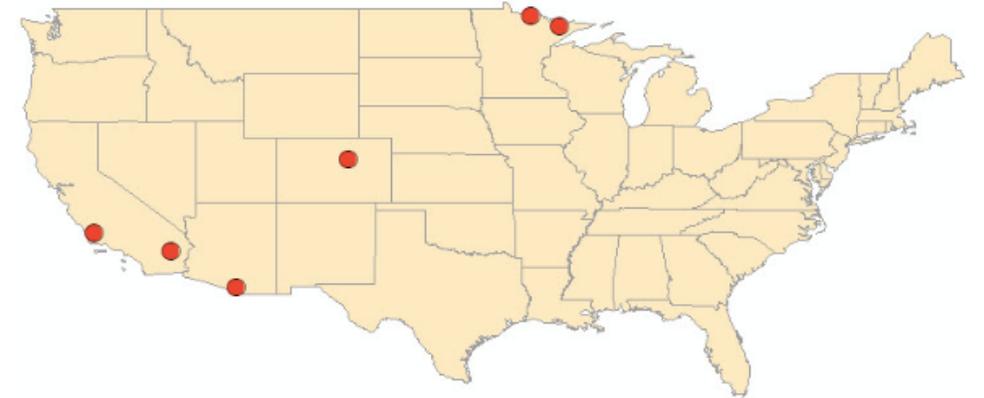


Figure 1. Study sites (California [2], Arizona [1], Colorado [1], and Minnesota [2]).

Tighe, M. L., & Chamberlain, D. (2009). Accuracy Comparison of the SRTM, ASTER, NED, NEXTMAP USA Digital Terrain Model Over Several USA Study Sites. In *ASPRS/MAPPS 2009 Conference Proceedings*. San Antonio, TX. Retrieved from http://www.asprs.org/a/publications/proceedings/sanantonio09/Tighe_2.pdf



DEM Applications

- Useful for mapping hazardous terrain
- Calculate:
 - slope and aspect
 - catchment area
 - forest canopy height
- Models:
 - runoff
 - stream networks
 - landslides

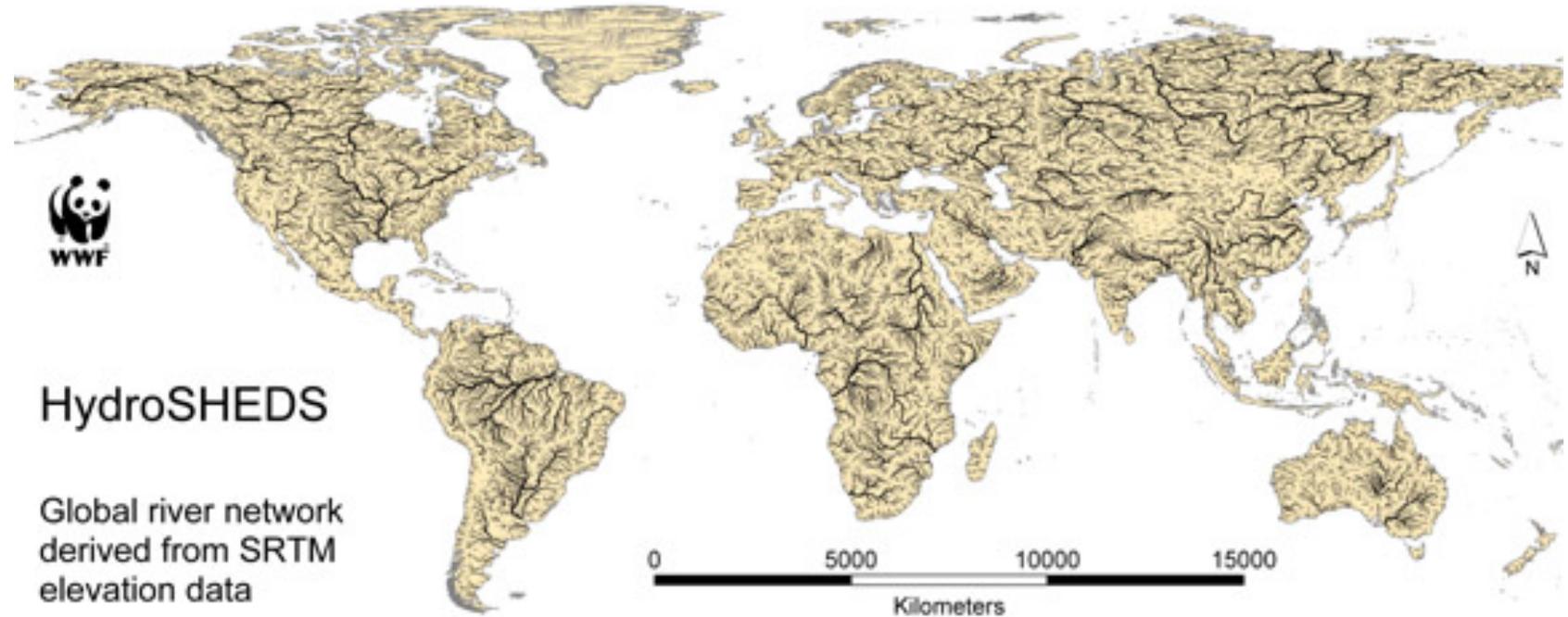
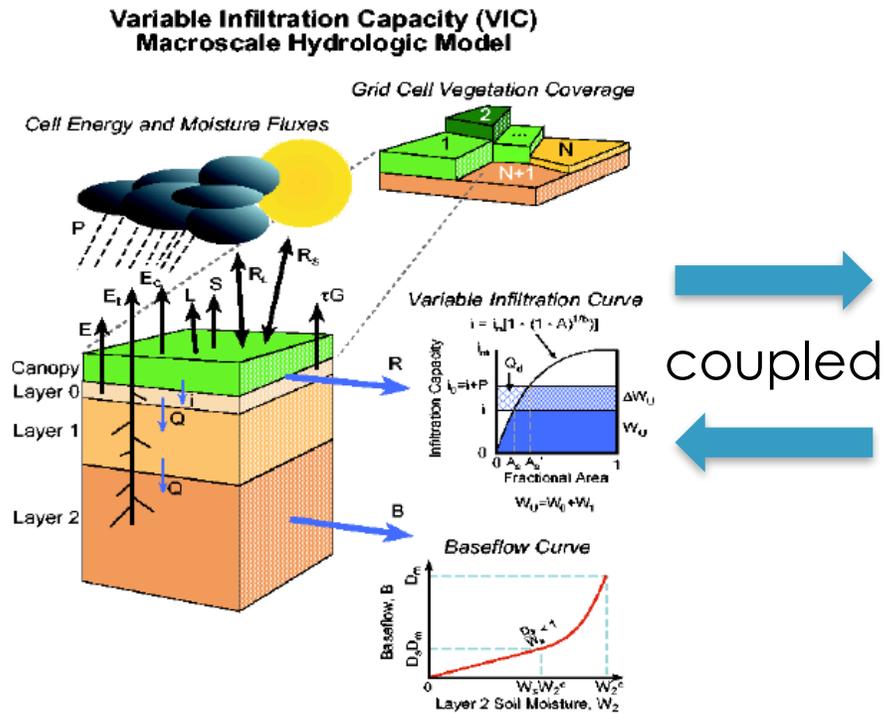


Image Credit: USGS HydroSHEDS/WWF



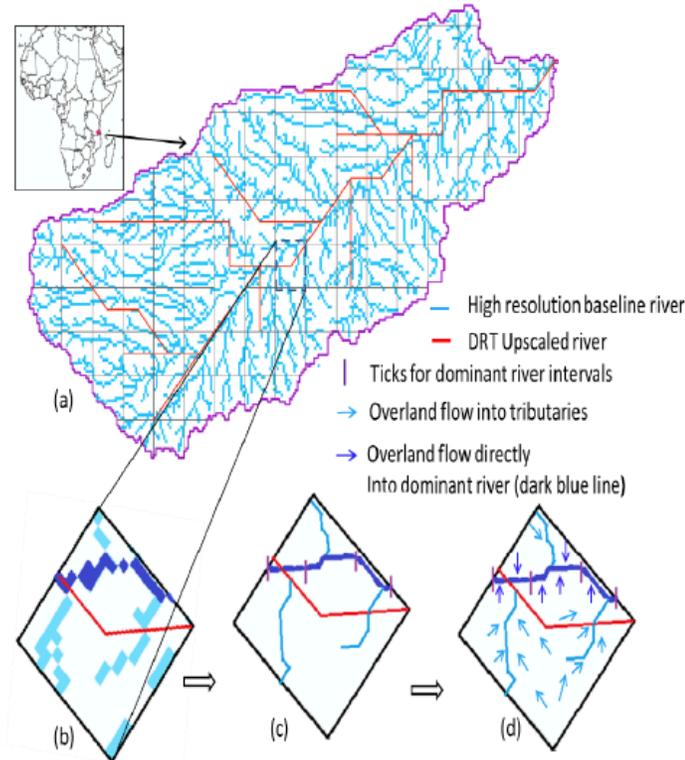
SRTM DEM Application in Flood Modeling

VIC



coupled

DRTR – Dominant River Tracing Based Routing



- The Global Flood Monitoring System (GFMS) uses HydroSHEDS derived from SRTM DEM for identifying river networks for routing models
- <http://hydrosheds.org/>

University of Washington

University of Maryland

Wu et al., *Real-time Global Flood Monitoring and Forecasting using an Enhanced Land Surface Model with Satellite and NWP model based Precipitation*. GFMS. http://flood.umd.edu/GFMS_conference.pdf



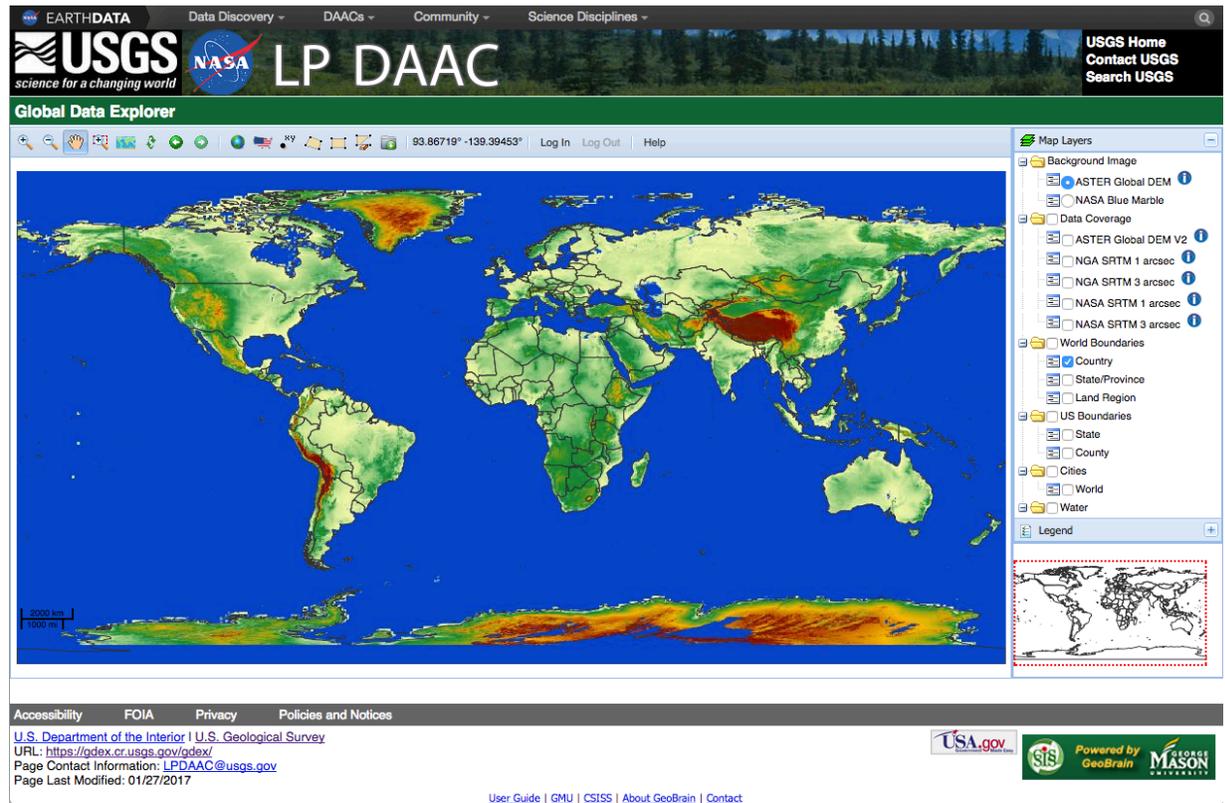


SRTM and ASTER DEM Data Access

Global Data Explorer (GDEx)

<http://gdex.cr.usgs.gov/>

- Seamless data viewer that provides access to multiple sources of digital elevation datasets
- Users can subset and download data by area of interest in multiple formats and projections
- Requires user registration via <http://urs.earthdata.nasa.gov>
- Data can be previewed before downloading



SRTM V3 and ASTER DEM from GDEx

<http://gdex.cr.usgs.gov/>

The screenshot shows the Global Data Explorer (GDEx) interface. At the top, there are navigation menus for 'Data Discovery', 'DAACs', 'Community', and 'Science Disciplines'. The main header features the USGS and NASA logos, along with 'LP DAAC'. The 'Global Data Explorer' title is prominently displayed. Below the header, there are search and navigation icons, and a status bar showing coordinates (93.86719° -139.39453°) and options for 'Log In', 'Log Out', and 'Help'. The central part of the page is a world map showing topographic data. A red box highlights the 'Map Layers' panel on the right side of the map. This panel lists several layers: 'Background Image' (with 'ASTER Global DEM' and 'NASA Blue Marble' selected), 'Data Coverage' (with 'ASTER Global DEM V2', 'NGA SRTM 1 arcsec', 'NGA SRTM 3 arcsec', 'NASA SRTM 1 arcsec', and 'NASA SRTM 3 arcsec' listed), 'World Boundaries' (with 'Country', 'State/Province', and 'Land Region' listed), 'US Boundaries' (with 'State' and 'County' listed), 'Cities' (with 'World' listed), and 'Water'. A 'Legend' button is at the bottom of the panel. A small inset map is visible at the bottom right of the main map area.

30 m data

This is a close-up view of the 'Map Layers' panel. It shows a list of layers with checkboxes and information icons. Two layers are highlighted with red boxes: 'ASTER Global DEM V2' and 'NASA SRTM 1 arcsec'. Red arrows point from the text '30 m data' to these two layers. Other layers visible include 'Background Image' (with 'ASTER Global DEM' and 'NASA Blue Marble'), 'Data Coverage' (with 'NGA SRTM 1 arcsec', 'NGA SRTM 3 arcsec', and 'NASA SRTM 3 arcsec'), 'World Boundaries' (with 'Country', 'State/Province', and 'Land Region'), 'US Boundaries' (with 'State' and 'County'), 'Cities' (with 'World'), and 'Water'. A 'Legend' button is at the bottom.



SRTM V3 and ASTER DEM from GDEx

<http://gdex.cr.usgs.gov/>

The screenshot displays the Global Data Explorer (GDEx) web application. At the top, there are navigation menus for 'Data Discovery', 'DAACs', 'Community', and 'Science Disciplines'. The main header features the USGS and NASA logos, along with 'LP DAAC'. A 'Log In' button is highlighted with a red box. The central area shows a world map with a color-coded DEM overlay. The right sidebar contains a 'Map Layers' panel with various data layers. The bottom of the page includes footer information such as 'U.S. Department of the Interior | U.S. Geological Survey' and 'Powered by GeoBrain'.

Login with your NASA Earthdata username and password



GDEX: SRTM Data Selection

<http://gdex.cr.usgs.gov/>

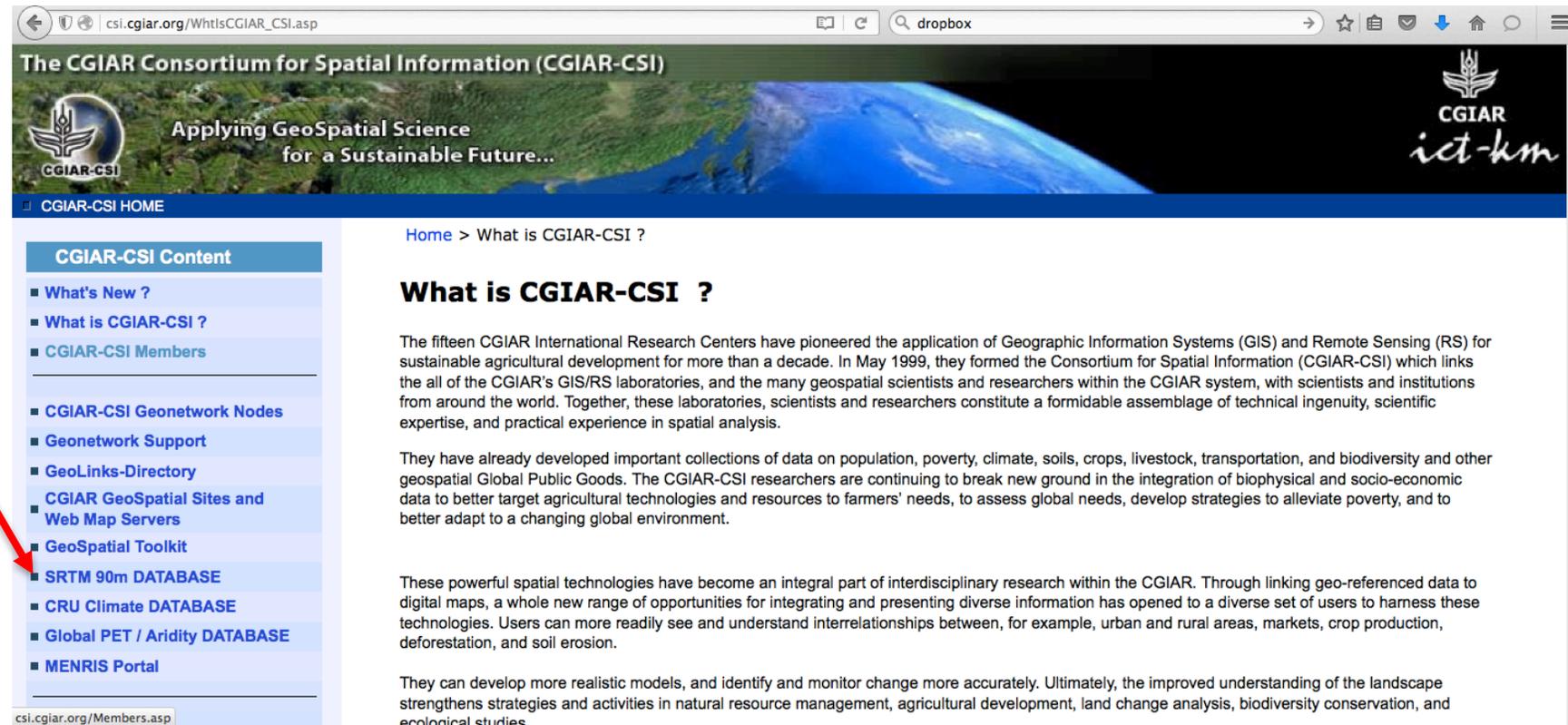
The screenshot displays the GDEX web application interface. At the top, there are navigation menus for 'EARTHDATA', 'Data Discovery', 'DAACs', 'Community', and 'Science Disciplines'. The main header features the USGS logo and 'LP DAAC'. A toolbar contains various icons for map navigation and data selection. A 'Zoom' callout points to the zoom in (+) and zoom out (-) icons. A larger callout 'Define region of interest by bounding box, state, country, or lat/long' points to a group of icons including a globe, a US flag, a state outline, and a bounding box. A 'Refresh' callout points to a circular refresh icon. A 'Download' callout points to a folder icon. On the right, a 'Map Layers' panel shows a list of data layers, including 'ASTER Global DEM', 'NASA Blue Marble', and 'NASA SRTM 1 arcsec'. A legend at the bottom right shows a map of the United States with a red dashed bounding box over the western region. The bottom of the page contains footer information including 'U.S. Department of the Interior | U.S. Geological Survey', 'URL: https://gdex.cr.usgs.gov/gdex/', 'Page Contact Information: LPDAAC@usgs.gov', 'Page Last Modified: 01/27/2017', and logos for 'USA.gov', 'SIS', 'GeoBrain', and 'GEORGE MASON UNIVERSITY'.



SRTM Data from CGIAR-CSI

http://csi.cgiar.org/WhatisCGIAR_CSI.asp

CGIAR-CSI: Consultative Group for International Agricultural Research
Consortium of Spatial Information



The screenshot shows a web browser window displaying the CGIAR-CSI website. The browser's address bar shows the URL csi.cgiar.org/WhatisCGIAR_CSI.asp. The website header features the CGIAR-CSI logo and the tagline "Applying GeoSpatial Science for a Sustainable Future...". A navigation menu on the left lists various content categories, with "SRTM 90m DATABASE" highlighted in blue. A red arrow points from the text "SRTM data (90 m)" on the left to this menu item. The main content area displays the heading "What is CGIAR-CSI ?" followed by a paragraph describing the consortium's mission and a list of data resources.

CGIAR-CSI Content

- What's New ?
- What is CGIAR-CSI ?
- CGIAR-CSI Members
- CGIAR-CSI Geonetwork Nodes
- Geonetwork Support
- GeoLinks-Directory
- CGIAR GeoSpatial Sites and Web Map Servers
- GeoSpatial Toolkit
- SRTM 90m DATABASE**
- CRU Climate DATABASE
- Global PET / Aridity DATABASE
- MENRIS Portal

What is CGIAR-CSI ?

The fifteen CGIAR International Research Centers have pioneered the application of Geographic Information Systems (GIS) and Remote Sensing (RS) for sustainable agricultural development for more than a decade. In May 1999, they formed the Consortium for Spatial Information (CGIAR-CSI) which links the all of the CGIAR's GIS/RS laboratories, and the many geospatial scientists and researchers within the CGIAR system, with scientists and institutions from around the world. Together, these laboratories, scientists and researchers constitute a formidable assemblage of technical ingenuity, scientific expertise, and practical experience in spatial analysis.

They have already developed important collections of data on population, poverty, climate, soils, crops, livestock, transportation, and biodiversity and other geospatial Global Public Goods. The CGIAR-CSI researchers are continuing to break new ground in the integration of biophysical and socio-economic data to better target agricultural technologies and resources to farmers' needs, to assess global needs, develop strategies to alleviate poverty, and to better adapt to a changing global environment.

These powerful spatial technologies have become an integral part of interdisciplinary research within the CGIAR. Through linking geo-referenced data to digital maps, a whole new range of opportunities for integrating and presenting diverse information has opened to a diverse set of users to harness these technologies. Users can more readily see and understand interrelationships between, for example, urban and rural areas, markets, crop production, deforestation, and soil erosion.

They can develop more realistic models, and identify and monitor change more accurately. Ultimately, the improved understanding of the landscape strengthens strategies and activities in natural resource management, agricultural development, land change analysis, biodiversity conservation, and ecological studies.

SRTM data (90 m)



CGIAR-CSI: SRTM Data Access

The CGIAR Consortium for Spatial Information (CGIAR-CSI) CGIAR ict-hm

Applying GeoSpatial Science for a Sustainable Future...

[CGIAR-CSI HOME](#)
[SRTM 90m DATABASE HOME](#)
[DISCLAIMER](#)
[HELP](#)

CGIAR-CSI Content

- Who are CGIAR-CSI ?
- CGIAR-CSI Representatives
- CGIAR-CSI Blog
- CRU Climate Data

SRTM Content

- **SRTM Data Search and Download**
- SRTM Data Processing Methodology
- SRTM FAQ
- SRTM Quality Assessment (PDF File - 2.55 Mb)
- About SRTM Imagery
- CIAT Landuse Project
- How to Search for Data?
- Disclaimer
- Contact Us

GeoNetwork Project

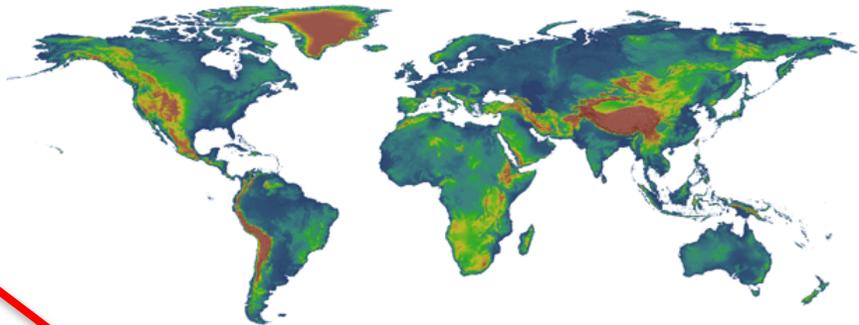
- CGIAR-CSI Geonetwork Nodes
- GeoNetwork Support

Visitors See more ▶

128,510	28,433	15,471
111,237	28,307	14,373
73,504	27,433	14,276
51,296	22,797	13,455
43,972	19,977	11,861
38,361	19,002	11,130
34,596	18,331	9,985
29,520	17,686	9,900

Pageviews: 1,637,638

SRTM 90m Digital Elevation Data



Hot: Resampled SRTM data to 250m resolutions for the entire globe are available [\(Click here\)](#)

UPDATE - VERSION 4: THE SPATIAL DATA CENTER HAS RELEASED NEW AUXILIARY DEMs. WE'RE CONFIDENT!

The CGIAR-CSI GeoPortal is able to provide proportions of the tropics and other areas for applications for sustainable development. The data is mosaiced into 5 deg x 5 deg tiles for easy browser or accessed directly from the ftp site.

The NASA Shuttle Radar Topographic Map (SRTM) data is available as 3 arc second (approx. 90m) resolution where water or heavy shadow prevents data collection.

Dr. Andy Jarvis and Edward Guevara of the CIAT Agroecosystems Resilience project, Dr. Hannes Isaak Reuter (JRC-IES-LMNH) and Dr. Andy Nelson (JRC-IES-GEM) have further processed the original DEMs to fill in these no-data voids. This involved the production of vector contours and points, and the re-interpolation of these derived contours back into a raster DEM. These interpolated DEM values are then used to fill in the original no-data holes within the SRTM data. These processes were implemented using Arc/Info and an AML script. The DEM files have been mosaiced into a seamless near-global coverage (up to 60 degrees north and south), and are available for download as 5 degree x 5 degree tiles, in geographic coordinate system - WGS84 datum. These files are available for download in both Arc-Info ASCII format, and as GeoTiff, for easy use in most GIS and Remote Sensing software applications. In addition, a binary Data Mask file is available for download, allowing users to identify the areas within each DEM which has been interpolated.

4. THIS LATEST VERSION REPRESENTS A SIGNIFICANT IMPROVEMENT FROM PREVIOUS VERSIONS, USING NEW INTERPOLATION ALGORITHMS AND BETTER DATA PROCESSING.

The SRTM 90m DEM data, produced by NASA originally, is a major breakthrough in digital mapping of the world, and provides a major advance in the accessibility of high quality elevation data for large areas. The data has been processed to fill data voids, and to facilitate its ease of use by a wide group of potential users. This data is provided in an effort to promote the use of geospatial science and the entire globe, covering all of the countries of the world, are available for download on this site. The SRTM 90m DEM's have a resolution of 90m at the equator, and are provided in both ArcInfo ASCII and GeoTiff format to facilitate their ease of use in a variety of image processing and GIS applications. Data can be downloaded using a variety of methods.

The SRTM data is currently distributed free of charge by USGS and is available for download from the National Map Seamless Data Distribution System, or the USGS ftp site. The SRTM data is available for all countries. The vertical error of the DEM's is reported to be less than 16m. The data currently being distributed by NASA/USGS (finished product) contains "no-data" holes which make the data less useful, especially in fields of hydrological modeling.

Click to select and download data




CGIAR-CSI: SRTM Data Access

Spatial selection can be by lat/lon or by clicking on the grid(s)



SRTM Data Selection Options

1. Select Server: CGIAR-CSI (USA) HarvestChoice (USA)

2. Data selection method: Multiple Selection Enable Mouse Drag Input Coordinates

Many tiles can be selected at random locations. These selected tiles are listed in the results page for download.

Decimal Degrees (ie 34.5, -100.5) Degrees: Minutes: Seconds (ie 34 30 00)

Longitude - min: max: Longitude - min: East max: East

Latitude - min: max: Latitude - min: North max: North

Longitude: 100.00 Latitude: 100.0 Tile X: 10 Tile Y: 10

3. Select File Format: GeoTiff ArcInfo ASCII

Select data format

Clear grid selection

i If you see above map flickering when using Microsoft Internet Explorer, please set the "Check for newer versions of stored pages" setting in Settings Tab in Internet Options to Automatic.

CGIAR-CSI Home | SRTM 90m Database | SRTM Data Processing Methodology | SRTM Data Search | Disclaimer | Contact Us

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CGIAR-CSI: SRTM Data Download

- Download options
- Digital elevation data can be downloaded as GeoTIFF

The CGIAR Consortium for Spatial Information (CGIAR-CSI)

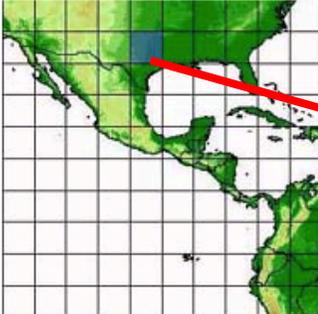
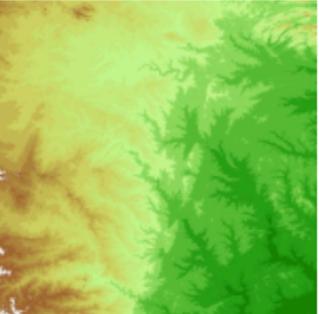
Applying GeoSpatial Science for a Sustainable Future...

CGIAR-CSI

CGIAR ict-km

<< BACK TO SEARCH ■ CSI HOME ■ SRTM MAIN ■ HELP

1 Items have been Found.

Description	Location	Image
<p>Product : SRTM 90m DEM version 4</p> <p>Data File Name : srtm_17_06.zip</p> <p>Mask File Name: srtm_mk_17_06.zip</p> <p>Latitude min: 30 N max: 35 N</p> <p>Longitude min: 100 W max: 95 W</p> <p>Center point : Latitude 32.50 N Longitude 97.50 W</p>		

CSI Server :  Data Download (FTP)  Data Download (HTTP)  Data Mask Download (FTP)  Data Mask Download (HTTP) [^TOP](#)

[0]

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GDEx and CGIAR-CSI

- Both tools are easy to use with spatial subsetting
- Data can be downloaded as GeoTIFFs for import into GIS
- GDEx SRTM is 30 m, whereas CGIAR-CSI is 90 m
- CGIAR-CSI provides combined, multiple tiles, where GDEx provides a series of individual tiles
- GDEx also provides access to ASTER GDEM2 and other DEM data
- GDEx requires user registration and login through **NASA Earthdata**





Next
Demonstration of GDEx

Questions

1. What is the resolution of SRTM terrain data?
2. The CGIAR tool provides merged SRTM tiles, whereas GDEx provides individual tiles that you have to merge to make into a raster. Why do we still prefer to use GDEx?

