Google Earth Engine Supercomputer DEM Inspector: Comparing and Analyzing Digital Elevation Models in Florida

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Introduction

- Today's geographers have access to abundant digital geographic data, which pushes the limits of desktop GIS computational power. This research presents the DEM Inspector tool, which allows non-coding Geographic researchers to easily access Google Earth Engine's supercomputing capabilities. In this study, the tool was used to evaluate different elevation models by comparing them with the surveyed elevations from the National Geodetic Survey Data Explorer. The goal was to determine which is the best elevation model for use for the terrain of Florida. The results showed that the USGS's 3DEP 1m elevation data was found to be the most refined. The project underscores the potential of GIS techniques in harnessing supercomputing for advanced research despite challenges in GEE's tools and documentation.

Research Objectives

- Create a DEM Inspector tool to analyze different DEM models. The goal is for any user, with no coding necessary, to insert any DEM model of interest and gather data, such as elevation, slope, and aspect of the terrain.
- To test the effectiveness of our app, we will compare the best quality DEMs available to the most accurate elevation data points we have of Florida from the National Geodetic Survey Data Explorer. Which DEM is the most accurate for the flat terrain of Florida?

Methods

- Different elevation models were collected based on resolution and relevance.
- A user interface was created to allow the user to click or to directly import their desired coordinates
- A sample of 30 points of Florida coordinates and corresponding elevation values were collected from the National Geodetic Survey Data Explorer and compared with each of the DEM models used.
- The longitude and latitude recorded from the NGS Data Explorer were imported to the DEM Inspector tool 30 times for each DEM.
- Each of the elevation values was subtracted from the standard values from the National Geodetic Survey and then stored in their absolute value. The differences were averages, per DEM.

Pseudocode of Application

1. Import DEM datasets of interest
2. Divide the user interface with the inspector tool on the left panel and map on the right panel
3. Present the user with DEM drop-down menu. Once the dataset is selected, update the map
4. Once DEM dataset has been selected, extract the elevation band and add it to the map layer.
5. Use Google Earth Engine's terrain functions to calculate slope and aspect layers.
6. Create storeCoordinates function and button function to store longitude and latitude values from user input, from either clicking on the map or manually inputting into the textbox.
7. Use the coordinates to extract elevation values from the digital elevation model of interest.

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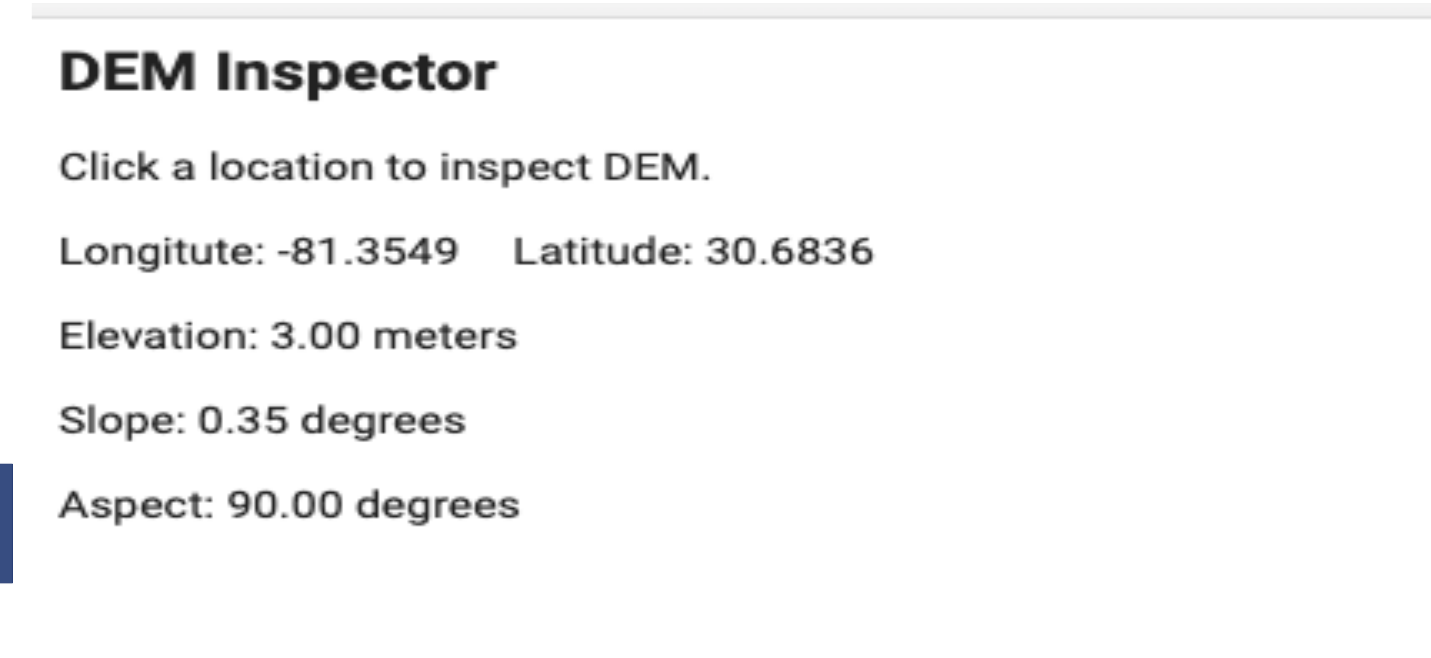
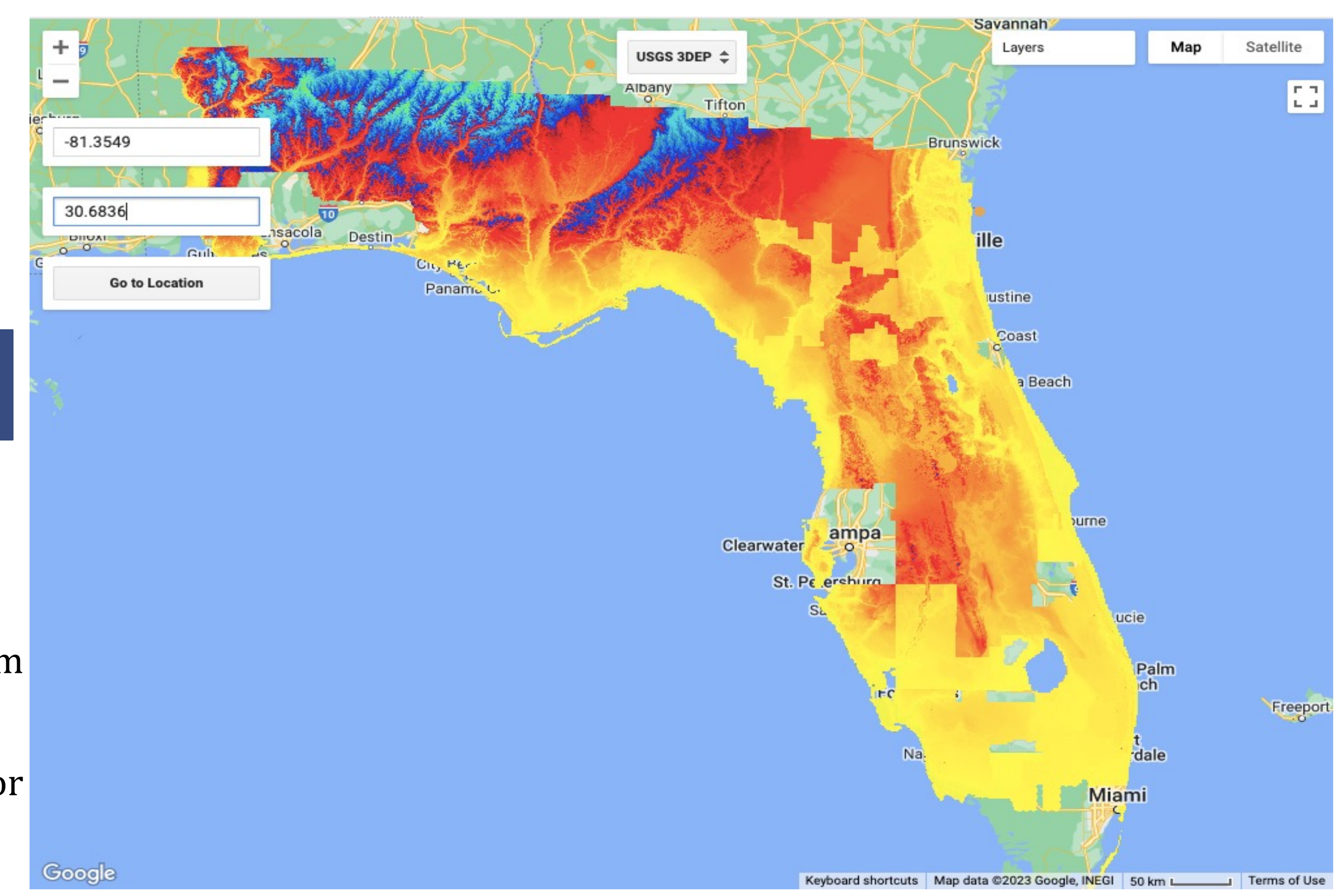
DEM INSPECTOR INTERFACE





Shuttle Radar Topography Mission (**SRTM**): SRTM was a joint project between NASA and the National Geospatial-Intelligence Agency (NGA) that used radar interferometry to collect elevation data. The data collected has been widely used for global topography mapping.

TanDEM-X: One of the twin German radar satellites launched by the German Aerospace Center (DLR). They operate in a close formation and use radar interferometry to create high-resolution DEMs. TanDEM-X is especially known for its global coverage and high precision.

Results

Under this study, the digital elevation models being evaluated are the Copernicus, SRTM 30m, Hydroshed, USGS 3DEP 1m, and GTOP030 were compared to the NGS Data. After calculating the differences for the 30 elevation data points in Florida for each DEM, these are the results:

Digital Elevation Model	Average difference from NGS standard	Resolution	Collection Date
Copernicus (Tandem X)	± 11.33 meters	9 meters to 30 meters	2010/12/01 – 2015/01/31
USGS 3DEP 1m (Lidar)	± 2.88 meters	1 meter	1998/08/16 – 2020/05/06
SRTM	± 24.30 meters	30 meters	2000/02/11 – 2000/02/22
HydroSheds	± 10.67 meters	90 meters	2000/02/11 – 2000/02/22
GTOPO30	± 20.37 meters	1 kilometer	1996/01/01

Conclusions

- The overall goal of this project was to create an application capable of harnessing the perks of supercomputing. This research and development has shown the speed and quality of data we can use to make further research and advancement using GIS techniques.
- The results show that the USGS's 3DEP 1m elevation dataset is the most refined and accurate for making measurements in Florida's terrain.
- The development of the DEM Inspector application came with many challenges. Although Google Earth Engine offers great computing power and API functions, GEE's tools and documentation have limited explanations of how their designed functions work. Therefore, we are left guessing if the proper formulas are used for specific calculations and are limited in what we can potentially code.
- The DEM Inspector tool can help facilitate future research projects needing to analyze elevation data.

References

1. https://geodesy.noaa.gov/NGSDataExplorer/
2. https://gis.stackexchange.com/questions/310973/manage-values-from-textbox-widget-in-google-earth-engine