# Establishing a Local Geoid Model in Costa Rica

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## Abstract

This project seeks to use Global Navigation Satellite System and gravity data collected in Costa Rica to contribute to local geoid model development. A geoid model is an equipotential surface, which coincides with that represented by the mean, undisturbed sea level. It is important to find the local geoid model for Costa Rica because it helps scientists advise contractors where infrastructure can be located when developing civil engineering projects and aiding tectonic and volcanic hazard prevention. To construct a geoid model for Costa Rica, we conducted fieldwork at sixteen locations in Costa Rica, including Cerro de la Muerte and Volcan Irazú. The data is processed, uploaded to QGIS, and compared to global geoid models of varying degrees and orders. Global geoid models with higher degrees and order are expected to closely correspond to geoid height values gathered at leveled benchmarks known as geometric geoid separations. We find this is true for the benchmarks on Cerro de la Muerte, but not for the benchmarks on Volcan Irazú. We expect this discrepancy is a result of the spatial distribution of historical data. The gravimeter is also a critical part of modeling the geoid because it will locate gravity anomalies below Earth's surface. Gravity anomalies will give insight to isostasy, or subsurface mass distribution, in the Cordillera Talamanca region. We successfully processed and set up tables of this data to perform further comparisons. Gravity and geoid height data will be further analyzed and used to propose modifications to the existing local geoid model.

## Background

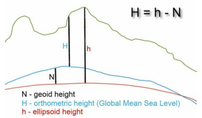



*Figure 1.* Geoid height (H) calculation

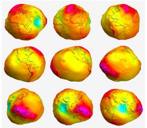
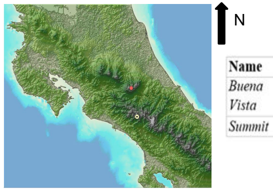


*Figure 2.* The Potsdam Potato

A geoid represents an equipotential field on the Earth's surface that is commonly referred to as undisturbed mean sea level. There are many pre-existing global geoid models with varying degrees and orders. However, there is no existing geoid model specific to Costa Rica, and Dr. Lucke and his colleagues are working to create one. It is important for a country to have a local geoid model because it provides a more accurate gravitational understanding of the region than a global geoid model does. Geoid models help scientists advise contractors where infrastructure should be built when developing civil engineering projects. It also supports tectonic and volcanic hazard prevention.

## Materials & Methods

To establish a local geoid model, we collected and processed Global Navigation Satellite System (GNSS) data and compared our findings to global geoid models. Specifically, we compared our findings to EGM2008, Eigen-6C4 Max, and GOCO Max, which are three global geoid models we sourced from the International Centre for Global Earth Models. The geoid models with the smaller degree in order are what we are looking for in order to get a more precise definition of our data point.




| Name | Observed | EGM2008 | Eigen6C4 | GOCO | EGM300 | Eigen-300 |
|---|---|---|---|---|---|---|
| *Buena Vista* | 18.19 | 17.83 | 17.81 | 16.83 | 15.99 | 15.34 |
| *Summit* | 12.99 | 15.35 | 15.33 | 14.73 | 15.34 | - |

*Figure 3:* QGIS Map and Data Table

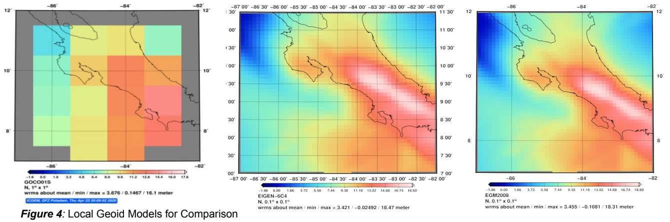



*Figure 4:* Local Geoid Models for Comparison

## Discussion & Future Work

In the future, we plan to collect data at more locations with the gravimeter in the northwest and northeast parts of Costa Rica. Collecting these points with a wide coverage will help scientists get a better understanding of the gravity measurements around Costa Rica. Understanding gravity's behavior in the region will also offer insight to isostasy and tectonic activity below the Earth's surface. Additionally, we will begin to work on making a complete geoid model for Costa Rica and continue comparing it to other geoid models, like those shown in Figure 4.

## Field Work

With a GNSS Trimble antenna and gravimeter we collected data in the field to contribute to our geoid model development.

- Cerro de la Muerte (*Buena Vista*): two six-hour observations with antenna. One with leveling height.
- Volcan Irazu (*Summit*). two six-hour observations with antenna. One with leveling height.

With the gravimeter we set up along the south eastern side of Costa Rica (San Vito) and recorded data along routes 612 & 613. Located in Figure 6.

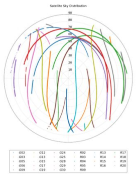



*Figure 5:* Precise Point Positioning (PPP)

Natural Resources Canada offers a Precise Point Positioning software that processes Trimble satellite data and provides users with the global positioning and satellite imaging paths that they need.


*Figure 6:* Graviter Data along Rt 612 &613

## Citations

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