Morphometric analysis of the terrain over time to characterize subsidence. Case study: Mexico City, Mexico.

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Abstract

It is well known that overexploitation of groundwater can lead to land subsidence due to the compaction of compressible aquitards. The soils of Mexico City are an important example of highly compressible lake sediments in compaction due to groundwater extraction that has significantly damaged urban and commercial building structures. Therefore, it is necessary to carry out specific studies related to topographic deformation. This talk presents a characterization of terrain changes over time from elevation models, presenting an alternative methodology to interferometry. To do this, free access elevation models generated between 2000 and 2012 were compared.

Introduction

The sinking process of Mexico City is determined by the geology and the type of soil that sustains it. The city was built on a lake (Texcoco) made up of thick soils of highly compressible volcanic and lacustrine clay deposits.

According to the Risk Atlas of the Tlalpan Delegation, the territory susceptible to differential subsidence is in the northeast portion, in the Coapa area, and adjacent to the Coyoacán and Xochimilco delegations. The fracturing of the subsoil has caused damage to all types of buildings and infrastructure, including hydraulic pipes, sidewalks, and pavements. The risk for the sinking phenomenon, to its frequency and affectation, is classified as medium. Previous studies indicate that there is annual subsidence of 15 to 25 cm in the Mexico City International Airport, 10 cm in the center, and between 10 to 15 cm in the southeast area of Mexico City.

Figure 1. In 2016 there was a subsidence of more than 2 meters and a crack that has a maximum width of 50 cm.

Metodology

To tie the two elevation models, the data was georeferencing with the Erdas Imagine software, which makes the adjustments with points that contain information in the x, y, and z directions. referencing the 2012 model to the 2000 model based on the location of streams.

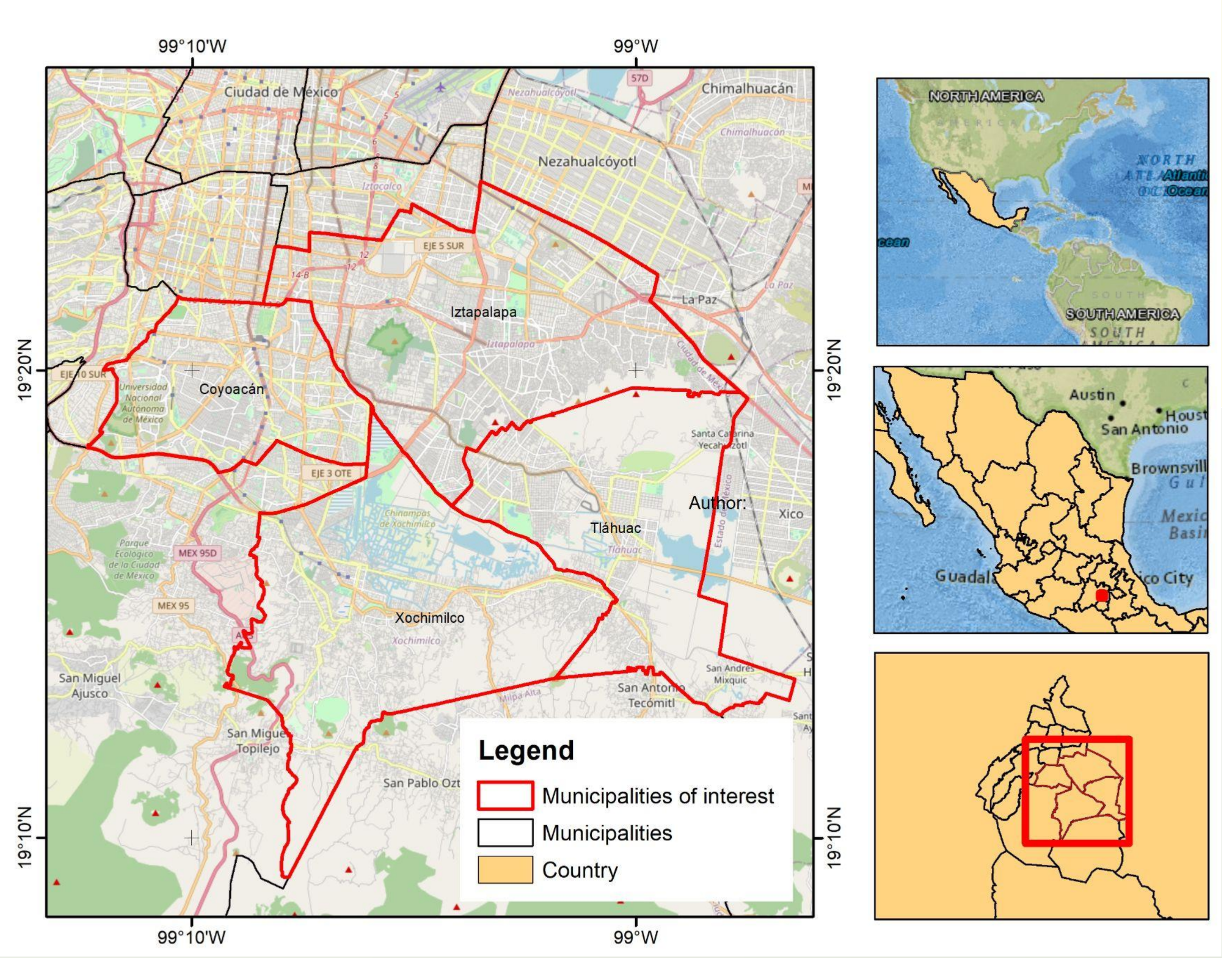

Figure 2. Site location map

An index of topographic position TPI and the degrees of the slope of the terrain were calculated. Both were compared directly by subtracting pixels that share a spatial location, subtracting the values obtained in the cells of the 2012 model to those of 2000.

Results

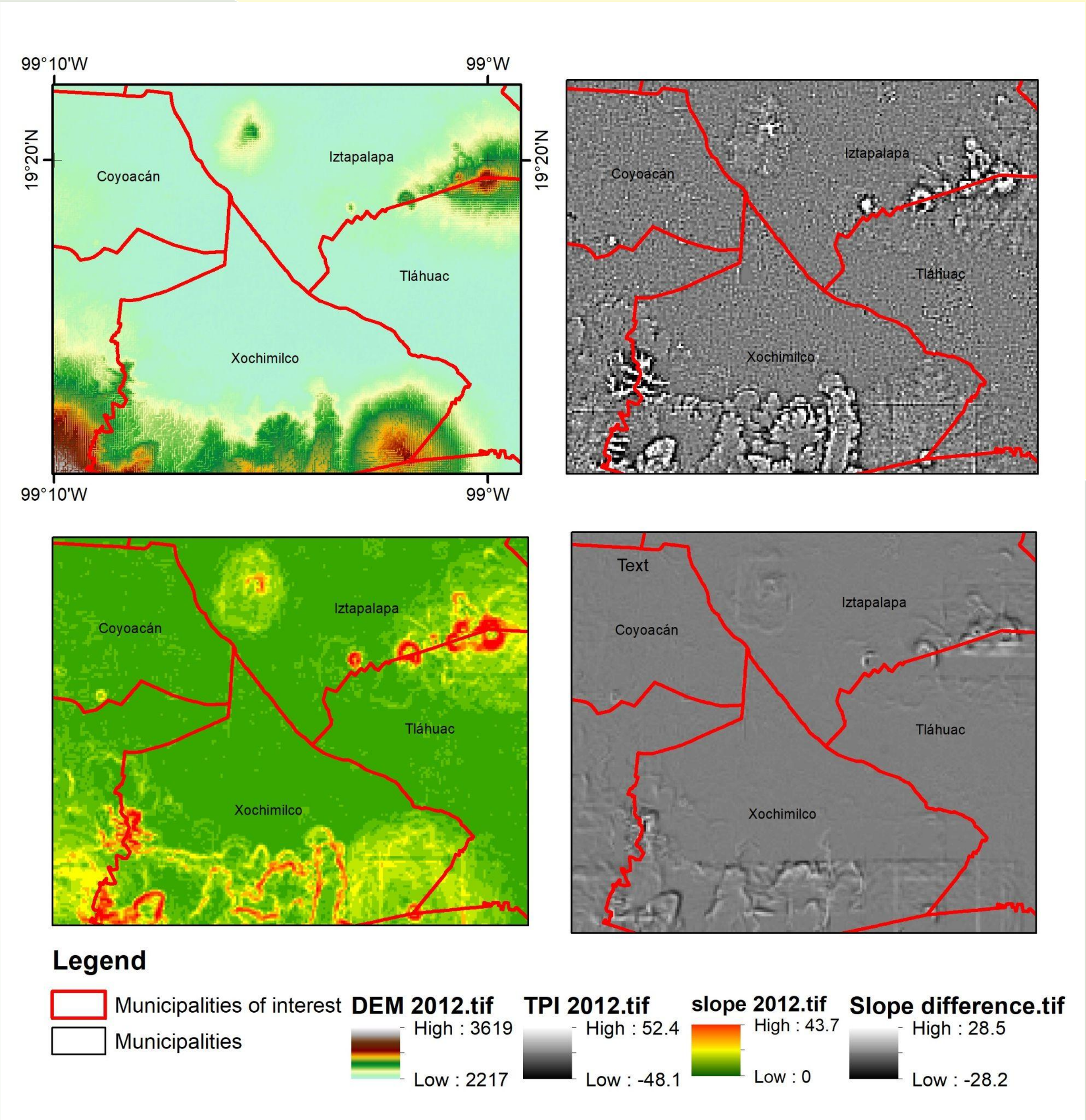

Figure 4. Maps resulting from applying the methodology, in the upper left part the elevation model of the year 2012 is shown, in the right part the result of TPI and in the lower left the processing of obtaining slopes also for the year 2012. The bottom right shows the resulting subsidence map.

Conclusions

- The georeferencing of the data in z was not effective since it is only trying to reach an average between the two, however, the tie in x and y has a good scope.
- The largest differences are reported in mountainous areas, and this is because the lag between pixels involves a very different height value between rasters.
- The difference between the TPI results shows a raster without visible topographic features, but that still does not show differences over time, that is, it only highlights what remains the same.
- The difference between slopes shows the places where the angle of the topographic relief has changed, highlighting areas that have been submerged or raised.

Bibliography

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