GEOGRAPHICAL INFORMATION SYSTEM (GIS) APPLICATION ON A DESCRIPTIVE SOIL COMPOSITION ANALYSIS IN NASSAU COUNTY, NEW YORK

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Abstract

In respect to previous knowledge of the Wisconsin Glacial Episode, our research focused on analyzing the current soil compositional make-up of Nassau County, New York in contrast to the soil compositional make-up dating back to the early 1900's. This research aims to construct a descriptive soil analysis while comparing how the soil of Nassau County has changed over time while taking into account various environmental factors. Those factors being climate change and erosion. Soil survey data provided by Field Operations of the Bureau of Soils was used in conjunction with 2020 Soil Survey Data collected by the United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS). Two bar graphs were then created to compare the percentages of sand, silt and clay for each soil type. Those numbers were then used to determine a trend which showed that the soil types located in Nassau County have slowly evolved over time.

1. Introduction

The compositional soil make-up of Long Island in New York is exceedingly unique as it stems from distinctive topography. Long Island topography is a direct product of the Wisconsin Glacial Episode that occurred approximately 22,000 years ago. The Wisconsin Glacial Episode left behind two of the most well-known topographic features of Long Island, those being the Harbor Hill and Ronkonkoma moraine. Both of these bi-products consist of glacial till which can be classified as Acrisol. Acrisol is primarily made-up of boulders, gravel, sand, silt and clay which can be traced back to the movement and initial melting of the continental ice sheets. (Monti, 1968) The Harbor Hill moraines and outwash plain were formed due to the movement and melting of the continental ice sheets creating a moderately flat surface extending southward. (Monti, 1968) The outwash plain comprises stream deposits from the glacial melt water that include well sorted sand and gravel. Over time stream deposits along the south shoreline have been refined by waves and ocean currents to form barrier beaches. Consequently, as the barrier beaches are being refined so is the compositional soil make-up of Long Island.

Using data provided by the United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), and Food and Agriculture Organization (FAO) of the United Nations our research aims to compare the most recent soil survey data of Nassau County against soil data from 1903 by the Field Operations of the Bureau of Soils. During the early 1900s Nassau County consisted of five primarily soil types. Hempstead Loam which contained high percentages of soil, Hempstead Gravelly Loam

which contained high percentages of silt, Galveston Sandy Loam which contained high percentages of sand and Galveston Clay that was primarily composed of mud and gravel.

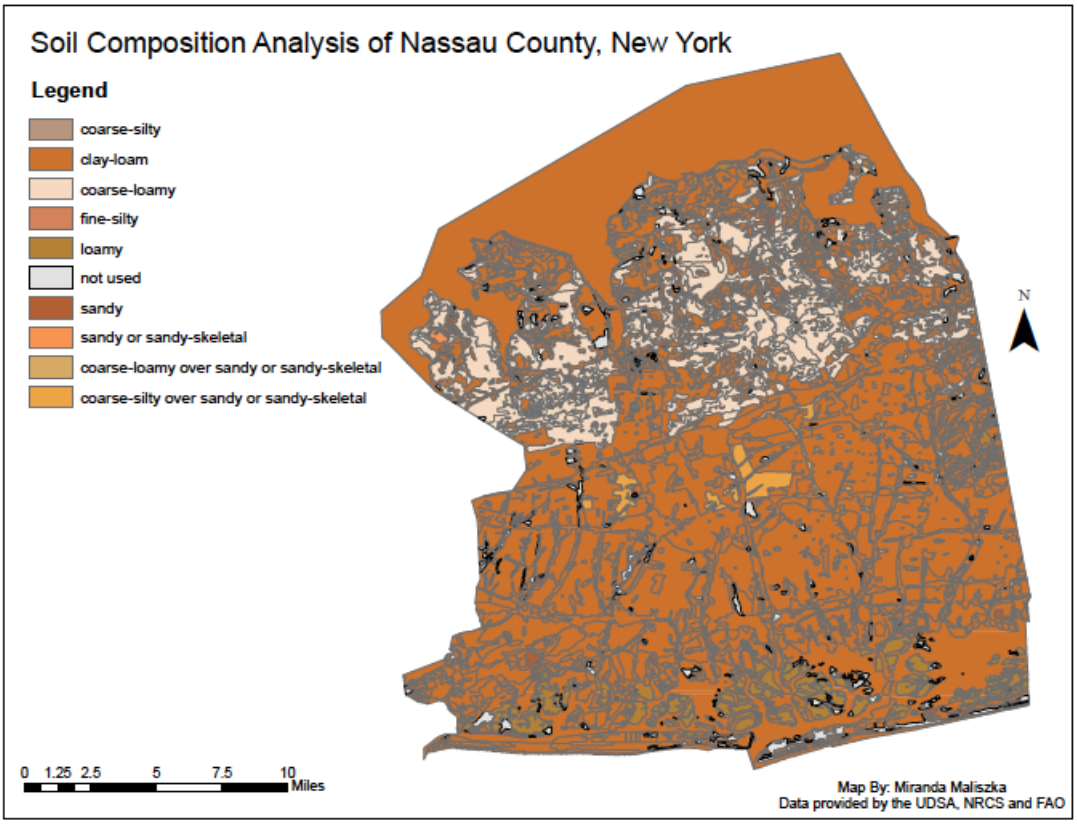

Figure 1: Map created by this research showcasing the soil composition of Nassau County, New York using data provided by the United States Department of Agriculture, Natural Resources Conservation Service

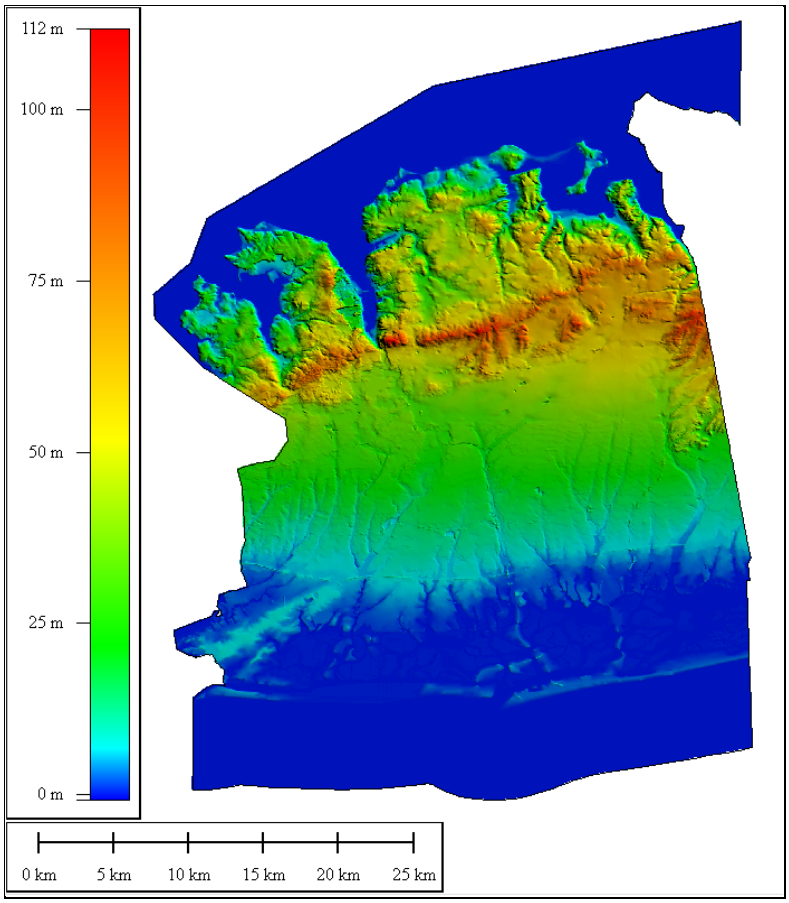

Figure 2: Digital Elevation Model (DEM) of Nassau county in Long Island, NY created in Global Mapper using a 10-meters resolution from the National Elevation Dataset (NED) shows the current topography.

2. Methodology

For this study, data provided by the United States Department of Agriculture (USDA) Natural Resources Conservation Service was used to compose a Soil Composition Analysis of Nassau County, New York. The data file included both tabular and spatial data that was used in conjunction with data provided by the Food and Agriculture Organization of the United Nations (FAO) to identify areas where soil data was not surveyed. The SSURGO database was used to run the Nassau County tabular data which generated hundreds of samples. ArcMap was then used to process and project the spatial data which excluded soil text classification as one of the attributes. To determine the soil text classifications of Nassau County, four attributes were combined from the tabular data file to the spatial data file. Those four attributes being; component, c-horizon, texture group and texture.

The data was then exported into a new geodatabase and projected with the intention of identifying the areas in which the NCRS provided no survey data. The areas that the

NCRS did not survey were identified using a Digital Soil Map of the World provided by the FAO of the United Nations. All of the areas that were not surveyed were identified with the soil text classification of Dystric Cambisols (Bd) with the following compositional make-up: 32.7% sand, 30.3% silt and 37.1% clay. Dystric Cambisols is the second most common soils group as it is composed of sand, silt and clay and is known for its extensively eroding and weathering qualities.

The soil triangle provided by the FAO in the original shapefile was used to identify the following soil composition which is clay-loam. The data was then reclassified as Clay-Loam. The most common soil types were taken from the Digital Soil Map of the World, FAO database. The first three most common soils are; Chromic Cambisols (BC), Dystric Cambisols (BD) and Humic Cambisols (BH) which are rich in silt, sand and clay. In addition to those; Rhodic Ferralsols (FR) that usually contain low silt-to-clay ratios, Philinthic Luvisols (LP) that predominantly made up of high-nutrients and clay, Planosols (W) and Dystric Planosols (WD) that are usually made of clay and contain poor pores.

The earliest record of soil surveys for Nassau County, New York dates back to the early 1900's which was reported by The Field Operations of the Bureau of Soils was used to make the comparison. To provide a visual representation of both the1903 and 2020 soil survey data, bar graphs were constructed. Since the 1903 data is older, only the soil types located in Nassau County were used for this project's premise. All of the percentage compositions of sand were added together from each location and were then averaged. This technique was then used to do the same for the percentages of silt and clay. The same process was then implemented for each of the soil types. The individual and overall percentages were then used for comparison.

3. Results

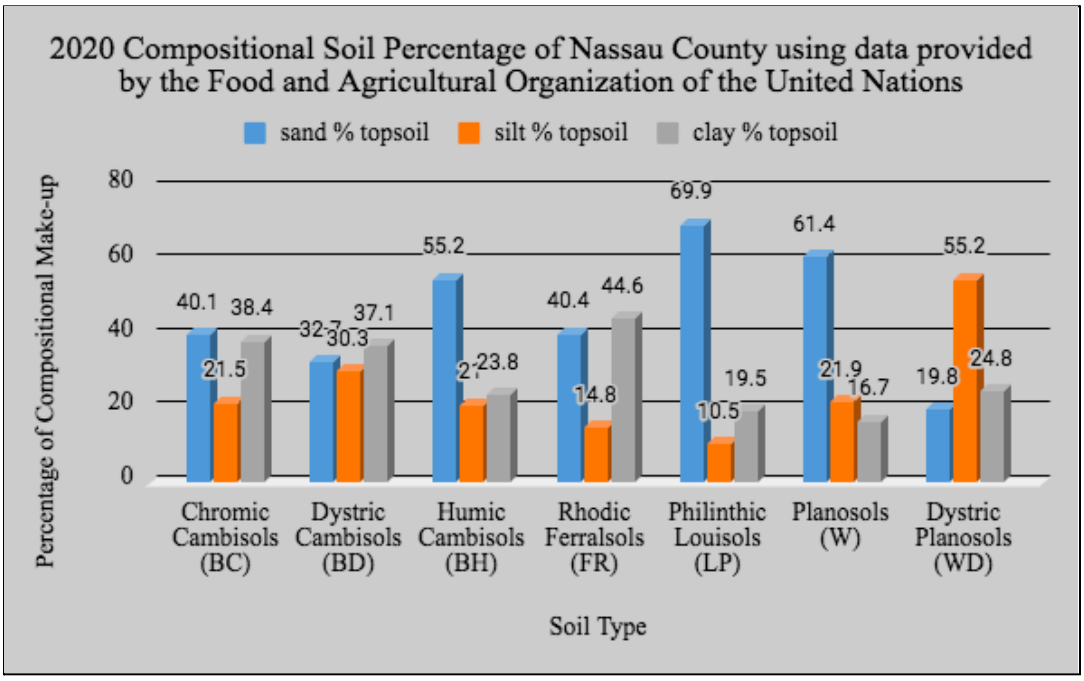

Figure 3: Bar Graph representing the topsoil percentage breakdown of sand, silt and loam in order to identify the most common soils in Nassau County, New York by using data provided by the Food and Agricultural Organization of the United Nations (2020).

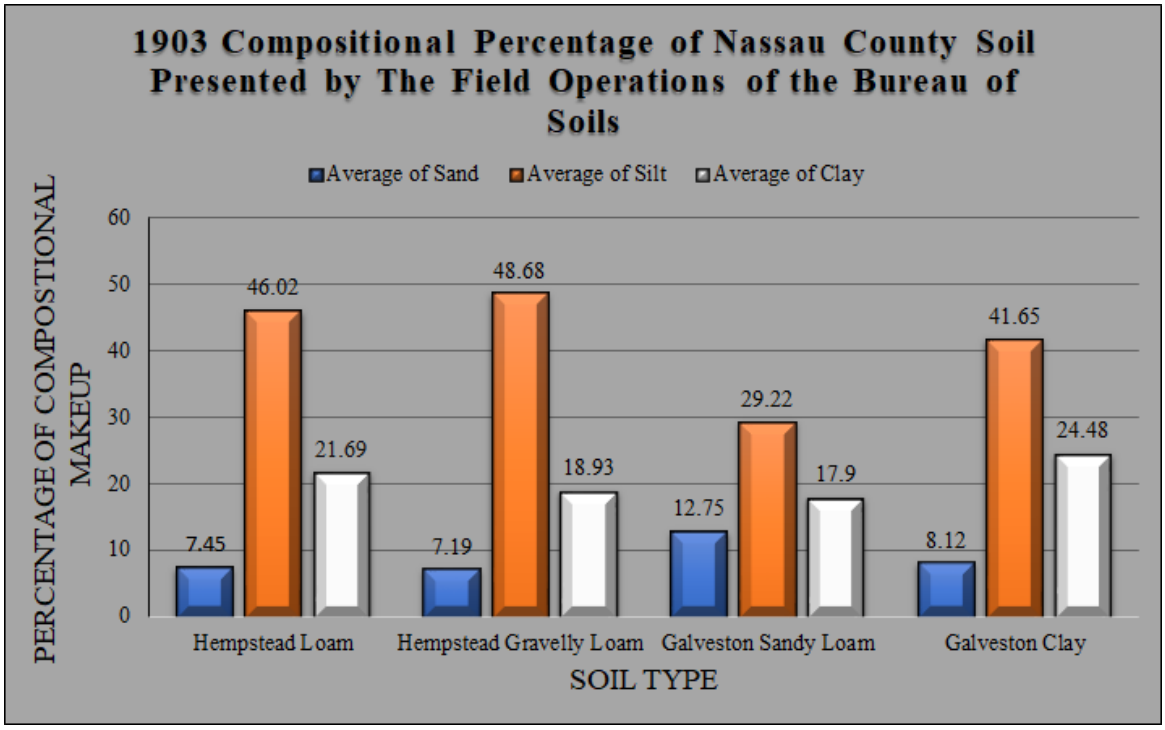

Figure 4: Bar Graph representing the soil make-up percentages of sand, silt and clay using data provided by The Field Operations of the Bureau of Soils (1903).

Looking at the most recent soil survey data provided by the Food and Agricultural Organization of the United Nations; three out of the seven most common soil types in Nassau County dominate more than 50% of their compositional make-up with sand (Figure 3), meaning that Philinthic Louisols (69.9%) and Planosols (61.4%) can be classified as Sandy Loam. Sandy Loam soils contain higher percentages of sand, however, they still share characteristics that include silt and clay. On the other hand, while Humic Cambisols (55.2%) have a high percentage of sand, they are classified as Sandy Loam Clay soils because they have a lower percentage of clay which is 23.8%. (Figure 3) When looking specifically at those three soil types, Philinthic Louisols has a much higher percentage of sand. Chromic Cambisols (38.4%) and Dystric Cambisols (37.1%) have larger percentages of clay which classifies them as Clay Loam. The last soil type being Dystric Planosols (55.2%) has a larger percentage of silt. However, looking at the four most common types of soils back in 1903, there is a strong correlation between the percentage of silt in all four of the samples. (Figure 4) The highest percentage of silt can be found in Hempstead Gravelly Loam (48.6%), while the lowest percentage of silt can be found in Galveston Sandy Loam. (29.22%)

4. Discussion

When comparing the 2020 soil survey data to the 1903 soil data, there is a substantial difference between the percentages of sand, silt, and clay overall. When looking at the 1903 survey data, there is a strong dominance of silt between all four samples (Figure 3), while today sand is more prominent amongst all seven samples. (Figure 4) These numbers yield very interesting results when reflecting on the initial formation of Nassau County. As mentioned in the introduction, Nassau County was formed as a result of a glacial ice sheet leaving behind two profound features such as the Harbor Hill moraine and outwash plain. When it comes to looking at the four soil types back in 1903 they lack a strong compositional make-up of sand, which is prevalent to mention as the majority of the soil samples found in Nassau County, New York, which today have high compositional percentages of sand. Looking at the percent composition of clay, it yields quite promising results as most of the land located in Nassau County today contains a high percentage of it.

Over the past hundred and fifthteen years there has been a slow progression of warming as a result of greenhouse gas emissions that may have affected the soil compositional make-up. As a result of climate change, there has been a slow increase in precipitation rate, which has caused greater amounts of chemical and mechanical weathering. Within the United States, the amount of precipitation has been increasing at a rate of 0.17 inches per decade. (EPA, 2016) The more rainfall that accumulates over time slowly begins to deteriorate the soil structure when it comes to the rocks within it. This provides strong evidence when comparing the high percentages of silt from 1903 to the current high percentage of sand as of 2020. As a result, this allows for a better understanding of how climate change has affected the soil composition change.

Besides climate change, erosion and poor soil health also play an important role in the compositional make-up of soil and how they can affect soil composition change over time. Over the past hundred and fifteen years Nassau County has been cultivated from acres of agricultural based land to a very fast-paced and industrialized environment. The stress of building houses, business and roads have also caused further defragmentation of rocks which encourages higher sand accumulation in Nassau County. However, even with an increase in the percentage of sand amongst all of the seven most common soil types, a large percentage of New York encompasses clay.

5. Conclusion

Using data from the USDA, NRCS and FAO of the United Nations, a map was produced to visually represent the current soil types located in Nassau County, New York. In addition, 1903 soil survey data provided by the Field Operations of the Bureau of Soils was used further to compare the progression of soil over the past century. With that knowledge in conjunction with current environmental factors such as climate change and erosion, a better understanding of how the soil composition has changed over time was cultivated. In conclusion, over the past hundred and fifteen years a county once dominating in silt has slowly been transformed to a ground of higher percentages of sand and clay.

6. Acknowledgement

Acknowledgements should be made to Dr. Antonios Marsellos for allowing us the opportunity to complete this independent research project. Additionally, acknowledgements must be made to the United States Department of Agriculture, Natural Resources Conservation Service and Food and Agricultural Organization of the United Nations. As well as the 1903 data provided by The Field Operations of the Bureau of Soils for all of the soil data used to complete this research.

7. CRediT authorship contribution statement

Maliszka, M.: Conceptualization, Formal analysis, Data curation, GIS mapping, Writing, Johnson, A.: Data curation, Writing, Formal analysis, Marsellos, A.E.: Supervision, Revisions, editing, DEM figure.

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