Virtualization of the drenched POOMPUHAR Port utilizing bathymetric data processing

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Abstract:
Marine archaeologists have unearthed Poompuhar, an ancient city, and harbor from the 4th century BCE that was situated in the Mayiladathurai District of Tamil Nadu, a southern Indian state. During the early Chola Kingdom's control, it was a well-established historical and ancient port that emerged with the growing oceangoing trade. This historic city and harbor serve as a metaphor for Tamil Nadu State civilization in the early 20th century. Then, in the year 500 AD, large shore waves swept this city away and destroyed it. These ancient cities and port ruins are still submerged and dispersed around the ocean's deep bottom. In reality, thorough examination and recreation of the life histories of harbour cities like Poompuhar are required to unearth several hidden virtues from the past. High-quality bathymetric data of the ocean floor have been gathered using multi-beam echo sounders. The primary results of the work are the precise identification and geo-tagging of the study region, the processing of the raw bathymetric data, and the thorough removal of undesirable signals. Here we have the interpolation method, which is important in creating bathymetric maps. Inversed Distance Weighting (IDW), one of several interpolation methods that are built into a GIS program, is used to create a bathymetric map based on the input processed bathymetric data. Later, the interpolated surface can be used to create a digital elevation model. The primary topic of this work is IDW, which focuses on a spatial and 3D interpolation approach to map the seabed using the provided input data. As a result, the IDW interpolation technique can be used to detect any submerged terrain anywhere in the world.

Keywords: Multi beam Echo Sounders, Bathymetry, Interpolation, Inversed Distance Weighting (IDW), ArcGIS.

1. Introduction

The historic location known as poompuhar in south India is the subject of this paper. The benefits, civilization, and individuality of contemporary technologies are brought out here. Coastal structures like groins detached offshore breakwaters, and sea walls have been used to successfully implement coastal protection measures for several years. In today's environmentally conscious cities, these buildings are rapidly losing favour. The construction of coastal structures and intervention structures, such as breakwaters, groins, jetties, and port constructions, results in rapid and irreversible changes to the shoreline. Sand is removed from the sediment budget and contributes to erosion along nearby shorelines when these structures retain sand on the side facing up drift. The impact that detached breakwaters' offshore distance, length, and the gap between detached breakwater fields have on the shoreline as well as the impact that groin length, groin field, and groin gap have on the beach vary significantly in a particular environment.

Multibeam eco sounder (MBES), in which hydroacoustic beams are directed toward the bottom to measure depth, is the most common method. The vertical distance between the MBES's transducer and either the sea floor or an object on the sea floor is measured. In a wide swath, the MBES sends multiple signal beams in various directions. Calculating the time difference between the hydro acoustic beam's moment of transmission and its moment of the reception following its reflection from the bottom yields the depth value. It is necessary to know the sound velocity and the beam directions. It is important to note that one of the fundamental data types utilized in systems modeling of the seafloor is the bathymetric data generated by multi-beam echo sounders.

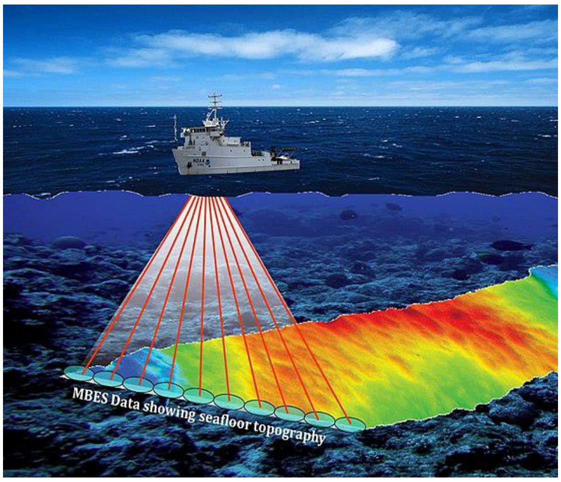

Figure 1 Pictorial representation of Multi-Beam Eco Sounder

The MBES provided bathymetric data in the form of raw data. After that, the data are processed into a set of points (XYZ) with known parameters. Interpolation can be used to predict unknown values using the processed data, such as water depths. The agreement of the interpolated values with values that are already known or accepted is a measure of an interpolation technique's accuracy. Although it has the advantage of defining the seabed's morphology, it has the drawback of handling and processing a much larger volume of data. Software is used to pre-process and process the raw bathymetric data. All kinds of geographic and spatial data can be stored, retrieved, managed, displayed, and analyzed using a Geographic Information System (GIS Software). The software for ArcGIS includes a variety of simple interpolation methods. To find a solution, the results should be examined and analyzed after specific interpolations have been identified. In this instance, the method of interpolation utilized is Inversed Distance Weighing (IDW)

2. Study Space

At the mouth of the Cauvery River is the port city of Poompuhar. The port of Poompuhar was chosen as the subject of the study. The port extends roughly 20 kilometers along the coast and up to 8 kilometers within the Bay of Bengal Sea. The terracotta ring wells, brick structures, and storage jars found in the intertidal zone of marine archaeological explorations around Poompuhar, as well as the brick structures, stone structures, and pottery found in offshore explorations, strongly support the existence of habitation sites. Poompuhar's submergence may be attributed in part to the shift in the shoreline that is mentioned in several sources.DST has proposed investing a significant amount in the reconstruction of Digital Poompuhar port.

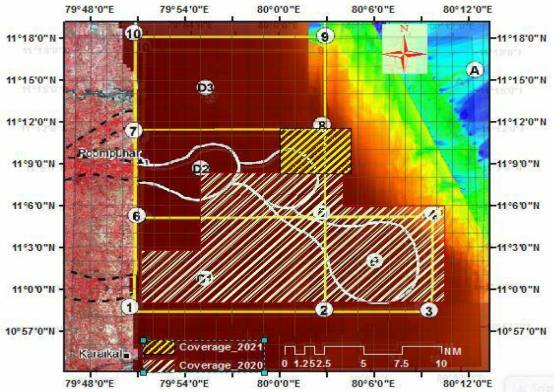

Figure 2 Submerged land area in Poompuhar

3. Methodology:

It is essential to be aware of the approach taken when creating bathymetric maps. Due to the lack of information, the methodology development process was difficult. The data are processed using Inversed Distance Weighting (IDW) interpolation methods.

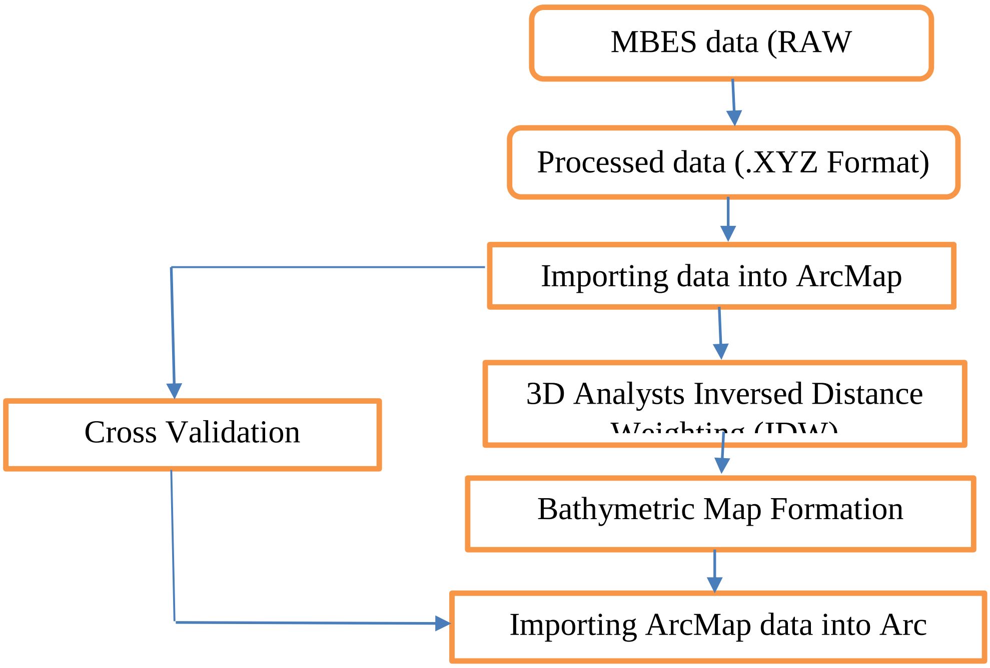

Figure 1 Methodology of Inversed Distance Weighting (IDW)

4. Inversed Distance Weighting

The IDW method, which is based on the idea of distance weighting, is used to interpolate spatial data in this study. From the measured depths that are already known, this method can be used to estimate unknown depth data. An exact or smoothing interpolator can be used with the IDW gridding technique. During interpolation with IDW, the data are weighted in such a way that the influence of one point on another decreases with distance from the grid node. As insufficient parameters can result in significant artefacts in the interpolated surface, particularly with IDW, reasonable parameters for each interpolation technique were first identified. Using brute force, a variety of interpolation parameter combinations were evaluated. All subsequent analyses were based on the parameters of each interpolation technique that produced the lowest median percent deviation for the entire study area. IDW had a power of 2 and a variable search radius of 8 points as its parameters. Various spatial data, such as estimations of surface water volume and soil moisture distribution and digital elevation models, are frequently processed using the IDW interpolation technique. The IDW method is implemented in ArcGIS software in such a way that it assigns point values by averaging data within a fixed search area. We can also calculate a new point value by selecting the option to specify a minimum number of neighbors within the search area. The point node is otherwise left empty. Altering the power parameter is another option.

5. Interpolation in ArcGIS

Interpolation can be found in the ArcGIS functions. ArcGIS interpolation tools, which can be found in the Processing toolbox, make it simple to create a continuous surface from discrete points. Using vector points with known values to estimate values at unknown locations to create a raster surface covering an entire area is how ArcGIS's interpolation process works.

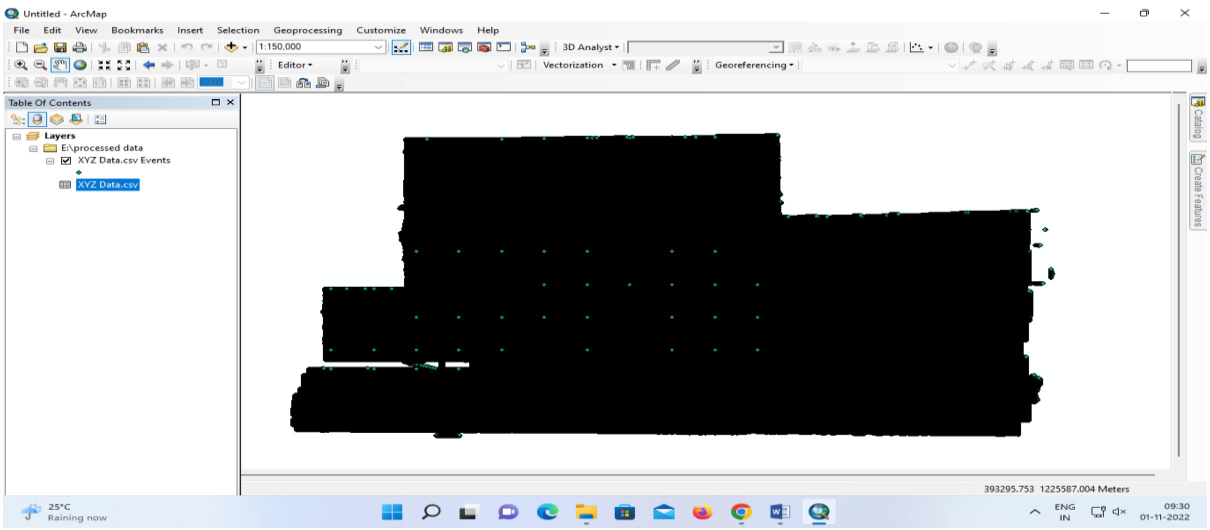

Figure 4 Processed XYZ data in ArcMap

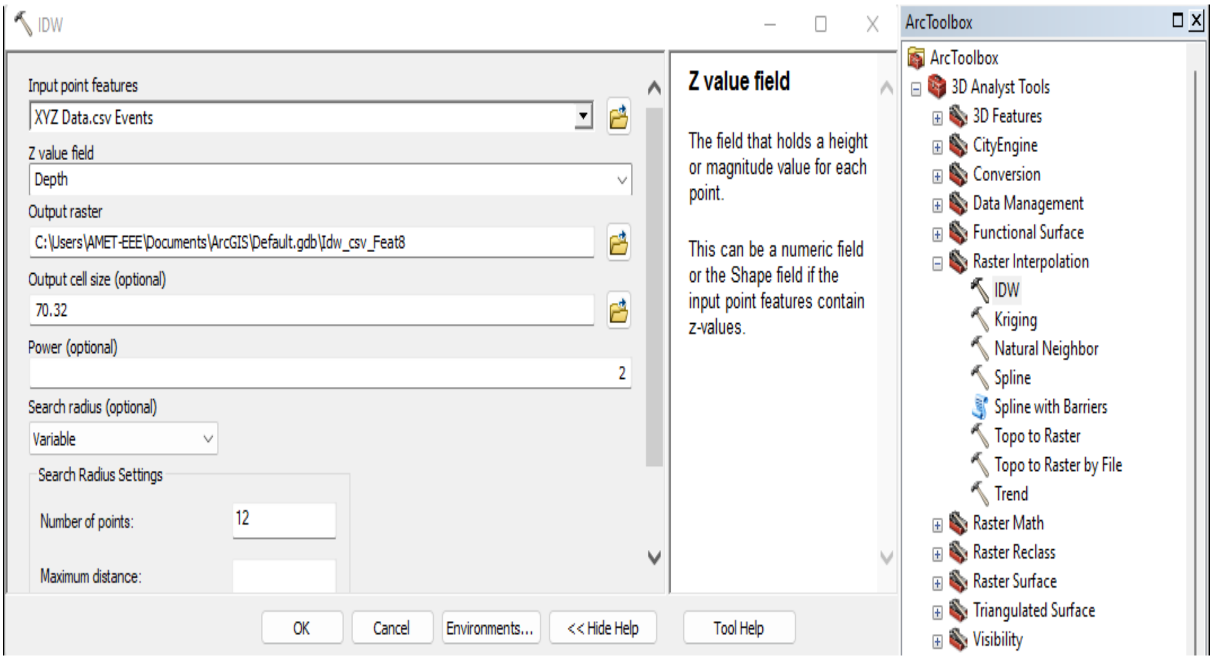

Figure 5 IDW in ArcGIS Toolbox

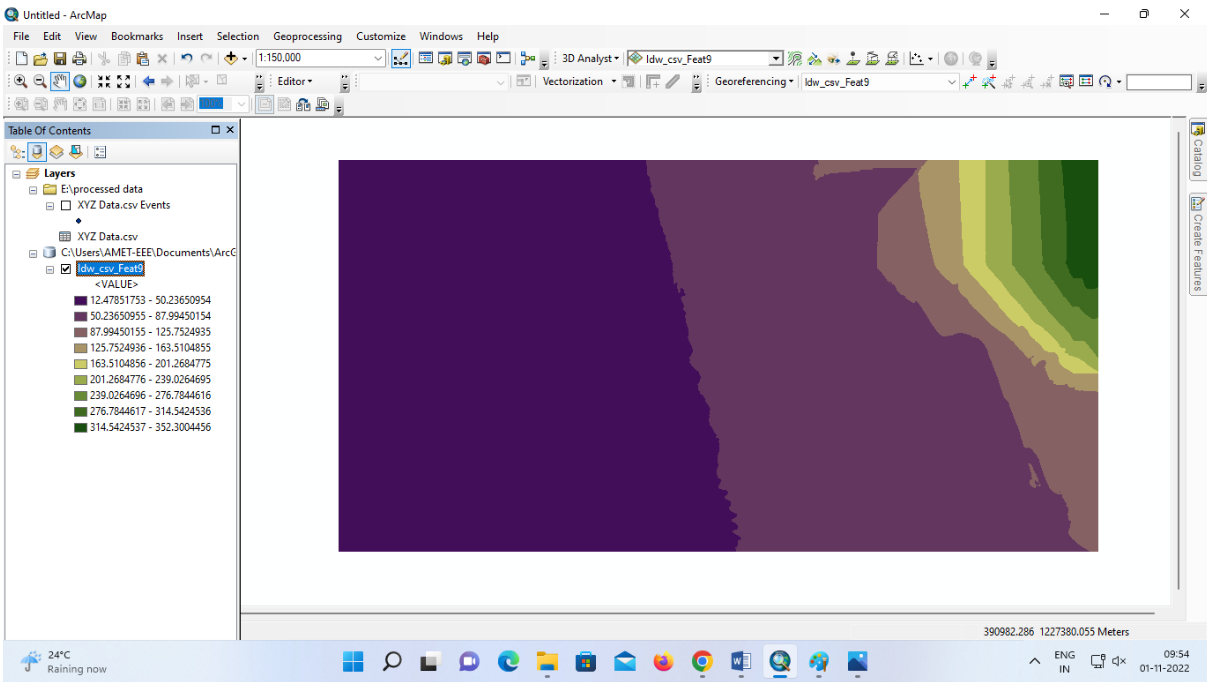

Figure 6 Interpolated XYZ data using the IDW technique

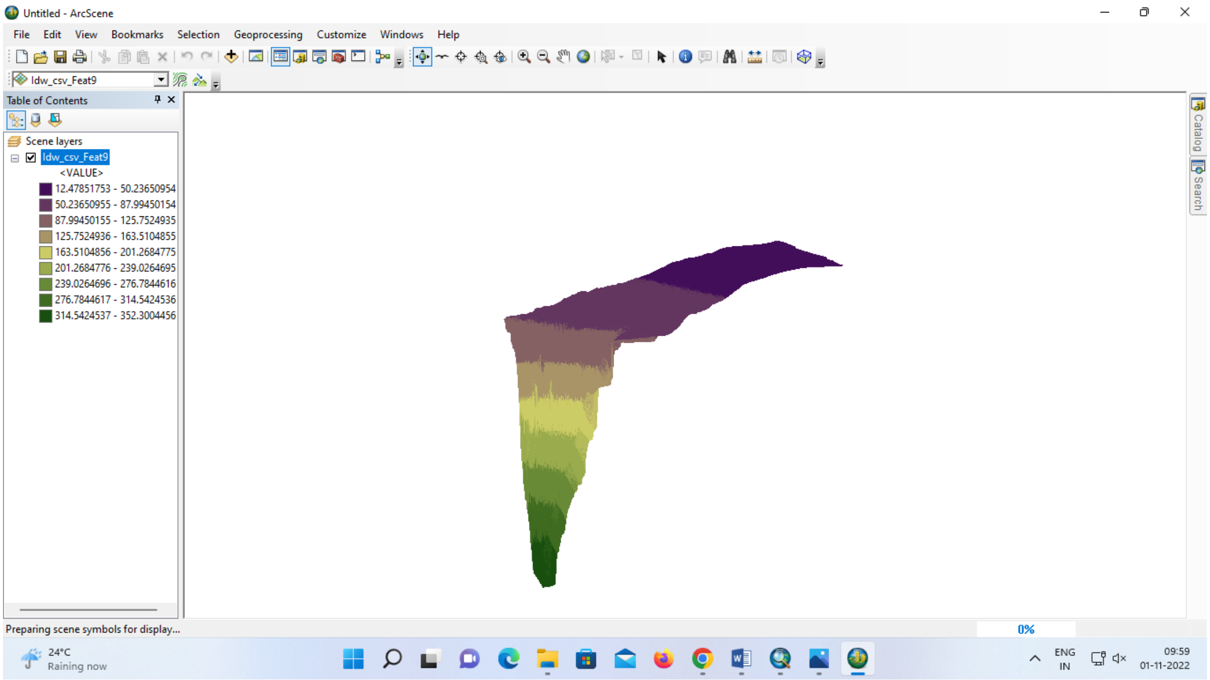

Figure 7 Digital Elevation Model (DEM) of bathymetric data created from IDW interpolation technique

6. Analysis and Interpretation

Analyzing the various natural disasters, such as earth movements, shifts in sea level, and migration of river systems, and visualizing the previous floods, cyclones, tsunamis, erosion, and sedimentation, as well as their influence on Poompuhar's extinction in various zones and periods; these can be combined into one GIS layer. All of the collected raw MBES data are converted into the XYZ format and the bathymetric surface is created using the interpolation technique. Different adding strategies were utilized, out of which Inversed Distance Weighting (IDW) is the most reasonable and exact technique in theGIS programming. From Fig.6, between the ranges 12.47851753 - 50.23650954, 50.23650955 - 87.99450154, and 87.99450155 - 125.7524935 it is understood that there may be some objects present in that particular region. It may be either; a demolished structure of a port or manmade sea walls. In Fig.7, DEM (Digital Elevation Model) depicts in a 3D visual format, where the presence of the submerged port structures can be easily identified by using the software ArcGIS. Mapped data provides color coding; various shades of color are assigned to different levels of the DEM generated from the ArcGIS software. From the generated map, we can understand the range of the surfaces and interpret the differences in different levels of the seafloor. The color-coded map varies from a smooth surface to the bottom depth of the sea level. The mapped bathymetric data is generated using a tool Inversed Distance Weighting (IDW) process present in the Arc Tool Box in the ArcGIS software, to depict the bottom sea bed. From the color-coded DEM map, we can assume land scape submerged under the sea around Poompuhar Beach. The exact Geo-Positon of the western wave and tide shadow slope of the Delta Region-D confirms that it should be a submerged harbor structure.

7. Conclusion: Thus the paper reveals that raw data of MBES, can be easily mapped using the ArcGIS software and interpolated by Inversed Distance Weighting (IDW) technique. The bathymetric map interpreted must be tied to the historic harbour and the structures, which were constructed by the ancient people around 15000 years ago. With the finite available data, we got many featured images under the sea. Those images have been identified as shipwrecks and manmade sea walls. All these raw data was mapped by using Inversed Distance Weighting (IDW) technique. Future study works study include; ROV Survey, sub-bottom profiling surveys, and image processing with noise removal gives a clear-cut image of the submerged port structures beneath the water of the Poompuhar City.

8. ACKNOWLEDGMENT

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