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FEASIBILITY ANALYSIS OF ELEVATION DATA FROM DEM FOR STUDYING THE MORPHOLOGICAL CHANGES OF THE RIVER

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Abstract: The study was undertaken to assess the feasibility of using remotely sensed elevation data in the form of DEM (Digital Elevation Model) for studying the morphological changes of the river. The river reach from Kuttippuram to Pattambi of Bharathapuzha was selected as the site for investigation as it is severely affected by sand mining which clearly depicts the morphological changes in the river cross section. The evaluation was done by finding the difference between the cross-sectional area of the river obtained by actual measurement and that obtained from DEM. The study utilised CARTOSAT DEM imageries of the year 2014 to evaluate the cross-sectional details**.** The analysis and assessment of satellite imageries were carried out using the ArcGIS 10.3 software. The Elevation Profile add-in toolbar was utilised to create profile graphs by taking sections across the river course in ArcGIS. Total station survey was conducted at 21 locations in seven Kadavus of the river in order to obtain the actual cross-sectional data. The cross-sectional areas of the river obtained from the DEM showed an average percentage deviation of 4.32 per cent with that obtained from the field measured values. The study revealed that elevation profile obtained from DEM's have sufficient accuracy for use in morphological analysis of rivers.

Keywords: Elevation profile, DEM, Elevation profile add-in, ArcGIS, morphology

I. INTRODUCTION

Rivers are the most prolific land surface sculptors. A variety of awe-inspiring landforms are carved out under fluvial processes [4]. In the nature, the most vital life sustaining system is the river. Rivers are the arteries of our planet; they are lifelines in the truest sense. Human interventions consequent to economic developments in the past few decades have imposed tremendous pressure on rivers. Numerous human actions are endangering the very existence of the river itself [9]. Understanding the morphology and behaviour of the river is a pre-requisite to have a scientific and rational approach to different river problems [7]. Fluvial geomorphological surveys have become increasingly popular over the last decade as a tool to support sustainable river management. It is now almost a standard practice to characterize river systems using remote sensing and GIS, and this has made significant contributions to our understanding of the processes responsible for shaping river morphology. It is also worth emphasising, that field surveys and historical analysis will always remain important ways of reading the landscape but RS data will support and corroborate conclusions drawn from these sources. River morphological changes indicates the change in shape and direction of river channel over time. The study was conducted to analyse the accuracy of remote sensing images for analysing the river morphological analysis. River bharathapuzha was selected as the study area. As its

too long a small stretch of the river reach was focussed where a great amount of morphological changes have been occurred. Pattambi to Kuttippuram reach of the river was selected which is severely affected by sand mining.

II. MATERIALS AND METHODS

2.1 Study area

The study area selected was the river stretch lying in between the towns Kuttippuram (10°50′38″N, 76°01′58″E) in Malappuram district and Pattambi (10° 45′ 21.72″ N, 76° 34′ 23.18″ E) in Palakkad district of river Bharathapuzha. The Bharathapuzha ("River of Bhārata") is also known as the River Nila, Perar or Ponnanipuzha. It is the second longest river in Kerala with a total length of 209 km and it lies in the central part of Kerala state, India. The river is considered to be one of the west-flowing 'medium' rivers of the country and lies approximately between 10° 26' and 11° 13' north latitudes and 75° 53' and 77° 13' east longitudes. Bharathapuzha originates at Kovittola Betta of Kundra reserve forest in the Western Ghats, located in Tamil Nadu, at an elevation of 2336 m above MSL, and flows westward to join the Arabian Sea at Ponnani (10° 47' 13" N, 75° 54' 40" E) Kerala, India [ ]. Bharathapuzha is a great victim of illegal sand mining and its effects are clearly noticeable on the river cross section which has altered the river morphology to a great extent. The mining activity is severe in the stretch of Pattambi - Kuttippuram reach.

CARTOSAT-1 DEM of the study area for the time period 2014 acquired from Earth Explorer were used to analyse the cross-sectional details. All imageries are of 30 m resolution. The imageries were processed and assessed using ArcGIS 10.5 software. Imageries for the evaluation were added to the data frame and the study area was extracted from the imageries using the tool Extraction by Mask, with reference to the feature mask data exported as a kml layer from google earth representing the study area. Cross sectional profile of various sections of the river channel was found out using the add-in elevation profile. The Elevation Profile add-in toolbar (Figure 1) allows to easily create profile graphs by simply drawing a line on the display in ArcGIS Desktop.

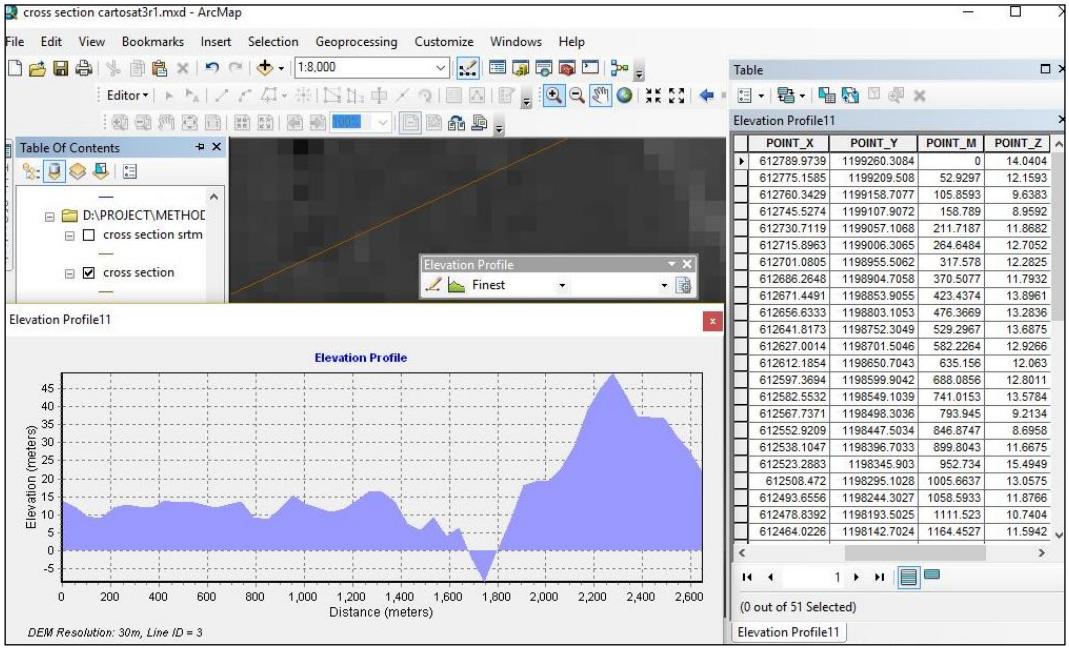

Figure 1. Elevation Profile add-in

Total station survey at seven Kadavus which were accessible, were conducted to analyse the accuracy of the profile graph obtained using Elevation Profile add-in. Kadavus are places in the river

reach where sand mining is a usual practice. Kadavus for survey were selected based on the areas with highest rate of mining. According to that the seven Kadavus selected were Vellanchery Kadavu, Nilayoram park, Mallur Kadvu, Kattadi Kadavu, Keltron Kadavu, Ummathur Ambala Kadavu and Kumbidi Ner Kadavu. Table 1 and Figure 2 shows the location details of the seven Kadavus. Total station survey was conducted in three sections at 30 m interval in each Kadavu. A total of 21 sections were surveyed. Data was collected from the accessible points only which forms only a representative portion in the actual cross section. According to the data obtained from the field a cross section profile graph for the seven Kadavus were drawn. Similarly, cross section lines representing these sections at each Kadavu were drawn in the CARTOSAT – 1 DEM and cross profiles were generated. The cross-section profile graphs from field were compared with the profile obtained from Elevation profile add-in and the percentage error was calculated to find out the accuracy of DEM for cross section analysis.

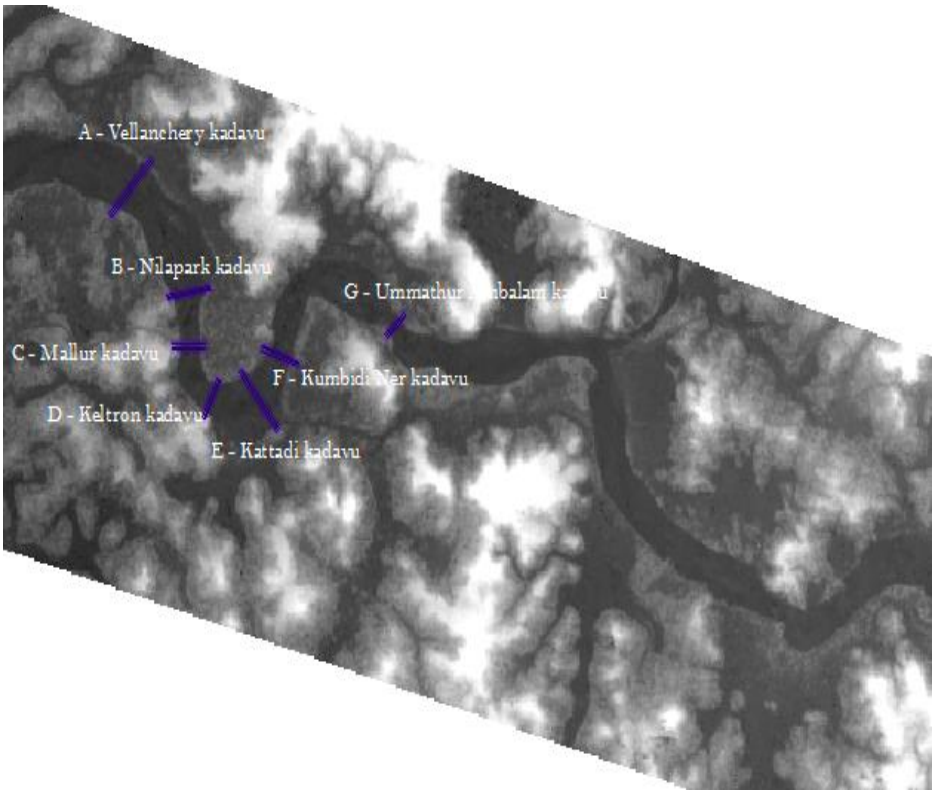

Figure 2. Kadavus selected for total station survey

Table. 1 Location of kadavus selected for total station survey

Name of Kadavu	Latitude	Longitude
Vellanchery	10^0 51’ 27.2” N	76^0 00’ 41.7” E
Mallur	10^0 50’ 24.8” N	76^0 01’ 20.0” E
Nilayoram park	10^0 50’ 50.8” N	76^0 01’ 32.0” E

Keltron	10^0 49’ 56.0” N	76^0 01’ 34.1” E
Kattadi	10^0 49’ 51.4” N	76^0 02’ 12.1” E
Kumbidi Ner Kadavu	10^0 50’ 18.2” N	76^0 02’ 22.5” E
Ummathur ambalam	10^0 50’ 30.9” N	76^0 03’ 21.4” E

III. RESULTS AND DISCUSSION

The feasibility of using remotely sensed elevation data in the form of DEM (Digital Elevation Model) for studying the morphological changes of the river was evaluated by finding the difference between the cross-sectional area of the river obtained by actual measurement and that obtained from DEM. The accuracy of data was calculated based on the percentage error obtained by comparing the cross-sectional area found out using the field value and DEM value. Table 2 shows the percentage error obtained in each Kadavu in three sections classified as the cross section at Kadavu, upstream of Kadavu and downstream of Kadavu.

Table 2. Percentage error calculation in the cross section

Cross sectional area of Kadavus in each section (sq. m.)									
	At Kadavu		Percentage error	Upstream of Kadavu		Percentage error	Downstream of Kadavu		Percentage error
Kadvus	Field value	DEM value		Field value	DEM value		Field value	DEM value	
Vellanchery	9454.36	9523.66	0.73	9480.47	9702.17	2.29	9620.05	9698.88	0.81
Mallur Nila park	4482.98	4602.52	2.6	4145.61	4305.61	3.72	4522.22	4807.69	5.94
Bridge Kadavu	3288.01	3401.04	3.32	3861.74	3877.63	0.41	3574.54	3652.54	2.14
Keltron	4321.87	4401.23	1.8	4966.47	5064.34	1.93	3559.01	3633.97	2.06
Kattadi	14371.34	14509.86	0.95	15453.69	15580.93	0.82	13610.53	13683.33	0.53
Nerkadavu	6130.69	6203.45	1.17	5752.96	5845.38	1.58	5532.96	5560.34	0.49
Ummathur ambalam	2478.16	2667.25	7.09	2909.44	2988.99	2.66	2460.43	2605.26	5.56

The cross-sectional area obtained from the DEM showed a percentage error varying from 0.41 per cent to 7.09 per cent with that from the field data. Average percentage error for elevations in the observed sections were 2.32 per cent. It was proven that the elevation profile obtained from DEMs have sufficient accuracy for use in morphological analysis of rivers. The feasibility of elevation data from DEM imageries revealed that the river morphological study using remote sensing and GIS techniques provided realistic information about the morphological changes along Kuttippuram to Pattambi stretch of Bharathapuzha river and this method can be successfully used for mapping and monitoring river morphological changes.

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