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UTM Coordinate Transformation For River Meandering Studies

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Abstract

River meandering studies using satellite images are mainly based upon the coordinates. A satellite image comes in Geo tagged form, which means they are having the coordinates i.e. latitude and longitude. Most of the satellite images are having WGS84 (world geodetic system 1984) datum, which give the UTM (Universal transeverse mercator) coordinates. In the present paper, we have applied the transformation to the UTM coordinates extracted from satellite images. Since the original UTM coordinates represent the real geometry of river meanders which cannot be used to model the river meanders. Hence, in order to study the geometry of river meanders, transformation of these UTM coordinates is a necessary step. In the present study, we have presented a simple mathematical transformation model for transforming the UTM coordinates into local coordinates.

Keywords:*UTM, Coordinate Transformation,River Meandering,Meandering geometry, Sine Generated Curve, WGS84,*

1. Introduction

Different kind of coordinates are used to position objects in a two- or three-dimensional space. ***Spatial coordinates*** (also known as global coordinates) are used to locate objects either on the Earth's surface in a 3D space, or on the Earth's reference surface (ellipsoid or sphere) in a 2D space. Specific examples are the geographic coordinates in a 2D or 3D space and the geocentric coordinates, also known as 3D Cartesian coordinates. Planar coordinates on the other hand are used to locate objects on the flat surface of the map in a 2D space. Examples are the 2D Cartesian coordinates and the 2D polar coordinates [1].Sine generated curves are most popular for studing river meanders [2-3]

2. Coordinate Transformation

Coordinate transformation is comprised of three steps namely origin transformation, rotation of coordinates and scaling. Above mentioned steps are discussed as follows:

2.1 Origin Transformation

In coordinate transformation, the fist step is to transform the origin which, is explained with the help of figure 1.

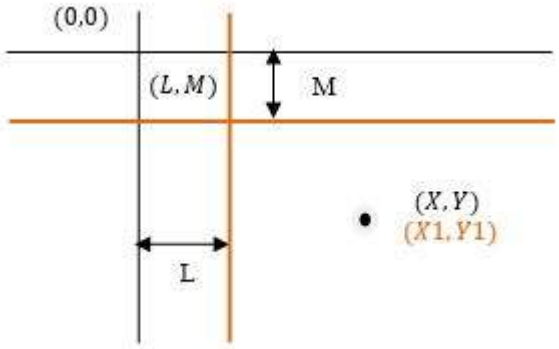

Fig. 1 Origin transformation

Where, $X1 = X - L$ and $Y1 = Y - M$ (1)

2.2 Transformation due to axis rotation

The process of axis rotaion, which helps in rotation of coordinates is described in figure 2 below:

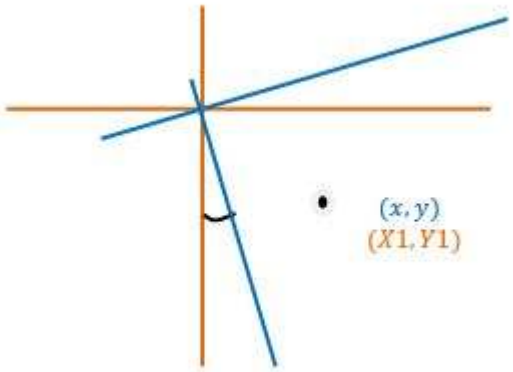

Fig. 2 Axis rotation

Axis rotated by an angle in anti clock wise and new trans--formed coordinate will be (x, y)
Where,

$$y = (X_1 \sin\alpha + Y_1 \cos\alpha) \quad (2)$$

And

$$x = (X_1 \cos\alpha - Y_1 \sin\alpha) \quad (3)$$

3. Testing Coordinates

In the present paper we have used 39 UTM coordinates for the transformation. These UTM coordinates are extracted from the Landsat-8 satellite image. These coordinates are of River Yamuna meander near Allahabad. Which is shown in figure 3. All the extracted UTM coordinates are presented in table 1.

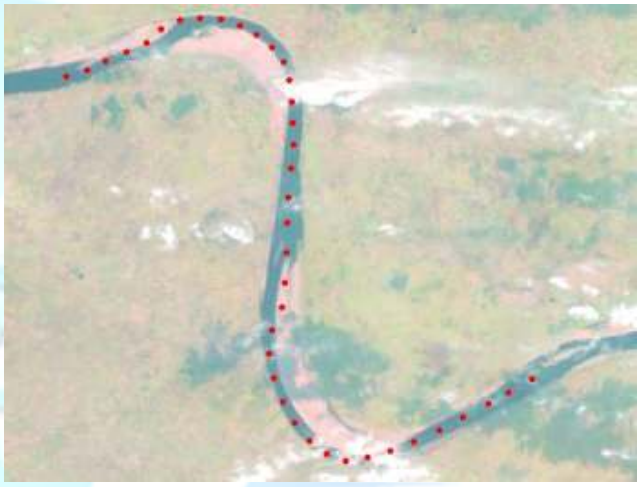

Fig. 3 Testing UTM coordinates superimposed on satellite image.

3. Results and Discussion

In the present work, we have transformed 39 UTM coordinates using equations 1 and 2. Details of UTM coordinates used in this work is presented in table 1.

Initially, origin transformation was applied to all the 39 UTM coordinates using equation 1. These coordinates were transformed with respect to rotated axis in anticlock-wise direction by an angele $\alpha = 33°$. And finally to get sinusoidal equal amplitude curve, X axis has been shifted down wards , hence a constant value of 368 is added to Y values. Also end corrections has been applied to get last point of x value as 0.

All the transformed coordinates are tabulated in table 1.

Table 1: UTM coordinate transformation of a river meander curve

Sine generated curve has been generated from sine curve of wavelength equal to meandering curve i.e. 11480 and Y values are calculated by multiplying the ordinate by amplitude of meandering curve. This sine generated curve is then superimposed on transformed meandering curve of the river.

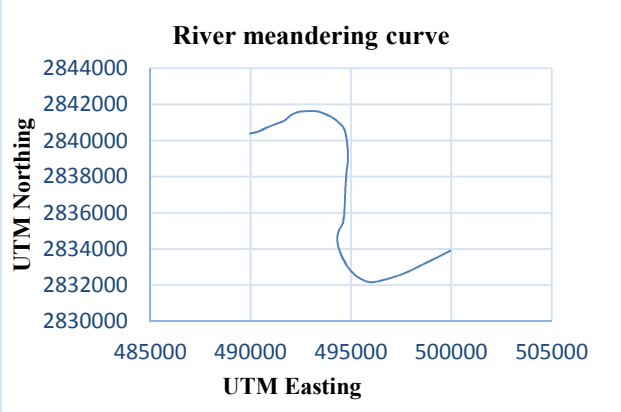

Fig. 3 Original River Meander Curve as per UTM coordinates

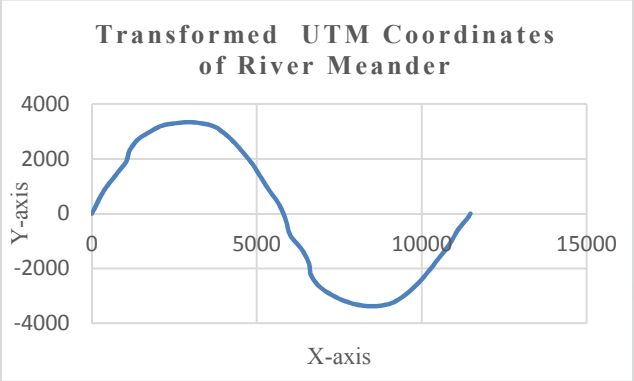

Fig. 4 River Meander transformed coordinates in local origin and with rotated axis.

Figure 3 and 4 shows the original UTM coordinates and transformed coordinates. The coordinates presented in table 1 are transformed using above mentioned steps.

UTM Coordinates		Origin Transformation		Rotational Transformation	
Easting	Northing	X	Y	x	y
489974	2840394	0	0	0	0
490427	2840526	453	132	308	726
490824	2840731	850	337	529	1114
491264	2840923	1290	529	794	1514
491687	2841118	1713	724	1043	1908
492001	2841406	2027	1012	1150	2321
492418	2841594	2444	1200	1396	2706
492841	2841631	2867	1237	1732	2967
493295	2841624	3321	1230	2115	3208
493691	2841472	3717	1078	2531	3296
494055	2841287	4081	893	2937	3339
494379	2841016	4405	622	3357	3288
494627	2840711	4653	317	3730	3168
494746	2840311	4772	-83	4048	2897
494813	2839852	4839	-542	4354	2547
494836	2839395	4862	-999	4622	2177
494839	2838922	4865	-1472	4882	1782
494793	2838416	4819	-1978	5119	1333
494740	2837804	4766	-2590	5408	791
494713	2837259	4739	-3135	5682	319
494697	2836624	4723	-3770	5877	-223
494660	2835969	4686	-4425	6014	-792
494598	2835443	4624	-4951	6340	-1267
494373	2834967	4399	-5427	6574	-1789
494313	2834457	4339	-5937	6645	-2249
494419	2833938	4445	-6456	6872	-2627
494617	2833425	4643	-6969	7243	-2949
494859	2832969	4885	-7425	7689	-3200
495173	2832592	5199	-7802	8140	-3345
495553	2832311	5579	-8083	8609	-3374
495967	2832165	5993	-8229	9081	-3271
496433	2832235	6459	-8159	9507	-2959
496906	2832380	6932	-8014	9860	-2579
497419	2832559	7445	-7835	10178	-2150
497968	2832814	7994	-7580	10511	-1638
498470	2833091	8496	-7303	10832	-1131
499013	2833386	9039	-7008	11103	-589
499449	2833621	9475	-6773	11397	-154
499955	2833915	9981	-6479	11480	0

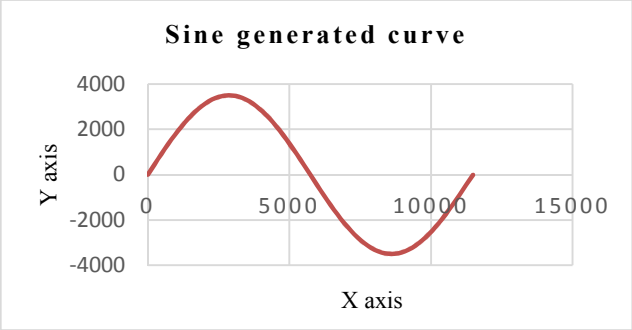

Fig. 5 Sine generated curve of equal wavelength and amplitude.

Langbein and Leopold [4] have stated that among a variety of meander shapes the sine generated curve fits the actual shape quaite well and better than alternatives. Hence we have used the sine generated curve to carry out this study as shown in figure 5.

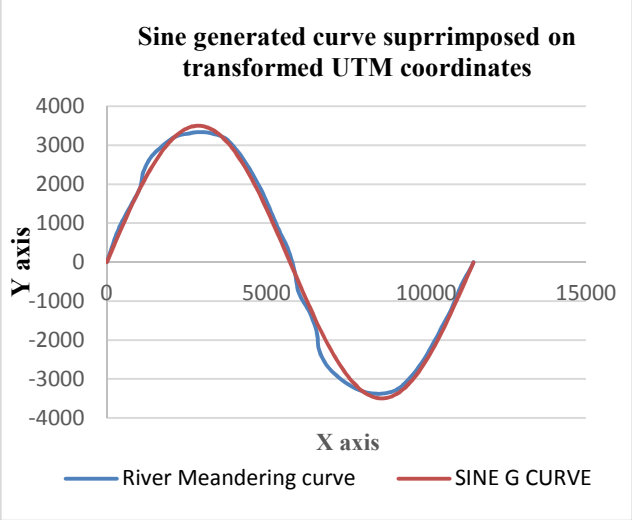

Fig. 6 Sine generated curve super imposed on transformed coordinates

Various studies on change detection, meandering parameters and river behaviours using Remote Sensing and GIS (Geographic information system) are found in literature [5-7]. In the present paper, sine generated curve has been included because it is easy to use and gives better results as compare to other shapes specially for river meander studies.

4. Conclusions

In river meander studies, shape of the river meander plays a critical role, and using satellite data this shape of a river can be extracted and analyzed for the research work. In the present work we have covered the coordinate transformation steps, which is one of the major steps in studying river meanders using satellite data. Investigations of the present study have led to following conclusions-

1. River flow can only by chance may be in Eastwards or Nothwards direction, so we require rotation of axis to get coordinates of meander curve so that its amplitude becomes the Y axis.
2. Since the origin of the UTM coordinates is far away from the testing coordinates, therefore these coordinate values can be transformed for new origins, about which rotation can be made.
3. Sine curve can easily be transformed for any value of amplitude and wavelength to fit the river meandering curve. This sine generated curve is very useful for calculating the meandering parameters.
4. Meander parameters are useful to define the river behavior and are very useful for hydraulic structures design and their planning.
5. In the river meanders studies, coordinate transformation and sine generated curves plays a critical role.

6. References

[1] Kevin Shirley and Jeff Knisley, Calculus: A Modern Approach, 2001.
[2] Irma Noorazurah Mohamad , Wei-Koon Lee and Raksmey May, Idealized River Meander Using Improved Sine-Generated Curve Method, Proceedings of the International Civil and Infrastructure Engineering Conference, pp 125-135, 2016.
[3] Sharon K. O'Kelley, The University of Georgia, Department of Science and Education notes on Transformations of the Sine and Cosine Graph – An Exploration.
[4] Langbein, W.B. and Leopold, L.B., River meanders -- theory of minimum variance. U.S. Geol.Survey, 1966. Prof. Pap. 422-H, 15 pp.
[5] Das J. D., Dutta T., Saraf A. K., "Remote Sensing and GIS Application in Change Detection of The Barak River Channel, N.E. India", Photonirvachak: Journal of the Indian Society of Remote Sensing, Vol. 35, No. 4, 2007.

[6] Majumdar S. S., Bhandari G., "Trend Analysis of River Course Changes using Historical and Recent Data", Indian Cartographer 2010.
[7] Das D., Deb M., Kar K. K.,"River Change Detection and Bankline Erosion Recognition using Remote Sensing and GIS", Forum geografic. Studii și cercetări de geografie și protecția mediului, Volume XIII, Issue 1 (June 2014).