Advances in Research
4(3): 142-150, 2015, Article no.AIR.2015.069
ISSN: 2348-0394

SCIENCEDOMAIN *international*
www.sciencedomain.org

Using Google Earth Images in Studying the Rasheed and Domiat Branches

Ahmed M. D. E. Hassanein[1*]

[1]Department of Systems and Information, Engineering Division, National Research Centre, Dokki, Cairo, Egypt.

Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

Article Information

DOI: 10.9734/AIR/2015/15336
Editor(s):
(1) Sergii Kavun, Dept. of Information Technologies, Kharkiv Institute of Banking, The National Bank of Ukraine (Kyiv), Ukraine.
(2) Ali Said Mohamed Al-Issa, College of Law, Sultan Qaboos University, Sultanate of Oman.
Reviewers:
(1) Anonymous, Nigeria.
(2) Mohamed E. Hereher, Dept. of Environmental Sciences, Faculty of Science at Damietta, Mansoura University, Mansoura, Egypt.
(3) Anonymous, USA.
Complete Peer review History: http://www.sciencedomain.org/review-history.php?iid=969&id=31&aid=8020

Original Research Article

Received 20th November 2014
Accepted 12th January 2015
Published 3rd February 2015

ABSTRACT

Google Earth images were widely used to remotely collect qualitative as well as quantitative data about rivers. The use of this free source of data to explore the Nile River was discussed in this paper. The route of the two branches namely Rasheed and Domiat were defined on Google earth. The Latitude and Longitude of selected points on the route were downloaded and plotted. The Haversine formula and the law of Cosines were used to calculate the length of each branch. The error in the calculations was evaluated. The height of each branch was plotted and discussed. Studying images of the Nile river could be used in measuring observations which helps to acquire quantitative as well as qualitative data about the water in the river with minimum costs.

Keywords: Google earth images; remote imaging accuracy; matlab™ accuracy; remote sensing.

1. INTRODUCTION

Google Earth is a free internet based application which integrates digital images and digital information [1]. It provides an easy to access and cost free image data that is needed by the map interested community. People can extract information from the obtained satellite images by digitizing areas under study and transfer them for use elsewhere [2]. Over the last several years,

**Corresponding author: E-mail: ahmed22@aucegypt.edu;*

Google Earth and Google Maps have been adopted by many academic institutions as academic research and mapping tools [3]. Authors of [3] were interested in discovering how popular the Google mapping products are in the academic library setting. A survey was conducted to establish the mapping products' popularity, and type of use in an academic library setting. Results show that over 90 percent of the respondents use Google Earth and Google Maps either to help answer research questions, to create and access finding aids, for instructional purposes or for promotion and marketing [3]. Also, the usage of the image data covers many areas among which discovering the possible use of lands, the covering of remote areas on earth and the development of rivers and lakes over time.

In ref [4], Google Earth technology and a Global Positioning System (GPS) were imported by China into a monitoring system for schistosomiasis surveillance of the banks of the Yangtze River in Jiangsu Province, China. Results were assembled and broadcasted via the Google Earth platform. The results confirmed that the surveillance system can be rapidly updated and easily maintained, which proves the Google Earth approach to be a user-friendly, inexpensive warning system for schistosomiasis risk. In ref [5], flooding remains the UK's most significant natural hazard and, because climate change adds uncertainty to the risk, new thinking is required for long term flood risk management. A practical and easy to implement approach were adopted using Google Earth based aerial photographic sources that are free to use and available for the whole of the UK to define emerging areas of risk. In ref [6], the recreation of a real expedition or field trip using digital media was discussed and named by the name Digital Fieldwork. The simplest form of digital fieldwork could be a video or photograph showing pupils a specific place rather than them being able to visit it. Whilst digital fieldwork is no substitute for the 'real thing', it can make an important contribution to learning where real fieldwork is not possible for reasons of cost, disability, or danger. In ref [7], the goal of this research is to investigate the potential of using Google Earth for Internet GIS applications. The study specifically examines the use of vector and attributes data and the potential of displaying and processing this data in new ways using the Google Earth platform. The results revealed that both vector and attribute data can be effectively represented and visualized using Google Earth. In ref [8,9], one of the major challenges in river restoration is to identify the natural fluvial landscape in catchments with a long history of river control. Around the Pas River catchment in northern Spain, land use and development have obscured the natural fluvial landscape in many parts of the basin. To address this issue, [8] used computer tools such as Google Earth, to examine the spatial patterns of fluvial landscapes. In ref [10,11,12], an attempt has been made, to apparatus the GIS techniques for river change detection using traditional to advance geographical data sources. The advances in Remote Sensing data and Topographical data are to be implementing for obtaining several years changes results in river stream. In ref [13], containership-info provides a guided Google Earth tour of the container terminals in the Shanghai region, China.

There are several advantages of remote sensing for assessing the water quality of a river [14]. For example, remote sensing is used to collect data from inaccessible areas. Images obtained remotely are used in measuring observations which helps to acquire quantitative as well as qualitative data about the water in rivers. Data can be recorded permanently and reproduced at any time. Remote sensing replaces costly and slow data collection on the ground ensuring that areas or objects are not disturbed. Information can be obtained from large areas in a very short time and dynamic measurements can be performed which helps in monitoring change [14,15]. Google Earth is becoming an inevitable tool to study geographical locations such as rivers.

In this work, to study the Nile River, distances between selected points along the river need to be calculated as accurate as possible. Towards this aim, the Longitude and Latitude data along the path of the Nile should be known. Mathematical methods of calculating distances between points along the path should be evaluated. The elevation of each point along the path should be defined.

In this paper, we discussed the possibility of using GE images to extract geographic data about the Nile River. The two branches Rasheed and Domiat were defined and their lengths were calculated. The change in elevation of the two branches was defined. The rest of this paper was divided into three parts. The Methods part dealt with introducing the mathematical and imaging tools which were used in this paper. The Results and Discussion part states how we selected points along the Domiat and Rasheed branches of the Nile River and imported the horizontal and vertical positions from GE. We used two different equations to calculate the lengths of the Rasheed and Domiat branches. The accuracy of each equation was evaluated. The accuracy of Matlab™ is assessed when extracting the horizontal and vertical position of each point along the branches of the Nile River. Finally, the conclusion part dealt with summing the work which was described in the Results and Discussion part and drawing the benefits of the work done.

2. METHODS

From GE, the geographic path of the Nile River was defined. A group of points were selected along the Rasheed branch including the common part as shown in Fig. 1. Another group of points were selected along the Domiat branch including the same common part as shown in Fig. 1. To copy an image from GE, one went to ‘Edit’ and then selected ‘Copy Image’. [1] A copy of the 3D viewer could then be pasted and saved as an image file as shown in Fig. 1. The image used in this study was captured on 4th of October 2013 and copied from GE on 8th of August 2014 (shown in Fig. 1).

Two equations were evaluated in calculating the lengths of the two branches. First, we tried to use the Haversine formula to calculate the great circle distance between two points – that is, the shortest distance over the earth’s surface between two points [16].

The distance d between points 1 and 2 on earth was [16]:

$$d = R \times c \tag{1}$$

Where R is earth’s radius (volumetric mean radius = 6,371 km [17]).

The constant c was calculated using [16]:

$$c = 2 \times \operatorname{atan2}\left(\sqrt{a}, \sqrt{1-a}\right) \tag{2}$$

Where $\operatorname{atan2}$ calculates the angle between the positive x-axis and the point defined by the coordinates $\left(\sqrt{1-a}, \sqrt{a}\right)$.

The constant a was calculated using [16]:

$$a = \sin^2\left(\Delta lat/2\right) + \cos(lat1) \times \cos(lat2) \times \sin^2\left(\Delta long/2\right) \tag{3}$$

where $lat1$ and $lat2$ were the latitude angles of the first and second points respectively. Δlat was the difference between the latitude angles of the first and second points. $\Delta long$ was the difference between the longitude angles of the first and second points. The distances which were calculated using formulas 1, 2 and 3 were much smaller than the earth’s radius so as to ensure avoidance of floating point error [18].

Fig. 1. An image which was copied from GE showing the Rasheed and Domiat branches of the Nile River [1]

All angles need to be in radians to pass to trig functions. The horizontal and vertical angles imported from GE were in degrees. To change from degree to radians, one needed to multiply by $\pi/180$.

Second, we tried to use the simpler law of cosines which is a reasonable 1-line alternative to the Haversine formula for many purposes. The choice might be driven by coding context such as available trigonometric functions in different languages. The distance d between point 1 and point 2 could be calculated using the Cosines law which can be stated as follows [19]:

$$d = \text{acos}\begin{pmatrix}\sin(lat1)\times\sin(lat2)+\cos(lat1)\times\cos(lat2)\\ \times\cos(long2-long1)\end{pmatrix}\times R \quad (4)$$

Where $long1$ and $long2$ were the longitude angles of the first and second points respectively.

Each formula was used to calculate the distance between each two consecutive points defining each path of the Nile River. For each branch, the summation of the distances between all consecutive points (defining the branch) was equal to the length of the whole branch.

From GE, one right clicked on each path and selected ‘Show Elevation Profile’. At every point on each path, the horizontal and vertical positions were known on screen. When one downloaded XML files from GE, two files were downloaded one for each branch. Each contained the descriptions of the place defined by one of the paths. Inside each file a Path object was found that specifies the position of the each point on the Path (longitude, latitude) [1]. The longitude and latitude of each point defining the Rasheed and Domiat branch were extracted from the XML file of each branch [20].

Next, we applied a method to extract directly the elevation data from GE. First, we used Matlab™ to convert an image of the elevation profile in GE to a plot. Second, we fitted the data in the plot to an equation that would transform it to a plot of the elevation data. A series of Matlab™ commands were executed to obtain a plot of the elevation values for the two branches under consideration.

Matlab™ was then initiated to be used to perform the following steps. Matlab™ commands were put inside angle brackets. The Matlab™ command [21] <imread> was used to read the image of the Nile River. The lower part containing the Elevation Profile of the image was selected. The command [21] <roicolor> was used to transfer the image to a gray scale image and returns a binary image. Following that, the command [21] <bwareaopen> was used to remove all small artifacts. Following that, the command [21] <find> was used to find out the location of the line describing the elevation profile in the image. A plot could then be drawn for the indices of each pixel forming the profile. An equation could then be found to transfer the indices of each pixel to its elevation value. The elevation values were then plotted.

3. RESULTS AND DISCUSSION

A plot of both branches was shown in Fig. 2. The Rasheed branch was plotted in red while the Domiat branch was plotted in blue. When Fig. 1 and Fig. 2 were compared, we deduce that the plot in Fig. 2 was almost identical to the image of the branches shown in Fig. 1.

In Table 1, we could find the theoretical (GE) length of each branch. The theoretical (GE) length was found on the upper part of the elevation profile which was downloaded from GE for each branch. The length of each branch as calculated by the corresponding formula was shown as well. The percentage error was calculated for each formula when compared to the theoretical (GE) values. The error was calculated as follows:

$$\%\text{Error} = \left|\frac{Theoretical(GE) - Calculated}{Theoretical(GE)}\right| \times 100 \quad (5)$$

When looking in Table 1, we find that for each formula the percentage error in calculating the length of the Domiat branch was much higher than that of the Rasheed branch. The number of points which were used to define the Rasheed branch was 1251 while the number of points which were used to define the Domiat branch is 995. The points were chosen randomly along the two branches so as to cover the whole length of each branch. In addition, the Rasheed branch was shorter than the Domiat branch. The Rasheed branch was defined using 4.73 points/km while the Domiat branch was defined using 3.65 points/km. The formulas were used to calculate the distance between each two consecutive points for each branch. The higher the rate of the number of points defining the branch the higher was the accuracy in calculating the length of the branch because each curve in the branch was more accurately defined and so its length was more accurately calculated.

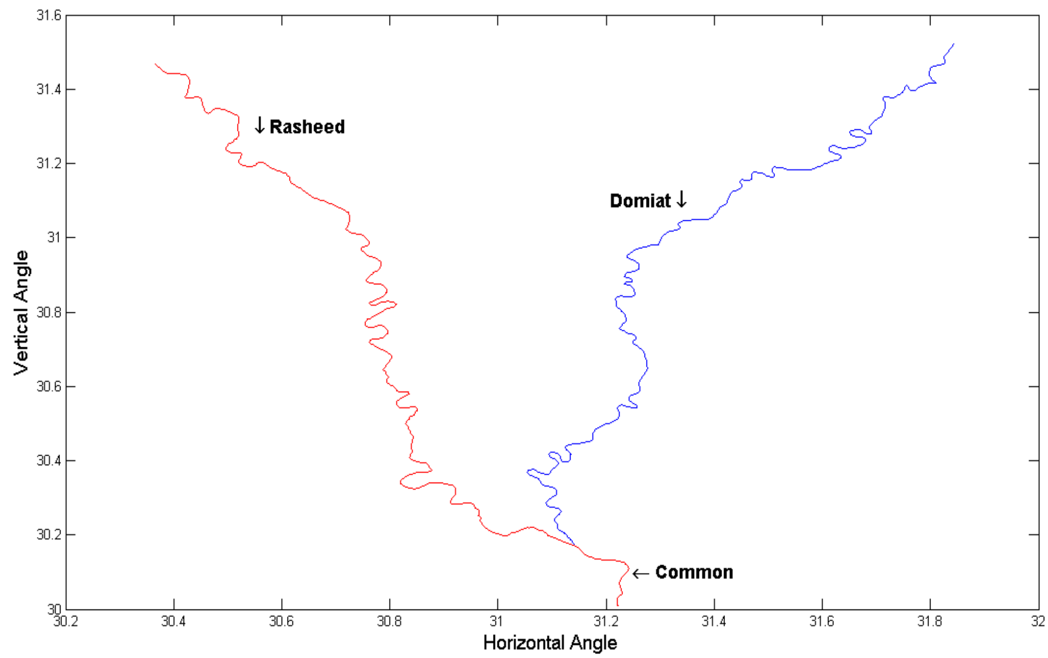

Fig. 2. A plot of the Domiat and Rasheed branches using selected points on each branch

Table 1. The accuracy in calculating the length of each branch of the Nile River using two different ways of calculations was tabulated

	Rasheed	Domiat
Theoretical (GE) (m)	264500	272500
Cosine (m)	264084.439494908	270075.132626132
%Error (Cos)	0.157111722151797	0.889859586740489
Haversin (m)	264084.440389871	270075.132336477
%Error (Hav)	0.157111383791721	0.889859693036030
Theoretical [22] (m)	262000	265000

Theoretical (GE) were the lengths of the two branches in meters as shown on GE images. Theoretical [22] were the lengths of the two branches in meters as found in ref.[22]. All percentage errors were calculated with respect to Theoretical (GE)

Another type of values which were named Theoretical [22] were shown in Table 1. Values of Theoretical [22] were the lengths of the two branches of the Nile River as mentioned in reference [22]. Theoretical [22] were mentioned for comparison purposes. Length of the Rasheed branch which was obtained from GE images was more accurate when compared to Theoretical [22] values than the length of the Domiat branch.

From another point of view, we know that the error when using the Haversine formula should be lower than when using the law of cosine [19]. The case was proven when looking into the errors of calculating the length of the Rasheed branch. The percentage error for calculating the length using the law of cosines was higher than that when using the Haversine formula. The difference between both was equal to 3.38×10^{-7}. But for the Domiat branch, the case was different. The percentage error for calculating the length using the law of cosines was lower than that when using the Haversine formula. The difference between both was equal to 1.06×10^{-7}. This discrepancy could be traced back to more than one reason. For example, Nowadays, JavaScript (and most modern computers & languages) use IEEE 754 64-bit floating-point numbers, which provide 17 significant figures of precision [23]. With this precision, both laws used in this paper give well-conditioned results down to distances as small as around 1 meter. The accumulated error when summing after using the same law for each consecutive two points is unknown. After some research, the following error was also seen.

All our previous plots and calculations in this paper were done using Matlab™. When we uploaded the same data using excel sheets, we found that the XML files provide us with angles that were accurate up to 13 decimal points. But the Matlab™ software only imported data with 12 decimal points even when using double precision numbers. The difference between the precision of Matlab™ and that of Microsoft™ Excel sheets was calculated for each of the points used to define each branch. Then statistical analysis was applied to know the effect of decimal points on accuracy of calculations. The Minimum, Average, Standard Deviation (SD), Maximum and Median parameters were calculated once for the difference in Horizontal angles and another for the difference in Vertical angles for each branch. The Minimum and Maximum values were all the same so the maximum error we could get whatever the branch is was the same. The highest average was for the difference in the Horizontal angles of the Domiat branch. The highest SD was for the difference in the Vertical angles of the Domiat branch. The minimum mean was for the difference in the Vertical angles of the Domiat branch. The variation in values of average, SD and mean were all concentrated in Domiat branch. More investigation was required to know if there is a link between these statistical parameters and the variation in the percentage of errors shown in Table 1.

The height of the Rasheed branch was plotted using the blue line as shown in Fig. 3. The line started with the value zero which is the sea level and then started increasing as the distance from the point at which the river meets the sea increased. A best fit was drawn for the variable increase in the height of ground.

The equation of the line (shown on graph of Fig. 3) was:

$$Elevation = 0.0554 \times Distance - 2.97 \quad (6)$$

where $Elevation$ was the height of the ground and $Distance$ was the length of the branch starting from sea level.

The height of the Domiat branch was plotted using the blue line as shown in Fig. 4. The line started with the value zero which is the sea level and then started increasing as the distance from the sea increase. A best fit was drawn for the variable increase in the height of ground.

The equation of the line (shown on graph of Fig. 4) was:

$$Elevation = 0.0466 \times Distance - 0.276 \quad (7)$$

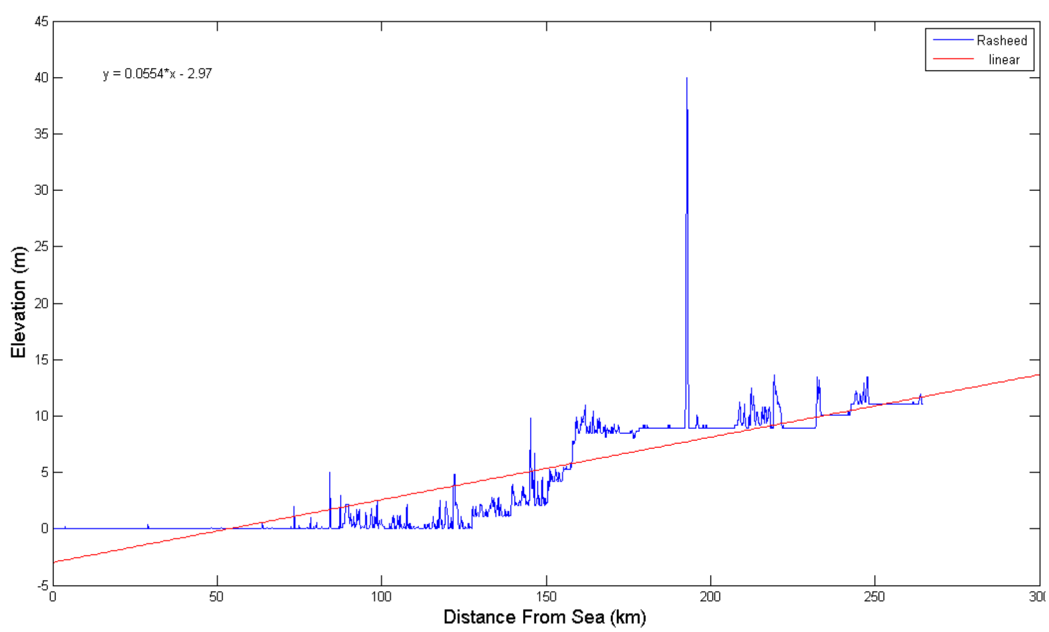

Fig. 3. A plot of the altitude values for the Rasheed branch. The equation of the line is for the linear one

Table 2. The accuracy of Matlab™ in calculating the Horizontal (H) and Vertical (V) positions was tabulated

	Minimum	Average	SD	Maximum	Median
Domiat H	0	4.55497E-13	2.86489E-13	9.02389E-13	4.9738E-13
Domiat V	0	4.48103E-13	2.94587E-13	9.02389E-13	4.01457E-13
Rasheed H	0	4.47747E-13	2.8414E-13	9.02389E-13	4.9738E-13
Rasheed V	0	4.49599E-13	2.87715E-13	9.02389E-13	4.9738E-13

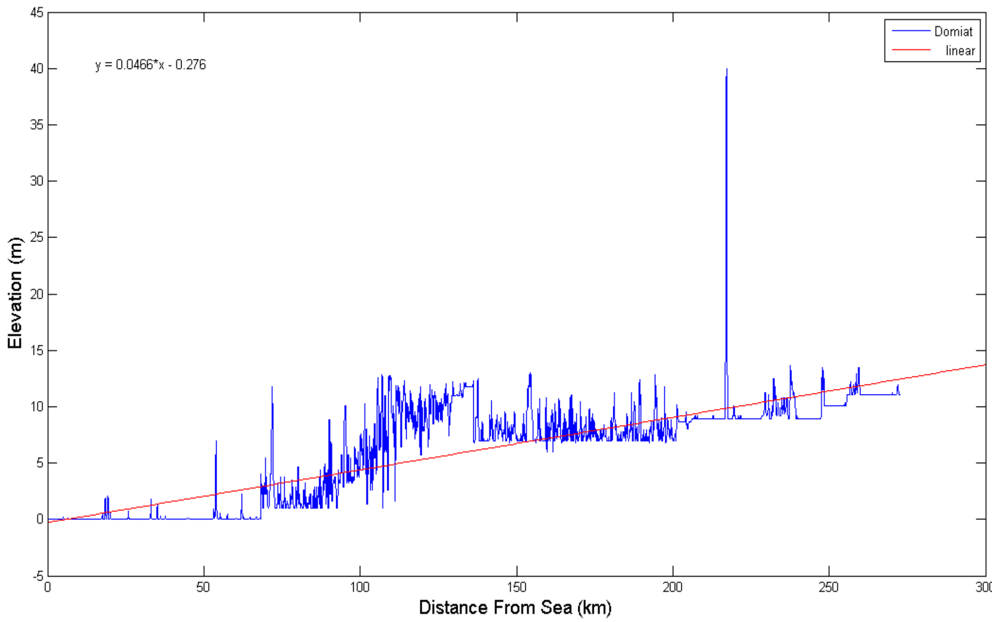

Fig. 4. A plot of the altitude values for the Domiat branch. The equation of the line is for the linear one

where $Elevation$ was the height of the ground and $Distance$ was the length of the branch starting from sea.

The rate of change of the height for the Rasheed branch was 5.54 cm per one km and for the Domiat branch was 4.66 cm per one km. The theoretical length of the Rasheed branch was 264 km while that of the Domiat branch was 272 km as shown in Table 1. The same common part was included in the heights of the two branches (as shown in Fig. 2). Both had to reach the same height (of the common part) from sea level while the Rasheed branch was shorter than the Domiat branch. This explained the higher rate of change of height for the Rasheed branch than that of the Domiat branch.

4. CONCLUSION

In this work, we used GE images to identify and measure the geographic extent of two branches of the Nile River. Selected points along each branch were identified and their Longitude and Latitude were downloaded from GE. The Haversine formula and the law of Cosines were used to calculate the length of each branch. The number of points per each km was important in determining the accuracy in calculating the lengths. The higher the number of points per km the higher was the accuracy. Importing data from GE to Matlab™ to perform calculations was done at the expense of losing one decimal point. The effect of this decimal point on accuracy is still open to further investigation. The rate of change of height for the Rasheed branch was higher than that of the Domiat branch. Rasheed was shorter than Domiat and so the higher rate was needed for both branches to reach the same meeting point up the Nile River.

COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. "Earth Help." Earth Help. N.p., n.d. Web; 2014.

   Available:https://support.google.com/earth/?hl=en
2. Nagi Zomrawi M, Ahmed G, Hussam M. Eldin: Positional accuracy testing of google earth. International Journal Of Multidisciplinary Sciences And Engineering. 2013;4:6
3. Eva Dodsworth, Andrew Nicholson. Academic uses of google earth and google maps in a library setting. Information Technology and Libraries. 2012;31:2.
4. Le-Ping Sun, You-Sheng Liang, Hong-Hui Wu, Zeng-Xi Tian, Jian-Rong Dai, Kun Yang, Qing-Biao Hong, Xiao-Nong Zhou and Guo-Jing Yang. A google earth-based surveillance system for schistosomiasis japonica implemented in the lower reaches of the Yangtze river china. Parasites & Vectors. 2011;4:223.
5. Trevor Maynard, Neil Smith, Alexandra Vincenti. Geomorphology and changing flood risk in the UK: Lloyd climate wise; 2012.
   Available:http://www.lloyds.com/news-and-insight/risk-insight/library/natural-environment
6. Jamie Buchanan-Dunlop, Google, Ricardo Sgrillo. Advanced digital fieldwork using google earth. Digital Explorer London digitalexplorer.co.uk; 2008.
7. Andrew Henry. Using google earth for internet GIS: MSc, institute of geography, school of geosciences. University of Edinburgh; 2009.
8. Benda L, Miller D, JB. Creating a catchment scale perspective for river restoration hydrol. Earth Syst. Sci., European Geosciences Union. 2011;15:2995-3015.
9. Gordon T. Amanbagara, John D. Njoku, Moses Obenade. Applying satellite remote sensing and GIS tools in the study of gully erosion. Journal of Scientific Research & Reports Sciencedomain international. 2015 4(3):253-264. Article no. JSRR. 2015.029.
10. Sainath P Aher, Shashikant I Bairagi, Pragati P Deshmukh, Ravindra D Gaikwad. River change detection and bank erosion identification using topographical and remote sensing data. International Journal of Applied Information Systems. 2012;2:3.
11. Alex McCorquodale, Ioannis Georgiou, Mallory Davis, Joao Pereira. Hydrology and hydrodynamic modeling of the mississippi river in southeast Louisiana. Pontchartrain Institute for Environmental Studies, University of New Orleans. Lake Pontchartrain Basin Foundation; 2010.
12. Sera Janson Zegre, Anne Hereford. National river data inventory & database plan: Downstream strategies. National Park Service Washington DC; 2012. Available:www.downstreamstrategies.com
13. Jan Svendsen, Jan Tiedemann. Containership-Info special: Port development in the greater shanghai region; 2006.

    Available:www.jantiedemann.de-www.Containership-info.net.tc
14. Shivangi S, KP, SNB, KTS. Water turbidity assessment in part of gomti river using high resolution google earth's quickbird satellite data. Geospatial World Forum, Hyderabad India; 2011.
15. Laxmi Joshi Shrestha, Mohan Devkota, Bhuvan Keshar Sharma. Phyto-sociologica assessment of sacred groves in Kathmandu Nepal. International Journal of Plant & Soil Science, Sciencedomain international. 2015;4:5.

    Article no. IJPSS .2015. 043.
16. Chopde NR, Nichat MK. Landmark based shortest path detection by using a and haversine formula. International Journal of Innovative Research in Computer and Communication Engineering. 2013;1:2.
17. Available:http://nssdc.gsfc.nasa.gov/planetary/factsheet/earthfact.html
18. Available:http://en.wikipedia.org/wiki/Haversine_formula
19. Ivis F. Calculating geographic distance: concepts and methods. NESUG Conference Data Manipulation Baltimore MD US; 2006.
20. Using google earth to make a map. Aurora Research Institute Aurora College. Available:http://www.accessnwt.ca/docs/default-document-library/using-google-earth-to-make-a-map.pdf
21. New graphics big data. Source Control Integration And More Math Works. N.p., n.d. Web; 2014.

Available:http://www.mathworks.com/
22. Sabae, Shawky Z, Saleh A. Rabeh. Evaluation of the microbial quality of the river nile waters at damietta branch, Egypt. Egyptian Journal of Aquatic Research. 2007;33(1):301-11.
23. Available:https://en.wikipedia.org/wiki/IEEE_floating_point

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history.php?iid=969&id=31&aid=8020