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# Remote Sensing & GIS Techniques in Automation Process of Watershed Area assessment

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*A number of water reservoirs, lakes are found in the particular area. These water bodies are occupying low land, plain lands, surrounded by hills and are generally used for domestic water supply, hydel power generation and irrigation purposes. They depend on the availability of seasonal water in nature. The purpose of the watershed assessment in the particular area is to aid the local government in their efforts to prioritize, develop and manage watershed in a proper manner. It was a challenge to explore watershed assessment in uttar Pradesh, India, due to surrounding hilly area. The groundwater table has declined and the extraction of ground water is not sustainable, but on the satellite image it is seen clearly in blue or cyan color depending on the depth of water. Spatial as well as spectral resolution has a very important role to play in watershed assessment. Other more detailed data sets, NDWI remote sensing techniques, drainage length, drainage order, drainage pattern, watershed, ESRI ArcObjects (Windows-based automated process to generate watershed and other product from SRTM data) and SRTM data outcomes made to the model to incorporate the new information. This information is used to enhance the region's watershed assessment for identifying potential area.*

***Keywords:*** *NDWI, watershed assessment, SRTM, GIS and remote sensing, spatial analyst, ESRI ArcObjects*

## I. INTRODUCTION

The Geographic information system (GIS) and remote sensing data are used for extracting the watershed assessment. Accuracy of the watershed (based on shape of the area), depends on the accuracy, effectiveness of the method used, resolution of the satellite imagery and SRTM data available. In the that paerticular area, watershed delineated from LISS-III image using NDWI, other product as slop, tin, aspect, hill shade, drainage length and drainage order generated from SRTM data and ESRI ArcObjects based, developed a Windows-based application to customize and automate the watershed process (to generate watershed product on a single click). A spatial analyst tool (ESRI ArcGIS software) is available and one has to set input, output, other parameters, etc., but in the automated process, one can get the required information on a single click (watershed automated process programming). Since the mid-1980s, with increased popularity of GIS technology and availability of digital elevation models (DEMs), the potential of using DEMs in studies and IRS LISS-III data has increased.

### B. Normalized Difference Water Index

The normalized difference water index (NDWI) is a method that has been developed to delineate water features and enhance their presence in remote-sensing satellite imagery (Figure 2). NDWI is an index from the near-infrared (NIR) and green channels that reflect changes in both the water content and vegetation canopies to enhance the presence of such features while eliminating the presence of soil and terrestrial vegetation features. It is calculated by the expression [2], $NDWI = (green - NIR)/(green + NIR)$ where green = reflectance in green band, NIR = reflectance in NIR band.

While in the interpretation on satellite images, water bodies have a unique spectral response in the visible range. Spectral band displays unique histogram according to pixel DN value on the image. The range of NDWI is zero to one and higher reflectance of NIR than green light. The infrared band gives a much better representation for water pixels identified than do the other visible bands. The NDWI outputs dense vegetation (29.921), degraded vegetation (173.299), open vegetation (104.847) and water body (1.853) changes have been found in the that particular area.

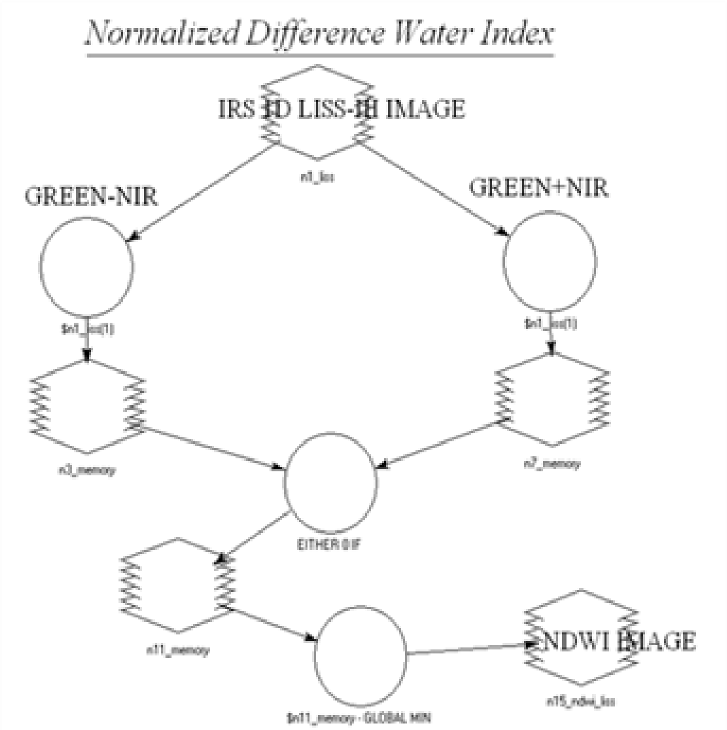


***Fig. :*** *NDWI Method.*

***C. Digital Elevation Model***

The digital elevation model, abbreviation "DEM" [3], is an extremely useful product of GIS for watershed assessment. The digital elevation model (DEM) is a digital representation of terrain elevation as a raster (a grid of squares) or surface of the earth (fixed-grid interval). The digital elevation model (DEM) has been used for extracting the landscape spatial information such as slope, aspect, contributing areas, drainage divides and channel network determined from DEM (SRTM data). Due to the complexity of watershed assessment, it is a continual challenge for planners and surveyors. Today, GIS is able to execute all these complex tasks. A GIS can manage data input, calculations and the presentation of the results [4]. The ArcGIS spatial analyst extension provides methods for describing the physical components of a surface such as aspect, hillshade, to identify sinks, determine flow direction, calculate flow accumulation, delineate watershed and create stream networks. In the that particular area, SRTM (Shuttle Radar Topography Mission) data have been used for terrain analysis. The obtained data are converted into height data called a digital elevation model (DEM) and utilized to generate a more precise three-dimensional map of larger observation area of the Earth than has ever been possible. The SRTM radar contains two types of antenna panels, C-band and X-band [5]. The digital elevation model (DEM) is made from the C-band radar data and provides as 3-arc second (approx. 90 m resolution) DEMs. These data were processed at the Jet Propulsion Laboratory.

***C.1. Slope***

Slope is defined as the ratio of the "rise" divided by the "run" between two points on a line [6] and is used to describe the steepness, incline and gradient. A higher slope value indicates a steeper incline and lower slope value indicates the flatter terrain. The slope is categorized as 0–3 (very gentle), 3–14 (gentle), 14–54 (moderate), 54–67 (strong), 67–72 (moderately steep).

***C.2. TIN***

TIN (Triangulated Irregular Network) represents surface as a triangular facet based on irregular spot – height (x, y coordinate and z value). The spot heights are connected with a series of edges to form a network of triangles [7]. TIN interpolation is calculated based on elevations of digitally extracted ridgelines [6]. TIN map with stored terrain information has been used for view of the high relief (408–490 m) and low relief (0–81 m) of the that particular area during the field survey.

***C.3. Aspect***

Aspect identifies the down slope direction of the maximum rate of change in value from each cell to its neighbors [6]. It can be used to calculate the solar illumination and has maximum value of 359.970 indicating the steepest down slope in the north direction while the minimum value −10 indicates the flat areas of the particular area.

***C.4. Hillshade***

Shadow and light are shades of gray associated with integers from 0 to 255 (increasing from black to white). In hillshade map of that particular area, the highest value determined is 254 shown in gray while the lowest value 0 is shown in black color. It has an azimuth of 3150 and altitude 450.The hillshade analysis is used to calculate lozcal illumination and landscape.

***C.5. Stream Network and Order***

Stream network identifies the number of upslope flow of surface water (lower–1, high–163) in different directions of surface water flow [8] through the stream network (Figure 5). The stream order is identified and classified as types of streams based on their tributaries [8]. The stream order is assigned on the basis of the method proposed in ref. [9]. In this method, order is assigned by the upstream. Therefore, towards increasing order, intersection of the two same-order streams will create a second-order stream and two second-order stream intersections will create a third-order stream (Figure 6) and so on. The high and low stream order will not increase the number of stream orders. The stream order numbering reveals that streams of the watershed are designated from first to fourth order. The that particular area exhibits the dendritic type of drainage pattern.

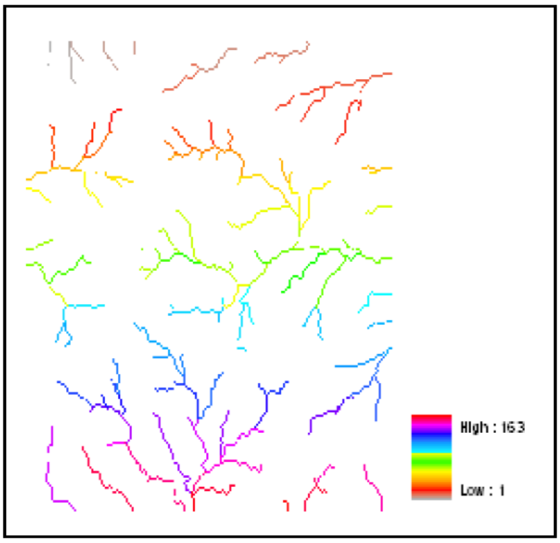


***Fig. :*** *Stream Network*

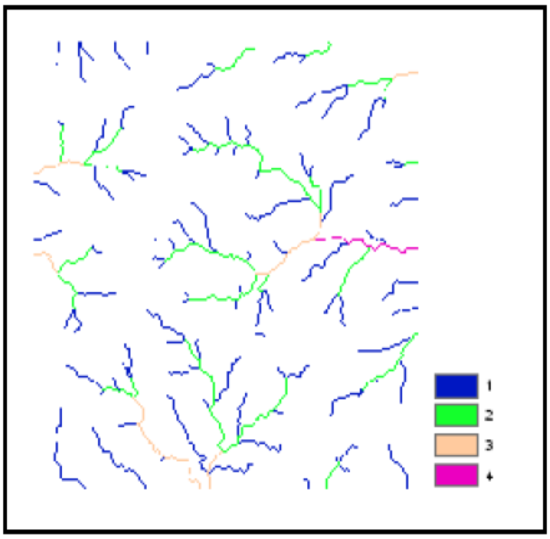


***Fig. :*** *Stream Order*

***C.6. Watershed Mapping***

The area that drains water is called drainage basin, or watershed or catchment, or contributing area. These assessments require an understanding of how water flows across an area and how changes in that area may affect the flow. The computer can follow the terrain to the inter-basin divides and divides the landscape into watershed. The slope, aspect and drainage system (outlet or the main stream) are useful for automatically generating map units in watershed analysis. Watershed is delineated through spatial analyst [10] from runoff characteristics sink (lower–1, high–375) and fill (lower–0, high–491) has been used to correct the imperfect lower value and its surroundings in digital elevation model. Sinks in elevation data are most commonly due to errors in the data. These errors are often caused by sampling effects and rounding of elevations to integer numbers. Flow direction (lower–1, high–128) determines the water flowout in each cell, flow accumulation (lower–0, high–12109) calculates the upslope location, generates the flow direction and stream network. The flow length (lower–0, high–17855) is determined from the length of upslope or downslope along the flow path in watershed. Watershed is the fundamental spatial unit for managing such as land use/land type, soil types, lithological, geomorphological and river flows, etc..

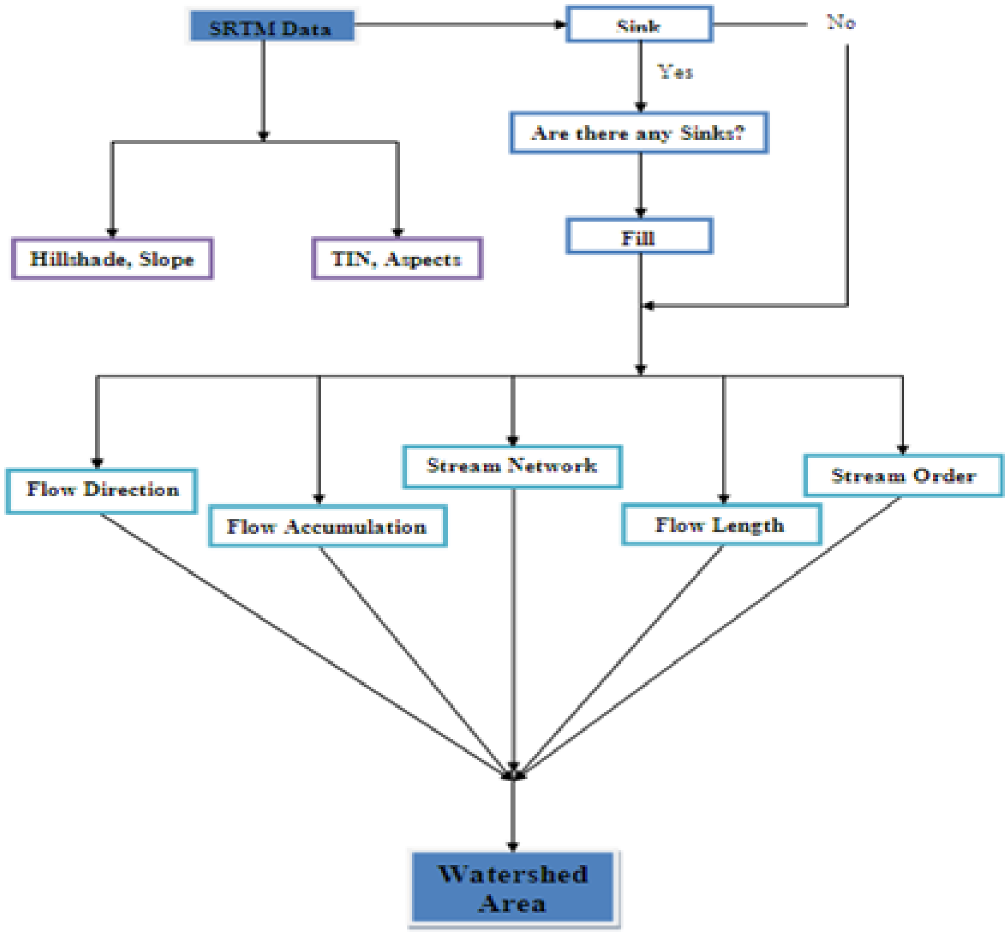


***Fig. :*** *Methodology of Watershed Delineation.*

## II. CONCLUSIONS

Monitoring is a vital aspect of habitat restoration that is often overlooked and can be difficult to fund. By monitoring restoration projects, it is possible to determine whether the methods used are effective in achieving restoration goals. Monitoring programs should measure quantifiable parameters such as seedling survival, water temperature, turbidity, presence of native animals, or cover of exotic vs. native plant species. Monitoring protocols for vegetation surveys, stream surveys, wildlife surveys and many other aspects of restoration have been developed and are available to guide monitoring programs.The results of monitoring programs should be continually compared with goals for each project and adaptive management measures should be implemented to ensure that goals are reached

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