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Identification Delineation and Mapping of Micro Watershed of Kolhapur Region

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Abstract:
Delineated watersheds are required for HSPF modeling and for BASINS watershed characterization reports, so we can characterize and investigate what is going on in one portion of the study area versus another. Delineation is part of the process known as watershed segmentation, i.e., dividing the watershed into discrete land and channel Segments to analyze watershed behavior. Boundary of a watershed consists of the line drawn across the contours joining the highest elevations surrounding the basin. A common task in hydrology is to delineate a watershed from a topographic map. Use of GIS (Geographic Information System) popular and has facilitated much of the work of hydrologists. The use of DEMs (Digital Elevation Models) in particular has made watershed delineation a smooth procedure. With help of QGIS delineation and mapping of micro watershed at Kaneri is done. This has given watershed boundary for the particular stream. The results obtained from watershed delineation have wider application for watershed management.

Keywords: HSPF, Basins, Delineation, Watershed, QGIS, GIS, DEM

1. Introduction

Water, the vital resource for the sustenance of life on earth is becoming a rare commodity due to various reasons. The ever growing demand for water due to the rapid growth in population, increasing agricultural activities, vagaries of monsoon coupled with fast urbanization and industrialization create an acute scarcity for water. The improper exploitation and scrupulous management worsen the situation where almost all the surface and ground water is being polluted due to disposal of human sewage and industrial effluents. In western Maharashtra, we receive moderate rainfall and there is scarcity of water in summer season in some areas of Western Maharashtra. So it is necessary to determine the problems and study these problems. These problems can be study by Identification Delineation and Mapping of Watershed. So we have selected the area of Kolhapur region of western Maharashtra for our project study.

The vast area covered by the Maharashtra can become a problem when studying water resource issues. For example, the western portions of Maharashtra receive an abundant amount of rain, while the eastern portions are virtually dry. Even during normal rainfall periods, some areas lack sufficient water supplies to meet all demands. This lack of water is magnified in periods of drought, to the extent that essential needs may be threatened. These issues alone require extensive planning for current and future water demands. If we also consider the effects of population growth, as well as new and emerging environmental issues, the need for complex management tools to identify, assess, and resolve these water resource issues becomes evident.

1.1. Study Area

- The area selected for present study is Kaneri watershed. Kaneri is situated in Kolhapur district.
- Kolhapur district is situated in the western ghat having steep slope towards the western side and gentle slope towards the eastern side. The Kolhapur district is a part of Deccan plateau which made of lava material.
- The longitude and latitude of Kaneri are 74°16'48"E and 16°37'34"N respectively

1.1.1. Details of Kaneri
- Total Area: - 965.24 Ha.
- Average Rainfall:- 44mm to 55mm
- Source of drinking water:- Lake-1, Well-3, Borewell-70
- Source of Irrigation water:- Lake-1, Well-103
- Area under Roads: - 18.28 ha.

1.2. Data Collection
- Survey of the existing water bodies.
- Visit to the houses of owners of water bodies like wells and bore wells.

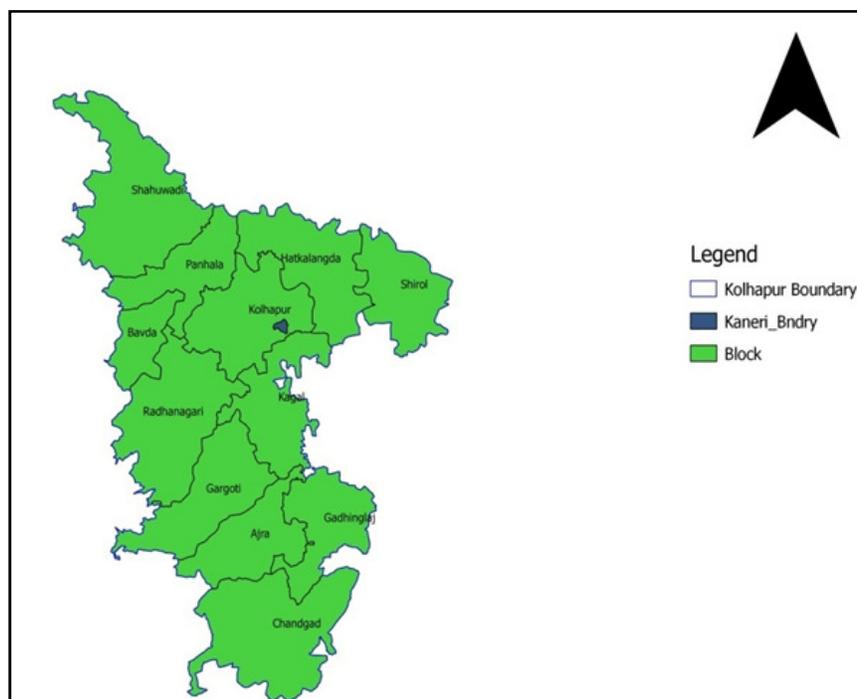These data are used for locating the actual location of water bodies on the map of the study area.

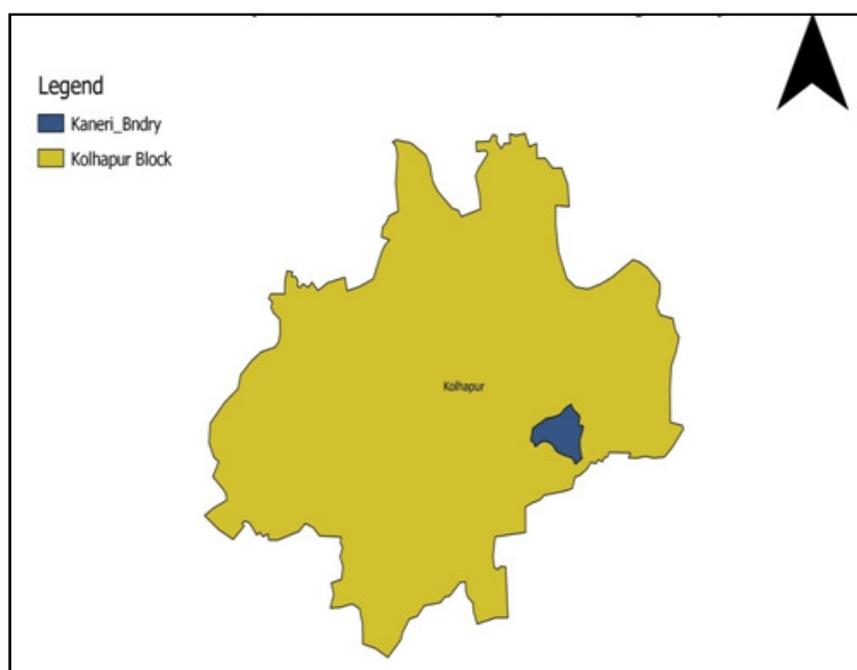*Figure 1: Boundary of Kaneri with respect to Kolhapur District*

Figure 2: Boundary of Kaneri with Respect to Kolhapur City.

1.3. Methods
- Drawing contour map by GIS using topographic maps of Kolhapur region.
- Delineation of Kaneri watershed with DEM development

1.3.1. Methods of Data Collection
- By observation
- Through Census Records available in Government offices and with the government Authorities
- Using GIS Software
- By collecting sample at different locations for quality and quantity assessment.
- Through Social Mapping of the areas.

1.3.2. Probable Methods of Data Collection
- Primary information- with actual technical survey
- Secondary information – from the data collected from different sources.

2. GIS System and Data Description

2.1. Introduction
Because GIS and digital data were valuable tools in the work performed for this thesis, it is appropriate to discuss the features and advantages of GIS, as well as describe the data sets used. This chapter will cover both tasks.

2.2. Geographic Information Systems
Before entering into a description of the data used in this research, it is first important to gain an understanding of GIS and the tools used to manipulate the data. Use of GIS has grown dramatically over the past decade, and it is now commonplace for business, governmental, and academic institutions to use GIS for many diverse applications. Consequently, many definitions of GIS have developed (ESRI, 1997). However, perhaps the most concise definition of GIS is that offered by the Association for Geographic Information: "A system for capturing, storing, checking, integrating, manipulating, analyzing and displaying data which are spatially referenced to the earth."
From this definition, we see that GIS is not simply a computer system for making maps, as most people assume. A GIS is an analytical tool. The major advantage of such a tool is that it allows you to identify the spatial relationships among map features (ESRI, 1997). This ability was fundamental in the choice of GIS for the Water Availability Modeling research project. By overlaying maps of water rights, river networks and river basins, relationships between features can be found. For example, we can know which water right fell on river reach and in which Basin, and which water rights are upstream and downstream of the current one. This process has previously been done by manual interpretation of paper maps, often a cumbersome procedure.
Another important feature of GIS is the linking of spatial data with geographic information about a particular feature on a map. Each feature in a GIS map is linked to a set of attributes that is stored in a database (ESRI, 1997). Therefore, a person can query a feature on a map and retrieve a wealth of information about the map feature. The programs used to perform such queries and analyses in this study were ARC/INFO GIS and Arc View GIS, both developed by the Environmental Systems Research Institute (ESRI).
ARC/INFO and ArcView differ in a couple of very distinct ways. For example, ARC/INFO uses a command language that functions similarly to the way a computer's operating system works: commands are entered at a prompt before different tasks (ESRI, 1997). However, ArcView is a much more visual medium for working with maps. Based totally in a Windows operating system, operations and commands are performed mainly through menu options and user-created scripts (or programs), rather than built-in functions.

2.3. Digital Elevation Models
One of the most important data sets needed for drainage area calculations is an accurate representation of the land surface. In a GIS framework, a Digital Elevation Model (DEM) contains such information. A DEM consists of a sampled array of elevations for ground positions that are normally at regularly spaced intervals, as shown in Figure 3

67	56	49	46	50
53	44	37	38	48
58	55	22	31	24
61	47	21	16	19
53	34	12	11	12

Figure 3: Sample representation of a DEM

In the early stages of this project, the best available data sets were 90-meter DEMs (3 by 3-arc second spacing), which contained elevation values at approximately 90-meter intervals (USGS, 1996). However, during the course of the work, the National Elevation Dataset (NED) was made available for the state of Texas. The NED files (or 30-meter DEMs) are DEMs with grid cells of 1 by 1-arc-second spacing or elevation values at 30-meter intervals. The next section discusses these two data sets in detail.

2.3.1. (90) meter DEM
The 90m DEM (often called the 3 arc-second DEM) provides coverage in 1- by 1-degree blocks for all the contiguous United States. The majority of the 3 arc-second DEMs were produced by the Defense Mapping Agency (DMA) from cartographic and photographic sources. However, the final product is distributed by the USGS EROS Data Center (USGS, 1996)
Elevation data from cartographic sources are collected from USGS 7.5-minute through 1-degree maps. Topographic features such as contours and ridgelines are first digitized and then processed into the required matrix form and interval spacing (USGS, 1996). Figure 4 shows an example of DEM elevation values in comparison to contour lines on a topographic map.
Manual and automated correlation techniques are used to collect elevation data from photographic sources. First, the elevations along a profile are collected at 80 to 100 percent of the eventual point spacing. Then, the raw elevations are weighted with additional information during the interpolation process in which final elevations are determined for the required matrix form and interval spacing (USGS, 1996).
The elevation data for the 3 arc-second DEM are referenced horizontally on the geographic (latitude/longitude) coordinate system of the World Geodetic System 1972 (WGS 72) and are referenced vertically in meters relative to the National Geodetic Vertical Datum of 1929 (NGVD 29). The data are approximately equivalent to that which can be derived from contour information represented on 1:250,000 scale maps (USGS, 1996).
Each file contains 1201 rows and columns or approximately 1.4 million cells and takes 6.91 MB of memory with elevations in floating point meters. The river basins covered by this study require 4-6 one-degree blocks to cover them. Typical grid sizes for the river basins were 10 million cells.

2.3.2. (30) meter DEM
The NED is a new raster product assembled by the USGS and has a resolution of 1 arc-second (approximately 30 meters) for the conterminous United States. The NED is designed to provide national elevation data in a seamless form with a consistent datum, elevation unit, and projection (USGS, 1999).
Building a seamless elevation database involved a complex system for performing the conversion and transformation of over 50,000 DEM files. Once all the DEMs in the National Digital Cartographic Database were identified, the system accomplished the following: filtered production artifacts, computed datum conversions, appended individual DEM files, computed coordinate transformations, resample data; merged the various sources, and performed edge matching between each separate DEM file. As with the 90-meter DEM, the files were stored in 1-degree by 1-degree blocks (USGS, 1999). Each file in this dataset contains 3600 rows and columns or approximately 12.9 million cells and takes 52.8 MB of memory with elevations in floating point meters. Typical 30-meter grid sizes for the river basins were 60 million cells.
Unlike the previous 30-meter DEM sources, the final NED product has universal data characteristics. In the NED assembly process, the elevation values were converted to decimal meters as a consistent unit of measure; North American Datum 1983 was consistently used as the horizontal datum; and all the data were recast into a geographic projection, whereas the earlier 30-meter DEMs were in UTM projection (USGS, 1999).

2.3.3. DEM Accuracy
The main factors that determine the accuracy of a DEM are the source resolution and the spatial resolution (or grid spacing) of the data profiles. Since a dependency exists between the scale of the source materials and the level of grid refinement possible, the source resolution determines the level of content that may be extracted during digitization. Within a standard DEM, most terrain features are generalized by being reduced to grid nodes spaced at regular intersections in the horizontal plane. This generalization reduces the ability of the DEM to represent positions of specific features smaller than the internal spacing of the nodes and results in a "smoothing" of the surface during gridding (USGS, 1996). Therefore, the assumption is that higher resolution data (i.e. smaller grid spacing) more accurately represents the drainage features of the terrain and results in more accurate watershed delineations.

3. Delineation of Kaneri in QGIS

3.1. Procedure of Creating Watershed.
- Preparation of raster image
- Obtaining raster image of Maharashtra from SRTM data.
- As the area of Kaneri is very small as compared to the area of Maharashtra
- So for obtaining the raster image of Kaneri a boundary of Kaneri is plotted and a buffer of 10m is drawn around the boundary of Kaneri.
- This buffer is divided by grids of equal intervals
- At every intersection of grid elevations are plotted using a Plug-in called "ELEVATION" from QGIS.
- From this elevation raster image of Kaneri is obtained.

- Adding raster image of Kaneri to QGIS. The name of this is "Kaneri_raster_final".
- Now using Grass Tool creating new map set.
- Creating contour maps, slope maps, aspect, hill shade etc.

3.2. Procedure of Creating Contours

- Select the Raster menu, and hover the mouse cursor to Extraction tool set and select the Contour tools to open the contour window.
- In the contour window, For Input file (raster) select SRTM Kolhapur from the drop down menu
- For the Output directory for contour lines (shape file), click on select and browse to C:\mapspace\practical\Ex8\surfaces folder and for file name type contours_50
- For Interval between contour lines key in as 50 and check the Attribute name and leave the name as default i.e. ELEV
- Set the option for Load into canvas when finished, once done click on OK button to run the contour function
- Close the contour window to view the newly created contours, drag and drop the Contours_50 to the Top in the Table of contents
- Display the Labels for contours using the ELEV field
- Using the Label toolbar display the labels for the contours with ELEV as field
- Select the Contours_50 layer in the Table of contents and click on the Label tool to open the Layer Labeling Settings

3.3. Procedure of Creating Slope

- Slope identifies the steepest downhill slope for a location on a surface.
- The Slope command takes an input surface raster and calculates an output raster containing the slope at each cell.
- Lower the slope value, the flatter the terrain; the higher the slope value, the steeper the terrain. The output slope raster can be calculated as percent slope or degree of slope.
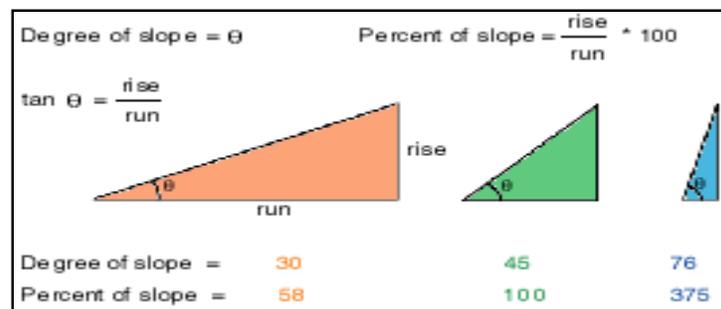

Figure 4

→ Open the GRASS Tools and under Modules list, Type r.slope and select it, For "Name of the elevation raster map" Select DEM from the drop down menu
→ Name the output slope raster map as DEM_Slope and click on the advanced options and make sure that percent has been selected and Run the slope module
→ Once done click on View Output and close the module and the GRASS tool set window.

4. Results and Discussion

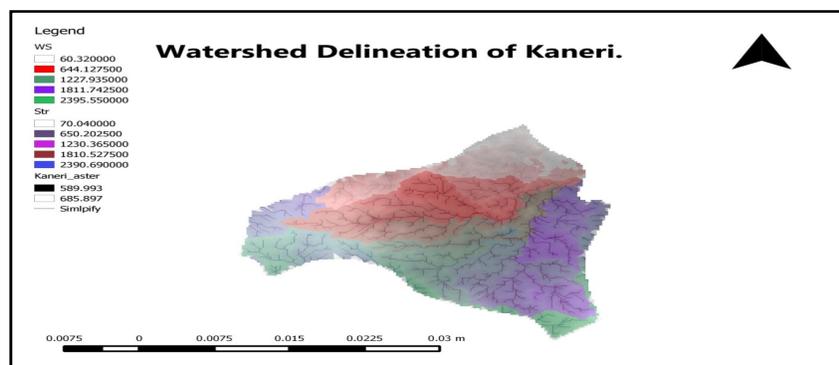### 4.1. Total Delineation Map of Kaneri
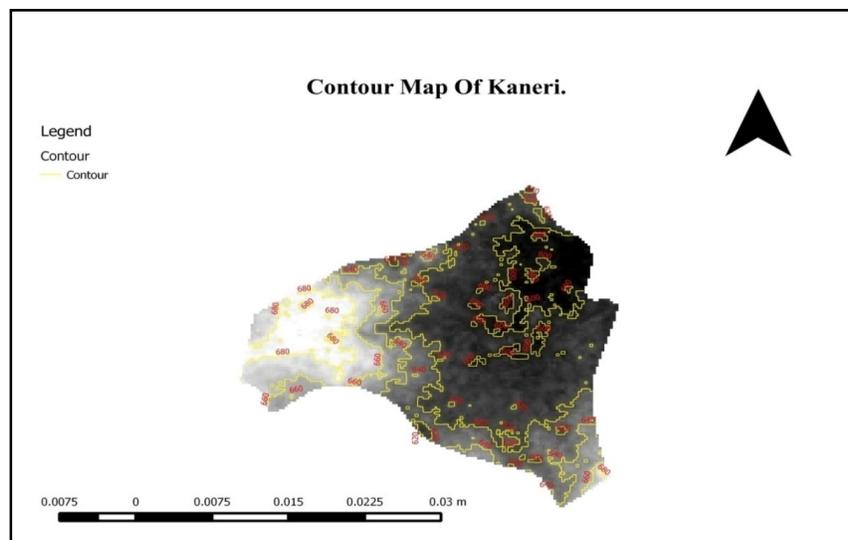

Figure 5

4.2. Contour Map of Kaneri

Figure 6: Contour Map of Kaneri
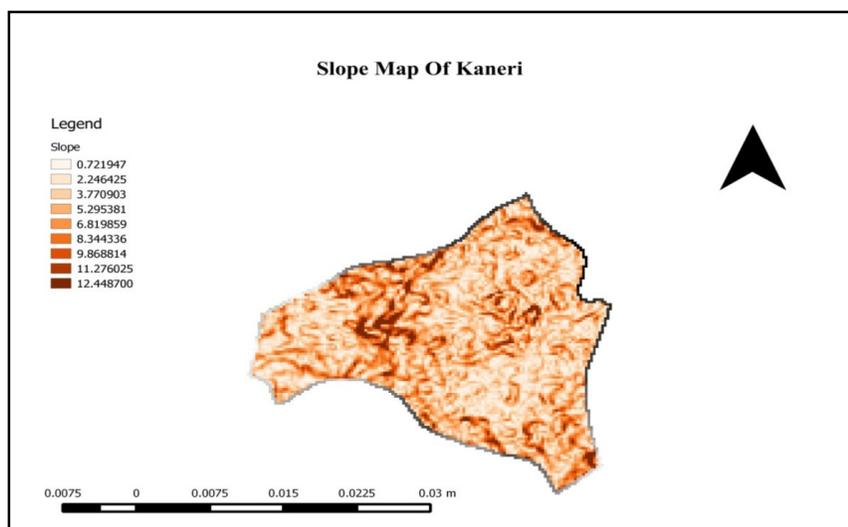
4.3. Slope Map of Kaneri

Figure 7: Slope Map of Kaneri

5. Conclusion
- Delineation & mapping of Kaneri Micro watershed with GIS is done in this research.
- Watershed delineation will give watershed boundary for that particular stream.
- The results obtained from watershed delineation have wider application for watershed management with the help of structures like farm pond, contour trench, bore wells. Wells gully plugging & terrace farming.
- Due to watershed management in Kaneri there is big change in crop production & hence farmers of that village have economical benefits.

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