DERIVATION OF MAPS FROM REMOTELY SENSED AND TOPOGRAPHIC DATA SOURCES

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Abstract: - We consider multi-date SPOT X band data of Durian Tungal minor catchment of Malaysia to map surficial features. These mapped features are delineated by employing visual techniques and certain semi-automated transformations. Besides this exercise, stream network is traced from surveyed topographic map, and is considered to generate a possible flood zone map by performing simple multiscale morphological closing transformation. These two step-studies provides an insight to understand the land use/cover features that fall under various flood zones, which further provides an understanding on prioritization aspects.

Key-Words: - Topology, catchment, Latitude, Longitude, SPOT, landuse, landcover.

1 Introduction

Topologically derived map can be related to surficial characteristics that can be mapped from remotely sensed data. Several studies that are related to catchment and reservoir analysis using remotely sensed data as primary input have appeared in the recent past [Sagar et al, 1995a; 1995b; Sagar and Murthy, 1997; Sagar and Rao, 1995; Chockalingam and Sagar, 2003]. SPOT MLA data of the Durian Tungal reservoir situated in Melaka state, Malaysia, with spatial resolution of 20m (Fig. 1a) is considered. In this paper, it is emphasized to map landuse/landcover features from SPOT X Band data acquired on 28/02/1998, of Durian Tungal reservoir catchment, situated in between N. Latitude $2^o15'$ - $2^o25'$ and Longitude $102^o15'$-$102^o23'$.

SPOT MLA data of Durian Tungal reservoir catchment area of 41 km^2 is processed by performing *watershed* transformation (Serra 1982) to automatically map the region within. Figure 1c illustrates the mapped features within this catchment. From this SPOT data, with a topographic map reference, reservoir catchment basin is demarcated (Fig. 1b), by taking the slope gradient into consideration. In figure 2d, stream flow network that is derived from topographic map is shown for better understanding of catchment characteristics. In this figure, a possible flow network that is also termed as sedimentation flow paths into reservoir is extracted by following skeletonization procedure. The details of the procedure adopted to extract network can be seen elsewhere [7].

2 Methods and Materials

From SPOT MLA data, During Tungal Reservoir is precisely isolated by applying simple thresholding technique. The isolated reservoir is shown in Figure 1d (as an inset picture). These measures include the areal extent of the reservoir surface, the perimeter of the reservoir which are well tallied with that of the values collected from Department of Irrigation and Drainage. It is quite conspicuous that the areal extent of this reservoir tends to vary with the rainfall pattern. It will be a useful study to extract this reservoir from multidate remotely sensed data. At this resolution of the binary image consisting of Machap Baru reservoir (Fig. 1d), possesses a network, the subsets of which facilitate to convert this reservoir surface area into fetch-like information by following certain morphological decomposition procedures.

Typical fetch-like information thus derived is shown in Fig 1d (as an inset picture). The centroids of the decomposed zones that are shown with different colors are connected to form the network with in the reservoir. Further this connectivity network is overlaid on the stream network that is traced and digitized to convert this whole reservoir catchment into connectivity-like information (Fig. 1d).

This whole connectivity network of this catchment is given with the Strahler's order numbers, and is shown with different colors for better legibility (Fig. 2a). The basic measures such as order-wise lengths and number within this 4^{th} order network are computed (Table 1). By employing these basic measures, the two important morphometric order ratios of topological importance are also computed (Table 1). The computed ratio of logarithms of bifurcation and mean length ratios of the network of the Durian Tungal catchment (Table 1) yields 1.77, which is the fractal dimension for this catchment. This is in accord with the values of other reported results for catchments.

From the image and its corresponding channel network organization, we try to correlate the features that are mapped visually with that of the channel influence zones. We derive channel influence zones by performing iterative multiscale closing transformation (Serra, 1982). Towards implementing the procedure to generate influence zone map from the order-designated stream network (Fig. 2a), we employ superficially simple multiscale closing transformation. Several steps include in achieving this influence map include:

Step 1: extraction of stream network from the topographic map

Step 2: designation of orders to the stream segments via Strahler's (1967) ordering scheme

Step 3: performing multiscale closing on the order-designated network till it occupies the non-network space such that the boundary matches as closely as possible with that of the catchment boundary

Step 4: identifying and computing the mapped feature from each sub-zone of influence map generated at step 3

Step 5: finding a relationship between the areas of specific mapped feature with that of the channel number/sub-zone number

We extract the channel network from a contour-based DEM. This channel network is designated with Strahler's (1967) stream ordering scheme (Fig. 2a). Further, this fourth order network is used to segment the region into different channel influence zones (Fig. 2b). These zones reflect the flood zones with in a catchment. These channel influence zones reflect the topology and topographic elevation. These maps collectively provide an insight to show a spatial relationship between the mapped features and these channel influence zones.

In addition to the thematic map derived from remotely sensed satellite digital data, certain maps like drainage network map (Fig. 2a), and influence zone map (Fig. 2b) that are derived in this study, which are essentially in the form of polygons, derived collectively from remote sensing and topographic information sources, one can draw several inferences of use to quantitative geo-morphologists. These two maps are respectively generated from SPOT X band data and surveyed topographic map. For a better understanding, the pictures of this minor catchment, on which geocomputational tools have been implemented to generate various thematic maps, were provided.

In addition to this, generation of thematic map, to further carry out morphometric analysis to draw inferences related to catchment characterization aspects, as a preliminary study, the whole network shown in figure 2a is considered. Certain secondary maps such as contour based DEM, and the whole network information may be generated to make relationships between morphometric characteristics and mapped features. From the two maps, it is understood that the rubber plantation is spread over almost all the flood zones ranging from level 1 to level 5. The increasing flood zone level is with increasing level of complexity of the catchment. In other words, the increasing level is from concave zone to higher degree of complexity. In contrast, the reservoir occupied the first level flood zone. In brief, all the flood zone levels are occupied with palm tree plantation. It is interesting to super impose the meteorological information with the time of satellite data acquisition to validate these general inferences.

3 Conclusions

By employing certain mapped information from remotely sensed and topographic map sources, and certain secondary maps derived from the primary source of network and elevation contours, it is possible to identify several land use/cover features that are prone to various degrees of floods. As many studies, where GIS concepts have been adopted, are plagued with several inaccuracies, powerful geocomputational tools that are being offered from mathematical morphology, fractal geometry, spatial sciences need to be thoroughly used to avoid inaccuracies in the generated final outputs. Any remotely sensed data analysis requires prior understanding about its histogram distribution. Although there are several algorithms that exist meant for feature extraction, algorithms based on morphological operators proved robust. Multi-date remotely sensed data is of use to perform multi-temporal analysis of a region. It is an interesting study if the region within the bio-geographic boundary is investigated across the seasons.

Mapping the surficial features according to the flood prone zones, provide an insight to better understand the catchment characteristics towards this goal, we consider channel network map as the basis to generate a flood zone map as it is more appropriate to understand the flood water dispersion initiated from concave zone i.e. channelized zone. In addition, to understand the land use features that are frequently effected by floods can be easily identified and can be protected by means of alternative measures. As a whole, the two maps respectively generated from remotely sensed and topographic data sources can be better employed in understanding the catchment properties and characteristics.

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Table 1. Morphometric parameters of Durain Tungal catchment network

No. of orders			
1	2	3	4
130	28	6	1

Order-wise lengths			
1	2	3	4
57	23	18	6

Mean lengths			
1	2	3	4
.44	.82	3	6

Bifurcation ratio			
N1/N2	N2/N3	N3/N4	RB
4.6	4.7	6	5.1

Men length ratios			
L2/L1	L3/L2	L4/L3	RL
1.86	3.66	2	2.51

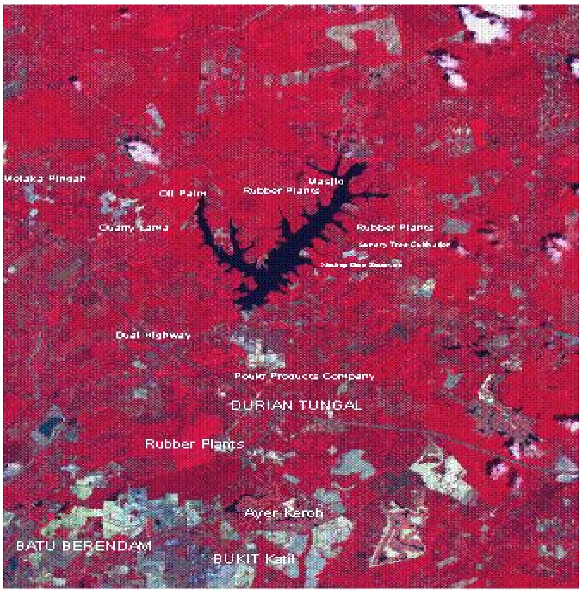

Fig. 1(a) SPOT LA data of Durian Tungal catchment and its surroundings

Fig. 1(b) Durian Tungal reservoir catchment area

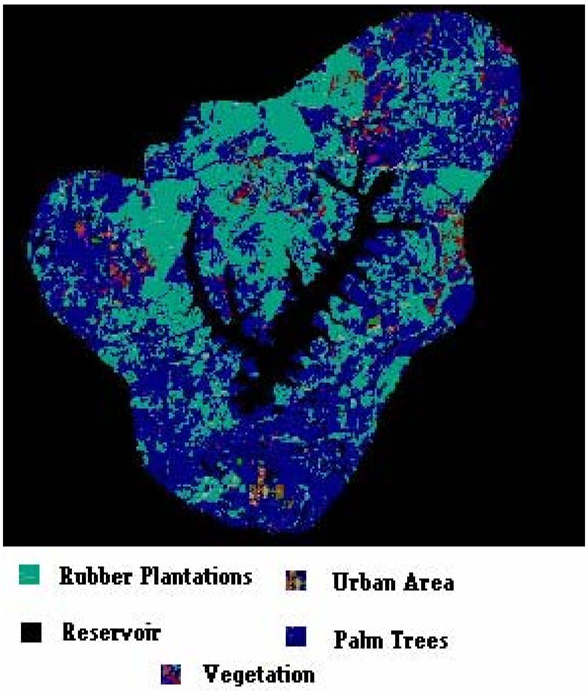

Fig. 1(c) The mapped units in the catchment

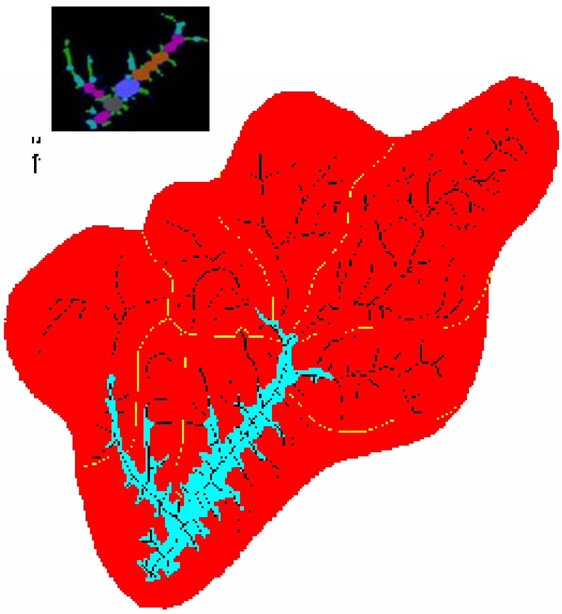

Fig. 1(d) Sub-catchments contributing to During Tungal reservoir catchment (the inset picture indicates the decomposed zones into reservoir, the centroids of which are added to form the networks within the reservoir to show the continuity in the network)

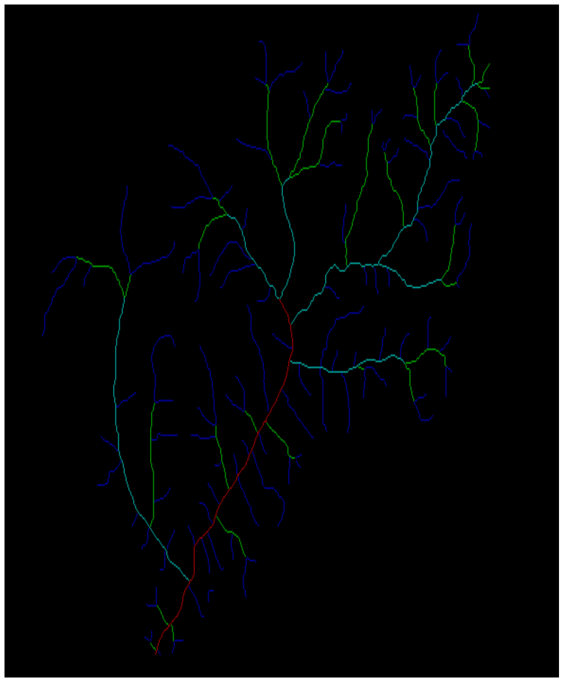

Fig. 2(a) The network after designation with Strahler's ordering technique

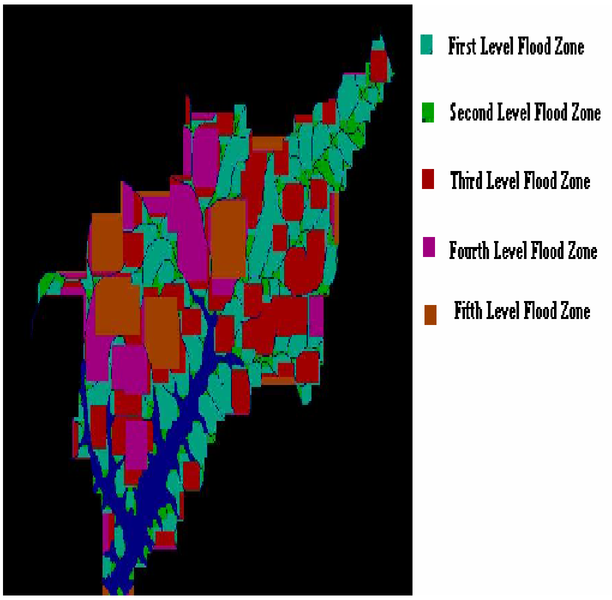

Fig. 2(b) Basin in reconstructed from this order designated stream networks via multiscale morphological closing transformation.