Building a New Kerala

Ideas and Reflections

Factoring Terrain Characteristics for Reconstruction of Kerala

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The State of Kerala has witnessed a trail of unprecedented devastation due to heavy rainfall during the month of August, 2018, which has created enormous landslips in the high ranges of the Western Ghats and flooded almost the entire State. More than 20 dams released water that cascaded down the tributaries leaving behind a trail of destruction. There is a long debate to pinpoint the source of the tragedy. It has been claimed that this nature's fury is caused by the wilful disregard and rejection of the Madhav Gadgil report on the Western Ghats. Large parts of the regions affected by the landslips and its aftermaths were specifically classified as ecologically sensitive zones by the Western Ghats Ecology Expert Panel in 2011. Before pointing out the unscientific land use pattern or noncompliance of Expert committee reports or mismanagement of dams, it is important to understand the terrain character of Kerala and contextualise the present incidence. This is significant particularly while planning for reconstruction of the State.

Kerala covering an area of 38960 km^2 can be divided into five major physiographic units: Mountain peaks, high ranges and plateaus (>600 metre); Foothills and plateau bounding slopes (300m to 600m); Uplands, lateritic mesa, ridges and mounds (100-300m); midlands and piedmont plains (20-100m); and coastal strip and adjoining lowlands. The Western Ghats crest line reaching to a maximum altitude of 2695m at the Anamudi in Idukki district lies within a short distance from the coast. The Western Ghats being the plateau scarp of south Indian shield has pronounced effect on the terrain character of Kerala. Relief distribution in terms of area-altitude ratio is asymmetric (Fig.1).

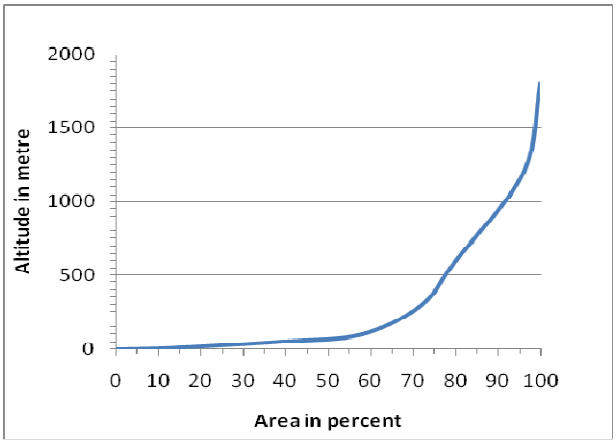

Fig 1. Area- altitude relationship in Kerala

Around 62% of the total geographical area of the State lies below 100m. The Western Ghats is a continuous mountain chain except for a number of breaches or gaps. The Palghat gap is the most prominent one, others being minor breaches located near Bodinayakannur, Gudalur and Ariankavu. Occurrences of numbers of plateaus, large, essentially level areas with considerable elevation, have

been identified within the high relief of the Western Ghats. These are the Wayanad Plateau (700-950m above msl), the Nelliampathi plateau (500-700m), Munnar Plateau (1500-2000m) and Greater Periyar plateau (700- 1000m). Margins of all these plateaus, which are scarp slopes, are highly vulnerable. Each of these physiographic units has their own characteristics. While these units are longitudinally placed in north-south direction parallel to the coastline, the rivers flowing from east to west cut across these units at perpendicular, thus the topography is undulated and the terrain character is complex.

As a part of our research activities myself and Srikumar Chattopadhyay in National Centre for Earth Science Studies, Trivandrum, carried out the detailed Terrain Analysis of Kerala in 1995 and worked out terrain maps and morpho-conservation maps for all the 14 districts of Kerala and delineated ecologically sensitive areas, and various terrain units with detailed characteristics features including slope, soil and land use. There are 22 terrain units in the State indicating complexity in land character. Around 44% area of Kerala lies in the category of >25% slope and 4% of lands record more than 100% slope. Areas with more than 100% are plateau margins and are most vulnerable. Most of the landslides during August, 2018 occurred in these areas.

Terrain units are integrated and consider both surface and near-surface attributes significant to humans. Information on terrain provides a broad guideline to act upon in identifying vulnerable area, and by considering population data along with terrain information it is possible to work out vulnerable areas and people under risk. Terrain information also helps to delineate which area is to be conserved and protected from random unscientific uses. It is also possible to work out terrain data at the panchayat level to guide micro-level actions.

The Periyar Basin

The State is drained by 44 rivers, of which three are west flowing (Kabani, Bhabani and Pambar). The streams originating from the Western Ghats are short and swift flowing. Thus there is heavy on-rush of water flow immediately after rain. With the onset of monsoon, the soil gets saturated in a couple of days, and surface flow begins. With excess rain, as it has happened in this year, drainage discharge increases manifold, and water gets piled up in the downstream. Rate of water dispersal is much lower than the water input from the mountains as the lowlands, and coastal plain are gently sloping causing flood havoc. The flood plains of all the rivers coalesce in the lowlands and coastal plain. The central Kerala lowlands where flood plains of Periyar, Chalakudy, Muvuttapuzha, Meenachil, Manimala, Pamba and Achankovil merged, experienced wide devastation due to high rainfall and their physiographic settings. Flood flows according to the river basin. Water yield of a river depends upon the catchment area. While deliberating on flood, the reference is often about administrative units like districts and panchayats. Seldom, a river basin is referred although flood management activities have to be taken up according to the river basins. Understanding terrain character of river basins is important to plan for flood management and reconstruction activities.

We consider here the case of Periyar river, which is the longest river (244 km) in the State and experienced maximum devastation during the recent flood. The Periyar drainage basin occupies nearly 60% of the total area of Idukki district and 47% of Ernakulam district. It is also the largest in

water potential, with a drainage area of 5398 km^2, of which 114 km^2 lies in Tamil Nadu. The annual yield of the basin is 11341 million m^3 or 2.1 million m^3/ km^2, well above the State average of 1.83 million m^3/km^2. The Periyar originates from the high hill of the Uda Mala in the Western Ghats at an elevation of 1560m and bifurcates near Alwaye into the Mangalapuzha and Marthandavarma branches. The Mangalapuzha confluences with the Chalakudi river and finally debouches into the Lakshadweep sea near Munambam. The other branch flows in a southerly direction and again bifurcates into two distributaries before joining the Vembanad lake near Varapuzha. Important tributaries of the Periyar are the Muthirapuzha, Perinjankutti, Idamalayar and Mangalapuzha. There are several reservoirs impounded on the main river and also on tributaries. Major reservoirs like, Idukki, Periyar lake, Anairangal, Mattupatti, Ponmudi, Mullaperiyar, Idamalayar, Bhuthathankettu, Cheruthoni, Kulamavu and Sethuparvathipuram are within the basin limit. During this August deluge due to incessant heavy rain, opening of the dams was essential to avoid bursting of the Idukki dam, which caused the Periyar river to swell rapidly and discharge seven lakh litres of water per second as indicated in one of the reports by M Gopokumar in The Hindu on 27th August, 2018.

The Periyar river traverses through highly diversified landform (Fig 2). In one of my earlier studies, I dealt with quantitative description of the drainage system in Periyar. It is highly significant now as it helps understanding hydrological behaviour of a watershed, interpret the fully integrated process-response modes and thereby provide the foundation for landscape management planning.

When we talk about a river, we mostly refer to the main trunk/ drainage line. However, there are a large number of streams originating from the mountainous slope that flow down the slope, join together and form a drainage network. During monsoon, all these small streams carry water and feed the main river. These small streams have different strengths and are designated under various orders starting from 1, indicating initiation of a flow in the hill slope. The Periyar, 8th order stream, consists of 15773 first order streams, 3411 second order streams, 770 third order streams, 171 fourth order streams, 36 fifth order streams, 9 sixth and 3 seventh order streams (Fig 3). While planning for flood management, these orders are important as it helps understanding nature of flow, fixing priority and scope of channelizing excess water. At first approximation level the Periyar basin has been divided into 3 seventh order sub-basins-Idamalayar, Muthirapuzha and Provenance. Total number of streams inclusive of all orders is 20174, 4273, 3873 and 9455 for the Periyar, and sub-basins of Idamalayar, Muthirapuzha and Provenance respectively. All these streams contribute water through respective sub-basins. Computing elongation ratio it is found that Provenance and Idamalayar are elongated in shape compared to Muthirapuzha. Flood water takes more time to concentrate at the outfall of the first two sub-basins than that in the case of Muthirapuzha. Several such indices have been worked out to understand geometry of the basin and sub-basins. These indices provide base level information to initiate flood management plan. It is possible to work out distribution of all the streams at the panchayat level and work out vulnerability according to order of basin/ watershed. Which basin has contributed how much water and which basin has been affected most can be deciphered from these database.

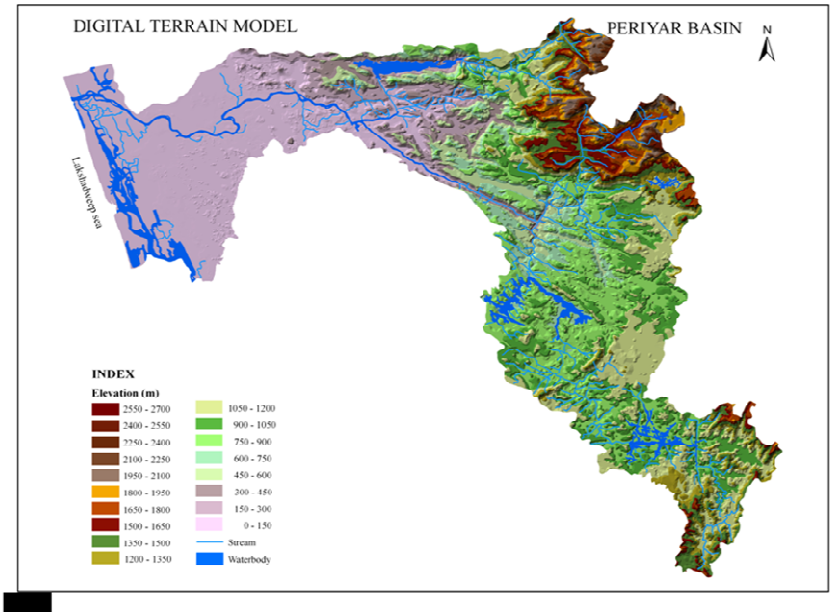

Fig 2: Digital Terrain Model

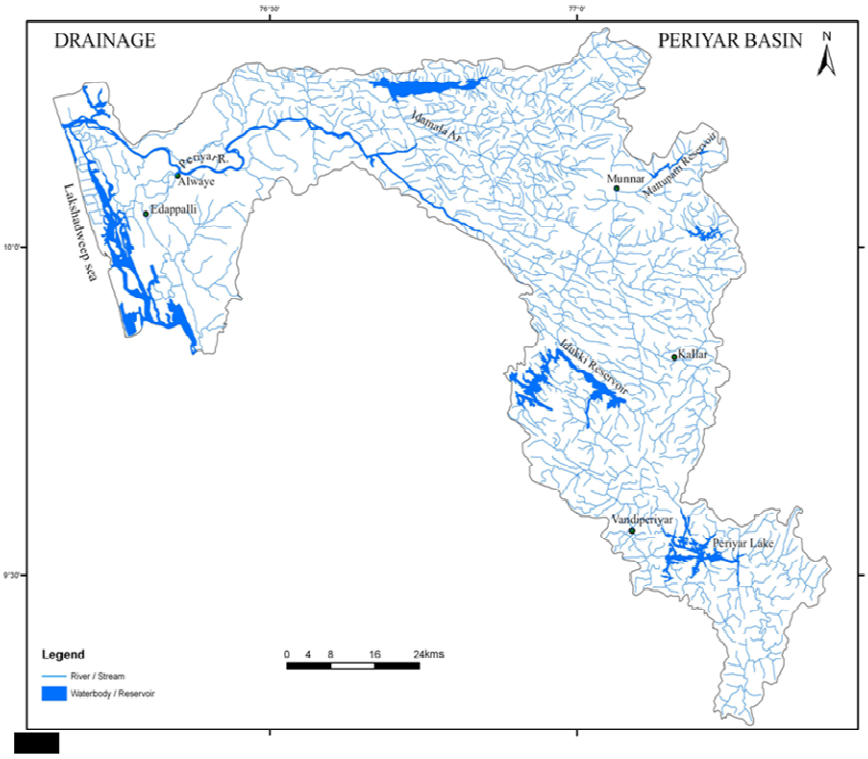

Fig 3: Drainage network of Periyar basin

The Periyar basin displays diversified terrain character and land use in the backdrop of the major landform units, viz, the Western Ghats, Munnar, Periyar plateau and the coastal plain. Forest occupies nearly 1500 km^2 (28%) of the basin area whereas cardamom and settlement with mixed tree crops occupy an area of 322 km^2 and 2176 km^2 respectively. The Periyar basin is ecologically sensitive, and nearly 80% of the total area situated in the high ranges is susceptible to erosion and mass movement. The present devastation due to landslides and floods in Kerala especially in Periyar basin falling within Idukki and Ernakulam districts once again manifests results of unabated anthropological interventions in ecologically sensitive areas. The terrain data generated under various programmes available in various institutions may be pulled together while discussing reconstruction plans.

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