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A Few Geomorphic Aspects of Manjira Basin for Resource Evaluation

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Abstract

Geomorphic knowledge of an area forms an important and essential component for any further studies and environmental planning. A basin provides an ideal unit with definite interrelations between inflows and outflows maintaining a dynamic equilibrium in the study area due to land & water resources being intricately related due to their varied interrelations.

Manjira river basin is an important sub-basin of Godavari in south India. The leaf shaped river basin stretches over an area of around 30,000 km2 across three major southern states namely Maharashtra, Karnataka and Andhra Pradesh. In fact the river assumes its major importance in Andhra Pradesh as it caters to the major water demands of Hyderabad metropolis. Nizam Sagar, the major river dam on it is much talked and debated about for its silting problem, which even today remains unsolved. Keeping in view not only the vastness of the basin but also the variety of geological and structural formations along with climatic induced fluvial processes culminating into various geomorphic landforms, an attempt is made in this paper to highlight the geomorphology of the basin leading to resource evaluation in the basin.

Key words: Geomorphology, Manjira river basin, Geological formations, fluvial process and resource evaluation.

Introduction

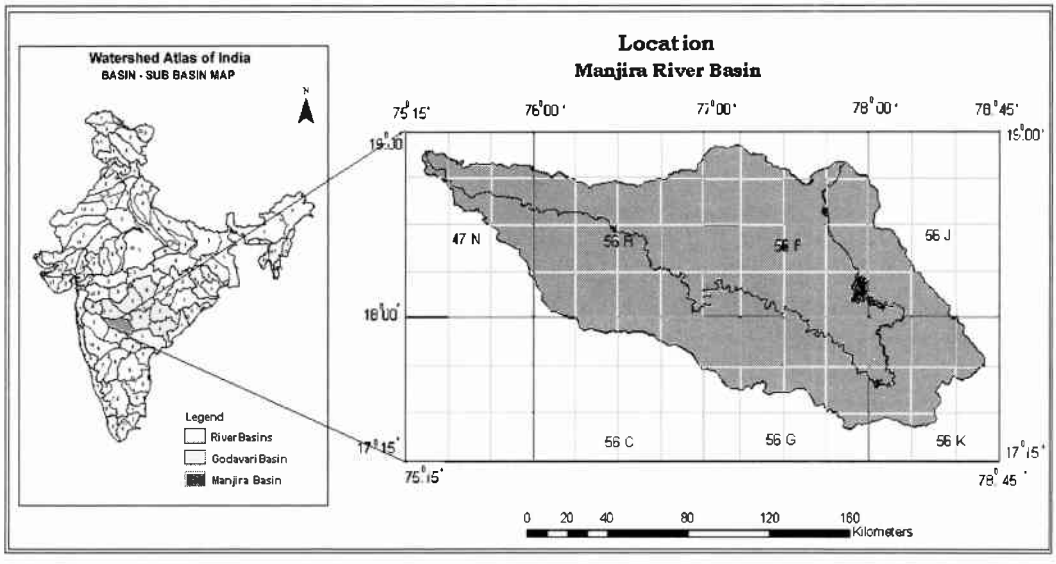
Geomorphology- a science dealing with form process interrelations is an intriguing subject which dwells into the nature of landforms. An appraisal of landforms in toto would help to evaluate the land more appropriately. Though there are wide ranging applications of geomorphic studies but emphasis on mere geomorphic landforms with resource evaluation has been limited. Morphometric analysis of drainage basins has been widely studied. To cite a few, Savindra Singh (2003) and Anita Pande (1996) have attempted delimitation of Morpho-units. Geomorphic landforms once identified provide an insight into the underlying structures and overlying process. (Babar(1998),Balaselvakumar (2000), Singh(1983)* In this context an attempt is made to have an appraisal of geomorphology of Manjira river basin.

Database and Methodology

SOI topographical sheets on 1:250,000 scale (47N, 56B, C, F, G, J, and K) along with WIFS image (path 100/60, dated 24.10.2005) formed the base for mapping of the region. DEM, slope and slope aspect are mapped using Arc GIS module 9.2 substantiated by field observations. District Geological maps of Ahmedpur, Latur, Beed, Osmanabad, Bidar, Medak and Nizamabad published by geological survey of India along with geomorphological map of india have also been referred.

Study area: Manjira River is a major tributary of Godavari draining in north North West to north North East direction, after traversing a southerly course for most of the part. The basin itself is leaf like with a well developed drainage network. The basin stretches between 17^0 15' to 19^0 N and 75^0 15'to 78^0 45' E (Map-1) covering a part of each state of Maharashtra, Karnataka and Andhra Pradesh.

Map-1 Location of Manjira Basin



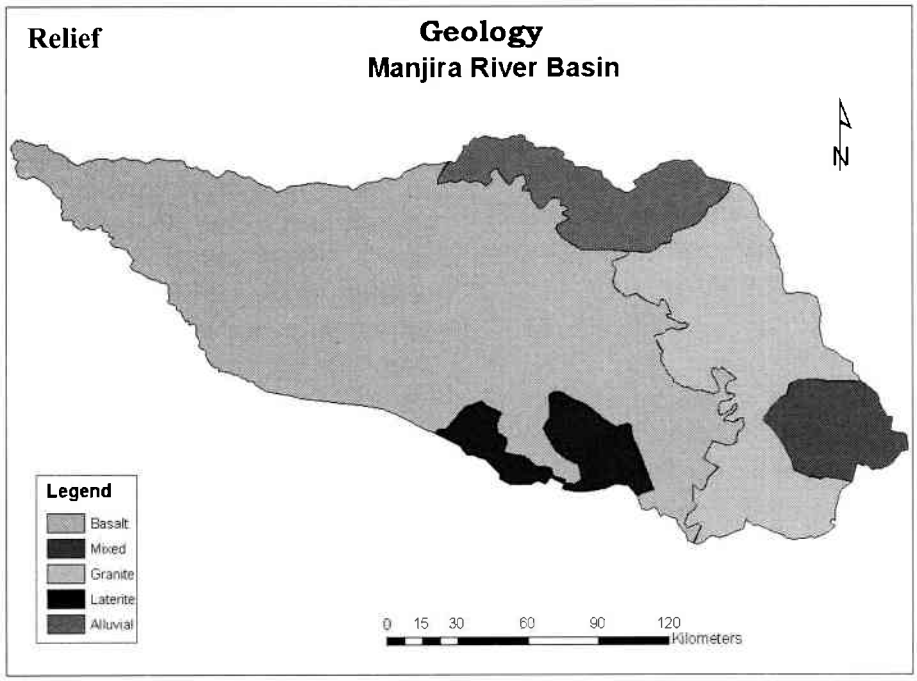
Climatically the region falls under Aw group as per Koppen's classification. The region is sub-humid with a tapering of to drier conditions to the west and near to the head source of the Manjira River. The temperature values range between 25^0C - 30^0C, whereas the rainfall ranges between 50cms to 84.7cms. Eastern and western tips of the basin receive an average of around 70cms of rainfall, whereas the central portion receives 80cms. Similarly the isotherms of 29^0 C are seen to the North eastern and western portions of the basin. In the central portion, the values range between 25^0C - 29^0C. However, it is significant to note that the pockets of highest temperatures occur only in the western and north eastern basin.

Geologically, the basin comprises of mainly Basalts, Granites and laterites association with alluvium and mined rock groups (map-2). It is generally observed that the rocks and relief are highly correlated in the study region as is evident from geomorphic map.

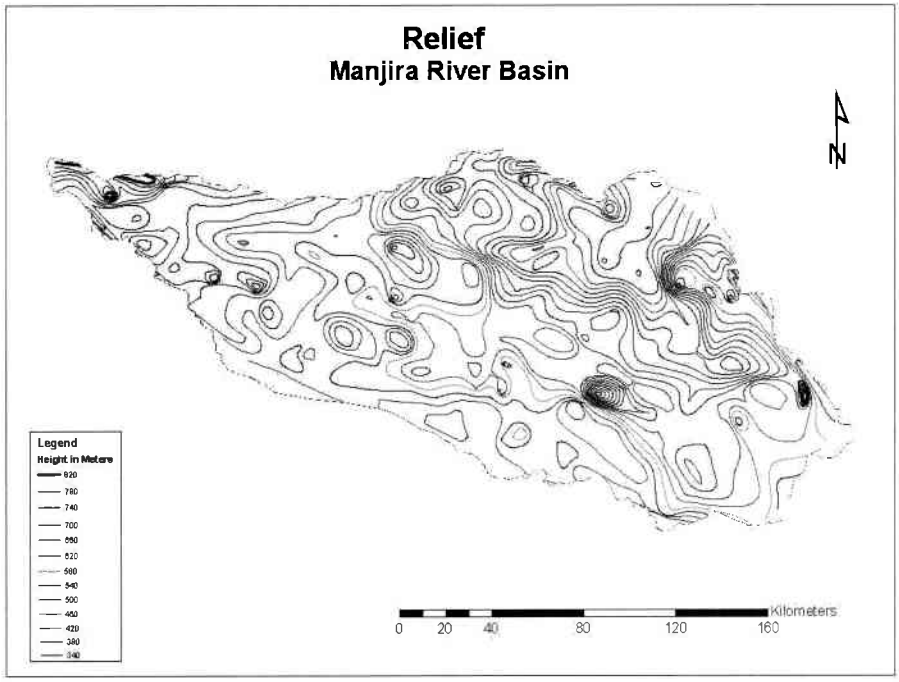
Geomorphology: To understand geomorphology of a region it is important that surfacial analysis is understood through relief attributes.

The height of 820mt is observed around Jamkhed and Patoda (Map-3). The high concentrations of contours are observed around Bidar, Yellareddy and Tupran. The trend of 600mt and 500mt contour brings out the general slope of the basin i.e. to

Map-2


Relief
Geology
Manjira River Basin
N
Legend
Basalt
Mixed
Granite
Laterite
Alluvial
0 15 30 60 90 120
Kilometers

Map 3


Relief
Manjira River Basin
N
Legend
Height in Metre
820
780
740
700
660
620
580
540
500
460
420
380
340
Kilometers
0 20 40 80 120 160

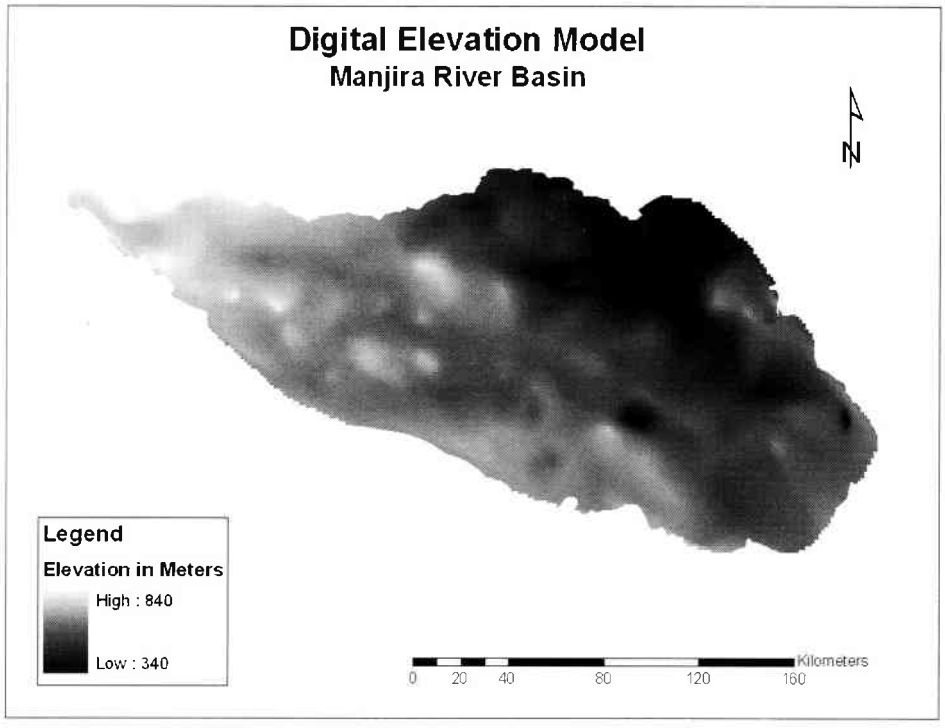
south east. Further 500 and 400mt contour clearly bring out the fault line in the region. Gradual slope towards North West and south of the basin suddenly reduces in the central portions. Again in north east of the basin high elevations are depicted. Tupran highland is standing tall to divert the direction of the basin to northwest where as Yellareddy highland restrict the river and further leaves a narrow passage towards north.

Surface analysis

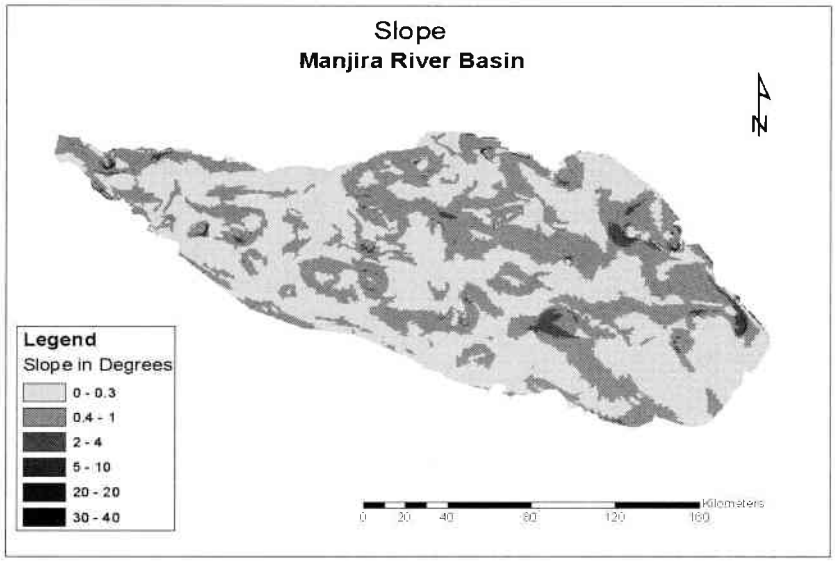
The topography of a land surface is represented by digital elevation data. This data set consists of the elevation in the form of grid points in a raster based GIS. In vector based systems the elevation is represented in the form of Triangulated Irregular Network (TIN). The most commonly used terrain functions are calculation of slope and aspect. The slope gives the rate of change of elevation and the aspect is the direction that a slope faces.

In this study the DEM created is based on vector data layer contours that have been procured from topographical maps on 1:2, 50,000 scale published by survey of India. This DEM model is in close correspondence with earlier depicted relief map. The region with high relief shows less DEM values. The DEM values range from 340-838 mt (Map. 4).Excepting the central region with values around 600mt, the rest of the study region accounts for lower DEM values.

Map 4



Map 5



Slope Aspect

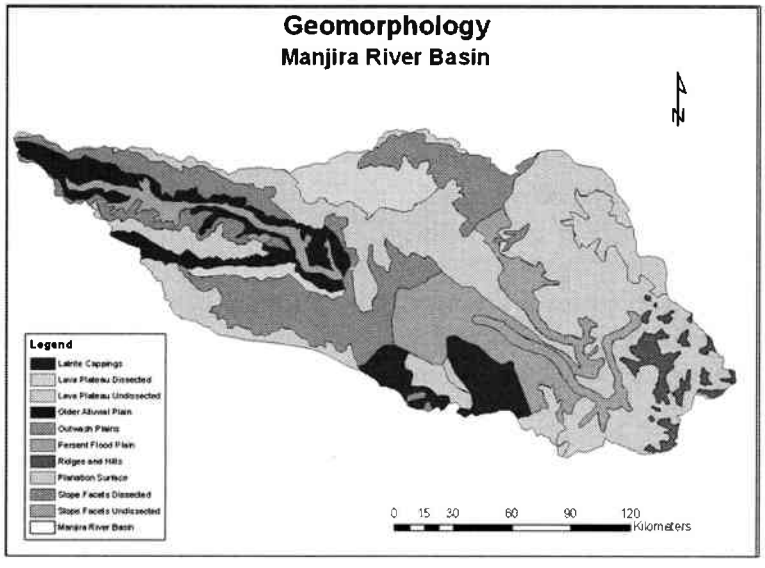
In physical geography, aspect generally refers to the horizontal direction to which a mountain slope faces.

Relief, Slope and Slope aspect in general depict north east ward slope with west and south west also showing higher relief. The central portion is almost flat which is drained by Manjira, the major river of the region (map. 5).

From the available terrain attributes geologic characters, and a set of land forms the following geomorphic land systems are identified.

a) Western raised highland and plateau
b) Isolated dissected ridges and inliers.

Map 6



c) Rolling planation surface and highlands.
d) River course and its valley lastly,
e) Outliers to the southeast.

The major rock groups owing their origin to endogeny existing in the region have been differentially dissected to form the following set of landforms (map. 6).

a) Laterite cappings in south
b) Lava plateau, dissected and undissected
c) Older and younger Alluvial plain
d) Ridges and Hills
e) Planation surface
f) Slope facets dissected and undissected.

Map 6

1. **Western raised highland and plateau** is one of the most dominant geomorphological region occupying three fourth area of the study region. This can be termed as extensive lava plateau. The plateau has been subjected to major dissection by major drainage lines. There has been alternate bands of dissected and undissected slope facets occurring in the region. It can be studied under as-

a) Extrusive (lava) plateaus in both undissected and dissected plateau remnants are conformable to lava flows at different altitudes. These are mostly flat top surfaces with minor irregularities in the form of residual hillocks/mounds. Drainage development is poor unless dissected by streams along the fractures/ joints. At places, plateaus are capped with laterites. Plateau margins are steep to very steep and marked by break-in-slopes.

Multiple slope dissection by streams, overall aerial denudation through extensive sheet wash/sheet removal and weathering of compact lava flows have mostly produced plateau bench topology under humid conditions with alternate wet dry spells characteristic of Sub-tropical humid/semi arid climates with variable rainfall.

Dissected upland plateau is flat ground which occurs at slightly higher elevation than the surroundings. It is often dissected by angulate to sub-dendritic drainages forming ribbed/stepped valley walls and flat valley floors. Micro relief features at places like low mounds and gentle undulations on the top of the surface, etc. characterise the unit. Intense areal denudation under humid condition often associated with chemical weathering have brought general level of original plateau surface into subdued upland planar surface. Subsequent stream dissection and effects of chemical etching are evident on the topography.

b) Rocky bench/rocky terraces are Steep benches which occur along the edge of lava plateaus, hill slopes and walls of amphitheatre valleys as narrow zone of multi-tier rocky terraces. Steps have steep to very steep slopes with development of sub-parallel drainage; while the bench surfaces are essentially flat with development of thin latsols and are devoid of drainage dissection. It is essentially formed by linear multiple slope dissection and slope retreat having differential response to stream erosion of contrasting lava flows under humid condition with alternating wet / dry spells.

c) Slope facets / elements occur either as rectilinear or curvilinear slope segments of considerable lateral extent especially

below the plateau top or along the foot slopes of plateaus / hill ridges. Linear stream dissection is common on the dissected slope facet. Slope angles vary from 10^0 to 40^0 depending upon the bedrock structure, slope aspects and geometry of landforms. Rapid mass wasting processes along the plateau fringe; faster rate of slope retreat and dissection than that of slope wash mechanism, are often influenced by the initial control of bedrock disposition.

2. **Isolated Lateritic dissected ridges** are gently rolling to level surfaces which occur at various elevations without appreciable micro relief features and drainage development. Top soil is hard crust of laterite, calcretes, silicretes, etc. Essentially is a product of chemical weathering with the aid of water table conditions and alternate wet and dry humid to semi arid conditions. These are Khondalites of eastern ghats mobile belt, basalts of deccan traps, other rock types of shield area under Tropical humid climate with alternate wet and drier phases.
3. **Rolling planation surface** is an another major surface lying entirely in the eastern part of the study region. This region comprise of planation surfaces, pediments/pediplains and peneplains.
   - **Plantation surfaces include duricrusts (pediments/pediplains and peneplains):-**
     - Extensive level surface occurs on archaen proterozoic gneiss at different elevations, representing base levels of erosion at the time of formation. Surface irregularities are minor with or without imprints of fossil drainages, often capped by laterite/latsol or thick weathered residue of underlying rocks. These are essentially formed by sheet wash and slope retreat mechanism under humid or even semiarid climatic conditions. Lateral erosion transgressing structural regime has resulted in lowering of relief, widening of valleys, exposure to roots of fold belt and development of extensive planar surfaces.
   - **Denudational origin:-**
     - Minimal control of structure Round crested, detached and isolated, small subdued hill/ ridges show moderate to gentle side slopes and low relative relief. Occasional development of dendritic drainage on the slopes is noticed. Lowering of relief and declining of slope is associated with strong slope wash/slope retreat under wet/ dry humid conditions within a cycle of planation.
4. **River course and its valley (Alluvial track)**

   These are units of fluvial and lacustrine origin on Low lying flats/plains
   - The genetic significance is that the plains are formed by deposition of sediments over the earlier lakes, presumably of non-glacial origin at the foot slope of mountain ranges, with gross geologic and climatic conditions of quaternary lacustrine

sediments in Young Mountain set up and Sub- alpine climate. Fluvial depositional plains in the flood basin are formed by seasonal over bank flood activities with or without erosional component.

- Older flood plains occur above the present day flood limit. The unit is more or less stabilized and capped with varying thickness of oxidized soil cover. Top surface is almost level to gently rolling with imprints of stabilizing sand bars, infilled streams and poorly drained by the present day drainages. These are essentially fluvial depositional plains and filled up channels/valleys of earlier generations and being subjected to pedo genesis.

Both younger and older alluviums in the drainage basin is found in riverine systems with a Sub-tropical humid climate with high seasonal rainfall in all major river valleys which are infilled with or without ridge. These are major valley fills/channel fills of various shapes and patterns, which occur within the flood basins with or without micro-relief generated by silt accumulation.

Accretion of sediments is carried through the channels/streams in the waning stages of flood cycles due to dissipation of stream power in some cases. Infilled valleys are formed by gradual siltation processes after avulsion of stream segment from its original matured course.Riverine terraces also constitute an upland belt along either side of the major river valleys in the form of paired and unpaired multi tier terraces at different elevations. Shapes and sizes of these terraces are guided by the nature of river courses at different stretches. These are mostly featureless surfaces and often show good development of soil. They lie above the present day flood limit with fluvial accretional and erosional origin associated mechanism respectively.

Semi-consolidated river borne alluvium of quaternary period is also evidenced in Subtropical humid climate with high seasonal rainfall, along the major river courses.

5. Outliers

Relict hills:-These are Remnant low hill/hilllocks of varying shapes and forms above the base level occur as inselbergs, tor and bornhard surrounded by an extensive planation surface. The region is characterized by an undulating terrain with erosional landforms like inselbergs, tors and ridges noticed amidst vast area of dissected pediment and pediplain. The highest elevation in the district is 664mt above mean sea level, which is in North North East of Tumpalli, while the lowest point is 329mt above mean sea level North West of Siripuram. The main rivers draining the district are the Godavari and its tributary Manjira.

Residual topography is formed after extensive planation either by pedimentation or by peneplanation processes is over.

Resource Evaluation:

Land use land cover resource appraisal under each mophoregion: The class1 category of land use and land cover is observed on WIFS satellite imagery (row /path: 60/100, dated: 24.10.2004). Five landuse and land

cover categories are picked up for the basin through unsupervised classification of image processing technique. They are Agriculture, Forest, Openscrub, Water bodies and Builtup. Agriculture with 14,619 sqkms, Forest with 13,875 sqkms, Openscrub with 1,189 sqkms, Water bodies with 933 sqkms and Builtup with 228 sqkms stand at first, second, third, fourth and fifth position respectively.

Table: Land use/Land cover under each Morphoregion in square kilometers

Morphoregion	Basaltic dissected plateau region	Alluvial tract	Granitic plantion surface	Latetritic hillocks	Mixed rock outliers	Total
Agriculture	8116	2805	1806	1034	858	14619
Forest	7802	3103	1311	822	837	13875
Open Scrub	507	24	24	56	99	710
Water bodies	306	313	136	63	115	933
Builtup	87	30	46	29	36	228
Total	16818	6275	3323	2004	1945	30,844

According to Morphoregion wise area cover, Basaltic dissected plateau with 16,818 sqkms stand first, where as latetritic hillocks with 2,004 sqkms stand 2nd & last(fourth) in area coverage. Further alluvial with 6,275 sqkms, Granitic planation surface with 3,123 sqkms, Mixed rock outlier with 1945 sqkms, takes second , third and fourth position respectively in basin area.

According to each morphoregion wise resource evaluation for Basaltic dissected plateau agriculture with 8,116 sqkms, forest with 7,802 sqkms, openscrub with 507 sqkms, water bodies with 306 sqkms and Builtup with 87 sqkms takes first, second, third, fourth and fifth position respectively. For alluvial tract, forest with 3,103 sqkms, agriculture with 2,805 sqkms water bodies with 313 sqkms and Builtup 30 sqkms openscrub with 24 sqkms, takes first, second, third, fourth and fifth position respectively. For Granitic planation surface morphoregion agriculture with 1,806 sqkms, forest with 1,311 sqkms, water bodies with 136 sqkms, builtup with 46 sqkms and openscrub with 24 sqkms, takes first, second, third, fourth and fifth position respectively. For latetritic hillocks agriculture with 1,034 sqkms, forest with 822 sqkms, water bodies with 63 sqkms, openscrub with 56 sqkms and builtup with 29 sqkms takes first, second, third, fourth and fifth position respectively.

For Mixed morphoregion agriculture with 858 sqkms, forest with 837 sqkms, water bodies with 115 sqkms, openscrub with 99 sqkms and builtup with 36 sqkms takes first, second, third, fourth and fifth position respectively

Agriculture seems to be a dominating landuse category both under Basaltic dissected plateau and alluvial region. This is mainly due to fertility status of soils similarly forest and water wealth are also equally higher in these two regions. Therefore these two regions stand out as potential resource regions.

CONCLUSION

Manjira Basin with its varied geomorphic forms exhibits intricate resource potential where by it is proved that geomorphic variables play only an important role in their distributional characters. Agriculture forest wealth and water resources are the major resources abundant in the region.

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