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Agroedaphic zoning of undulating topography using GIS techniques

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ABSTRACT
Planning of sustainable use of natural resources in highly undulating topography is quiet complex when compared to other area. Hence, the study was conducted to generate a soil resource database for generation of agroedaphic zones of Pathanamthitta district. Survey of India toposheets and soil resource maps from Department of Soil Survey were used for study purpose. The major soil-physiography observed in the study area is Low Land, Mid Land and High Land Of which 60 % of the area fall in midland region. 10 soil mapping units is observed in the study area. The study area is divided into 4 different slope gradient classes for Agro-Edaphic Zoning. They are very gently sloping (0-3%), gently sloping (3-5%), moderately sloping (5-10%), and steep sloping (>25%). The majority of the study area belongs to very gently sloping (0-3%). Agro-Edaphic data base were integrated in the GIS environment to obtain 11 Agro-Edaphic Zones

Key words : Topography, Agroedaphic zones, GIS technique.

INTRODUCTION

Sustainable development of regions with highly undulating topography is a challenging task as the areas are having highly diverse and fragile ecosystems. This makes the planning of the use of natural resources more complex than any other area. A practical approach is to subdivide the area of interest into smaller zones with homogenous soil units which may be of more or less similar soil characteristics (physiography soil texture, and soil depth) and slope. Several approaches of agro edaphic zones are in the country use manual integration for use of natural resource data (Sehgal, J.L *et. al.* 1992). Hence ,the present study aims at generating a soil resource database for development of agro edaphic zones in Pathanamthitta district.

MATERIALS AND METHODS

General Description of Study Area

Geographical Setting:

The study area for Agro-adaphic zoning is Pathanamthitta district which is a part Western Ghat ecosystem. The study area is situated between 76^0 29' to 77^0 01' E longitude and 9^0 06' N to 9^0 30' N latitude. The total area of the district is 2642 sq. km., of this 1390.73 sq.km., come under forest. The study area extends to nearly 124498 Ha.

Topography

The district consists of three natural divisions, viz., the lowland, the midland and the highland. The highland stretches through the western ghats and descends to the midland in the centre, down to the lowland and coconut gardens on the western borders of Alappuzha district. The topography of the district is highly undulating. It starts from the tall hillslopes covered with thick forests on the East along the mountains down to the valleys and small hills to the flat and of coconut trees in the West.

Data used:

Soil resource : Soil map along with its characteristics made available from Department of Soil Survey.
Collatoral : SOI Toposheets

Image processing & GIS Software used

ERDAS 8.6, Arc GIS

The various procedures adopted in the present investigation consists of following important steps.

Creation of Physiographic-soil data base

The soil resource inventory was compiled from reports of Department of Soil Survey, Kerala.

Creation of Terrain Slope data base

The terrain slope map of study area was created using Digital Elevation Model (DEM) generated from the SOI toposheets

Agro- edaphic zones (AEdZ)

Agro-edhapic zones depicting soil and terrain potentiality for agriculture was generated by combining soil characteristics (physiography soil texture, and soil depth), and slope.

The soil resources data base was derived from the soil maps. Agro-edaphic zones were generated by GIS aided integration of physiography, soil characteristics and terrain slope.

Key (Mapping Unit)

Agro-Edaphic Zone

a) Physiography

1 Low land 2 Mid Land 3 High Land

b) Soils

Table 1: Soil series of Pathanamthitta district

Legend	Series Name	Description
MTR	Muthur series	Muthur series- Wetland soils. Poorly drained alluvial soils with depth more than 150cm developed from fluvial sediments. Extremely acid. Soils dark brown to reddish yellow with clay loam to clay texture
VGL	Vengal series	Vengal series- Colluvio-alluvial soils. Moderately well drained soils with more than 100cm depth. Very strongly acid. Soils dark brown to yellowish brown with sandy clay loam to clay texture. Gravels noticed in the surface horizons.
AYR	Ayroor series	Ayroor series- Riverine alluvium. Imperfectly drained with depth more than 150cm developed from fluvial sediments on river banks. Medium acid. Soils dark reddish brown to yellowish red with loam to clay loam texture.
KVR	Kaviyoor series	Kaviyoor series- Laterite soils. Well drained soils with depth more than 100cm.

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		Strongly acid. Soils dark reddish brown to yellowish red with gravelly clay loam to gravelly sandy clay texture.
ADR	Adoor series	Adoor series- Laterite soils. Well drained with more than 100cm depth. Strongly acid. Soils reddish brown to strong brown with gravelly loam to gravelly clay texture. Gravel content goes upto 70% in the subsoil.
KNI	Konni series	Konni series- Laterite soils. Well drained with depth more than 100cm developed from gneissic material. Strongly acid. Soils dark reddish brown to strong brown with gravelly loam to gravelly clay texture.
AVN	Airavan series	Airavan series- Alluvium. Poorly drained soils with more than 150cm depth. Very strongly acid. Soils dark greyish brown to dark yellowish brown with silt loam to clay loam texture.
KPR	Kumaranperoor series	Kumaranperoor series- Foothill soils. Well drained with depth more than 75cm developed from gneissic material. Medium acid. Soils dark reddish brown to yellowish red with gravelly loam to gravelly clay texture.
KMN	Kodumon series	Kodumon series- Hill soils. Well drained with depth more than 75cm developed from gneissic material. Very strongly acid. Soils very dark brown to strong brown with sandy clay loam to gravelly clay texture. Rock outcrops and gneissic boulders noticed in the subsoil.
GKL	Gudarakal series	Gudarakal series- Hill soils. Well drained with depth more than 100cm developed from gneissic material. Strongly acid. Soils dark reddish brown to brownish yellow with gravelly clay loam to gravelly clay texture. Gravel content decreases with depth. Gneissic boulders noticed in the subsoil
MYR	Muzhiyar series	Muzhiyar series- Forest soils. Well drained with depth more than 150cm developed from gneissic material. Extremely acid. Soils reddish brown to reddish yellow with silt loam to clay texture. Stones and weathered gneissic boulders seen in the subsoil.

c) Slope gradient

1.	Very Gentle	0 – 3 %
2.	Gentle	3 – 5 %
3.	Moderate sloping	5 - 10 %
4.	Steep	10 - 25 %
5.	Very Steep	> 25 %

RESULTS AND DISCUSSION

Delineation of Agro-edaphic zones

Agro Edaphic Zones are basic component in determining crop suitability leading to sustainable use of land resources. Physiography, soil depth, texture and terrain slope are essential inputs in shaping to Agro-edaphic zones in the study area. Agro-edaphic map was prepared on the basis of agro-edaphic parameters. The spatial extend of different edpahic parameters are illustrated in fig: 1.

Physiography

Physiography plays an important role in influencing soil development and climatic condition of the study area. The major soil-physiography observed in the study area are Low Land, Mid Land and High Land. Majority of the area i.e., 60 % fall in midland region

Fig 1 : Extend of different Physiographical units of Pathanamthitta District

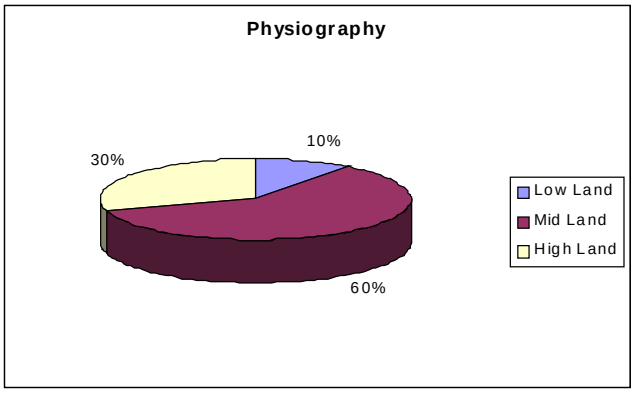


Table 2 : Extend of different Physiographical units of Pathanamthitta District

Physiography	Area (Ha)	Percentage
Low Land	12912	10%
Mid Land	76252	60%
High Land	37328	30%

Soils

Soils provide foothold for most plants, and are basis for our existence. Soil mapping units is an area of land delineated on a map, which consists either of a single soil type, or of multiple soil types occurring as a complex or association. Each soil type occurring in each soil mapping unit is characterized in terms of its land characteristics and qualities, which relate to the edaphic requirements of plants or to land use requirements for management or conservation, There are 10 soil mapping units observed in the study area.

Terrain slope

Terrain slope is another component of defining Agro-edaphic Zone. The study area is divided into 4 different slope gradient classes for Agro-Edaphic Zoning. They are very gently sloping (0-3%), gently sloping (3-5%), Moderately sloping (5-10%), and steep sloping (>25%). The majority of the study area belong to very gently sloping (0-3%). Area extend of different slope groups depicted in the Table 3 and fig: 2

Table 3 : Slope gradient of Pathanamthitta district

Slope	Area (Ha)	Percentage
0 – 3 %	65008	51%
3 – 5 %	37920	30%
5 – 10 %	10344	8%
10 – 25 %	8716	7%
> 25 %	4504	4%

Results reveal that nearly half (43%) of the district comprised of edaphic zone 6 i.e., midland having gentle to moderate slope with laterite to gravelly soil followed by mid land having steep sloping with

Fig. 2 :

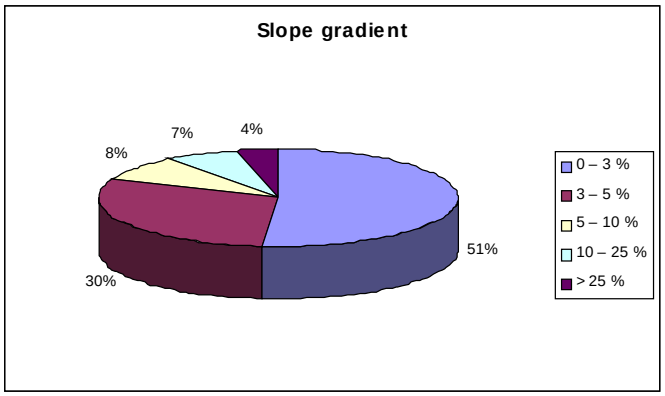


Fig. 4 : Edaphic data base were integrated in the GIS environment to obtain 11 Agro-Edaphic Zones (AEdZ I to XI).

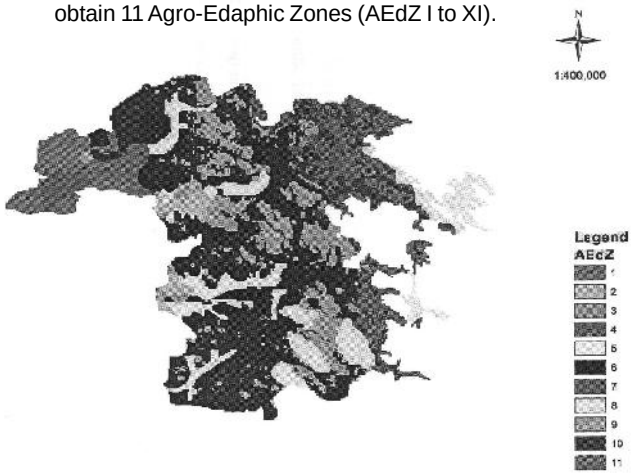


Fig.3 : Aroedaphic database was generated comprising of soil characteristics, Physiography and slope.

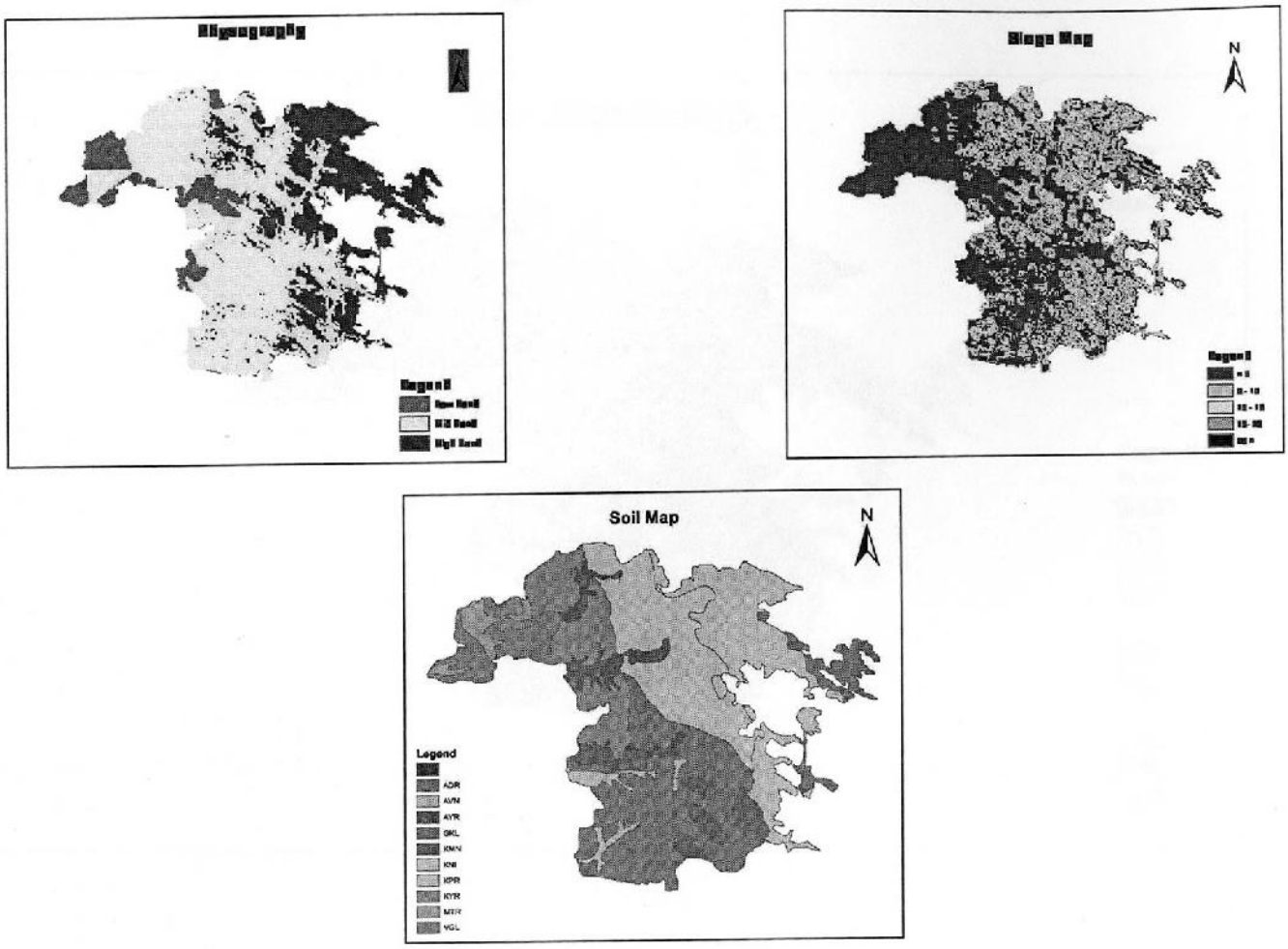
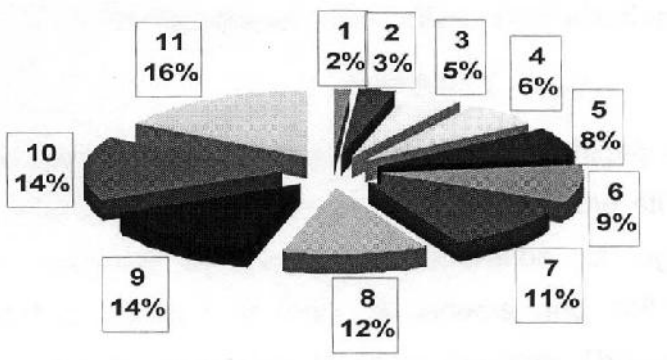


Table 4 : Spatial Extent of Agro-Edaphic Zones

Ag-Ed Zone	Description	Area (Ha)	Perce-ntage
1.	Low land-Gentle to moderate sloping-clay loam to clay	5528	4%
2.	Low land-Gentle to moderate sloping-alluvial loamy	2670	2%
3.	Low land-Gentle to moderate sloping-lateritic clayey to gravelly	3005	2%
4.	Mid land- Gentle to moderate sloping- clay loam to clay	4970	4%
5.	Mid land- Gentle to moderate sloping- alluvial loamy	7821	6%
6.	Mid land- Gentle to moderate sloping- lateritic clayey to gravelly	53048	43%
7.	Mid land- Gentle to moderate sloping- gneissic gravelly loam to loam	4012	3%
8.	Mid land- Gentle to moderate sloping- sandy clay loam to gravelly clay texture	9881	8%
9.	Mid land- Steep sloping- lateritic clayey to gravelly	15826	13%
10.	High land- Gentle to moderate sloping- gneissic gravelly loam to loam	8018	6%
11.	High land- Steep sloping- sandy clay loam to gravelly clay texture	9629	8%

Fig. 5 : Special extent of Agroedaphic zones of Pathanamthitta district.



laterite clayey to gravelly type of soil.

CONCLUSION

Pathanamthitta district was divided into 11 Agro-Edaphic Zones of which majority of the area comes under zone 6 i.e., midland having gentle to moderate slope with laterite to gravelly soil followed by mid land having steep sloping with laterite clayey to gravelly type of soil.

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