# Role of relief and slope in Agricultural Land use: A case study in Valapattanam River basin in Kannur District, Kerala using GIS and Remote Sensing


## Abstract

The present study aims to determine the relationship between relief and agricultural land use; and slope and agricultural land use in Valapattanam river basin in Kannur district using GIS and Remote Sensing. Land is a delineable area of the earth's terrestrial surface, encompassing all attributes of the biosphere immediately above or below this surface, including those of the near-surface climate, the soil and terrain forms, the surface hydrology (including shallow lakes, rivers, marshes and swamps), the near surface sedimentary layers and associated groundwater reserve, the plant and animal populations, the human settlement pattern and physical results of past and present human activity. Survey of India Topographic maps in 1:50000 scale are used as a base map for delineating the basin. Contours were digitized and DEM was created. Using Landsat imagery and agricultural land use maps were prepared using satellite digital data by digital image processing method using ERDAS IMAGINE image processing software. From the study it is found that there is a strong correlation between Agricultural land use and relief and slope in the Valapattanam River basin. GIS and Satellite Remote sensing were useful to establish the relationship of Agricultural land use with relief and slope. Higher the relief and slope lower the agricultural land use.



**Keywords:** Remote Sensing, biosphere, sedimentary layers, Topographic maps Topographic maps, Landsat imagery


## Introduction

Land is the basis for many life support systems. Land is a delineable area of the earth's terrestrial surface, encompassing all attributes of the biosphere immediately above or below this surface, including those of the near-surface climate, the soil and terrain forms, the surface hydrology (including shallow lakes, rivers, marshes and swamps), the near surface sedimentary layers and associated groundwater reserve, the plant and animal populations, the human settlement pattern and physical results of past and present human activity (terracing, water storage or drainage structures, roads, buildings, etc.) (Brinkman and Smyth, 1973 and FAO, 1995). Wise land use/land cover is an essential basis for a healthy and prosperous future of the society. Functions of land are manifold and depend upon site, situation and function. Land evaluation is part of the process of land-use planning. The essence of land evaluation is shell to compare or match the requirements of each potential land use with the characteristics of each kind of land. The result is a measure of the suitability of each kind of land use for each kind of

land. Land properties vary in time and space. Land-use/ land cover is dynamic. Over the years a variety of evaluation procedures have been proposed to cope with the complexity of land and its use.

Vink (1983) established relationship between Landscape Ecology and Land Use. Soma Roy Choudhury (1992) studied terrain and its impact on the land use of the Tista basin in West Bengal. Kaberi De (2010) made a study on terrain characteristics and their impact on land use of the Torsa-Raidak interfluves in West Bengal. Tools like Remote sensing and GIS were widely used in studies on land use, resource management and agriculture by Sahai and Karela (1987), Singh et al (2003), Salem Essa et al (2005), Lo and Yeung (2006) and Patel (2008). In this paper an attempt is made to see the relationship between relief and agricultural land use; and slope and agricultural land use in Valapattanam river basin in Kannur district using GIS and Remote Sensing.

**Study area**

Valapattanam River is one of the important rivers in north Kerala. Out of the 44 rivers of Kerala, seven west-flowing rivers are in Kannur district and Valapattanam River is the longest among them. It is the ninth longest river in the State and by the quantum of water resources, it gains fourth place. The Valapattanam basin extend between latitudes 11º 49'30" N and 12º 13' 50" North and longitudes 75º 58' 55" E and 75º 17' 22" East (Fig. 1). The length of the river is 110.50 Km with a catchment area of 1907 Sq km of which approximately 1321Sq km of area falls within the territory of Kerala State and the remaining in the Karnataka State. The river covers about 43.45% of Kannur district. Important tributaries of Valapattanam River are Bavali, Aralam, Veni or Vallithodu, Iritty, Sreekandapuram rivers, and Kattampallipuzha.

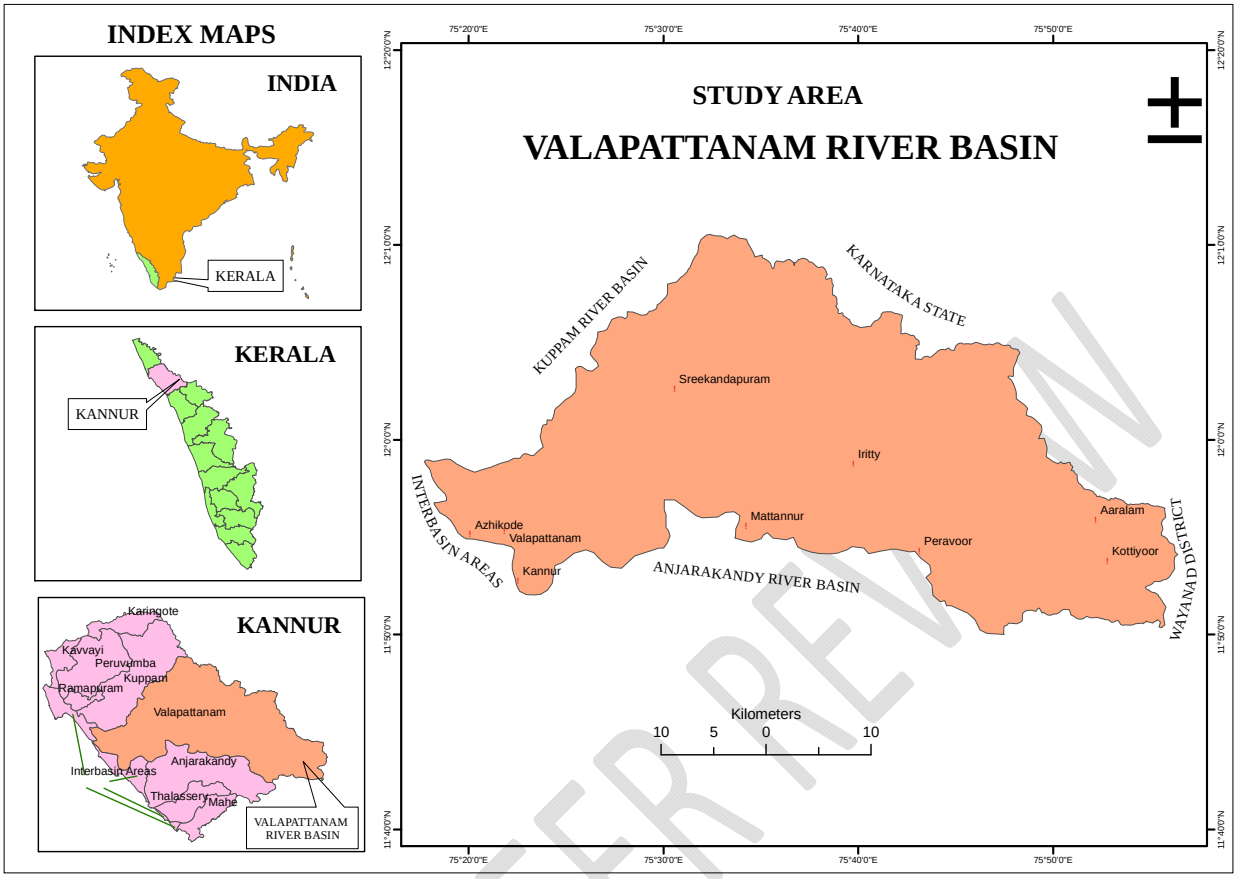



Fig.1

## Materials and methodology

Survey of India Topographic maps in 1:50000 scale are used as a base map for delineating the basin. Contours were digitized and DEM was created. Based on the contours a relief map was prepared (Fig.2). Using DEM slope map was prepared (Fig.3). ArcGIS software was used for the integration and analysis. Using Landsat imagery and agricultural land use maps were prepared using satellite digital data by digital image processing method using ERDAS IMAGINE image processing software (Fig.4). Relief categories were intersected with agricultural land use categories and areas were calculated. Same way Slope categories were intersected with agricultural land use categories and areas were calculated. To show the relationship trend graphs were prepared. Correlation coefficients were also made to establish the relationships.

## Analysis

Relief is the difference between the highest and lowest elevations in an area. A relief map shows the topography of the area. A relief shows changes in elevation over a given area

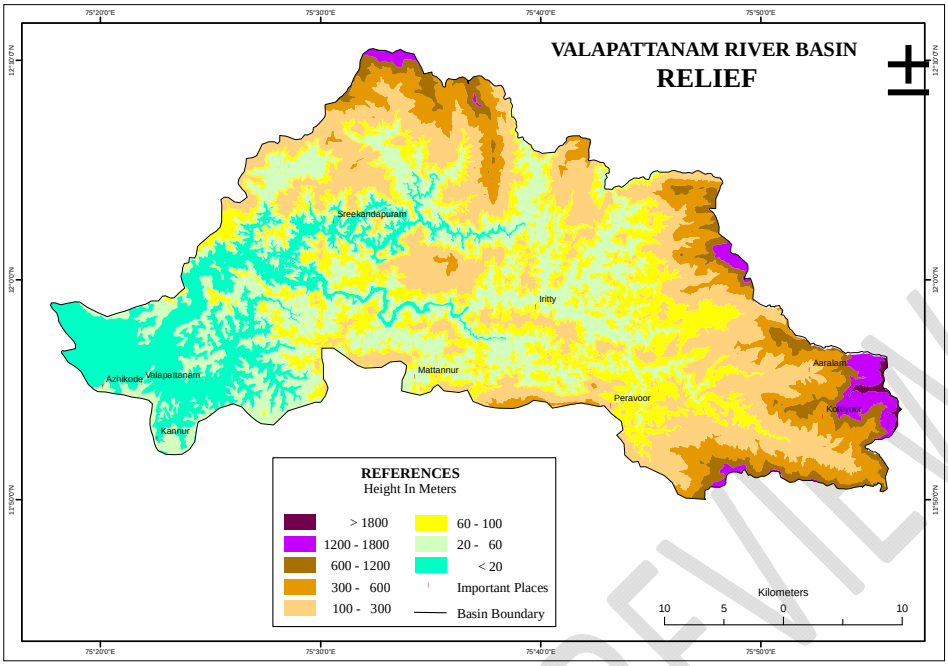



Fig.2

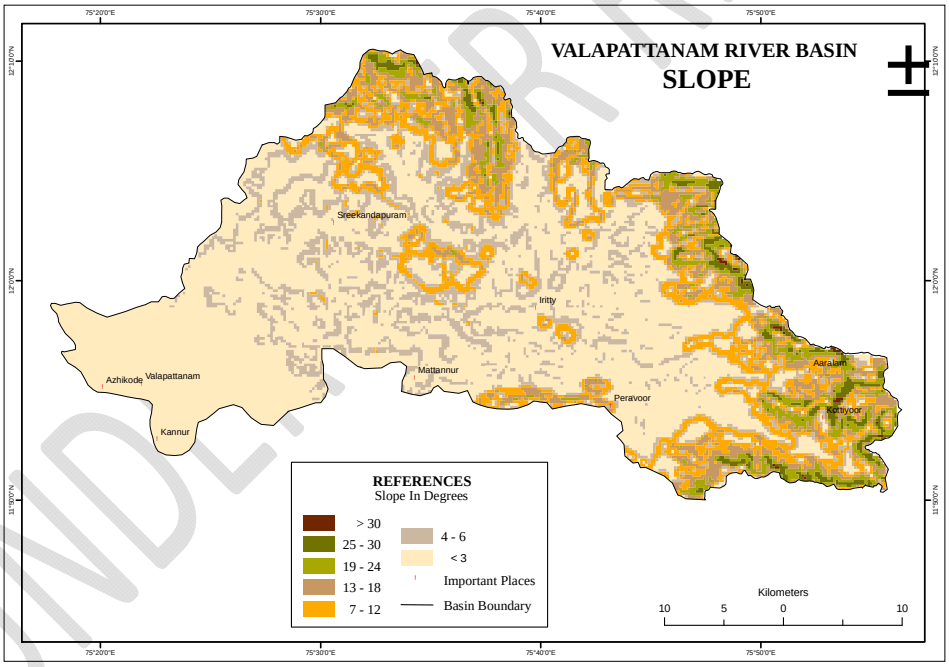



Fig.3

of land. It is the expression of the interaction of several different phenomena and processes within the earth's crust and on its surface. Relief has strong influence on the processes and phenomena related with land, such as climate, hydrology etc. It is also a well known fact that both natural and accelerated processes of soil erosion are largely dependent upon the nature of local relief. Relief is therefore intimately connected with many of the other elements of landscape resources. Agricultural land use is strongly influenced by the size and shape of the

relief forms. The distribution of area under different elevations is given in the Table 1. About 25 percent of the basin has an elevation between 100 and 300 meters. Elevation of about 20 to 60 meters occupies 24.3 percent of the total basin area and 20.3 percent area is occupied between 60 to 100 meters elevation. Major portion of the district is covered between 20 meters and 300 meters elevation. They are mostly in the midland regions of the district.

**Table 1**

**Valapattanam River basin: Relief**

| Sl.No. | Height above mean sea level | Area (sq.km) | Percent to the basin area |
|---|---|---|---|
| 1 | Below 20 | 169.3 | 13.0 |
| 2 | 20-60 | 317.4 | 24.3 |
| 3 | 60-100 | 264.8 | 20.3 |
| 4 | 100-300 | 331.1 | 25.4 |
| 5 | 300-600 | 139.5 | 10.7 |
| 6 | 600-1200 | 54.3 | 4.2 |
| 7 | 1200-1800 | 25.8 | 2.0 |
| 8 | Above 1800 | 3.1 | 0.2 |

Many physical attributes vary along a natural slope. Seven categories of slope are recognized in the Valapattanam basin based on the degree of steepness. Plateau edges and high mountain region have steep slopes. Many physical and biological processes acting on the landscape are highly correlated with topographic position: a hilltop, valley bottom, exposed ridge, flat plain, upper or lower slope, and so on. Examples of these processes include soil erosion and deposition, hydrological balance and response and wind exposure. More than 50 percent of the basin has very gentle slope of less than 3 degree slope angle (Fig: 3). About 20 percent has 3to 6 degree of slope angle. The next category is the 6 to 12 degree slope which also constitutes 14 percent. Slope angle of 12 to 18 occupies almost 10 percent and higher slope angles or steep slope constitute limited area of less than 5 percent of the total basin area (Table 2).

**Table 2**

**Valapattanam River basin: Slope**

| Sl.No | Slope | Area(sq.km) | Percent to the basin area |
|---|---|---|---|
| 1 | >30 | 3.6 | 0.3 |
| 2 | 24-30 | 29.5 | 2.3 |
| 3 | 18-24 | 61.7 | 4.7 |
| 4 | 12-18 | 119.6 | 9.2 |
| 5 | 6-12 | 179.6 | 13.8 |
| 6 | 3-6 | 218.5 | 16.8 |
| 7 | <3 | 694.5 | 53.3 |

**Land Use/Land Cover**

Valapattanam river basin is richly endowed with agricultural resources. Most of the area comes under agricultural land use. Coconut is the dominant crop in the basin followed by rubber,

cashew, arecanut, paddy and other crops. Land use/ land cover of Valapattanam River basin is shown in Fig 4.

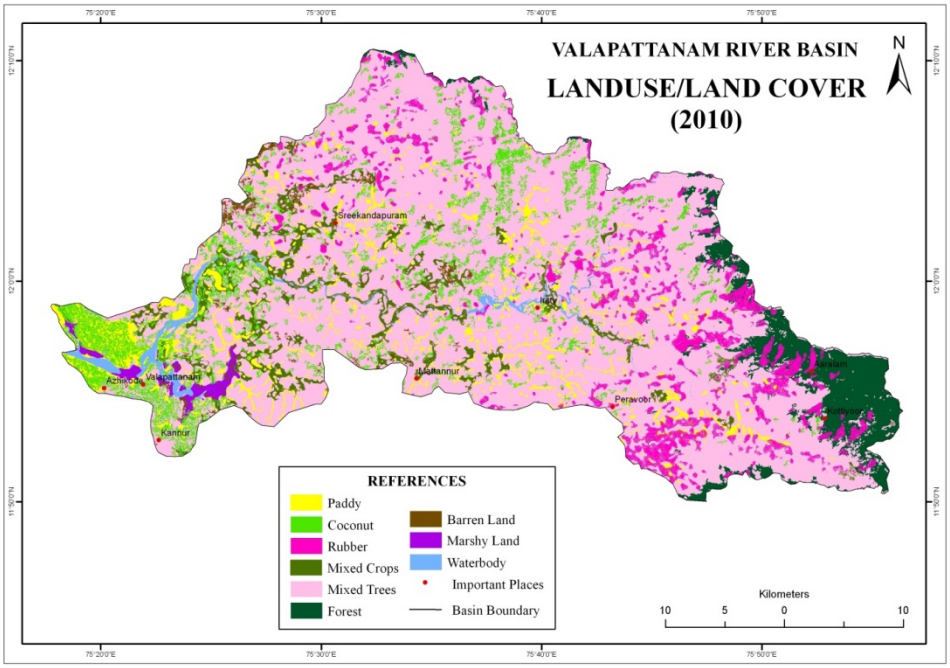



Fig: 4

Mixed trees include cashew, pepper, mango, and jack fruit. Mixed crops include banana, plantain, tapioca and other crops. Area under different land use/ land cover is given in the Table.3. The upper reaches of the Valapattanam River basin are extensively cultivated with plantation cash crops like coffee, and rubber. Tapioca, cashew and pepper occupy the midland regions. At the lower elevations of the river valleys, tapioca, coconut and other tree crops are interspersed with paddy cultivation. The lowland coastal area is dominated by coconut and partly by cashew and paddy. The diversity of tree crops is markedly high at the lowland – midland junction. Conversion of forest area for developmental activity includes plantations in the uplands.

**Table 3**

**Valapattanam River basin – Area and Percentage under Land use/Land cover**

| Sl.No | Land use/land cover | Area in sq.km | Percentage to the total area |
|---|---|---|---|
| 1 | Paddy | 90.5 | 6.93 |
| 2 | Coconut | 98.18 | 7.51 |
| 3 | Mixed crops | 68.09 | 5.21 |
| 4 | Mixed trees | 825.09 | 63.13 |
| 5 | Rubber | 90.13 | 6.9 |
| 6 | Forest | 79.26 | 6.06 |
| 7 | Barren land | 20.2 | 1.55 |
| 8 | Marshy land | 11.73 | 0.9 |
| 9 | Water body | 23.74 | 1.82 |

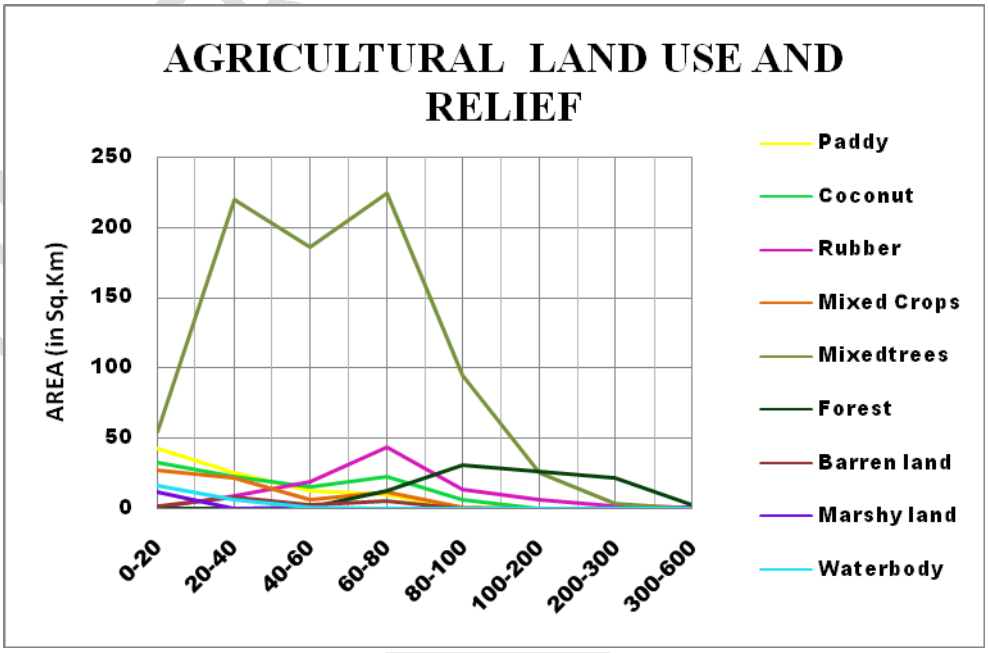
## Relief and Area under Agricultural Land Use

Relief ranges from zero to above 1800 meters in the basin. Area under paddy is high in the low land region of the basin and gradually decreases in area with increase in height towards east. Water body also follow similar trend. Marshy area is confined to low land only. Area under rubber is low in the lowland region; it is high in the midland region and decrease towards highland. Similarly mixed trees are found more in the midland region compared to low and high land region. Forest area is showing increasing trend from midland to high land. Barren lands are confined to midland region. Graph:1 shows the relation between agricultural land use and different height categories. Table: 4 Shows area of agricultural land use in square kilometers under different height categories

**Table 4**

**Valapattanam River basin – Relief and area under agricultural land use**

| Relief | Paddy | Coconut | Rubber | Mixed Crops | Mixed trees | Forest | Barren land | Marshy land | Water body |
|---|---|---|---|---|---|---|---|---|---|
| **Below 20** | 42.7 | 32.4 | 0.4 | 27.3 | 54.7 | 0.0 | 1.9 | 11.8 | 16.1 |
| **20-60** | 25.2 | 22.4 | 8.8 | 22.2 | 220.5 | 0.0 | 7.5 | 0.1 | 6.5 |
| **60-100** | 13.1 | 15.3 | 18.5 | 6.7 | 186.7 | 0.8 | 2.1 | 0.0 | 1.3 |
| **100-300** | 10.2 | 22.7 | 43.2 | 11.8 | 224.7 | 13.1 | 5.2 | 0.0 | 0.2 |
| **300-600** | 0.3 | 6.0 | 13.2 | 0.8 | 95.1 | 30.9 | 0.4 | 0.0 | 0.0 |
| **600-1200** | 0.0 | 0.4 | 5.4 | 0.0 | 25.3 | 26.5 | 0.0 | 0.0 | 0.0 |
| **1200-1800** | 0.0 | 0.1 | 1.5 | 0.0 | 3.3 | 21.7 | 0.1 | 0.0 | 0.0 |
| **Above 1800** | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 3.1 | 0.0 | 0.0 | 0.0 |




Graph: 1

**Slope and Area under Agricultural Land use**

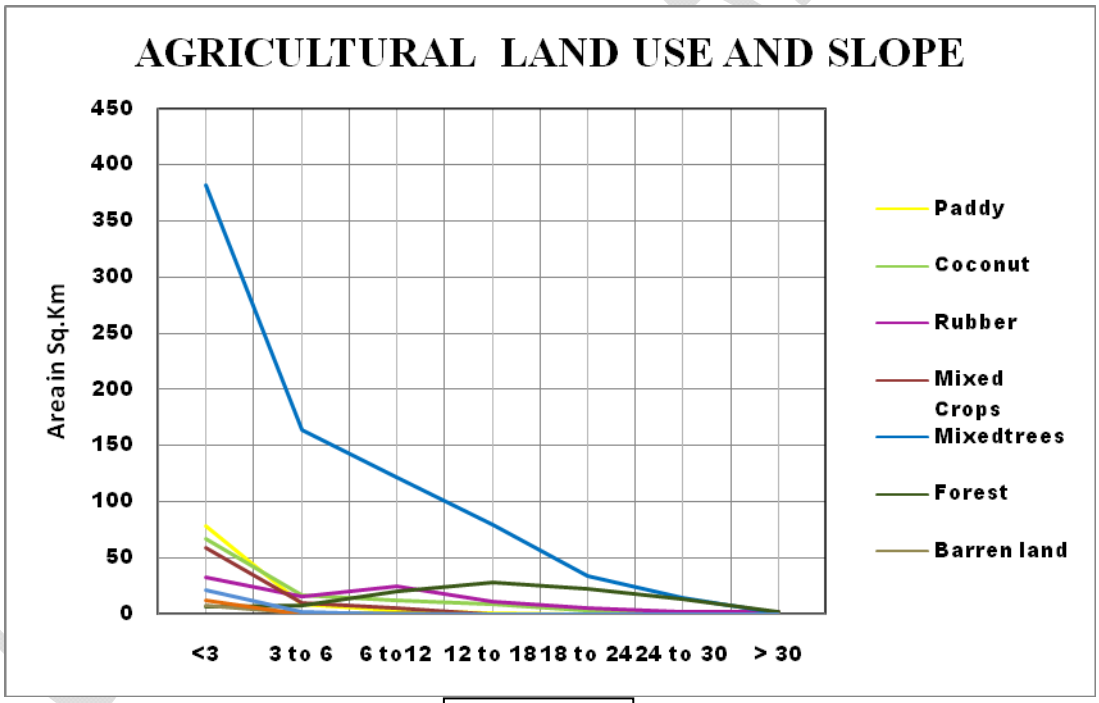
All the categories of agricultural land use show high area in low slope areas of Valapattanam River basin (Graph: 2).They gradually decease in area at higher slope region.

**Table 5**

**Valapattanam River basin - Slope and area under agricultural land use**

Area in sq.km

| Slope | Paddy | Coconut | Rubber | Mixed Crops | Mixed trees | Forest | Barren land | Marshy land | Water body |
|---|---|---|---|---|---|---|---|---|---|
| <3 | 78.3 | 66.6 | 32.2 | 59.5 | 382.2 | 5.6 | 8.0 | 11.9 | 21.8 |
| 3 to 6 | 9.1 | 15.9 | 16.0 | 10.5 | 163.9 | 6.8 | 1.3 | 0.0 | 2.1 |
| 6 to12 | 3.2 | 11.9 | 24.0 | 5.2 | 121.7 | 20.3 | 0.9 | 0.0 | 0.0 |
| 12 to18 | 0.9 | 8.0 | 11.3 | 0.2 | 79.2 | 28.2 | 0.1 | 0.0 | 0.0 |
| 18 to24 | 0.0 | 2.5 | 5.6 | 0.0 | 34.2 | 21.9 | 0.0 | 0.0 | 0.0 |
| 24 to30 | 0.0 | 0.4 | 2.5 | 0.0 | 14.0 | 13.3 | 0.0 | 0.0 | 0.0 |
| > 30 | 0.0 | 1.3 | 2.3 | 0.0 | 0.7 | 1.5 | 0.0 | 0.0 | 0.0 |




Graph: 2

**Conclusion**

From the study it is found that there is a strong correlation between Agricultural land use and relief and slope in the Valapattanam River basin. GIS and Satellite Remote sensing were useful to establish the relationship of Agricultural land use with relief and slope. Higher the relief and slope lower the agricultural land use.

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