Original Research Article

Land Suitability Evaluation for Legume Crops and Horticulture Crops in Paman Kallur-1 Micro-Watershed using Geospatial Techniques

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A B S T R A C T

A detailed study was conducted to assess the land capability and land suitability of Paman kallur-1 micro-watershed. The micro watershed is located in Lingasugur taluk, Raichur district, Karnataka, India, which lies between the latitude and longitude of 76°37’ N – 16°7’ E and 76°39’ N– 16°5’ E. Initially, land resource survey was carried out at 1:8000 scale to derive soil phase units based on land surface and profile characters. Four soil series were identified and further mapped into six soil phase units. The soil phase unit “THDhD2g1S1R1” covered maximum area of 137 ha (32.22%) with moderate slope (5-10%) and moderate erosion in Paman kallur-1 micro-watershed. Land capability with subclasses in the study area was IIIe having limitations of soil erosion, texture, soil drainage, soil fertility and topography. Therefore, 97.15 per cent of the study area is suitable for legume and horticultural purposes. Further, Soil phase unit wise and with corresponding survey number, crop plan with suitable interventions for field crops, horticultural crops, vegetables, millets and pulses were prepared for the benefit of the farmers.

Keywords
Land capability, Crop suitability, Geospatial technology and Micro-watershed

Article Info
Accepted: 12 November 2019
Available Online: 10 December 2019

Introduction

The balance between economic viability and destruction of a nation often depends on how the land resource base is managed. Proper land management cannot be done without land use planning (Geetha et al., 2017). An essential part of land use planning is land evaluation. Land evaluation is the assessment of the potential of land for alternative uses using systematic comparison of the land use requirements (LURs) with land quality/
characteristics (Dent and Young, 1981). Land evaluation forges a link between the basic survey of resources and the taking of decision on land use planning and management. It puts at the disposal of users relevant information about land resources that are necessary for planning development and taking management decisions (Kharche and Gaikawad, 1993).

North-Eastern dry zone part of Karnataka is having very hot and semi-arid climate. The rainfall region is very erratic and prone to drought and most of the region is covered with black cotton soil with Pigeon pea, Paddy and Cotton as major crops. Soil which is a natural resource has variability inherent to how the soil formation factors interact within the landscape. However, variability can occur also as a result of cultivation, land use and erosion. Salviano (1996) reported spatial variability in soil attributes as a result of land degradation due to erosion.

The land resources inventory in the micro watershed for various crops is necessary to choose the right crop and suitable variety for the area. In order to assess, a detailed land resource inventory and its evaluation were undertaken using geospatial technology. The geospatial techniques are essential for the investigation of spatial variations of soil and crop parameters across agricultural fields, which can lead to the efficient implementation of site-specific management systems (Najafian et al., 2012).

Assessing the extent and degree of suitability of the land resources in the micro watershed for various crops is necessary to choose the right crop and suitable variety for the area. In this regard, a detailed land resource inventory and its evaluation were undertaken using geospatial technology in Paman Kallur-1 micro watershed of North Eastern Dry Zone of Karnataka, to characterize land capability and crop suitability.

Materials and Methods

Paman Kallur-1 micro-watershed (Chiknagaur sub-watershed, Lingasagur taluk, Raichur district) is located in between 76°37’ N – 16°7’ E and 76°39’ N– 16°5’ E, covering an area of about 425.72 ha, bounded by Hirenagnur, Gejjalagata, Paman Kallur and Chikhesrur villages (Fig. 1).

The average rainfall of this region is 335 mm. geologically the study area is characterized by granite and gneiss. The detailed land resource survey (at 1:8000 scale) of the entire micro-watershed was carried out in the year 2016, with the help of cadastral map overlaid on IRS LISS-IV merged Cartosat-1 imagery having 2.5 m spatial resolution (Fig. 2). Rapid traversing was carried out to record soils at varying physiographic position. Based on geology, drainage pattern, surface features, slope characteristics and land use, landforms and soil profile were identified (Soil Survey Staff 1999). Four soil series were identified and further mapped into six soil phase units and their area distribution and description were mapped in Figure 3 and Table 1.

Morphological characteristics of different soil are shown in Table 3. These data have been used to evaluate the land capability classification (Sehgal, 1996) and land suitability. For various field crops and horticultural crops based on the soil limitations, climatic regimes and land characteristics the suitable interventions with crop plan were developed by NBSS & LUP.

Results and Discussion

Land capability classification

The classification is based on the inherent soil characteristics, external land features and environmental factors that limit the use of land (Table 2). Based on the susceptibility of soils to erosion (e), soils (s), topography (t) and
drainage (d) limitations the study area was classified into different land capability classes. Arable lands that are fit for agriculture were grouped under I to IV and non-arable lands were grouped class VI to VIII. Soil morphological characteristics of soil units are matched with land capability classification (Sehgal, 1996).

Based on soil properties, the soils of Paman kallur-1 micro-watershed of Lingasugur taluk have been classified into only one land capability class i.e., IIIes (Fig. 4). All the series of micro-watershed was grouped under class III which is moderately good cultivable lands. These soils were marginally cultivable lands due to severe limitations of erosion, Slope, texture, soil depth limitations. The entire micro-watershed area was fall under IIIes of about 414 ha. Similar findings were also reported by (Leelavathi et al., 2009).

### Land suitability classification for crops

Land suitability was evaluated following FAO (1979) guidelines. It involved formulation of climate and soil requirements of the crop and ratings of these parameters highly suitable (S1), moderately suitable (S2), marginally suitable (S3), and unsuitable (N1). The suitability criteria for sorghum, cotton, tomato and coconut are given by Naidu et al., (2006) was followed and was given in Table 2.

### Land suitability for Horticultural crops

The suitability assessment for horticultural crops in Paman kallur-1 MWS showed that an area of 393 ha (90.05 %) was marginally suitable (S3) and 30 ha (7.11%) was currently not suitable (N1) for Ground nut with limitations of rooting condition, texture, slope and gravel (Fig. 5).

In case of Green gram, Bengal gram and Black gram an area of 246 ha (57.83%) was moderately suitable, 137 ha (32.22%) area was marginally suitable and 30 ha (7.11%) area was found to be currently not suitable (N1) due to severe limitations of rooting condition slope, texture and gravel (Fig. 6, 7 and 8 respectively).

Redgram covering an area of 60 ha (14.10%) was moderately suitable, 323 ha (75.95%) was marginally suitable and 30 ha (7.11%) area was found to be currently not suitable (N1) due to severe limitations of rooting condition slope, texture and gravel (Fig. 9). Similar findings were also reported by (Rajesh et al., 2018).

### Proposed crop plan

Crop plan for field crops and horticulture crops for HEGmC2 soil phase unit has suitable interventions such as, Deep and wider size pit, Drip irrigation with suitable soil and water conservation measures Cultivation on raised beds with mulches, Graded bunds and strengthening of field bunds for vegetables and field crops.
### Table 1: Mapping units description of Paman kallur-1 micro-watershed

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Map symbol</th>
<th>Description</th>
<th>ha (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CHRhC2g1S1</td>
<td>Chatra series, Shallow (25-50 cm), Gently sloping (1-3%), Sandy Clay loam, textured soil with moderate erosion, Gravelly (15-35%), Strong (0.01 to 0.1%).</td>
<td>60 (14.08)</td>
</tr>
<tr>
<td>2</td>
<td>CHRhD2g1S1R1</td>
<td>Chatra series, Very shallow (&gt;25 cm), Moderately sloping (5-10%), Sandy Clay loam, textured soil with moderate erosion, Gravelly (15-35%), Strong (0.01 to 0.1%), Fairly rocky (2-10%).</td>
<td>49 (11.46)</td>
</tr>
<tr>
<td>3</td>
<td>CHRhE2g1S1R1</td>
<td>Chatra series, Very shallow (&gt;25 cm), Strongly sloping (10-15%), Sandy Clay loam, textured soil with moderate erosion, Gravelly (15-35%), Strong (0.01 to 0.1%), Fairly rocky (2-10%).</td>
<td>30 (7.11)</td>
</tr>
<tr>
<td>4</td>
<td>HEGmC2</td>
<td>Heggapur series, Moderately shallow (50-75 cm), Gently sloping (1-3%), Clay, textured soil with moderate erosion.</td>
<td>60 (14.1)</td>
</tr>
<tr>
<td>5</td>
<td>KMThC2g1S1</td>
<td>KumarKhed Tanda series, Shallow (25-50 cm), Gently sloping (1-3%), Sandy Clay loam, textured soil with moderate erosion, Gravelly (15-35%), Strong (0.01 to 0.1%).</td>
<td>77 (18.19)</td>
</tr>
<tr>
<td>6</td>
<td>THDhD2g1S1R1</td>
<td>Thodki series, Moderately shallow (50-75 cm), Moderately sloping (5-10%), Sandy Clay loam, textured soil with moderate erosion, Gravelly (15-35%), Strong (0.01 to 0.1%), Fairly rocky (2-10%).</td>
<td>137 (32.22)</td>
</tr>
<tr>
<td>7</td>
<td>Others*</td>
<td>Water body</td>
<td>12 (2.85)</td>
</tr>
<tr>
<td>8</td>
<td>Total</td>
<td></td>
<td><strong>425.72</strong></td>
</tr>
</tbody>
</table>

### Table 2: Suitability criteria table

<table>
<thead>
<tr>
<th>Crop requirement</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil –site characteristics</td>
<td>Highly suitable (S1)</td>
</tr>
<tr>
<td>Slope %</td>
<td>2-3</td>
</tr>
<tr>
<td>Length of Growing period Days</td>
<td>&gt;110</td>
</tr>
<tr>
<td>Soil drainage class</td>
<td>Well to mod. drained</td>
</tr>
<tr>
<td>Soil reaction pH</td>
<td>5.5-7.5</td>
</tr>
<tr>
<td>Surface soil texture Class</td>
<td>L, sil, Sl, Cl, Sicl, Scl</td>
</tr>
<tr>
<td>Soil depth Cm</td>
<td>&gt;75</td>
</tr>
<tr>
<td>Gravel content % vol.</td>
<td>&lt;15</td>
</tr>
<tr>
<td>Salinity (EC) dSm⁻¹</td>
<td>&lt;1.0</td>
</tr>
<tr>
<td>Sodicity (ESP) %</td>
<td>&lt;10</td>
</tr>
</tbody>
</table>
### Table 3 Physico-chemical properties of soil series

<table>
<thead>
<tr>
<th>Series</th>
<th>Mapping unit</th>
<th>Geology</th>
<th>Depth (cm)</th>
<th>Slope %</th>
<th>Colour</th>
<th>Texture</th>
<th>Land use</th>
<th>Drainage</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHR</td>
<td>CHRhC2g1S1</td>
<td>Granite</td>
<td>25-50</td>
<td>3-10%</td>
<td>5 YR 4/4,3/3</td>
<td>Sandy clay loam, sandy loam</td>
<td>Agriculture</td>
<td>Well drained</td>
</tr>
<tr>
<td>CHR</td>
<td>CHRhD2g1S1R1</td>
<td>Granite</td>
<td></td>
<td></td>
<td>5 YR 3/4,4/6</td>
<td>Sandy clay loam, sandy loam</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HEG</td>
<td>HEGmC2</td>
<td>Gneiss</td>
<td>50-75</td>
<td>1-5%</td>
<td>10YR 3/3,3/1</td>
<td>Sandy clay loam</td>
<td>Agriculture</td>
<td>Well drained</td>
</tr>
<tr>
<td>KMT</td>
<td>KMThC2g1S1</td>
<td>Gneiss</td>
<td>25-50</td>
<td>3-10%</td>
<td>7.5 YR 4/3,5/3</td>
<td>Sandy clay loam</td>
<td>Agriculture</td>
<td>Moderately well drained</td>
</tr>
<tr>
<td>THD</td>
<td>THDhD2g1S1R1</td>
<td>Granite</td>
<td>50-75</td>
<td>1-5%</td>
<td>5 YR 3/4,2.5 YR 5/6</td>
<td>Sandy clay loam</td>
<td>Agriculture</td>
<td>Moderately well drained</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Series</th>
<th>Mapping unit</th>
<th>Rockiness</th>
<th>Gravelliness %</th>
<th>Stoniness</th>
<th>Structure</th>
<th>Consistency</th>
<th>pH</th>
<th>EC</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHR</td>
<td>CHRhC2g1S1</td>
<td>nil</td>
<td>Gravelly</td>
<td>strong</td>
<td>1 fmsbk</td>
<td>sh, fr, ss, sp</td>
<td>Neutral</td>
<td>Non saline</td>
</tr>
<tr>
<td>CHR</td>
<td>CHRhD2g1S1R1</td>
<td>Fairly rocky</td>
<td>Gravelly</td>
<td>strong</td>
<td>2 fmsbk</td>
<td>h, fr, vs, vp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HEG</td>
<td>HEGmC2</td>
<td>nil</td>
<td>nil</td>
<td>nil</td>
<td>1ffmgrsbnk</td>
<td>sh, fr, ss, sp</td>
<td>Moderately alkaline</td>
<td>Non saline</td>
</tr>
<tr>
<td>KMT</td>
<td>KMThC2g1S1</td>
<td>nil</td>
<td>Gravelly</td>
<td>strong</td>
<td>1 fmsbk</td>
<td>sh, fr, ss, sp</td>
<td>Slightly alkaline</td>
<td>Non saline</td>
</tr>
<tr>
<td>THD</td>
<td>THDhD2g1S1R1</td>
<td>Fairly rocky</td>
<td>Gravelly</td>
<td>strong</td>
<td>1 fmsbk</td>
<td>sh, fr, ss, sp</td>
<td>Moderately alkaline</td>
<td>Non saline</td>
</tr>
</tbody>
</table>

**Table 4** Proposed Crop Plan for Paman kallur-1 Micro-watershed

<table>
<thead>
<tr>
<th>LMU</th>
<th>Mapping unit</th>
<th>Survey number</th>
<th>Field crops</th>
<th>Horticulture crops</th>
<th>Suitable Intervention</th>
</tr>
</thead>
</table>
| LMU-1   | CHRhC2g1S1, CHRhD2g1S1R1, CHRhE2g1S1R1 | Hirenagur:- 165,70,193,194,198, 193,210,209,208.  
  Gejjalagatta:- 76,73,74,75,3  
  Chikhesrur:- 23,22,65,62,66,61,58 ,35,34,33,30,32,180, 149,51,151,158. | **Sole crop:** sorghum, Bajra, Navni, Red gram, Green gram, Cotton, Maize, Sun flower, black gram, bengal gram, ground nut , maize | **Fruit crops** : custard apple, Tamarind, jamun, Ber, Sapota, Anola,  
  **Veg:** Onion, Tomato, Brinjal, Chilli, Bhendi, Green leaf, curry leaf, Tomato,  
  **Flowers** - Gaillardia, marigold, Chrysanthemum, lilly | Deep and wider size pit, Drip irrigation with suitable soil and water conservation measures Cultivation on raised beds with mulches and drip. |
| LMU-2   | KMThC2g1S1            | Paman kallur:- 172,171,170/1,173/2, 170/2,7,8,169,179,9(1),170,177/1,177/2,180/1,180/1,152,150,184,  
  Hirenagur:- 212,  
  Chikhesrur:- 27,26,31. | **Sole crop:** sorghum, Bajra, Navni, Red gram, Green gram, Cotton, Maize, Sun flower, black gram, bengal gram, ground nut , maize | **Fruit crops** : custard apple, Tamarind, jamun, Ber, Sapota, Anola,  
  **Veg:** Onion, Tomato, Brinjal, Chilli, Bhendi, Green leaf, curry leaf, Tomato,  
  **Flowers** - Gaillardia, marigold, Chrysanthemum, lilly | Deep and wider size pit, Drip irrigation with suitable soil and water conservation measures Cultivation on raised beds with mulches and drip. |
| LMU-3   | THDhD2g1S1R1          | Hirenagur:- 84,192,191,200,205, 206,207,204,203,  
  Gejjalagatta:- 4(1),2. | **Sole crop:** sorghum, Bajra, Navni, Red gram, Green gram, Cotton, Maize, Sun flower, black gram, bengal gram, ground nut , maize | **Fruit crops** : custard apple, Tamarind, jamun, Ber, Sapota, Anola,  
  **Veg:** Onion, Tomato, Brinjal, Chilli, Bhendi, Green leaf, curry leaf, Tomato,  
  **Flowers** - Gaillardia, marigold, Chrysanthemum, lilly | Deep and wider size pit, Drip irrigation with suitable soil and water conservation measures Cultivation on raised beds with mulches and drip. |
| LMU-4   | HEGmC2                | Hirenagur:- 186/1,189,70,158,15 5,154/2,154/3. | **Sole crop:** sorghum, Bajra, Navni, Red gram, Green gram, Cotton, Maize, Sun flower, black gram, bengal gram, ground nut , maize | **Fruit crops** : Sapota, Jamun, Guava, Tamarind, Lime, Musambhi, Custard apple, Jackfruit, Amla, pomegranate,  
  **Veg:** Onion, Tomato, Brinjal, Chilli, Bhendi, Green leaf, curry leaf, Tomato,  
  **Flowers** - Gaillardia, marigold, Chrysanthemum, lilly | Deep and wider size pit, Drip irrigation with suitable soil and water conservation measures Cultivation on raised beds with mulches and drip. Graded bunds and strengthening of field bunds |
Fig.1 Location map of Paman kallur-1 micro-watershed

Fig.2 Satellite image of Paman kallur-1 micro-watershed
**Fig. 3** Soil map of Paman kallur-1 micro-watershed

**Fig. 4** Land capability map of Paman kallur-1 micro-watershed
Fig. 5 Land suitability map for Ground nut in Paman kallur-1 micro-watershed

Fig. 6 Land suitability map for Green gram in Paman kallur-1 micro-watershed
Fig. 7 Land suitability map for Bengal gram in Paman kallur-1 micro-watershed

Fig. 8 Land suitability map for Black gram in Paman kallur-1 micro-watershed
Fig. 9 Land suitability map for Redgram in Paman kallur-1 micro-watershed

Fig. 10 Land suitability map for Custard apple in Paman kallur-1 micro-watershed
Fig. 11 Land suitability map for Guava in Paman kallur-1 micro-watershed

Fig. 12 Land suitability map for Jamun in Paman kallur-1 micro-watershed
Fig. 13 Land suitability map for Mango in Paman kallur-1 micro-watershed

Fig. 14 Land suitability map for Sapota in Paman kallur-1 micro-watershed
Fig. 15 Land suitability map for Musambi in Paman kallur-1 micro-watershed

Fig. 16 Land suitability map for Tamarind in Paman kallur-1 micro-watershed
Fig. 17 Land suitability map for Jackfruit in Paman kallur-1 micro-watershed

Fig. 18 Land suitability map for Pomegranate in Paman kallur-1 micro-watershed
Whereas, CHRhC2g1S1, CHRhD2g1S1R1, CHRhE2g1S1R1, KMThC2g1S1 and THDhD2g1S1R1 soil phase units have interventions like deep and wider size pit for fruit crops, drip irrigation with suitable soil and water conservation measures and cultivation on raised beds with mulches and drip irrigation for vegetables (Table 4).

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How to cite this article: