



P-ISSN: 2349-8528

E-ISSN: 2321-4902

IJCS 2018; 6(1): 624-628

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Received: 15-11-2017

Accepted: 22-12-2017

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Development of software for land capability classification

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Abstract

Land refers to a delineated part of the earth's surface, including mountains, rivers, swamps, deserts, islands, and coast areas. Soil comprising minerals and biological materials is a natural feature of the earth's surface and support plant growth. The software helps to surveyor, field officers in classifying the land, to suggest special soil and water conservation practices and to recommend the crop cultivation for the classified land. To run the software use the command Alt+F9 or run command. After giving the command the user is firstly promoted to enter the slope of land in percentage, then it will asks for the depth in cm. When depth is entered it will ask for the final input i.e. soil type. Enter the respective soil type. As soon as the inputs are entered, it will display the result on the screen. The developed software is run successfully with the different conditions and the results are noted. Overview and brief description of software developed in 'C++' language, which was tested for different depths, slopes and soil types. Developed software is useful for suggesting the soil and water Conservation practices. The software is very easy to operate and general guideline and idea about the running software to any new person.

Keywords: Soil, Soil classification, software, C++ language.

Introduction

Land refers to a delineated part of the earth's surface, including mountains, rivers, swamps, deserts, islands, and coast areas. Soil comprising minerals and biological materials is a natural feature of the earth's surface and support plant growth. Land characteristics are influenced by the atmosphere, the soil and underlying geology, the relief, the hydrology, the plant and animal populations and finally the human activities.

Watershed management

Watershed management is comprehensive terms which mean the rational utilization of land and resources of any watershed. It is essentially concerned with the integrated planning of watershed for proper land use, treatment and its management for higher productivity, from each unit land area.

Capability classification

Land capability classification refers to a systematic arrangement of different kinds of land according to those properties that determine the ability of the land to reproduce on a virtually permanent basis ^[1]. This system was devised by the U.S. Department of Agriculture has been used since the 1950's to asses the appropriate uses of various types of land ^[2].

It is one of the groupings made primarily for agricultural purposes. In this classification the arable soils are grouped according to potentialities and limitation for sustained production of common cultivated crops. Non arable soils are grouped according to their potentialities and limitations for the production of permanent vegetation and according to their risk of soil damage.

Soil profile characteristics

The important soil properties which are interpreted for classifying lands under different land capability classes are

- Soil texture
- Soil slope
- Effective soil depth and hard pan
- Permeability and internal drainage

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- Availability of nutrients
- Soil salinity, alkalinity and toxicity and
- Coarse soil fragments.

External features of land

Water logging slope and erosion are the factors that determine land capability and limit the use of land for particular purposes only. Slope influences the degree of erosion and workability of land. The effect of slope is reflected on erosion, hence this factor is not considered separately. The degree, length and type of slope should be taken in to consideration while assessing erosion or land capability. Terrace of land, which originally had a higher slope, may give the same erosion and runoff as land with lower and uniform slope.

Climatic factors

Rainfall, temperature and wind velocity are important components of climate. These climatic factors also affect the land e.g. excessively high or low rainfall will cause water logging or drought conditions which will adversely affect the choice of production.

Classification

The lands under different capabilities can be classified into groups, classes, subclasses and units from higher to lower levels of generalization.

Land capability classes

There are eight land capability classes. The work of soil

LC Class	Wild life	Forestry	Grazing			Cultivation			
			Limited	Moderate	Intense	Limited	Moderate	Intense	Very intense
Class I									
Class II									
Class III									
Class IV									
Class V									
Class VI									
Class VII									
Class VIII									

Fig 3.1: Suitability of land capability classes for different land use

Simple levelling

It is the simplest operation in levelling when it is required to find the difference in elevation between two points, both of which are visible from a single position of the level. Formula for calculating the slope is given as:

$$\text{Slope (\%)} = \frac{\text{Reading at B} - \text{reading at A}}{\text{Distance between A and B}} \times 100$$

Various ranges of slopes for land capability classes is given in the following table.

Table 1: Ranges of slopes for land capability classes

Notation	Slope class	Land capability class	Slope ranges (%)
A	Nearly level	Class I	0-1%
B	Gentle sloping	Class II	1-3%
C	Moderate sloping	Class III	3-5%
D	Strongly sloping	Class IV	5-10%

damage or limitation in use becomes progressively greater from Class I to VIII.

Land capability sub classes

Land capability sub classes provide information about the kind of conservation problem or limitations involved. Sub classes are groups of capability units which have the same major conservation problems, such as e-erosion, w-excess wetness, s-root zone limit-attains, c-climatic limitation.

Material and methods

Land capability classification

The land capability classification system devised by the U.S. department of Agriculture has been used since the 1950s to assess the appropriate uses of various types of land. It is especially helpful in identifying land use and management practices that can minimize erosion, especially that induced by rainfall. There are two broad groups of LCC namely.

- Land suitable for cultivation and other uses: This groups includes four classes namely Class I to Class IV based on increasing intensity of hazards and consequent limitations of land use.
- Land not suitable for cultivation; in this group there are four classes from Class V to Class VIII lands. These classes are very well suited to forestry, grassland and wildlife. Increasing intensity of hazard and limitation of land use; the relative degree of limitations in land use with hazards is progressively fighter from Class I to Class VIII.

3.2.2 Soil depth

Soil depth affects the soil capability in reference to availability of plant nutrients, moisture and root development [3]. The greater soil depth is important for dry land farming as the quantity of water stored in deeper soil layers will also be higher making more water and nutrients available to root zone. A soil depth of 150 cm has been considered as the minimum need for good cultivation and plant growth.

Soil depth evaluation

Soil depth can be checked by a soil auger. On average, four to five sites samples for hectare of land. Samples should be taken from the centre and at each compass point 50m from the centre. The average soil depth is then computed. The various ranges of soil depth for land capability classification are given in the following table.

Table 2: Ranges of soil depth

Symbol	Name	Depth Range (Cm)
D1	Very shallow	0-7.5
D2	shallow	7.5-22.5
D3	Moderately deep	22.5-45.0
D4	Deep	45.0-90.0
D5	Very deep	>90.0

Table 3.4: Soil type recommended for different classes.

Capability class	Soil type
I	Silty Clay loam, Clay Loam, Loam, Sandy Loam, Silty Loam, Sandy Clay Loam.
II	Silty Clay Loam, Clay Loam, Sandy Loam, Silty Loam, Sandy Clay Loam.
III	Sandy Clay, Silty Clay, Clay, Loamy Sand.
IV	Clay, Sandy.

The software

The software is organized into small modules. Mainly the modules are categorized as follows:

1. Land slope
2. Soil depths
3. Soil Type

While running the software the user is firstly promoted for the basic information like, slope of the land, soil depth and soil type.

After this primary interactive data feeding the programme starts computation which" leads to the final classification of land, selection of crops to be grown and conservation measures to be adopted in that land. The software automatically selects the class from the data base available with the software.

The software is very easy to operate and general guideline and idea about the running software to any new person is given in flow chart.

In the above flowchart statement indicate the results, which give the class of land, conservation practices and limitations for cultivation.

3.5 Testing of software

By using the above methodology we made the software in 'C++' language. The software is testing for various characteristics of land i.e. depth of soil, slope of land, and soil type.

3.5.1 Procedure to compile the software

First open the terminal. Give the command to compile the software, the command is Alt+F9.

3.5.2 Procedure to run the software

To run the software use the command F5 or run command After giving the command the user is firstly promoted to enter the slope of land in percentage, then it will asks for the depth in cm. When depth is entered it will ask for the final input i.e. soil type.

As soon as the inputs are entered, it will display the result on the screen. The procedure is same for each loop. But if the entered input do not match with the condition given in the software it will display result.

Soil type	Numerical Notation
Loam	1
Sandy Loam	2
Silty Loam	3
Clay Loam	4
Sandy Clay Loam	5
Silty Clay Loam	6
Sandy Clay	7

Results and Discussion

The software is divided into two section as described below.

1. Input Section
2. Result Section

Input Section

While running the software the user is firstly promoted to enter the slop of land in percentage then user should enter the depth in cm and finally the user has to select the soil type number from the table.

When the input match with the given condition in software, then in display result with particular class. The range of slope, depth and soil type number with respect to land capability class are given in following table.

Result section

In result section the software shows the four outputs as

1. Land capability class.
2. Suggested soil and water conservation practices.

Table: Ranges of different inputs

LCC	Slope (%)	Depth (cm)	Soil type no,
Class-I	0-1	>=90	1-6
Class-II	1-3	45-90	2-6
Class-III	3-5	22.5-45	7-10
Class-IV	5-10	7.5-22.5	10 or 11

Input Section

Please enter following data:

Enter slope (in percentage): 1

Enter depth (in centimetre): 97

1. Loam	2. Sandy Loam	3. Silt Loam
4. Clay Loam	5. Sandy Clay Loam	6. Silty Clay Loam
7.Sandy clay	8. Silty clay	9. Loamy sand
10. Clay	11. Sandy	

Enter soil type: 4

Result section

Soil is in land capability class I
Suggested soil and water conservation practices are better manuring fertilization,

Fig. 4.1: Output result of land capability class – I

This is the programme on land capability classification, which helps to find land capability classes, suggest special soil and water conservation practices and limitation for cultivation. It requires the following input data.

Input Section

Please enter following data:

Enter slope (in percentage): 3
Enter depth(in centimetre): 65

1. Loam	2. Sandy Loam	3. Silt Loam
4. Clay Loam	5. Sandy Clay Loam	6. Silty Clay Loam
7.Sandy clay	8. Silty clay	9. Loamy sand
10. Clay	11. Sandy	

Enter soil type: 5

Result Section

Soil is in land capability class-II

Suggested soil and water conservation practices are contour tillage, strip, cropping simple terrace, grassed waterways, suitable mulching.

Fig. 4.2: Output result of land capability class – II

This is the programme on land capability classification, which helps to find land capability classes, suggest special soil and water conservation practices and limitation for cultivation. It requires the following input data.

Input Section

Please enter following data:

Enter slope (in percentage):4.5
Enter depth(in centimetre):40

1. Loam	2. Sandy Loam	3. Silt Loam
4. Clay Loam	5. Sandy Clay Loam	6. Silty Clay Loam
7.Sandy clay	8. Silty clay	9. Loamy sand
10. Clay	11. Sandy	

Enter soil type:-8

Result section

Soil is in land capability class-III

suggested soil and water conservation practices are strip cropping, terracing, diversion ditches water ways, contour tillage, cover crops and mulching.

Fig. 4.3: Output result of land capability class – III

This is the programme on land capability classification, which helps to find land capability classes, suggest special soil and water conservation practices and limitation for cultivation. It requires the following input data.

Input Section

Please enter following data:

Enter slope (in percentage): 8
Enter depth(in centimetre): 21

1. Loam	2. Sandy Loam	3. Silt Loam
4. Clay Loam	5. Sandy Clay Loam	6. Silty Clay Loam
7.Sandy clay	8. Silty clay	9. Loamy sand
10. Clay	11. Sandy	

Enter soil type: 10

Result section

Soil is in land capability class-IV

Suggested soil and water conservation practices are terracing, contour strips.

Fig. 4.4: Output result of land capability class – IV

This is the programme on land capability classification, which helps to find land capability classes, suggest special soil and water conservation practices and limitation for cultivation. It requires the following input data.

Input Section

Please enter following data:

Enter slope (in percentage):0.5
Enter depth(in centimetre):93

1. Loam	2. Sandy Loam	3. Silt Loam
4. Clay Loam	5. Sandy Clay Loam	6. Silty Clay Loam
7.Sandy clay	8. Silty clay	9. Loamy sand
10. Clay	11. Sandy	

Enter soil type: 11

Result section

Soil is in land capability class-V

suggested soil and water conservation practices are woodland management practices like stocking within the carrying capacity & prevention of fire.

Conclusion

Thus the following conclusion can be obtained from the present study.

1. The day on which every engineer would be having computer on his desk is not far of so keeping this fact in mind it is concluded that this software could be quite useful for agricultural engineers, field officers and surveyors in classifying the land capability class for watershed management plan.
2. Developed software is useful for suggesting the soil and water conservation practices.

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