

## Research article

# Capacity of soil use in the watershed of the Corriente del Lobo, Itatinga, São Paulo, Brazil

## Capacidad de uso de la tierra en la cuenca de la Corriente del Lobo, Itatinga, São Paulo, Brasil

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### Abstract

The objective of this research was to define the use capacity classes of 2403.25 ha in the basin of La Corriente del Lobo - Itatinga (SP), (22°03'56" to 22°59'12" of latitude S and 48°38'47" to 48°41'25" of longitude W Gr.). The soil use capacity was obtained by using the SIG IDRISI 32 crossing the documents of steepness and soils, and the document of judgment of soil use capacity classes and of the utility survey of the physical milieu. The areas with use capacity classes and subclasses presented the following values: IIIa - 68.60 ha (2.85%), IIIe,s - 1919.15 ha (79.86%); IIIe - 210.60 ha (8.76%); IVe - 3.38ha (0.14%); IVe,s - 157.42 ha (6.55%) and VIe,s - 44.10 ha (1.84%). The lands of the basin were distributed in three classes (III, IV and VI) and six subclasses, but the biggest extension (79.9%) belonged to the subclass IIIe,s. The modules of the IDRISI allowed to discriminate, mapping and to quickly quantify the soil use capacity of the areas of classes and subclasses in the basin.

**Key words:** Brazil, capacity of soil use, Geographical Information System, Itatinga, soil use, watershed.

### Resumen

El objetivo del trabajo fue definir las clases de capacidad de uso de 2403.25 ha de la cuenca de la Corriente del Lobo - Itatinga (SP) (22° 03' 56" - 22° 59' 12" de latitud S y 48° 38' 47" - 48° 41' 25" de longitud O). La capacidad de uso de la tierra se obtuvo mediante el SIG-IDRISI 32 del cruzamiento de las cartas clinográfica y de suelos y de la Tabla de juzgamiento de clases de capacidad de uso de la tierra y del levantamiento utilitario del medio físico. Las áreas de las clases y subclasses de capacidad de uso presentaron los siguientes valores: IIIa - 68.60 ha (2.85%), IIIe,s - 1919.15 ha (79.86%); IIIe - 210.60 ha (8.76%); IVe - 3.38 ha (0.14%); IVe,s - 157.42 ha (6.55%) y VIe,s - 44.10 ha (1.84%). Las tierras de la cuenca se distribuyeron en tres clases (III, IV y VI) y seis subclasses pero la mayor extensión (79.9%) pertenece a la subclase IIIe,s. Los módulos del IDRISI permitieron discriminar, mapear y cuantificar rápidamente la capacidad de uso de las áreas de las clases y subclasses de la cuenca.

**Palabras clave:** Brasil, capacidad de uso de la tierra, cuenca hidrográfica, Itatinga, Sistema de Información Geográfica, uso de la tierra.

## Introduction

Land use capacity looks for harnessing soil conditions with minimal loss, based on the expressive detail factors that may influence the structure and composition of the soil such as relief, erosion, soil type, climate, among others (Araújo Jr., 1998). The type of use can be used to identify areas with economic and sustainable productivity capacity (Norton, 1940).

The use capacity indicates the degree of crops intensity that can be applied to the soil, without losing its productive capacity (Ribeiro and Fields, 1998; Dainese et al., 1999). The survey soil conditions and the natural environment for agriculture is of great value. A conscious exploration, based on certain conservation practices regarding soil type, allows better use and increase of soil sustainability because increases the potential and use of resources for future generations (Araújo Jr., 1998).

Soil conservation involves practices that have been evaluated in recent decades, as a new form of agriculture that seeks to maintain good soil conditions and the adoption of emergency or preventive practices, including erosion control, modern techniques of agricultural mechanization, the correct and proper use of fertilizers and amendments as

well as the most productive varieties (Araújo Jr., 1998).

This study aimed to define, map and quantify the types of land use capacity of the basin La corriente del Lobo - Itatinga (SP), taking into account information from clinographic letters and soil, local data, the classification table, among others.

## Materials and methods

This work was developed in 2403.25 hectares of the basin La Corriente del Lobo, located in the municipality of Itatinga, São Paulo, Brazil (22° 03' 56" - 22° 59' 12" S and 48° 38' 47" - 48° 41' 25" W), located in the watershed Las Piedras tributary of Pardo river from the Middle Paranapanema. The basin is 826 MASL, Latosols are the predominant and reforestation

The clinographic chart (Figure 1) was obtained manually through an analog abacus (De Biasi, 1970), from sheets if Pratânia (SF-22-ZBV-4) and Itatinga (SF-22-ZD-II-2) on the scale 1:50000 (IBGE, 1973), using six slope classes ranges (0-3%, 3-6%, 6-12%, 12-20%, 20-40% and >40%). These are used by Brazilian researchers who work in soil use and management for future conservation projects (Filadelfo Jr. 1999).

Clinographic and soil charts were scanned

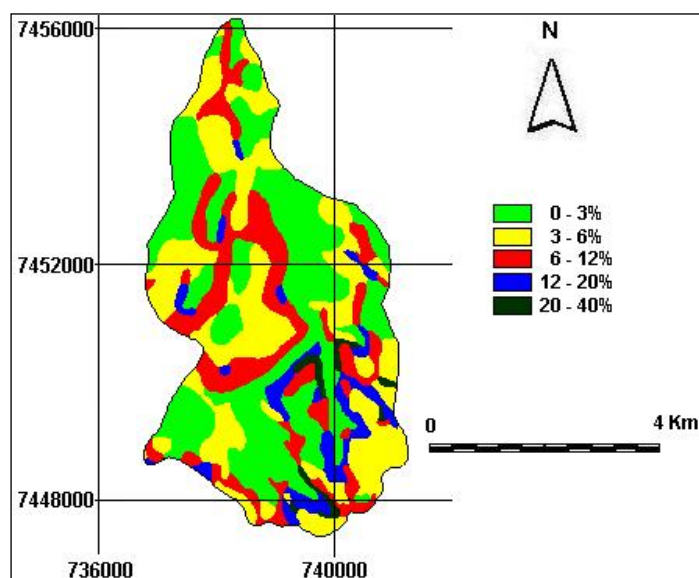


Figure 1. Slope classes chart from the watershed land La Corriente del Lobo - Itatinga (SP), Brazil.

(Figure 2) and imported to the Geographic Information System - IDRISI 32 (Eastman, 1998), in BMP format generated in the scanning process to IMG format for the module File/Import. To georeference these cards and digital image, four control points located at the edges of the module Reformat / Resample were selected. Vectorization of boundaries for slope types and soils was made through On Screen Digitizing module to get the mask polygon of the basin area. Tracking the types of slope and soil on the watershed polygon was done using the module Reformat / Raster / Vector Conversion / Lineras.

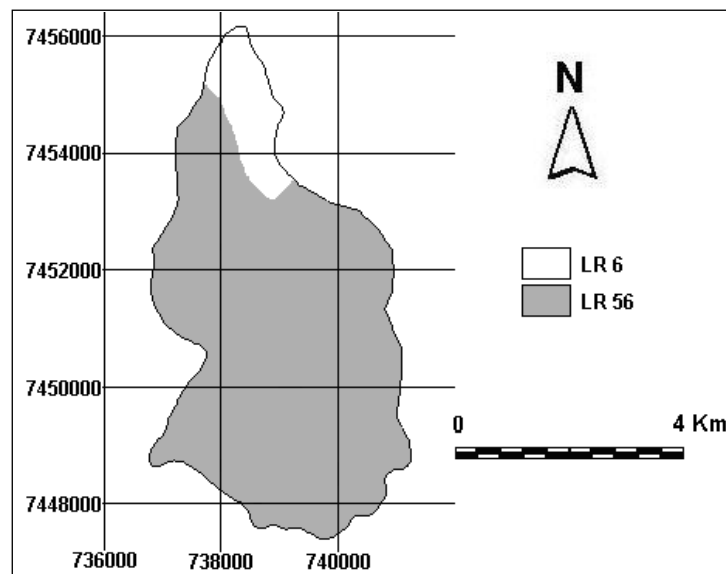
Red Latosols Soils (LR6) are formed by associations of Eutroferic and Distroferic soils with flat and undulating relief, and Eutroferic Red Nitosols soil with soft wavy relief and mollic horizon, with clay texture. Red Latosols Soils (LR56) are formed by the association of Dystrophic soils and Red Yellow Dystrophic Latosols soil, with soft wavy flat relief.

The chart for land use capacity was made from the intersection of information from the clinographic and soil charts. For the first, a judging table for use capacity classes developed by França (1963) and Lepsch et al. (1983) was used, and adapted by Zimback and Rodrigues (1993) by the module Analysis/Database Query/Overlay. The areas of soil slope type and land use capacity were

determined with GIS - IDRISI, using the previous module.

The land use capacity was classified by the constant classification manual system for the utility survey of the physical media, and the land classification was made using the criteria from the judging table (França, 1963; Lepsch et al., 1991), adapted by Zimback and Rodrigues (1993) shown in Table 1. This table shows the types of land use capacity for each criteria of the parameter of the limitation, including: apparent fertility (FA), effective depth (PE), permeability and drainage (PD), runoff (DF), stoniness (P), risk of runoff (RI), sheet erosion (EL), rill erosion (ES) and gully (V). The assessment of the constant parameters of Table 1 was adapted to the following criteria:

- **FA.** It was based on the physical and chemical characteristics of the different types of soils in the municipality, according to the land survey made by Oliveira et al. (1999);
- **PE.** It was determined based to the morphology description of each type of soil, according to the description of each unit and the soil survey by Oliveira et al. (1999);
- **PD.** Established from the physical properties of each type of land, mostly by constant texture according to the analysis of the survey.



**Figure 2.** Soil unit chart from the watershed La Corriente del Lobo - Itatinga (SP), Brazil.

. **Table 1.** Judging table for land use capacity in the studied land.

Characteristics	Criteria	Use capacity classes							
		I	II	III	IV	V	VI	VII	VIII
Fertility	Very High	x							
	High	x							
	Meddium		x						
	Low			x					
Effective dept (cm)	Very Low						x		
	>200	x							
	100 - 200	x							
	50 - 100		x						
Permeability and drainage	25 - 50					x			
	<50						x		
	Excessive		x						
	Good	x							
Runoff	Moderate		x						
	Poor			x					
	Very poor					x			
	Very fast				x				
Stoniness (%)	Fast			x					
	Moderate		x						
	Slow	x							
	Very slow		x						
Runoff risk	Without stons	x							
	<1		x						
	1 - 10			x					
	10 - 30				x				
Slope (%)	30 - 50				x		x		
	>50		x						
	Without risk	x							
	Occasional			x					
Laminar erotion	Oftern					x			
	Very often							x	
	0 - 3	x							
	3 - 6		x						
Rill erosion	6 - 12			x					
	12 - 20				x				
	20 - 40						x		
	>40							x	
Erosion in middle rills	No apparent	x							
	Slight		x						
	Fast			x					
	Moderate					x			
Deep rill erosion	Severe						x		
	Extreme							x	x
	No apparent	x							
	Ocational			x					
Gullie erosiom	Often		x						
	Very often			x					
	No apparent	x							
	Ocational			x					
Gullie erosiom	Often				x				
	Very often					x			
	No apparent	x							
	Ocational				x				
Gullie erosiom	Often					x			
	Very often						x		
	No apparent	x							
	Ocational				x				
Gullie erosiom	Often						x		
	Very often							x	
	No apparent	x							
	Ocational				x				
Gullie erosiom	Often							x	
	Very often								x
	No apparent	x							
	Ocational				x				

**Source:** França (1963), Lepsch *et al.* (1991), Zimback y Rodrigues (1993).

- **DF.** Runoff types (Table 2) were constructed based on the main factors that interfere the axes intensity: (1) Infiltration that varies with soil type, as red nitosol distroferric (structured red land) and red-yellow dystrophic latossol which decreases the intensity. The greater infiltration, the less runoff will be. (2) The slope directly affects runoff intensity, therefore, the smaller the slope, the lower the contribution to total runoff.
- **P.** It was determined by the morphology of each type of soil, according to the lifting of Oliveira et al. (1999);
- **RI.** Runoff risk was determined by field observation using the lift conducted by Oliveira et al. (1999);
- **The slope** was determined in the field according to the particular class in the municipality.

- The **erosion types** were taken from the defined criteria in the field observations and information obtained from the Ministry of Agriculture and Supply of São Manuel-SP.

Within each class, the subclasses classification for land capacity was done by using the constraints listed in Table 3, as suggested Lepsch et al. (1991).

## Results and discussion

71% of the basin area is in the slope class <6% (Figure 1 and Table 4). Flat areas with slope between 0-3%, and areas with gently slope between 3-6%, are recommended for annual crops use with simple conservation practices such as soil contour farming that allow erosion control (Filadelpo Jr., 1999). The LR56 soil unit comprises 91.1% of the area dominated by relatively flat and gently undulating slope.

Data shows the type of slope between 0-12% as dominant, occupying 91.46% (2198.01 ha) of the total basin area, which is suitable for annual crops with extensive use of mechanization according Lepsch et al. (1991). In general, the slope type 0-3% (39.5% and has 948.08), 3-6% (31.51% to 757.26 ha) and 12.6% (20.50% to 492.67 ha) represents the plane to undulate slope group (0-12%) (Chiarini and Donzeli, 1973).

The areas with slopes between 12-20% (heavily wavy) and between 20-40% (hilly), comprise 6.7% (161.01 ha) and 1.84% (44.23 ha) respectively.

Knowing the subclasses of land use capacity is an important tool that allows the pla-

**Table 2.** Slope ranges and criteria to establish classes of runoff.

Slope (%)	Runoff criteria	Classes
0 - 3	Slow	I
	Very slow	II
3 - 6	Slow	I
	Moderate	II
6 - 12	Moderate	II
	Fast	III
12 - 20	Fast	III
20 - 40	Very fast	IV
> 40	Very fast	IV

**Table 3.** Limitations to define subclasses of land use capacity.

Erosion (e)	Soil (s)	Water (a)	Weather (c)
Strong slope	Low depth	Water table capacity	Prolonged drought
Long slope	Sandy texture throught the profile	Runoff risk	Frost
Abrupt textural change	Stoniness	Slow fall of organic soils	Cold winds
Laminar erosion	Expansive clay	Organic soils deficiency	Snow
Rill erosion	Low saturation of bases	Oxigen deficiency in the soil	
Gully erosion	Aluminium toxicity		
Wind erosion	Low Exchange capacity		
Deposits of erosion	Acid sulfate or sulfates		
Low permeability	High sodium saturation		
Horizont A sandy	Excess of soluble salts		
	Carbonate excess		

**Table 4.** Slope classes based on soil units occurring in the basin of the watershed La Corriente del Lobo - Itatinga (SP), Brazil.

Slope classes (%)	Soil Units					
	LR6 <sup>t</sup>		LR56 <sup>t</sup>		Total	
	ha	%	ha	%	ha	%
0 – 3	92.52	3.85	855.56	35.60	948.08	39.45
3 – 6	80.03	3.33	677.23	28.18	757.26	31.51
6 – 12	38.22	1.59	454.45	18.91	492.67	20.50
12 – 20	3.36	0.14	157.65	6.56	161.01	6.70
20 – 40	0.00	0.00	44.23	1.84	44.23	1.84
Total	214.13	8.91	2189.12	91.09	2403.25	100

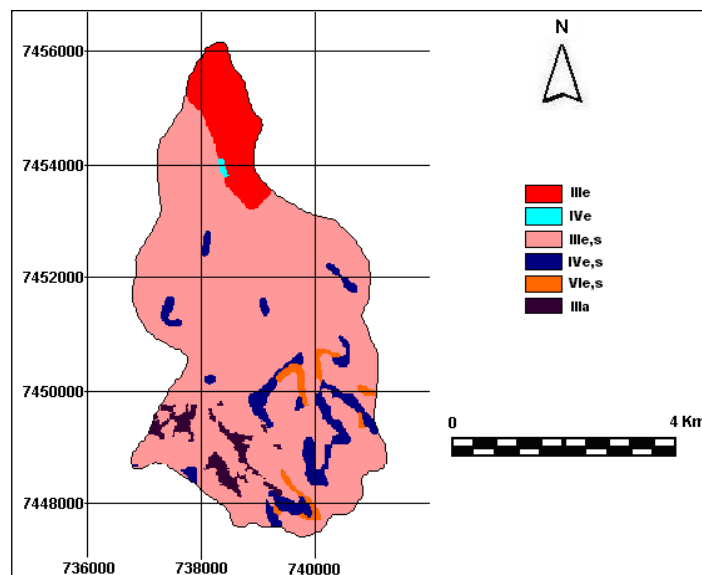
ning for a better use of resources in segmented areas, in terms of cultural practices, but always embedded within the overall context of watersheds.

The land use capacity, class III, dominates 91.47% of the basin (Figure 3 and Table 5). According to Araújo Jr. (1998), those are arable land that requires intensive practices or complex management for the production of annual crops with medium to high yield. The moderately sloping topography of the soils in this class requires intensive care for erosion control, as much as the internal drainage deficiency demands a water management, and

the low productivity requires special practices for soil improvement. This class includes the best lands without irrigation from some semi-arid regions. Units that belong to this class in El Lobo basin are LR6 and LR56, that represents 210.53 ha and 1987.73 ha respectively.

Class IV consists of the soil units LR6 (3.36 ha and 0.14%) and LR56 (6.55% and 157.41 ha), which are not suitable for permanent crops, but suitable for irrigated annual crops. Those units exhibit high slope, severe erosion, very poor drainage and low productivity.

Class VI includes arable land without annual species, except by pasture or refores-



**Figure 3.** Land use capacity chart in the watershed La Corriente del Lobo - Itatinga (SP), Brazil.

**Table 5.** Land use capacity classes in La Corriente del Lobo basin- Itatinga (SP), Brazil

Classes	Basin area	
	ha	%
IIIe	210.53	8.76
IVe	3.36	0.14
IIIe,s	1919.24	79.86
IVe,s	157.41	6.55
VIe,s	44.22	1.84
IIIa	68.49	2.85
Total	2403.25	100

tation. This class shows shallow soils or excessive slope, these soils are common in arid and semiarid regions. The unit LR56 in this soil class represents 1.84% that is 44.22 ha.

The subclass IIIe,s is the most significant and prevalent as it represents the 80% of the total basin area. It is located in the soil unit LR56 and represents 79.86% (1919.24 ha) of sandy textured soils with low fertility. The LR6 unit, characterized by highly fertile soils when compared to LR56 unit, has the subclass IIIe as the greatest contribution (8.76% and 210.53 ha) in the total basin area.

Subclasses VIe,s and IIIa show the highest limitations. The first have soil erosion problems and is only suitable for pasture and forests, while the second shows occasional flooding problems.

### Conclusion

El Lobo basin, Itatinga, SP, Brazil, has the most representative slope classes as levels between 3-6%, while the least common are between 20-40%. LR56 unit, with 91.08%, and the land use capacity class III with 91.47%, are the ones that dominate the basin.

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