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Rescue of saturated hydraulic conductivities and steady Infiltration rates data in the State of Rio de Janeiro - Brazil

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Abstract

Saturated hydraulic conductivity and steady infiltration rate are essential parameters in irrigation, and drainage projects, as well as in hydrological and climatological modelling. These data are hardly found in widely used soil databases in Brazil, and they are still reported in dispersed publications. This study aims to rescue SIR and K_s data for the state of Rio de Janeiro and make them available to users. In total 934 measurements of K_s and 24 of SIR were compiled. The soil types most frequent measured were Gleissolos and Neossolos, as well agriculture and pastures for the land-use system. The most popular methods to evaluate the K_s were constant head in the lab and the Guelph permeameter in field evaluations, and for the SIR, the double ring method. The data ranged from 0.40 to 1073 mm h^{-1}. The lack of information in some regions of the Rio de Janeiro States indicates priority areas for increasing K_s and SIR determination.

Keywords: constant head, Guelph permeameter, double ring

Introduction

Evaluating soil water dynamics involves the determination of soil hydraulic parameters such as saturated hydraulic conductivity (K_s) and steady infiltration rate (SIR). These parameters have been largely used in hydrological models, irrigation, and drainage projects, as well as in studies related to the fate of nutrients and pesticides and water erosion. The saturated hydraulic conductivity (K_s) characterizes the capacity of the soil to transmit water in saturated conditions. Its measurement can be done in the laboratory using methods developed under transient conditions or under steady-state conditions, or even under field conditions, with the popular use of the Guelph permeameter. However, the determination of soil hydraulic properties is costly and time-consuming, and very difficult to be evaluated in large areas due to the high spatial variability of these parameters. SIR and K_s data for the state of Rio de Janeiro have been retrieved and compiled. This study is part of a national effort of the Brazilian Soil Science Society (SIBCs) to rescue and make available the data of SIR and K_s to Brazil.

Methodology

The study was performed by obtaining data on basic SIR and/or K_s obtained from lab or field evaluations in soils located in the state of Rio de Janeiro - Brazil. These studies were found by a bibliographic survey of articles, theses and dissertations, conference announcements, technical publications, and reports. The SIR and K_s data were stored in a soil database (SDB) structured including other information related: sampling location (site description, geographic coordinates, land use), physical, chemical properties, and water retention at different matric potential. The measuring methods used to evaluate SIR and K_s are also included in the SDB. Some parameters were mandatory, such as the county, soil classification, land use, granulometry, saturated hydraulic conductivity (K_s – mm/h) (obtained in laboratory or in the field) or steady infiltration rate (SIR – mm/h) and methods for determination of K_s or SIR. The land-use systems and soil classification were harmonized using the rules of classification used in the Project MapBiomas (MAPBIOMAS, 2020) and soil classification using the first order of classification of the last version of the Brazilian Soil Classification System (Santos, 2018). The data were classified according to land use and soil type. Descriptive statistics of mean, maximum, and minimum values for soil types in combinations with land use were calculated.

Results and discussion

The results totalizing 934 data of K_s and 24 data of SIR (Bernardes, 2005; Bhering 2007; Duarte, 2004; Fabian, 1997; Instituto do Açúcar e do Álcool, 2011; Nacinovic, 2013; Silva, 2011). The county of Campos dos Goytacazes does have probably the largest Ks and SIR data base in Brazil. The most frequent soil types evaluated were Gleissolos (26%) followed by Neossolos (26 %) and Cambissolos (22%). Agriculture and pastures were the land uses systems more evaluated for SIR and K_s in Rio de Janeiro (Figure 1)

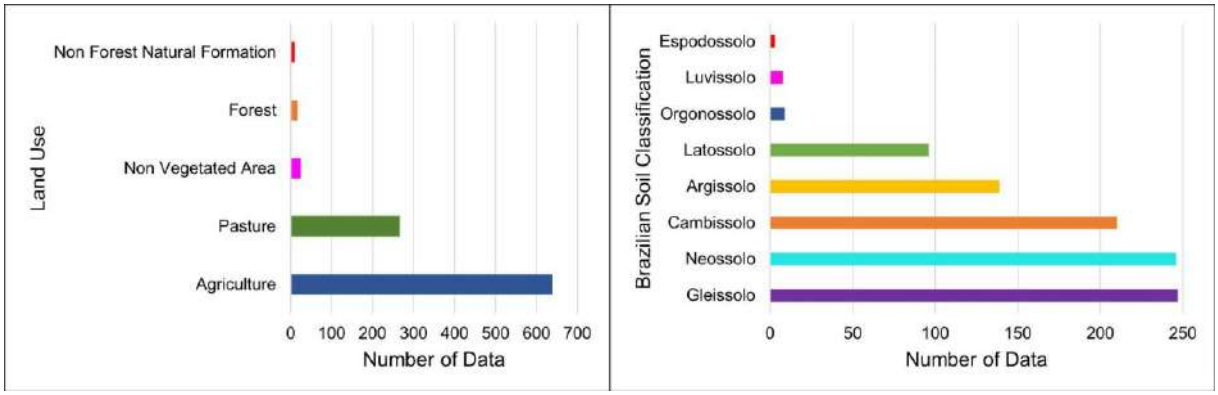

Figure 1 - Number of available data of Saturated Hydraulic Conductivity (K_s) or Steady Infiltration Rate (SIR) for different soil type and land uses in the State of Rio de Janeiro - Brazil.

The most frequent method to evaluate de K_s was the constant head soil core for lab and well permeameters (i.e Guelph permeameter) for field evaluations. To evaluate the SIR, in a total of 24 data, the most frequently method was the double ring. The

highest K_s value was 1073 mm h^{-1} measured in a Neossolo and lowest values (0,4 mm h^{-1}) in a Neossolos and Latossolo covered with pastures. Espodossolos show the minimum value of K_s 249 mm h^{-1}. The K_s values > 500 mm h^{-1} repeated in soil types were a consequence of the maximum rate of the method used. The SIR evaluations were also concentrated in Gleissolos and Argissolos. The lowest values 1 mm h^{-1} G were measured in Gleissolos covered by pastures. However, Gleissolos also showed a SIR of 114 mm/h with an average of 140 mm/h (Table 1).

Conclusions

The State of Rio de Janeiro has more than 900 measurements available for K_s or SIR. However, the most part of the data are concentrated in Gleissolos and Neossolos in the north part of the state near the cost. The soil covered by original Atlantic Forest is poorly measured. The most popular methods for K_s measurements were constant head soil core and well permeameters in the field. The K_s and SIR are valuable data for many applications. This rescue of dispersed data may be useful for many projects. The lack of information about hydraulic information in some regions or soil may indicate priority areas for evaluations. This soil database will be available together with the data from other states of Brazil in a public data bank.

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Table 1 - Descriptive statistics of saturated hydraulic conductivity (K_s) and steady infiltration rate (SIR) for different soil types and land used in the state of Rio de Janeiro.

Soil Type	Land Use	K_s [mm h^{-1}]			SIR [mm h^{-1}]		
SiBCs	Mapbiomas		average	maximum	minimum	average	maximum
Gleissolo	Agriculture	1	29	>500	7	140	338
	Pasture	1	38	>500	1	57	114
	Non forest	2	39	161	-	-	-
Neossolo	Agriculture	1	156	1073	-	-	-
	Pasture	0,4	403	>500	-	-	-
	[1]Non forest	1	9	31	-	-	-
Cambissolo	Agriculture	1	42	748	-	-	-
	Pasture	1	23	>500	-	-	-
Argissolo	Agriculture	3	131	>500	17	48	83
	Pasture	2	117	819	-	-	-
	Non forest	1	8	30	-	-	-
Latossolo	Agriculture	38	113	226	-	-	-
	Pasture	0,4	27	177	-	-	-
	Forest	17	316	998	-	-	-
Organossolo	Agriculture	12	67	152	-	-	-
	Pasture	44	66	88	98	98	98
Luvissolo	Pasture	-	-	-	12	74	180
Espodossolo	Agriculture	249	416	>500	-	-	-

1 - Non forest natural vegetation (Mapbiomas classification system. SiBCS – Sistema Brasileiro de Classificação de Solos.