15 **ACCURACY AND VARIABILITY OF RUNOFF SAMPLING METHODS**

16 **ABSTRACT**

17 The method used to obtain runoff samples in soil erosion monitoring studies is an important

18 source of data variability. In this study, we evaluated the manual sampling method used in

19 Brazil. We present as an alternative the prototype of a sample splitter for suspensions with

20 high concentration of total solids. Using soil material with 583 g kg^{-1} of sand and 89 g kg^{-1} of

21 clay, the manual method and the sample splitter were tested for their ability to produce

22 representative samples of suspensions with a concentration of 2, 10 and 50 g L^{-1} of total

23 solids. An underestimation of 30% or more of the concentration of total solids was observed

24 using the manual method, with a variation of the same magnitude (CV between 20 and 45%).

25 The splitter was efficient in producing samples representative of the suspension – even

26 without altering the particle size distribution of the total solids. Both absolute percentage

27 errors (|<5%|) and the variation between replicates (CV <3%) were small. The problems with

28 the manual method are due to the inefficient homogenization that facilitates the differential

29 sedimentation of the particles of different sizes. If these problems are also found in other

30 studies, then the prototype that we developed is a reasonable alternative.

31 **Keywords:** Erosion monitoring, Soil loss, Sandy soil, Sample splitter, Uncertainty.

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2

INTRODUCTION

Soil erosion is one of the major concerns of soil scientists (Panagos et al., 2017). Proof of this

are the many soil erosion monitoring plots distributed around the globe (Anache et al., 2017;

García-Ruiz et al., 2015). One of the main difficulties encountered in soil erosion research is

the great variability of the data, which results from the diversity of methods and monitoring

strategies employed (Boix-Fayos et al., 2006; García-Ruiz et al., 2015; Nearing et al., 1999;

Poesen, 2018). Lack of resources for monitoring longer than 5-10 years to obtain more

consistent data is also detrimental (Anache et al., 2017). The greater the variability of the

data, the greater our uncertainty about the magnitude of soil losses (García-Ruiz et al., 2015).

An important source of variation in soil loss data is the method of sampling the runoff

collected in erosion plots (Kinnell, 2016). A runoff sample should be as representative as

possible of reality. This requires the collected runoff be perfectly homogenized. Such

homogeneity is difficult to achieve when particles of different sizes and densities are present

in the sediment (Ciesiolka et al., 2006; Kinnell, 2016; Todisco et al., 2012). Previous studies

suggested that manual sampling methods are among those that suffer the most from this

problem, commonly resulting in underestimates of soil losses (Ciesiolka et al., 2006; Lang,

1992; Zöbisch et al., 1996). For this reason, more elaborate sampling methods were proposed

(Todisco et al., 2012). But they still require the suspension to be homogenized beforehand.

An alternative is to use sample splitters such as the cone and churn splitters, widely used for

sampling suspensions with low concentration of total solids (Capel et al., 1995; Horowitz et

al., 2001). Sample splitters produce samples with constitution very similar to the original

suspension without human intervention.

Erosion monitoring studies in Brazil indicate that soil losses range from 0.1 to 136 Mg ha^{-1}

year^{-1} (Anache et al., 2017). For sandy soil, soil losses can easily reach over 150 Mg ha^{-1}

year^{-1} (Lanzanova et al., 2013). However, since a large part of the Brazilian estimates is

58   based on the use of a manual sampling method (Amado et al., 2002; Cardoso et al., 2012;

59   Corrêa et al., 2016; Eltz et al., 2001; Silva et al., 2005; Tengberg et al., 1997; Veiga and

60   Wildner, 1993; Volk and Cogo, 2009), it is possible that soil losses are even greater.

61   The objective of this study is twofold. First, to evaluate if the manual method of runoff

62   sampling used in Brazil underestimates soil losses and quantify the magnitude of this

63   underestimate. Second, to develop and test a prototype sample splitter that can be used with

64   suspensions with high concentration of total solids collected in erosion monitoring plots.

MATERIALS AND METHODS

Soil material

67   The two sample splitting methods – manual and splitter – were evaluated in a controlled

68   laboratory experiment using suspensions, composed of distilled water and fine soil material,

69   created to simulate runoff samples. The soil material was collected from the upper part (0–20

70   cm depth) of the A horizon of a soil profile derived from sedimentary rocks of the Santa

71   Maria Formation. Located at -29°42'47.01"N and -53°42'43.36"E, 90 m a.s.l., the profile had

72   no apparent anthropic use, and was classified as an Argissolo Vermelho-Amarelo Distrófico

73   típico in the Brazilian classification and as a Rhodic Acrisol in the international classification.

74   With an A-E-Bt-C horizon sequence, the clay content is very low in the topsoil and increases

75   considerably with depth, with a direct effect on the soil bulk density and porosity. The low

76   content of basic cations, phosphorus and organic matter reflect the small availability of plant

77   nutrients in the soil parent material (Tables 1 and 2) – the analytic data are available in the

78   Free Brazilian Repository for Open Soil Data (febr, www.ufsm.br/febr), dataset ctb0013.

79   Similar characteristics are found in the topsoil of a large portion of the Central Depression

80   region of the Rio Grande do Sul state (Figure 1), having been the target of many erosion

81   monitoring studies (Amado et al., 2002; Cogo et al., 1984; Eltz et al., 2001; Volk and Cogo,

82   2009).

83   The collected soil material was air-dried, crushed and passed through a 2-mm sieve. The

84   particle size distribution of the resulting fine soil material was determined using three

85   samples of about 20 g each. The total clay content (<0.002 mm diameter) was determined via

86   the pipette method after chemical dispersion and mechanical disintegration. The first was

87   achieved using 1 mol L^{-1} sodium hydroxide (NaOH). The latter consisted of horizontal

88   stirring for 4 hours at 120 cycles per minute in the presence of two nylon spheres (diameter:

89   1.71 cm; mass: 3.04 g; density 1.11 g cm^{-1}). The total sand content (0.053–2.00 mm

90   diameter) was determined via wet sieving. The total silt (0.002–0.053 mm diameter) content

91   was determined by difference. According to these analyzes, the particle size distribution of

92   the fine soil material (0–20 cm) consists of 583 g kg^{-1} of total sand, 89 g kg^{-1} of total sand,

93   and 328 g kg^{-1} of total silt.

94   **Manual sampling method**

95   The first experiment carried out aimed at assessing the efficiency of the manual method, that

96   is, its ability to produce representative samples of the artificial suspensions (runoff). The

97   samples were expected to have a concentration of total solids (sediment) approximately

98   equivalent to that of the suspension from which they were obtained. Three concentrations of

99   total solids were used: 2, 10 and 50 g L^{-1}. They were prepared by adding the necessary mass

100 of fine soil material to 3 L of distilled water in 10 L plastic containers (buckets), that is, 6, 30,

101 and 150 g, respectively. Five buckets (replicates) were prepared for each concentration. In

102 each bucket, one person homogenized/stirred the suspension with one hand. After 10

103 seconds, without stopping the homogenization, another person collected a sample by

104 immersing a 250 mL beaker into the suspension. The concentration of total solids in the

105 samples of each suspension was determined as a function of the sample volume and the mass

106 of total solids measured after oven drying at 105 °C until complete evaporation of the water.

107   The five samples from each of the three artificial suspensions were summarized by

108   computing the mean, standard deviation, and coefficient of variation. The estimation error, e_{ij},

109   was computed as the difference between the concentration of total solids in a suspension j as

110   estimated by a sample i, $\hat{y}_{ij}$, and the true concentration, y_j, that is,

111    $e_{ij} = \hat{y}_{ij} - y_j$

112   where $i = 1, 2, \ldots, n$, with $n = 5$, and j is one of the three artificial suspensions. The percent

113   mean estimation error (pME), defined as the percentage magnitude of the estimation error in

114   relation to the true concentration in a suspension j, was calculated with

115
$$\mathrm{pME}_j = \sum_{i=1}^{n=5} e_{ij}/y_j \times 100$$

116   Finally, the estimation errors were submitted to a one sample, two-tailed t-test to test if its

117   mean was equal to zero (H_0: $\mu = 0$) or, alternatively, less or greater than zero (H_1: $\mu \neq 0$). The

118   t-statistic was given by

119
$$t_j = \frac{e_j}{s_j\sqrt{5}}$$

120   where s_j is the sample standard deviation of the estimation error. The exact p-value of the t-

121   test was obtained from the Student's t cumulative distribution function (CDF) with $n - 1$

122   degree of freedom.

123   **Sample splitter method**

124   The prototype sample splitter was constructed with polyvinyl chloride (PVC) and wooden

125   parts (Figure 2). It is composed of a suspension reservoir, located on the upper part, which

126   consists of a 300-mm long, 75-mm diameter PVC plastic pipe with a maximum net capacity

127   of 1 L of suspension. The bottom of the reservoir consists of a PVC internal domed end cap.

128   A 15-mm diameter hole was drilled on the center of the cap to connect a 300-mm long, 15-

129   mm diameter PVC plastic pipe. The dome shaped end cap helps directing the reservoir

130   suspension to the smaller diameter pipe connected to the lower end. The function of this

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131   smaller diameter pipe is to direct the suspension in a continuous and concentrated flow to the

132   splitting device, a Y-connector placed at its lower end. All parts are glued to each other using

133   PVC-specific adhesive material. Since the splitter has two outlets, A and B, it produces two

134   samples of the suspension at each splitting operation. Finally, the PVC parts were fixated on

135   a wooden platform, leveled with both horizontal and vertical planes. The investment made to

136   build the splitter was about 40 US dollars.

137   The sample splitter method was submitted to three tests. The first test aimed at evaluating if

138   the volume of the suspension affects the performance of the splitter, specifically, its capacity

139   to produce pairs of samples with approximately equivalent volumes. Four volumes of

140   distilled water were evaluate – 100, 300, 500, and 1000 mL – using five replicates. At each

141   repetition, the total volume of distilled water was poured into the splitter's reservoir at one

142   time. The two resulting samples, A and B, were collected in beakers and their volume

143   determined using calibrated graduated cylinders. The estimation error and its ratio to the true

144   value (half of the total volume of distilled water), both defined above, were calculated for

145   both samples. Estimation errors were submitted to the one sample, two-tailed t-test as

146   described for the manual method. In addition, the estimation errors of outlets A and B were

147   tested for equality using the paired samples, two-tailed t-test. The t-statistic was given by

$$t_j = \frac{\bar{d_j}}{s_{dj}\sqrt{5}}$$

148

149   where d_j is the mean of differences between estimation errors of outlets A and B, s_{dj} is the

150   sample standard deviation of the differences, and j is one of the four volumes tested.

151   The second test to which the splitter method was submitted was the same applied to the

152   manual method, that is, regarding its ability to produce a representative sample of a

153   suspension. The same concentrations used to evaluate the manual method were employed,

154   also with five replicates each. The artificial suspensions were prepared in 500-mL plastic

155   containers. After vigorous shaking for 10 seconds, each suspension was poured into the

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156   splitter's reservoir at one time and both samples, A and B, collected in 250-mL beakers. The

157   splitter was washed with distilled water after each repetition. The concentration of total solids

158   in the samples was determined as described for the manual method. The estimation errors

159   were submitted to one and paired samples, two-tailed t-tests as above.

160   Finally, the total solids contained in the samples produced by outlets A and B of the splitter

161   were analyzed for particle size distribution. The same method used for the analysis of the soil

162   material employed to produce the suspensions was used. The aim of this test was to evaluate

163   the capacity of the splitter to produce samples where the total solids have a size distribution

164   approximately equivalent to that observed in the total solids of the suspension. The one and

165   paired samples, two-tailed t-tests were used to evaluate the estimation errors of the clay and

166   sand content.

167   **RESULTS AND DISCUSSION**

168   **Manual sampling method**

169   The test performed with the manual runoff sampling method showed that the resulting

170   samples were not representative of the artificial suspensions used (Table 3). A statistically

171   significant underestimate of 30% or more of the concentration of total solids was observed

172   for all three suspensions evaluated (2, 10 and 50 g L^{-1}). In addition, we observed a somewhat

173   large variation among the five replicates. These empirical findings corroborate the initial

174   hypothesis of the present study – raised from the reports presented in similar works

175   developed in other parts of the world (Ciesiolka et al., 2006; Kinnell, 2016; Lang, 1992;

176   Todisco et al., 2012; Zöbisch et al., 1996) – that the manual runoff sampling method used in

177   Brazil is inconsistent and inefficient.

178   Our findings suggest that the annual soil losses in areas of southern Brazil with coarse texture

179   soil – < 100 g kg^{-1} of clay and > 500 g kg^{-1} of sand – could be up to 30% higher than the

180   values reported in the literature. For example, according to Lanzanova et al. (2013), a

181   standard (bare) soil erosion monitoring plot (width = 3.5 m, length = 22 m, slope = 0.055 m

182   m^{-1}) located near the place where we collected the soil material for this study lost about 2.5

183   Gg ha^{-1} of soil in 16 years. Based on the results of our study, the most likely amount of soil

184   lost in this plot could be 3.6 Gg ha^{-1}. However, attention must be paid to the fact that our

185   results are based on one-person sampling. Zöbisch et al. (1996) evaluated five experienced

186   professionals and observed estimation errors between 5 and 83%. This means that our tests

187   need to be repeated by others to produce more representative results – although the variation

188   observed by Zöbisch et al. (1996) agrees with our results.

189   **Sample splitter method**

190   The results of the first test performed with the prototype sample splitter showed that its

191   efficiency is not affected by the volume of water (Table 4). Both outlets A and B produced

192   samples with similar volumes. However, the splitting process seems to become less efficient

193   as the volume of water decreased. The largest errors were observed when the volume of water

194   was 100 mL, possibly due to the swirling effect of the water inside the 15-mm diameter PVC

195   plastic pipe connected to the lower end of the reservoir. The function of this pipe is to direct

196   the water in a continuous and concentrated flow to the splitting device (Y-connector).

197   Apparently this objective was only attained when the volume of water was greater than 100

198   mL. Thus, it is reasonable to recommend that the sample splitter be used only with

199   suspensions of volume greater than 250-300 mL.

200   The prototype sample splitter was efficient at producing representative samples at both

201   outlets A and B for all three artificial suspensions tested – 2, 10 and 50 g L^{-1} of total solids

202   (Table 5). Compared to the manual sampling method, the absolute errors were considerably

203   small (pME < |5%|), as well as the variation between the repetitions (CV < 3%). The

204   occurrence of a consistent trend of negative estimation errors, indicated even by the t-test

205   statistic, means that it is possible to correct the estimated concentration of total solid with a

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206 high degree of confidence. In addition, this underestimation can be avoided or minimized by

207 adopting additional care during the splitting operation. We observed that, during pouring of

208 the suspension into the splitter's reservoir, larger diameter particles (sand) tend to remain

209 inside the container where the suspension was stored. To avoid or minimize this loss of

210 particles it is necessary to vigorously shake the container and pour the suspension rapidly into

211 the reservoir. An additional practice is to wash the container using a known volume of

212 distilled water and then pour the new suspension into the splitter.

213 Samples produced by the splitter also were representative of the artificial suspensions tested

214 in terms of sand content (Table 6). This occurred regardless of the splitter's outlet. The

215 exception was for the artificial suspension with the lowest concentration of total solids, 2 g L^{-1}

216 , for which the estimation error was deemed too large. For all the five replicates, on average,

217 the sand content was underestimated by about 50%. We note, however, that this

218 underestimation was not due to the sample splitting process itself. It resulted from the issue

219 reported above, that is, particles of larger diameter tend to remain inside the container where

220 the suspension was stored. This loss of larger particles results in the underestimation of the

221 sand content.

222 The estimation errors of the clay content in the samples of both outlets were considerably

223 larger than those for the sand content (Table 7). Errors were especially large for the artificial

224 suspension with 2.00 g L^{-1} of total solids. This occurred because, for the soil material used,

225 the quantity of clay in the resulting samples was inferior to the detection limit of the

226 analytical method used. When the concentration of total solids was higher (10 and 50 g L^{-1}),

227 the percentage estimation error was lower, its significance decreasing as the concentration of

228 total solids increased.

229 **CONCLUSION**

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230   The tests we performed showed that the manual runoff sampling method used in Brazil is

231   unsuitable for the sampling of suspensions containing total solids with prevalence of coarse

232   particles (sand). In addition to underestimating the concentration of total solids, there is a

233   large variation in the estimated values. This means that the sampling method constitutes an

234   important source of variation in the results of soil erosion monitoring studies. This variation

235   adds to the uncertainty coming from other sources already described in the literature on the

236   subject. Our recommendation is that our experiment be reproduced by other research groups,

237   since the results may be affected by the person responsible for sampling the suspension. Also,

238   we recommend that experiments using different types of soil material – in terms of particle

239   size distribution – be carried out so that an equation can be computed to correct soil loss

240   estimates.

241   The prototype sample splitter that we developed proved to be efficient in producing samples

242   from artificial suspension with different concentrations of total solids without changing the

243   particle size distribution. This efficiency was clear and consistent mainly for suspension

244   volumes above 250-300 mL and concentrations of total solids greater than 2 g L^{-1}. Thus, if

245   the problems that we identify in the manual sampling method are also found by other

246   research groups, the prototype we developed is presented as a reasonable alternative.

247   However, further assessments of the sample splitter should be performed using a wider range

248   of concentrations of total solids and particle size distributions.

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332   **FIGURES**

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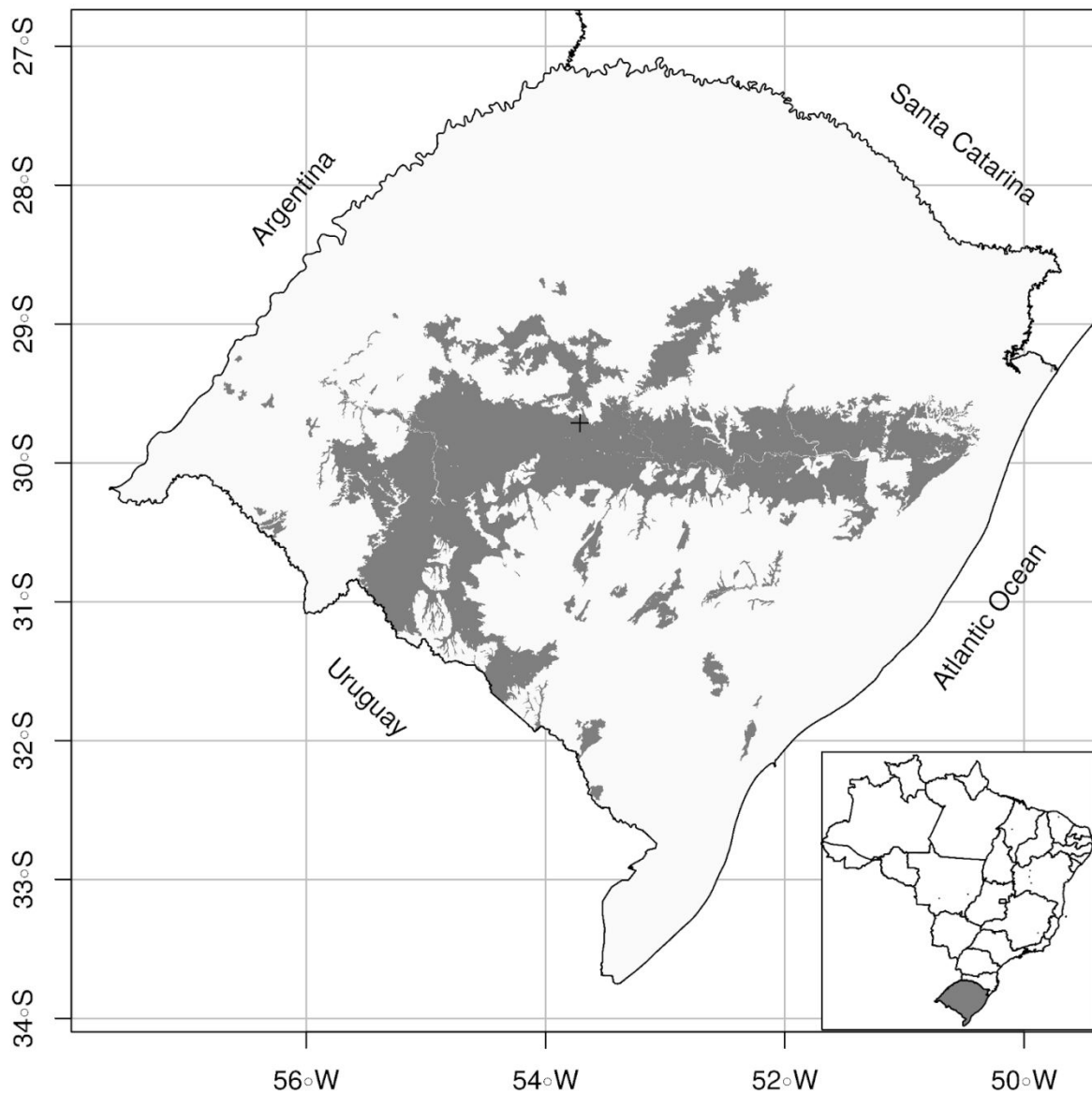
334
335   Figure 1: Area of the state of Rio Grande do Sul with a superficial soil layer similar in texture

336   to the soil material used in this study. The cross near the center of the state indicates the

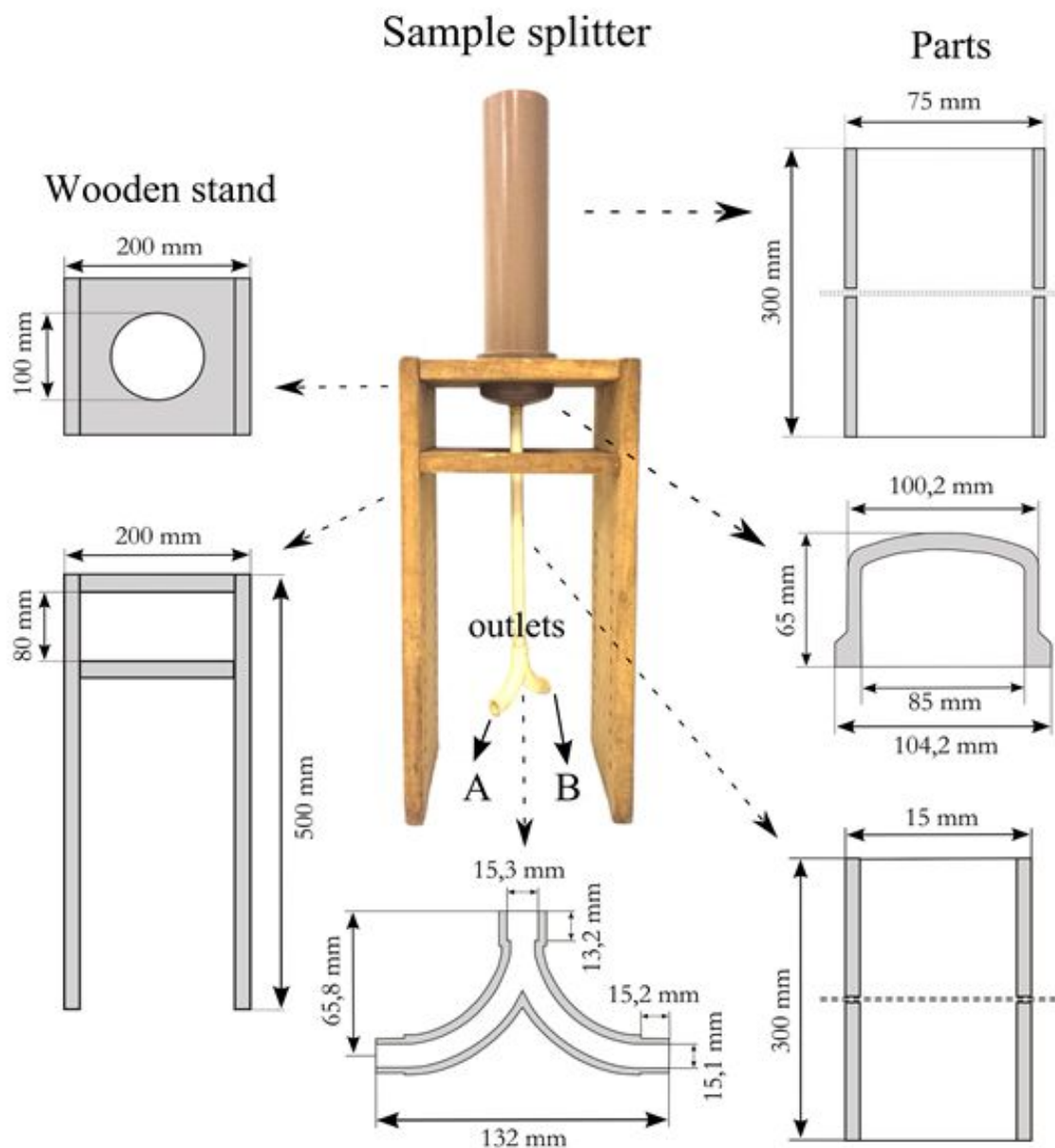337   location where the soil material was collected.

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340 Figure 2: Prototype sample splitter compared to the manual method. The constituent PVC and

341 wooden parts and their dimensions (unscaled) are shown in detail.

342   **TABLES**

343

344   Table 1: Physical properties of the soil profile horizons.

Horizon	Bounds	Coarse sand	Fine sand	Clay	Bulk density	Particle density	Macro-porosity	Micro-porosity
	cm	--------- g kg^{-1} ---------			------- g cm^{-3} -------		------ m^3 m^{-3} --------	
A	0-40	140	441	73	1,41	2,65	0,215	0,25
E	40-60	108	414	70	1,68	2,63	0,133	0,23
Bt	60-90	80	307	262	1,65	2,69	0,060	0,33
C	90-120	60	298	282	1,55	2,76	0,040	0,40

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348   Table 2: Chemical properties of the soil profile horizons.

Horizon	Bounds	pH	Ca^{2+}	Mg^{2+}	K$^+$	H+Al	P$_2$O$_5$	Organic matter
	cm	-	----------------- cmol$_c$ kg^{-1} -----------------				mg L^{-1}	g kg^{-1}
A	0-40	4,6	2,00	0,35	0,05	2,20	1,5	12
E	40-60	4,5	1,90	0,25	0,07	1,37	0,7	6
Bt	60-90	4,6	2,85	0,80	0,04	2,51	0,7	4
C	90-120	4,7	2,35	1,50	0,05	2,56	0,7	3

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Table 3: Concentration of total solids in five samples obtained using the manual sampling method from three artificial suspensions with a known concentration of total solids of 2, 10 and 50 g L^{-1}. Statistics: SD – standard deviation, CV – coefficient of variation, pME – percentage mean estimation error, t_1 – one-sample t-test statistic, p_1 – p-value of the t_1-test.

	2 g L^{-1}	10 g L^{-1}	50 g L^{-1}
1	1,1600	4,0600	25,5500
2	1,1800	6,6800	58,6500
3	1,3600	4,8100	44,7300
4	2,0100	4,2600	32,3600
5	0,9800	4,6200	16,9800
Mean (g L^{-1})	1,3400	4,8900	35,6500
SD (g L^{-1})	0,4000	1,0500	16,3800
CV (%)	29,8200	21,3900	45,9300
pME (%)	-33,1000	-51,1400	-28,6900
t_1	-3,7097	-10,9415	-1,9587
p_1	0,0207	0,0004	0,1217

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Table 4: Volume of the five samples produced by outlets A and B of the sample splitter for initial volumes of 100, 300, 500 and 1000 mL. Statistics: SD – standard deviation, CV – coefficient of variation, pME – percentage mean estimation error, t_1 and t_2 – one and two-sample t-test statistic, p_1 and p_2 – p-value of the t_1 and t_2-test.

	100 mL A	100 mL B	300 mL A	300 mL B	500 mL A	500 mL B	1000 mL A	1000 mL B
1	48,00	50,00	155,00	145,00	245,00	254,00	507,00	484,50
2	44,00	54,00	144,00	156,00	261,00	239,00	457,00	534,50
3	47,00	51,50	153,00	146,00	248,50	251,00	492,50	498,00
4	45,50	53,00	150,00	150,00	256,00	244,00	512,50	477,50
5	42,00	57,00	146,00	154,00	249,50	250,00	525,50	464,00
Mean (mL)	45,30	53,10	149,60	150,20	252,00	247,60	498,90	491,70
SD (mL)	2,39	2,66	4,62	4,82	6,41	6,02	26,24	26,89
CV (%)	5,27	5,00	3,09	3,21	2,54	2,43	5,26	5,47
pME (%)	-9,40	6,20	-0,27	0,13	0,80	-0,96	-0,22	-1,66
t_1	-4,4020	2,6110	-0,1940	0,0930	0,6970	-0,8910	-0,0940	-0,690
p_1	0,0117	0,0594	0,8558	0,9305	0,5240	0,4234	0,9298	0,528
t_2	-3,4660		-0,1420		0,7910		0,3030	
p_2	0,0257		0,8937		0,4732		0,7770	

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Table 5: Concentration of total solids in five samples obtained using the prototype sample splitter from three artificial suspensions with a known concentration of total solids of 2, 10 and 50 g L^{-1}. Statistics: SD – standard deviation, CV – coefficient of variation, pME – percentage mean estimation error, t_1 and t_2 – one and two-sample t-test statistic, p_1 and p_2 – p-value of the t_1 and t_2-test.

	2 g L^{-1} A	2 g L^{-1} B	10 g L^{-1} A	10 g L^{-1} B	50 g L^{-1} A	50 g L^{-1} B
1	1,97	1,98	9,99	9,99	48,52	47,84
2	1,99	2,01	9,75	9,82	49,43	48,72
3	1,95	1,93	9,90	9,71	49,57	48,59
4	2,03	1,91	9,84	9,70	50,40	48,11
5	2,01	1,96	9,96	9,90	49,61	49,39
Mean (g L^{-1})	1,99	1,96	9,89	9,82	49,51	48,53
SD (g L^{-1})	0,03	0,04	0,10	0,12	0,67	0,60
CV (%)	1,59	2,02	0,97	1,26	1,35	1,23
pME (%)	-0,50	-2,10	-1,12	-1,76	-0,99	-2,94
t_1	-0,7070	-2,3700	-2,6010	-3,1680	-1,6500	-5,4940
p_1	0,5185	0,0768	0,0600	0,0339	0,1742	0,0053
t_2	1,2710		1,3690		2,7850	
p_2	0,2727		0,2429		0,0496	

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Table 6: Sand content in the total solids of five samples obtained using the prototype sample splitter from three artificial suspensions with a known concentration of total solids of 2, 10 and 50 g L^{-1}. Statistics: SD – standard deviation, CV – coefficient of variation, pME – percentage mean estimation error, t_1 and t_2 – one and two-sample t-test statistic, p_1 and p_2 – p-value of the t_1 and t_2-test.

	2 g kg^{-1} A	2 g kg^{-1} B	10 g kg^{-1} A	10 g kg^{-1} B	50 g kg^{-1} A	50 g kg^{-1} B
1	342	299	550	515	523	580
2	367	268	515	575	588	592
3	320	327	577	534	593	579
4	316	293	538	574	590	606
5	294	311	585	525	597	576
Mean (g kg^{-1})	327,57	299,68	553,35	544,53	578,18	586,60
SD (g kg^{-1})	27,68	21,99	28,65	28,10	31,11	12,35
CV (%)	8,45	7,34	5,18	5,16	5,38	2,11
pME (%)	-43,81	-48,60	-5,09	-6,60	-0,83	0,62
t_1	-20,6350	-28,8150	-2,3140	-3,0610	-0,3470	0,6510
p_1	0,0000	0,0000	0,0816	0,0376	0,7464	0,5506
t_2	1,3460		0,3730		-0,6030	
p_2	0,2497		0,7281		0,5791	

Table 7: Clay content in the total solids of five samples obtained using the prototype sample splitter from three artificial suspensions with a known concentration of total solids of 10 and 50 g L^{-1}. Statistics: SD – standard deviation, CV – coefficient of variation, pME – percentage mean estimation error, t_1 and t_2 – one and two-sample t-test statistic, p_1 and p_2 – p-value of the t_1 and t_2-test.

	10 g kg^{-1} A	10 g kg^{-1} B	50 g kg^{-1} A		50 g kg^{-1} B
1	68	78	87		93
2	72	60	90		94
3	60	91	91		89
4	84	60	92		78
5	83	83	83		85
Mean (g kg^{-1})	73,39	74,47	88,77		87,90
SD (g kg^{-1})	10,25	13,92	3,57		6,57
CV (%)	13,96	18,69	4,02		7,47
pME (%)	-17,54	-16,32	-0,2600		-1,2300
t_1	-3,4080	-2,3330	-0,1470		-0,3730
p_1	0,0271	0,0799	0,8904		0,7279
t_2		-0,1150		0,2460	
p_2		0,9138		0,8178	

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