Available online at www.sciencedirect.com
ScienceDirect
Procedia Computer Science 98 (2016) 419 – 424
Procedia Computer Science

International Workshop on Data Mining on IoT Systems (DaMIS16)

Mining geostatistics to quantify the spatial variability of certain soil flow properties

Gerardo SEVERINO[a,*], Maddalena SCARFATO[a], Gerardo TORALDO[b]

[a]*Department of* Agricultural Sciences, *University of Naples* - Federico II, *via Università* 100, *Portici* (NA), I-80055, Italy
[b]*Department of* Mathematics and Applications, *University of Naples* - Federico II, *via Cintia* (Monte S. Angelo), *Naples*, I-80126, Italy

Abstract

The functional dependence of the relative *unsaturated hydraulic conductivity* (UHC) $K_r(\psi) \equiv \exp(\alpha\psi)$ upon the matric potential ψ, [L], via the soil-dependent parameter α, [L^{-1}], has been traditionally regarded as a deterministic process (i.e. $\alpha \sim$ constant). However, in the practical applications one is concerned with flow domains of large extents where α undergoes to significant spatial variations as consequence of the disordered soil's structure. To account for such a variability (hereafter also termed as "heterogeneity") we adopt the mining geostatistical approach, which regards α as a *random space function* (RSF). To quantify the heterogeneity of α, estimates of local-values were obtained from $\sim$ 100 locations along a trench where an internal drainage test was conducted. The analysis of the statistical moments of α demonstrates (in line with the current literature on the matter) that the log-transform $\zeta \equiv \ln\alpha$ can be regarded as a structureless, normally distributed, RSF. An novel implementation of the present study in the context of the "Internet of Things" (IoT) is outlined.

© 2016 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).
Peer-review under responsibility of the Program Chairs

Keywords: soil; relative hydraulic conductivity; heterogeneity; mining geostatistics

1. Introduction

The challenging and very difficult task to develop modelling of flow and transport in soils of large extents has been undertaken only in the last decades by using a mining geostatistical approach[1,2]. The use of data-mining methods is due to the difficulties into quantifying the spatial distribution of the soil flow properties[3,4,5]. However, while a considerable effort has been invested to quantify the heterogeneity of certain soil properties, such as the Darcy's permeability coefficient[6], a very limited information about the spatial distribution of the α-parameter (relating the matric potential to the UHC) is available. Indeed, there have been only a limited number of studies[7,8,9,10] focusing on the spatial variability of α, and nevertheless they suffer from many limitations, the most important of which is about the extreme difficulty to carry out precise *in situ* measurements (somewhat similar to the analysis of water waves distribution[11]). In view of such shortcomings, the present paper aims at showing how to use a data-mining

* Corresponding author. Tel.: +39-081-2539426; fax: +39-081-2539412
E-mail address: gerardo.severino@unina.it

1877-0509 © 2016 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).
Peer-review under responsibility of the Program Chairs
doi:10.1016/j.procs.2016.09.064

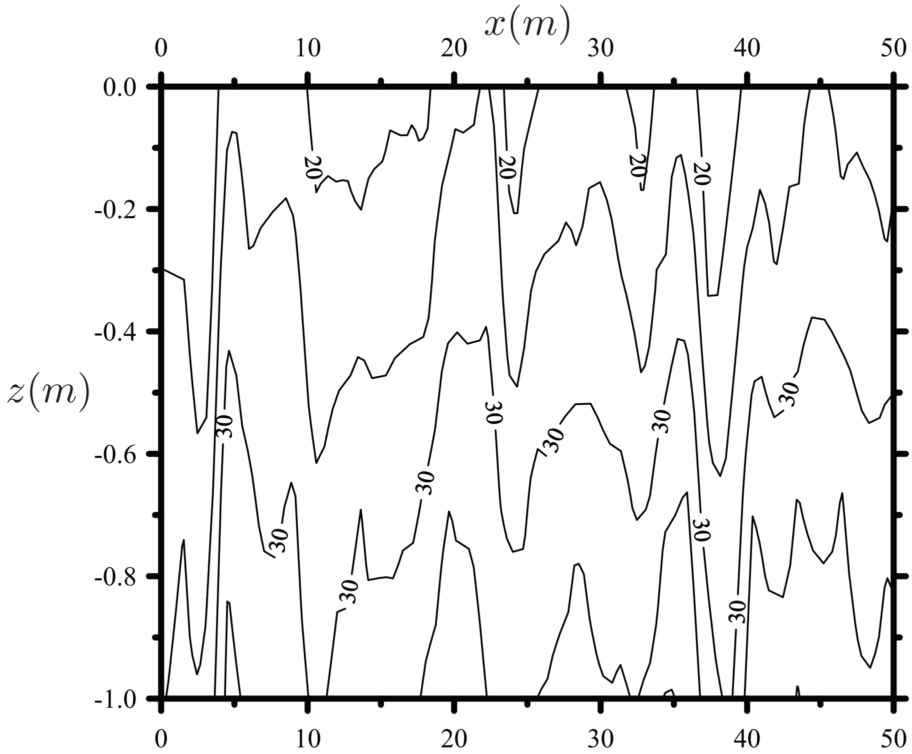

Figure 1. Distribution of the iso-values of λ_c (cm) along a vertical cross-section at the Ponticelli site (Naples, Italy); vertical exaggeration: 250/6.

(geostatistical) approach to quantify the spatial variability of the α-parameter. In addition, we believe that the present paper provides useful hints on how to combine devices/sensors and data in order to set up a compact web-tool (such as IoT) to gain quick analyses of complex (heterogeneous) environments, similarly to other studies concerning similar problems [12,11,13].

2. Characterization of the spatial variability of the α-parameter by means of the mining geostatistical approach: from theory to the practical use

The theoretical framework

The α-parameter is more than a curve-fitting number, since it is related to the soil's texture. Indeed, it has been demonstrated [8] that the characteristic length $\lambda_c \equiv \alpha^{-1}$, [L], is a measure of the importance of the capillary force relative to the gravitational one. More precisely, $\lambda_c \to 0$ implies that gravity dominates capillarity (coarse textured soils), and *viceversa* (fine textured soils). Since, the soil's texture is highly variable from point to point in the soil, a tantamount degree of variability is detected into the values taken by the α-parameter. This is clearly seen in the Figure 1 that shows the contour levels of λ_c (cm) along a vertical cross-section in a trench.

A detailed characterization of the spatial distribution of α (and more generally of any soil flow property) via the so-called "standard approach" (i.e. by collecting samples in the field and subsequently determining local values) requires: i) considerable time, and ii) great expense/effort, therefore rendering such an avenue practically impossible. A viable (and widely accepted) alternative is to treat α as a "stochastic process in the space" or equivalently a RSF [14,6]. As a consequence, characterization of the heterogeneity of α is cast within the more general approach of the data mining methods.

Download English Version:

https://daneshyari.com/en/article/4962067

Download Persian Version:

https://daneshyari.com/article/4962067

Daneshyari.com