C09

Influence of Physical Clogging on Infiltration and Groundwater Recharge

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1. Introduction and objectives:

Managing groundwater resources sustainably plays an important role to society and environment. In semi-arid and arid regions, groundwater is vital for the lives and livelihoods of most of the population. Recently its sustainability is threatened by the increasing demand, water stress in terms of both quantity and quality, and groundwater overexploitation together with climate change. Floodwater harvesting is employed to be used in groundwater recharge [GWR] and to overcome its overexploitation and mismanagement. Both recharge dams and recharge basins are few examples of the surface spreading techniques [SST] for GWR. Although SST shows initial high efficiency in recharging, it reduces its competence rapidly with time due to soil clogging. The soil clogging results from combinations between biological, chemical, physical[a], and/or mechanical clogging.

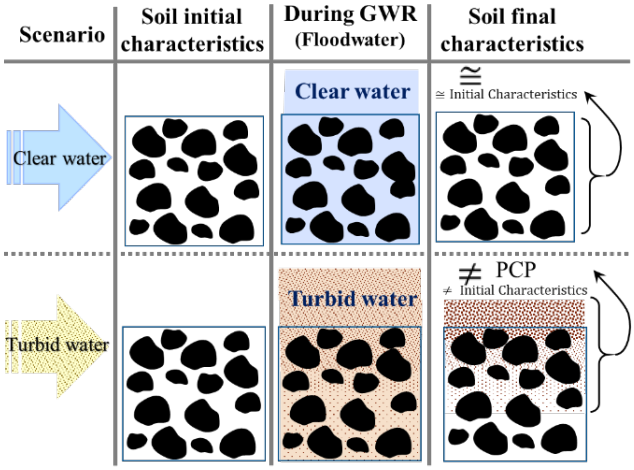

Fig. 1: conceptual diagram showing the difference between clear water and turbid water existence over soil and PCP occurrence.

Physical clogging phenomena; occurs when fine suspended particles in the harvested floodwater deposits inside the top most porous surface layer of the basins/streams bed [Furtherly referred in this paper as PCP] (Fig. 1). It causes huge reduction -around one to two order of magnitude [1] [2] in the infiltration rates, hydraulic conductivity and accordingly GWR.

This paper targets the following objectives: 1) understanding PCP occurrence; due to the existence of suspended sediments in the harvested floodwater, 2) identifying the factors affecting such phenomena, and 3) highlighting the influence of each factor and its significance.

2. Methods and techniques:

Achieving such objectives requires: (1) Data collection and archiving from previous studies regarding PCP in one-dimensional experiment[b]. (2) Quantitative comparative analysis [QCA] was held to evaluate the data collected for identifying the general,

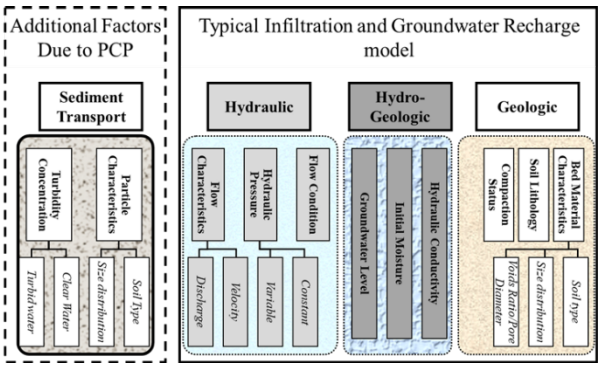

Fig. 2: Illustrative diagram showing factors affecting infiltration and GWR due to PCP.

[a] This paper focuses on Physical clogging since in ephemeral and semi-ephemeral streams other clogging types doesn't have much time to develop.

[b] In this paper the data from available one-dimensional experiments in field or in laboratory were collected and analyzed to reduce the factors influencing PCP and get initial understanding of the phenomena itself..

internal and external factors, and assessing data for limitation and validation.

3. Results and discussion:

This paper argues that the conventional methods regarding PCP managing in GWR using SST needs to be based on phenomena understanding and clear relations. From archiving and categorizing of collected data, factors were identified as shown in Fig. 2.

Not to mention, although many researchers concluded/stated the need of the further understanding [3] [4]; yet due to PCP complexity and conceal, majority of studies considered either: 1) PCP as a fact not as an output to monitor the change in the infiltration and GWR, 2) discussing specific factors which were chosen according to the need of each specific study, or 3) very special circumstances and conditions for the case studies which makes it difficult to be generalized.

Consequently, the first and the third objectives were very difficult to be achieved due to the lack in common data for QCA to be done. Fig. 3 is an example of QCA done for collected data [5] [3] [6] [4] showing the particle size ratio and the resultant clogging depth after PCP fully developed. The hydrostatic pressure head [H_p] was also considered in order to clarify the spatial randomness of the data. The data shows the direct impact of the H_p on the clogging depth for single SS/BM ratio. Although, some the relation between data could be realized as shown in blue. However, it also shows: 1) ambiguity in some other relations as shown in red, 2) dificulty in identifying relations and trends, and 3) scarcity and limitation of the data to validate any proposed hypothesis.

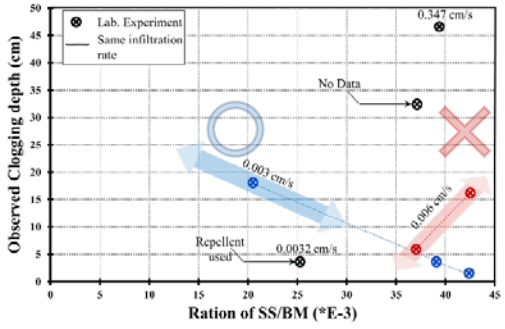

Fig. 3: Relation between ration of bed material particle size [BM] to suspended sediments particle size [SS] and clogging depth.

In order to overcome such problems, a one-dimensional experiment was proposed as shown in Fig. 4, to understand PCP as an output. Furthermore, scenarios matrix was designed and proposed as well to study the impact of each of the different factors on the PCP occurrence. The results from this experiment should cover some of the gaps in the trends and relations identification.

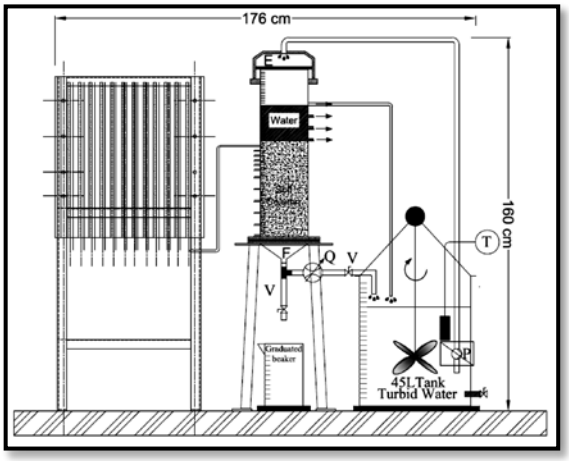

Fig. 4: Schematic diagram of the proposed experiment setup

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Keywords:

Physical clogging, Infiltration rate, Groundwater recharge, Hydraulic conductivity.

The work carried out through this paper is part of the PhD thesis research which aims: 1) to minimize the impacts of the physical clogging occurrence; due to the existence of suspended sediments in the harvested floodwater and 2) to hinder the change of the characteristics of the recharge basin.