Nature Environment and Pollution Technology
An International Quarterly Scientific Journal

ISSN: 0972-6268	Vol. 10	No. 2	pp. 247-250	2011

Original Research Paper

Differentiation of Natural Recharging Zones of Groundwater in Watersheds: A Simple Method

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Nat. Env. & Poll. Tech.
Website: www.neptjournal.com

Received: 19-7-2010
Accepted: 22-8-2010

Key Words:
Natural recharging sites
Groundwater
Water table
Mamam river basin
Watershed

ABSTRACT

The natural recharging of groundwater in any watershed is a key parameter on which many other components of the watersheds are depended on. Finding out of natural recharging zones of groundwater and their preservation is a prime requirement for maintaining the socio-ecological equilibrium, but such attempts were not been dealt seriously till now owing to the intricacy involved in it. Here, a simple technique is developed to find out the natural recharging zones of groundwater in a watershed. The depths to water table (below ground level) measured in a systematic network of observation wells just before the starting of the monsoon rainfall and just after the initiation of the monsoon spell (after the heavy downpour of the initial 2-3 weeks) are used to delineate the natural recharging zones. The zones, which act as the areas of natural recharge of groundwater should be conserved and no landscape alterations should be allowed in such zones. The present simple methodology, which is cost effective can be applied to any river basins/watersheds to delineate the natural recharging zones of groundwater.

INTRODUCTION

Globally, the withdrawal of freshwater from groundwater aquifers has increased by 400% between 1940 and 1990, due to increased population growth and expanded economic development activities (UNEP 2003). As a result, many local areas have begun to experience significant freshwater shortage problems. An estimate of United Nations reveals that by the year 2025, two third of humanity will face the shortage of freshwater. The rising population at an alarming rate and the irrational and indiscriminate large scale alterations of the landscapes are the challenging issues for the planners at present. To fulfil sustainable management of freshwater, there are few solutions such as, finding alternate or additional water resources or augmenting groundwater recharge by artificial methods. To date, much attention has been given to the first option and only limited attention has been given to optimizing groundwater recharging. But finding out of natural recharging zones of groundwater on a watershed/river basin basis should receive prime importance, since it can significantly related to the sustainable development of underground water resources. But such attempts were not undertaken seriously till now owing to the complexities associated with it. Delineation of such zones through which the groundwater system is getting recharged annually is considered as a difficult as well as an expensive task, and hence not received much attention till now. Here, a simple technique is developed to find out the natural recharging zones of groundwater in a watershed.

MATERIALS AND METHODS

The depths to water table (below ground level - bgl), measured in a systematic network of observation wells just before starting of the monsoon rainfall (end of May in South India) and just after the initiation of the monsoon spell (after the heavy downpour of the initial 2-3 weeks; end of June in South India), are used as the input data to delineate the natural recharging zones. The water levels of monsoon time (end of June) are subtracted from the water levels of pre-monsoon time (end of May). If the water level has come up immediately as a result of the rain, the subtracted value will be positive. If the difference is significant (say >1m), it indicates natural recharging at that site. Since the data have been taken just after the heavy downpour during the initial phase of the monsoon, the shallowing of water levels can be ascribed solely to the natural recharging of groundwater through the percolation of rain water at that place itself. Such an exercise has been done for the Mamam river basin and the adjoining watershed area.

STUDY AREA

Mamam river basin is a 5th order river basin draining through the Trivandrum district of Kerala State, India (Fig. 1). The total length of the main channel is 33.13 km and the total area of study comes to be 168.59 km^2. The major rock types found in the basin are Garnet Biotite Gneisses, Khondalites and Charnockites. One of the critical blocks of Kerala, the Chirayinkeezh block, situates at the lower reaches of the river basin (CGWB 2003, 2005) and hence, the present study was

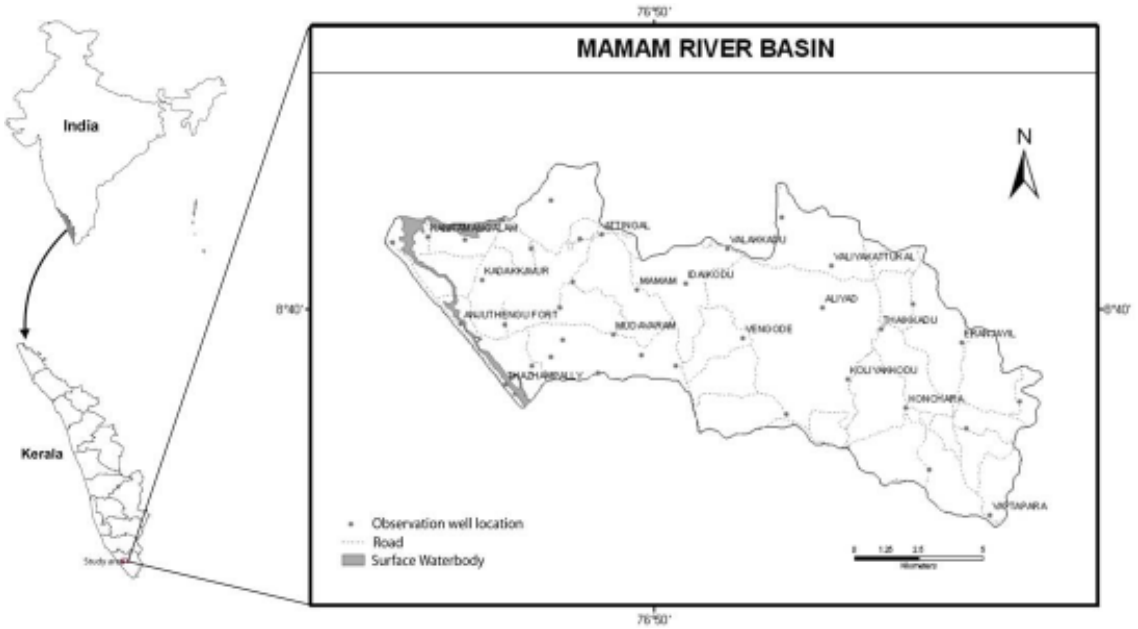

Fig. 1: Location of observation wells in Mamam river basin.

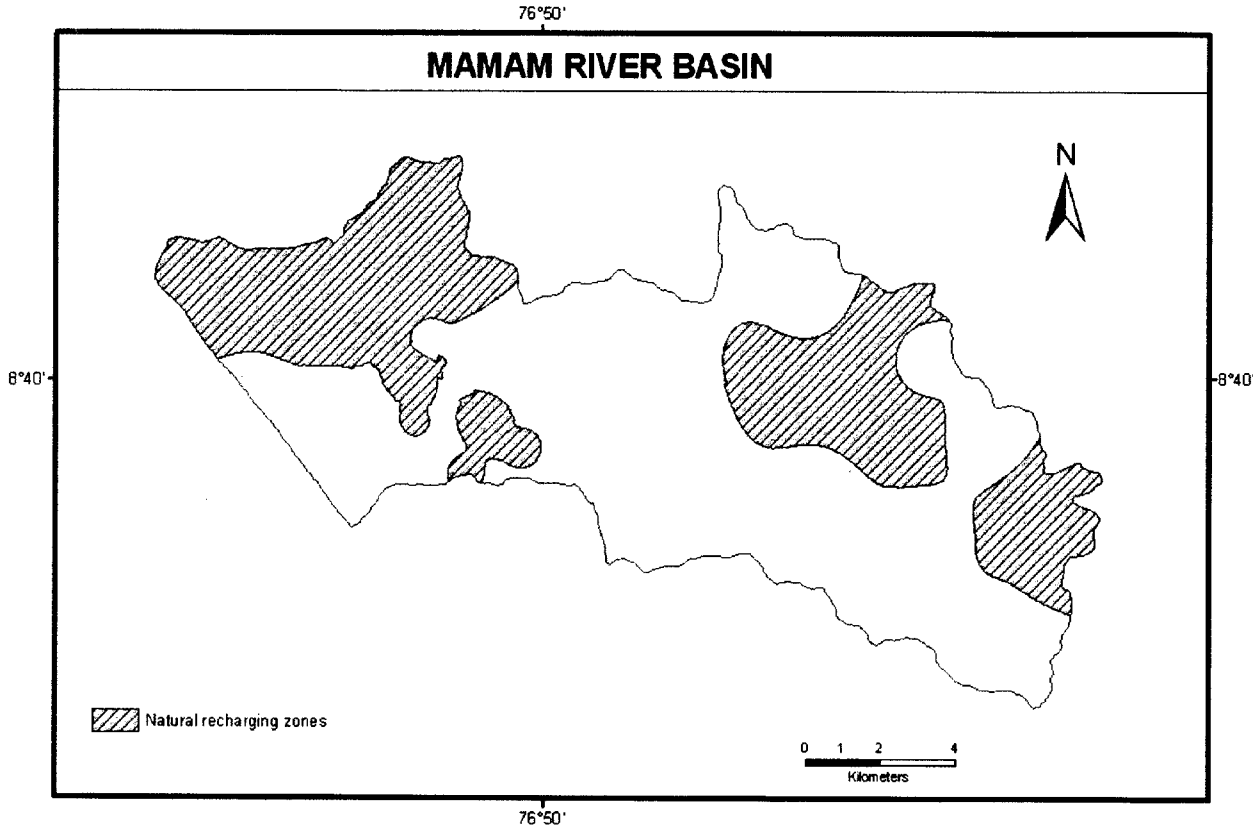

Fig. 2: Natural recharging zones of groundwater in the study area.

Table 1: Spatial and temporal variation of depth to water table below ground level (m).

Observation well number	Depth to water table below ground level (m)		Difference in water level (m)	Remarks
	May	June		
1	1.87	0.87	1	Natural Recharging site
2	1.86	3.82	-1.96	
3	1.78	1.45	0.33	
4	5.74	2.70	3.04	Natural Recharging site
5	4.31	3.48	0.83	
6	9.30	7.60	1.7	Natural Recharging site
7	3.96	5.30	-1.34	
8	10.14	4.93	5.21	Natural Recharging site
9	11.25	10.08	1.17	Natural Recharging site
10	7.67	5.22	2.45	Natural Recharging site
11	3.12	1.85	1.27	Natural Recharging site
12	5.99	4.90	1.09	Natural Recharging site
13	8.27	7.15	1.12	Natural Recharging site
14	7.83	6.50	1.33	Natural Recharging site
15	6.20	5.31	0.89	
16	9.66	9.00	0.66	
17	11.72	11.05	0.67	
18	8.02	5.70	2.32	Natural Recharging site
19	9.56	10.63	-1.07	
20	7.64	6.95	0.69	
21	7.83	6.85	0.98	
22	4.95	4.27	0.68	
23	9.67	9.80	-0.13	
24	11.01	10.75	0.26	
25	9.86	7.40	2.46	Natural Recharging site
26	7.90	7.50	0.40	
27	6.30	5.40	0.9	
28	5.26	2.09	3.17	Natural Recharging site
29	8.31	8.15	0.16	
30	11.96	11.63	0.33	
31	6.76	5.95	0.81	
32	6.65	6.05	0.6	
33	3.40	2.85	0.55	
34	10.20	9.17	1.03	Natural Recharging site
35	12.94	12.50	0.44	
36	5.24	3.15	2.09	Natural Recharging site
37	4.14	3.18	0.96	
38	7.86	6.75	1.11	Natural Recharging site

extended to the entire area of the block in addition to the Mamam basin.

DIFFERENTIATION OF NATURAL RECHARGING ZONES

Thirty eight open wells have been monitored for the present study and the measurements were made at the end of May and June months. The location of the observation wells is given in Fig. 1. The data collected from these observation wells during the two months are given in Table 1 along with the difference in water levels. The spatial variation of the difference in water levels is depicted in the Fig. 2 by plotting a contour of 1 m difference. The regions having a difference of more than 1m are depicted as natural recharging zones. It can be noted from the Fig. 2 that there are four such zones in the present study area, viz., Vakkom-Kadakkavur-Attingal stretch, a small portion lying in the Azhoor-Mangalapuram panchayaths, Nellanadu-Valiyakattukal-Koliyakodu stretch and the north-western portion of Vembayam panchayath. The Vakkom-Kadakkavur-Attingal stretch is characterized by the highest soil infiltration rate observed in the study area (Rajesh 2008) and also it posses the deepest soil column in the study area.

The zones, which act as the areas of natural recharge should be conserved and no landscape alterations should be attempted or allowed in such zones. Any untoward exercise will lead to the cessation of such zones as the natural recharging zones. In the present study area, the natural recharg-

ing zones witness many disparaging activities like the mining of sand from the river channels as well as from the land areas. The solid and liquid waste dumping site of Attingal Municipality is situated in one of the natural recharging sites (Rajesh 2008). Anomalous groundwater pH values were reported from the downstream sides of this dumping site (Rajesh et al. 2006) and it can be related to the dumping of urban wastes, especially the liquid waste in the natural recharging zone. Such activities should be stopped immediately to sustain the hydro-ecological equilibrium of the watershed. It is also found that the aerial extents of the natural recharging zones are less in comparison with the total area of the watershed. This fact can be a serious constraint in the development and utilization of groundwater resource and hence, due weightages should be given to the natural recharging zones of groundwater in a river basin/watershed. In other words, the zones which act as natural recharging zones should be preserved and landscape alterations or any other destructive activities should not be allowed in such zones.

CONCLUSIONS

The present simple methodology, which is cost effective also can be applied to any river basins/watersheds to delineate the natural recharging zones. The local self government bodies should take special interest in conserving such zones and keep them devoid of any polluting activities like dumping of solid/liquid wastes.

ACKNOWLEDGEMENT

This study forms part of a project sanctioned by the Kerala State Council for Science, Technology and Environment, for which the KSCSTE is gratefully acknowledged. Author thank DST-FIST and KSCSTE-SARD facilities in the Department of Geology, University of Kerala. Facilities provided in the Department of Geology, University of Kerala is gratefully acknowledged.

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