Evaluation of check-dam recharge through water-table response in ponding area

Precipitation is the principal source of replenishment of moisture in the soil through the infiltration process and subsequent recharge to the groundwater through deeper percolation. The amount of infiltrated moisture that will eventually reach the water table is accounted as the natural groundwater recharge. The natural recharge depends on intensity, duration, amount of rainfall, infiltration capacity of the topsoil zone, antecedent soil moisture conditions and water-table depth[1]. The natural recharge takes place in pulses in semi-arid regions as the area experiences monsoonal rainfall in pulses. In the ponding condition, water is continuously available till the pond becomes dry, making infiltration and percolation active till the availability of water in the pond. It is therefore expected that the responses of the water table in ponding and non-ponding areas are to be different and the comparative analysis will yield accrued recharge due to artificial recharge structure. Here, we have attempted to evolve a method to account for the efficiency of a check dam in recharging the groundwater system and evaluate the increase in quantum of groundwater recharge by comparing with natural rainfall recharge. As the monitoring process had to be of continuous mode, a site within the National Geophysical Research Institute (NGRI) campus, Hyderabad was selected, as shown in Figure 1.

The experimental site falls over a granite terrain and a second-order stream generating from a closed high mound is harvested through a mini-check dam having a storage capacity of 150 cubic m. Site selection for the check dam was done with the help of cadastral and drainage maps of NGRI, followed by geophysical survey to ascertain the thickness of the weathered zone. Long-duration infiltration test was conducted prior to construction of the check dam to ascertain the hydraulic nature of the ponding area. The test yielded an infiltration rate of 400 mm/h. The check dam was constructed to harvest the run-off water from an area of 350 sq. m and a borehole was drilled to a depth of 40 m within the ponding area to monitor the response of water level to storage. The transient changes in water level were monitored continuously using an automatic water-level recorder (IN-SITU, Minitroll water-logger), installed at a depth of 15 m below the water level (water level at the time of installation was 7.54 m below ground level). The aquifer zone met in the borehole is at a depth of 12 m beyond which the borehole did not encounter any other aquifer zone. Daily rainfall data were collected from the NGRI rain gauge station maintained within the campus. Water-level data were retrieved from the logger at the end of the monsoon. Cyclic water-level change was prominently seen in the records, showing the effect of semi-diurnal TIDES[2,3]. However, the hydrographs were not subject to tidal correction as we have only studied the long-term (monthly) records. The rain gauge station placed about 200 m away from the experimental site was utilized for monitoring daily rainfall during the rainy season and run-off collection at the check dam.

Specific yield of the phreatic aquifer is an important parameter for evaluating percolation efficiency from an artificial recharge site. Specific yield of 3.9% was estimated for the phreatic aquifer at the NGRI campus using moisture-influx measurement and water-level change observed over several monsoon years[1]. Studies[4] on determining the specific yield of the water-table aquifer in Aurepalli watershed located in a similar granitic terrain and hydrogeological conditions situated 50 km away from the study area using long-duration pumping tests on dug wells and shallow boreholes, yielded an average specific yield of 2.6%. An average specific yield of 3.2% from these two methods was therefore considered for calculation of ponded infiltration recharge at the check dam site. Daily rainfall events ≥15 mm of the 2005 monsoon year were considered and the ponding recharge computed using water-level rise after the rainy day from the water-level recorder data and average specific yield of 3.2%. The computed recharge due to ponding for different rainfall day events is presented in Table 1.

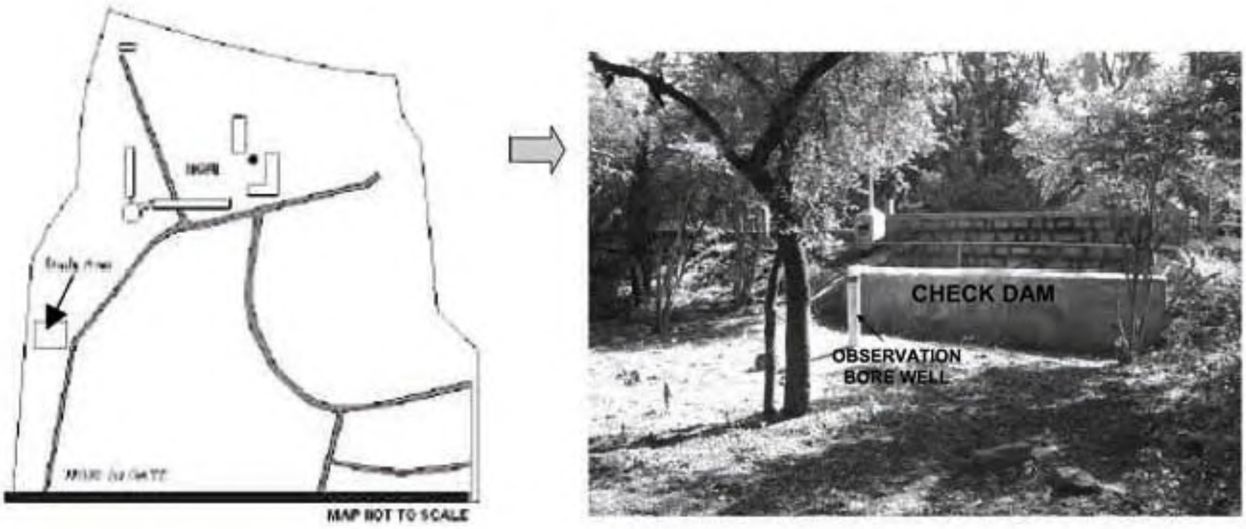

Figure 1. Location map of the study site with check dam and observation bore well.

Table 1. Rainy days with daily rainfall and consequent water-level changes and estimated percolation rate using time lapse and ponding recharge

Rainy day	Rainfall (mm)	Total rainfall (mm)	Water-level fluctuation (mm)	Specific yield (%)	Ponding recharge (mm)	Time lapse* (h)	Percolation rate (mm/h)
8 September 2005	60.4	60.4	695	3.2	22.24	24:00	28.95
21 September 2005	41.6	41.6	348	3.2	11.14	16:00	21.75
14 October 2005	27	27	345	3.2	11.04	30:00	11.5
17 October 2005	31.4 }	71.4	822	3.2	26.65	27:00	30.44
19 October 2005	40 }						
26 October 2005	16.4	16.4	201	3.2	6.43	8:00	25.13
29 October 2005	87	87	2340	3.2	74.9	29:00	80.69

*Time lapse: Time interval between rainfall event and maximum water-level rise.

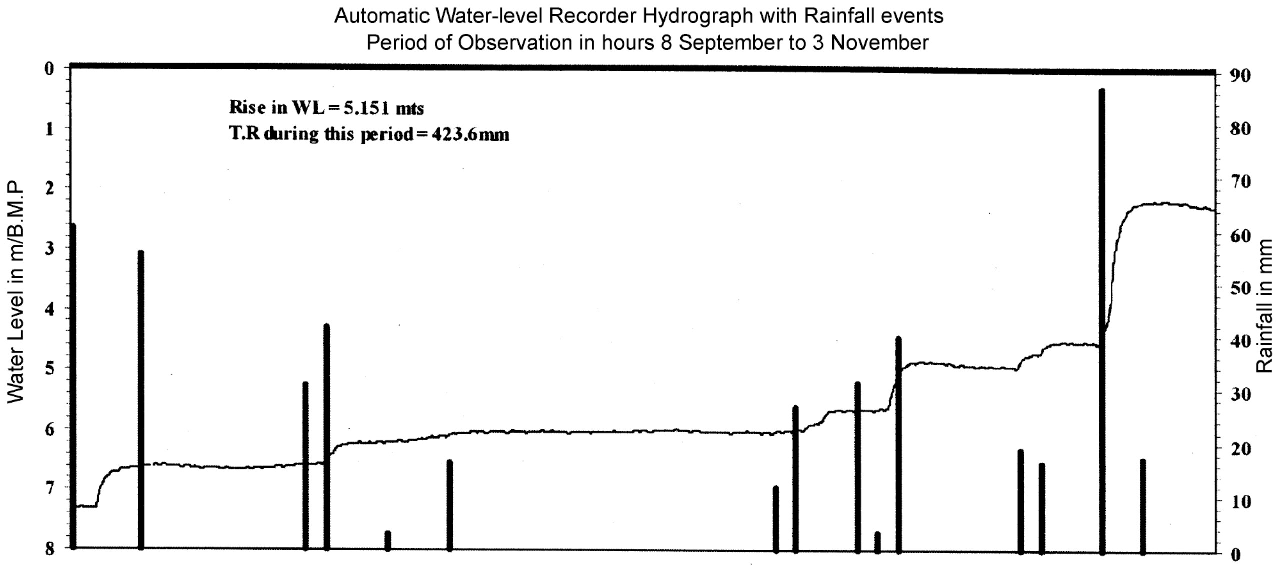

Figure 2. Hydrograph of bore well for September–November 2005 along with rainfall.

The study area experiences monsoonal rainfall from June to October every year, with an average annual rainfall of 650 mm. Five to six daily rainfall events which generated run-off to the artificial recharge structure were considered to investigate the response of the aquifer to ponding during the study period. Recharge from the check dam storage and subsequent water-level change were critically analysed by selecting time window-frames from continuous water-level record. The hydrograph for the period from 8 September to 3 November 2005 exhibiting water level in pulse mode rise with respect to rainfall is shown in Figure 2. An attempt on correlating the rainfall amount and subsequent rise in water level yielded an exponential relation indicating that daily rainfall exceeding 40 mm/day results in significant rise in water level due to recharge from storage.

Also, an attempt has been made to relate the percolation rate estimated from ponding recharge and the resultant water-level rise. A linear relationship was observed indicating that repeated filling of the check dam enhances groundwater recharge from storage. The linear relation observed is similar to the relationship established between natural recharge and water-table fluctuations[5,6]. The natural recharge estimated using the tritium technique over several granitic watersheds revealed that only 5–8% of rainfall contributes towards recharge[7]. However, when we calculate the percentage of recharge due to cyclic ponding with respect to rainfall, it varied from 27 to 40%, showing the advantage of ponded recharge in granitic terrain through check dams with smaller catchments. The described attempt on recharge evaluation through water-level response is a simple method for evaluation of pond recharge. The recharge estimated by this method yielded values similar to those of percolation tank recharge evaluated using injected tritium and environmental chloride methods[8,9]. However, careful site selection through scientific investigations and harvesting in a cascading manner along a drainage channel would result in high efficiency in groundwater recharge through artificial recharge methods.

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ACKNOWLEDGEMENTS. We thank the Director, NGRI, Hyderabad for encouragement to promote rainwater harvesting practices within the campus and for support in the scientific evaluation studies. We also thank our colleagues for timely support in the fieldwork and for their useful suggestions. This work was carried out as part of CSIR (Task Force) Network project on groundwater.

Received 9 January 2006; revised accepted 3 January 2007

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Psilorhynchus amplicephalus, a new species from Balishwar river of Assam, India

Fishes of the genus *Psilorhynchus* McClelland are known to occur primarily in the Gangetic drainage of southern Asia[1]. Distribution of this genus is restricted to lowland and high gradient streams of the Ganga–Brahmaputra drainage and streams of India in Manipur along the India–Myanmar border[2]. Most ichthyologists recognize this genus under a separate family Psilorhynchidae[2,3]. At the same time, few authors have retained this group in the family Cyprinidae[4,5]. Psilorhynchidae has been considered as a distinct family, as it differs from the cyprinid family in having variation in the arrangement of pharyngeal teeth and number of simple rays in paired fins (pectoral and pelvic fins)[6,7]. Six species, namely *Psilorhynchus balitora* McClelland 1839, *P. homaloptera* Hora and Mukherji 1935, *P. pseudechensis* Menon and Datta 1964, *P. sucatio* Hamilton 1822, *P. gracilis* Rainboth 1983 and *P. microphthalamus* Viswanath and Manojkumar 1995 are described. *P. homaloptera rowelyi* Hora and Misra 1941, a subspecies described from Chindwin river, is one of the two species of this genus from Burma[2]. *P. gracilis* described from streams/rivers of Chittagong hill tracts may also be distributed in the river drainages in the adjoining Indian states, namely West Bengal and Assam. Most of the species are found to inhabit shallow streams with pebbles and sandy bottom, except *P. homaloptera* that prefers high gradient streams with rocky bed substrate. Recent collections made during an ichthyological survey in Balishwar river of Barak river basin at Malidor village (24°14′24.1″N, 92°32′40.1″E), Silchar, Assam had a small collection of fishes belonging to the genus *Psilorhynchus* that has not been described so far, which after a detailed study is reported here as new to science. The holotype (F. 7601; 56.8 mm standard length) was deposited in the Zoological Survey of India, Southern Regional Station, Chennai and the paratypes kept preserved at Manonmaniam Sundaranar University Museum of Natural History, Alwarkurichi. Morphometric measurements and meristic counts were as given by Rainboth[2]. The name *amplicephalus* (*ampli* – wide, broad; *cephalic* – head) has been chosen for it having a relatively broad head.

The new species can be easily diagnosed by the spindle-shaped, subcylindrical body and anteriorly compressed head. Further, it can be identified by features like scale-less abdomen, horizontally placed pectoral and pelvic fins and also by the presence of 35–36 scales along the lateral line series. These fishes have dark brownish spots in the predorsal region and also along the sides of the body. The relatively bigger head, deeper body and smaller mouth distinguish it from other species of this genus. A hump-like shape found in the predorsal region of bigger specimens is also a distinct feature that has not been reported in any other species. The morphometric and meristic characters of the holotype and paratypes are given in Table 1.

Body elongate with arched back and a flat bottom. Head depressed at the anterior region and gradually raising towards occiput gives a triangular shape from side view. Hump-like structure in the predorsal region. Mouth small, transverse and ventrally placed. Deep rostral grooves separate the ventral surface of snout from lateral surface. Upper lip joined to lower lip at corner of mouth by a prominent folded flap of skin. Upper lip rigid and lower lip thick, fleshy and papillated. Papillae globular in shape, of varying size found up to chin. Eye large, placed in the upper half of the head. Abdomen naked, the scaleless region extends from below the head to a little before the base of the pelvic fin (Figure 1). Scale and fin counts of the new species are as given below.

Lateral line scales 32–36 (scales along the lateral line), predorsal scales (mid-dorsal scales anterior to dorsal fin) 9–11, circumferential scales (scale rows around the part of the body where it is highest at the dorsal fin origin) 17–19, circumpeduncular scales (scales around narrowest part of tail region before caudal fin) 10, lateral transverse scale rows (above lateral line up to dorsal origin and below lateral line up to pelvic origin) 4/3, anal scale rows (scale rows between anus and anal fin) 9–11.

Paired fins (pectoral and pelvic fins) are inserted horizontally like wings of a