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Changes of groundwater levels and land use with the introduction of canal system in Maheshwar block of Narmada basin (Central India)

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Groundwater is said to be depleting at an alarming rate, and is stated as a major concern for agriculturally driven countries like India. Therefore, understanding the dynamics of water system of the country is prerequisite for assuring its sustainability. According to the GRACE (Gravity Recovery and Climate Experiment) satellite data, the declining TWS (terrestrial water storage) trends are apparent in north and south of India during 2003-2016, while the Narmada river basin which is situated in the central west of the country, shows apparent increase of TWS. In this study, part of the Narmada river basin was chosen as the study site. The major occupation in the basin is agriculture, and hence, water is, in principle, consumed for irrigation. Between 2003 and 2016, the two dams (Indira Sagar dam (2005) and Omkareshwar dam (2008)) were constructed, and the resulting canal system was considered to highly influence water resources availability in the area. To understand the possible effects of the canal system on groundwater level behaviour, we chose the Maheshwar block as the study domain because of its simple canal system layout and single basaltic aquifer setting. The groundwater levels were analysed based on two situations, i.e., before and after canal construction. For the analysis, two distinct seasons, i.e., dry pre-monsoon and rainy monsoon seasons were also taken into account. In the block, the first canal was constructed by 2010, and second by 2013. Based on the extent of each Canal Command Area (CCA), the block was divided into two zones, Zone A (CCA under 1st canal) and Zone B (CCA under 2nd canal). Among the wells studied, five were located within Zone A. After the canal construction, on an average, about 2 m rise was observed in these well water levels, that is, about 2.45 m in pre-monsoon while 1.62 m in monsoon seasons, respectively. Similar analysis was performed for wells not located in CCA, and it was found that no recognizable change of the groundwater levels was observed. The changes in the land use land cover (LULC) pattern were studied using Landsat 5, Landsat 7 ETM+ and Landsat 8 OLI/TIRS imageries in the block. All the LULC maps were cross-checked with maps from National Remote Sensing Centre (NRSC), India, and these were consistent between each other. The expansion of the agricultural area was studied through 2003-2016. The cultivated area increased from about 8% before the operation of the canal to about 27% after operation in Zone A, whereas the increase was smaller in Zone B, that is, from 2% to around 11%. Based on the NDVI (Normalized Difference Vegetation Index) obtained through Landsat images from different seasons, we also observed that cropping patterns have changed from fallow/single cropping to double/triple cropping after the introduction of canal system in both zones. Based on

observations, available amount of water and groundwater storage have increased after canal operation compared with before the operation, and this may at least partly explain the reason why TWS has increased in this area.