Development of an IoT-based pumping control system for withdrawal of freshwater from brackish groundwater zone

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The Internet of Things (IoT)-based pumping control system is crucial for tackling water quality issues and optimizing pumping operations in brackish groundwater zones like southwest Punjab, ensuring sustainable access to freshwater. In the present study, an IoT-based system for controlling the pumping of freshwater from a brackish groundwater zone in the southwest region of Indian Punjab was developed. The developed system was tested at different locations in the field and the working performance was satisfactory. The statistical comparison of the electrical conductivity (EC) recorded with and without the developed system indicated that the developed sensor-based automatic pumping control system is capable of controlling the pumping of water from tubewells with the set permissible limit of EC of 4 mS/cm as given in the source code. The results revealed that the optimal gap between two consecutive pumping of a tubewell for tapping good quality water in the study area was at most 6 h as affected by EC. Furthermore, it was observed that tubewells with greater depths (182.9–213.4 m) exhibited lower groundwater salinity, whereas those with shallower depths (10.7 m, 19.8 m, 30.5 m and 42.7 m) showed higher salinity levels. The lesser variation of groundwater salinity with pumping duration was at a depth beyond 40 m from the ground surface. The cost of the developed system was computed to be US$ 182.16 only. Overall, the developed system which is cost-effective would be useful for controlling the tubewell operation for tapping good quality water from the brackish groundwater zone in the study region.

Keywords: Automation, brackish groundwater, Internet of Things, pumping, sensor.

the polar ice caps[1]. The hydrologic cycle, formation of soil, growth of the plant, and the provision of water for human activities all depend on groundwater. Throughout history, humans have exploited groundwater, but in the past century, the demand for it and society's capacity to use and contaminate it have exponentially risen[2]. The rapid population growth and intensified agriculture strain water and soil are critical for meeting current food demand. The overutilization of brackish groundwater makes it difficult to remove salts from the soil, resulting in the accumulation of salts within the crop's root zone[3]. Salinity is an important issue in irrigation water that needs to be addressed as soon as possible as it inhibits crop growth[4]. The use of the Internet of Things (IoT), automation and big data analytics has penetrated every part of the world over the years. Now a days, many automatic techniques are used in agricultural sector[5] such as irrigation drones, robots for planting, automatic irrigation, automatic harvesting tools, etc. With the help of precise data collected from IoT, farmers can now accomplish the same amount of work in less time and also enhance the agricultural yield, and convert their conventional farms to smart farms. The concept of wireless sensor networks was made feasible through digital electronics, wireless communications and micro-electromechanical systems technology for monitoring groundwater, flood and the environment[6]. This system is based on IoT that consists of many significant technologies, including remote control, data gathering, transmission and monitoring. The water distribution was managed by a microcontroller under the needs of the crops. In Punjab, approximately 98% of its net sown area is irrigated, with 26.2% relying on canal water and 72.5% on groundwater via tubewells[7]. Punjab has experi-