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Evaluating Geomorphometric Variables to Identify Groundwater Potential Zones in Sahel-Doukkala, Morocco

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Topography and geology are considered the primary factors influencing groundwater flow and accumulation. To evaluate their potential in identifying groundwater potential, an integrated approach was provided and used in this work to delineate groundwater potential zones in Sahel-Doukkala, Morocco, by combining geomorphometric variables and a Multi-Criteria Evaluation (MCE) technique. Aside from lithology, all variables used in this approach were derived from a 10 m Digital Elevation Model (DEM) generated from ALOS-PRISM stereo-images using photogrammetric techniques. The chosen variables were considered to be very closely associated with groundwater circulation and accumulation, namely lithology, topographic wetness index (TWI), convergence index (CI), lineament density, lineament intersection density, and drainage network. These variables were given weights based on their respective importance in the occurrence of groundwater, by using a cumulative effect matrix. This process has shown that lineament density had the most effects on other variables, with the biggest weight (24%), followed by lineament intersection density (20%). TWI and CI succeeded 16% while lithology and drainage network density had the least weight (12%). Later, in a GIS system, an MCE based weight sum method was used for generating the groundwater potential zones map.

The obtained map was classified into three zones, viz. “poor”, “moderate” and “high”. These zones delineate areas where the subsurface has varying degrees of potential to store water and also indicate the availability of groundwater. It was found that the zone with “high” potential covered an area of approximately 714 km^2 (44 % of the study area), and it identified areas that are suitable for groundwater storage. These zones showed a high association with low drainage density, low TWI values, and a high density of lineaments and lineament intersections. The groundwater potential zones map produced by the proposed approach was verified using the location and groundwater level depth of 325 existing wells that were categorized as successful, and the result was found satisfactory, with 91% of the successful exiting wells were located at zones that fall in the “moderate” and “high” areas. In addition, the validity of the proposed approach was tested according to the groundwater level depth, which indicates the actual groundwater potential. It was found that places with "high" potential have an average groundwater level depth of approximately 27 m, whereas areas with “moderate” and “poor” potential showed an average of 31 m and 37 m, respectively. The validation results show a good agreement between existing groundwater wells

and the obtained groundwater potential zones map and were considered to be reasonable. Therefore, the produced map can be of great help to hydrogeologists to detect, with time and cost-effectively, new zones that may carry a high groundwater potential.

Because DEM data is one of the most widely and easily accessible data, the proposed method is well suited for areas where data is scarce. As result, it can be widely used to develop conceptual models based on geomorphometric variables as primary inputs for similar arid and semi-arid regions suffering from data scarcity.