Quantifying Available Water at the Village Level: A Case Study of Horongo, Mali, West Africa

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Despite on-going efforts to develop adequate water supplies, only one in every five residents of the developing world currently has access to clean water (UNDP 2006). This means that 1.1 billion people have to travel more than 1 km from their home to access clean water and collect water from sources that may even contain pathogens and bacteria on a regular basis (UNDP 2006). Nevertheless, the statistics reflecting global water access are projected to become worse in the near future. Large areas of South America, Asia and Africa are threatened by increased temperatures and populations and decreased precipitation (Alcamo et. al 2000). In response to the potential negative effects from water scarcity, baseline hydrologic characterization of water sheds should be implemented as much as practical. Characterization of the hydrologic conditions of watersheds can help improve the effectiveness of water access projects, and anticipate risk of insufficient water supply in specific regions. To improve the accuracy of estimated hydrologic conditions, local climate data should be used as much as practical. Horongo, a small rural village in the Kayes region of Mali, has experienced inadequate water supply at the end of the dry seasons for at least the past 2 generations (Traore 2006).

Money-generating activities that occur during the rainy part of the year typically have to be suspended and women must spend exhausting hours of their day and night during the dry season to obtain enough water for their families. Current village activities that require water included domestic tasks, gardening, and drinking water for livestock. According to water use interviews conducted in 2008, village water use varied throughout three main seasons from approximately 10-40 Lpcd. The village water sources in cluded 64 hand-dug wells and an ephemeral wetland/stream.

A simple watershed-scale water balance was used to estimate the amount of groundwater and surface water that was contributed by the up-slope watershed and eventually passes through the near-surface aquifer beneath the village. This water balance is a variation of the common Thornthwaite method and can easily be calculated using basic spreadsheet software. Collectively, groundwater and surface water supplies were estimated at 75 mm/year across the contributing basin (10 km2), which translates to approximately 800, 000 m3/year or approximately 10% of average annual precipitation. All precipitation and temperature data used for the water balance evaluations were acquired from local records for the years 2000-2007.

The aquifer hydraulic conductivity was also determined from ten manual pumping tests performed in four hand-dug wells. The recovery curves of the tests were fit with the Papadopoulos-Cooper solution using the program AQTESOLVE. Hydraulic conductivity was estimated at 1 m/day and assumed consistent for the entire watershed.

To evaluate whether the estimates from the water balance and manual pumping tests were appropriate and to further explore water development, a watershed-scalegroundwater model was created to Simulate seasonal changes in the subsurface hydrology.

The model was used to explore groundwater development by drilled wells equipped with motorized pumps. The model suggests that if pumps extracted water throughout the village (0.38 km2) approximately 4 20 m3 of water could be accessed safely each day during the dry seasons. Realistically, for every well, up to a total of four, the village could access 0-100 m3 of water daily. Water needs of the village as of 2008 could be safely produced by the installation of two wells.