Groundwater use and climate

The Makutapora Record

Stephen Katanga checking groundwater levels in the Makutapora Wellfield.

For more than half a century, the Ministry of Water, the Dodoma Urban Water Supply and Sewerage Authority (DUWASA) and the Tanzania Meteorological Agency have been monitoring groundwater abstraction, groundwater levels, and rainfall in central Tanzania at the Makutapora Wellfield (Figure 1). These observations comprise *the longest published record of groundwater levels in the tropics* and provide unique insight into the relationships among groundwater abstraction, storage and replenishment by recharge.

First, *The Makutapora Record* reveals that intensive pumping of groundwater (>30,000 cubic metres per day) to provide a climate-resilient water supply to the national capital of Dodoma, is sustained by recharge that results from exceptionally heavy seasonal rainfall occurring infrequently, on average, during just 1 rainy season in 5. Second, *The Makutapora Record* reveals that the wellfield store substantial volumes of groundwater, estimated to be 3.8±0.4 million cubic metres for every 1 metre decline in the water table. Using this observed relationship, current abstraction of 1.1 million cubic metres per month over one year, is predicted to lower groundwater levels in the wellfield by 3.5±0.4 metres in the absence of recharge.

The uncertain and irregular patterns of recharge observed in *The Makutapora Record* complicate sustainable management of the wellfield. Sustained periods of groundwater depletion in the absence of substantial recharge are evident from *The Makutapora Record* during the 1970s.

The Makutapora Record reveals, however, a strong link between heavy seasonal rainfalls associated with the El Niño Southern Oscillation (ENSO) and major recharge events. Because ENSO events tend to take place every 3 to 7 years, this link suggests that recharge may be expected to occur, albeit infrequently, in the future. Climate change is projected to increase the intensity of rainfall in the Dodoma region. Although this shift may lead to longer droughts and more frequent and intense floods, *The Makutapora Record* indicates that it favours groundwater replenishment by rain-fed recharge.

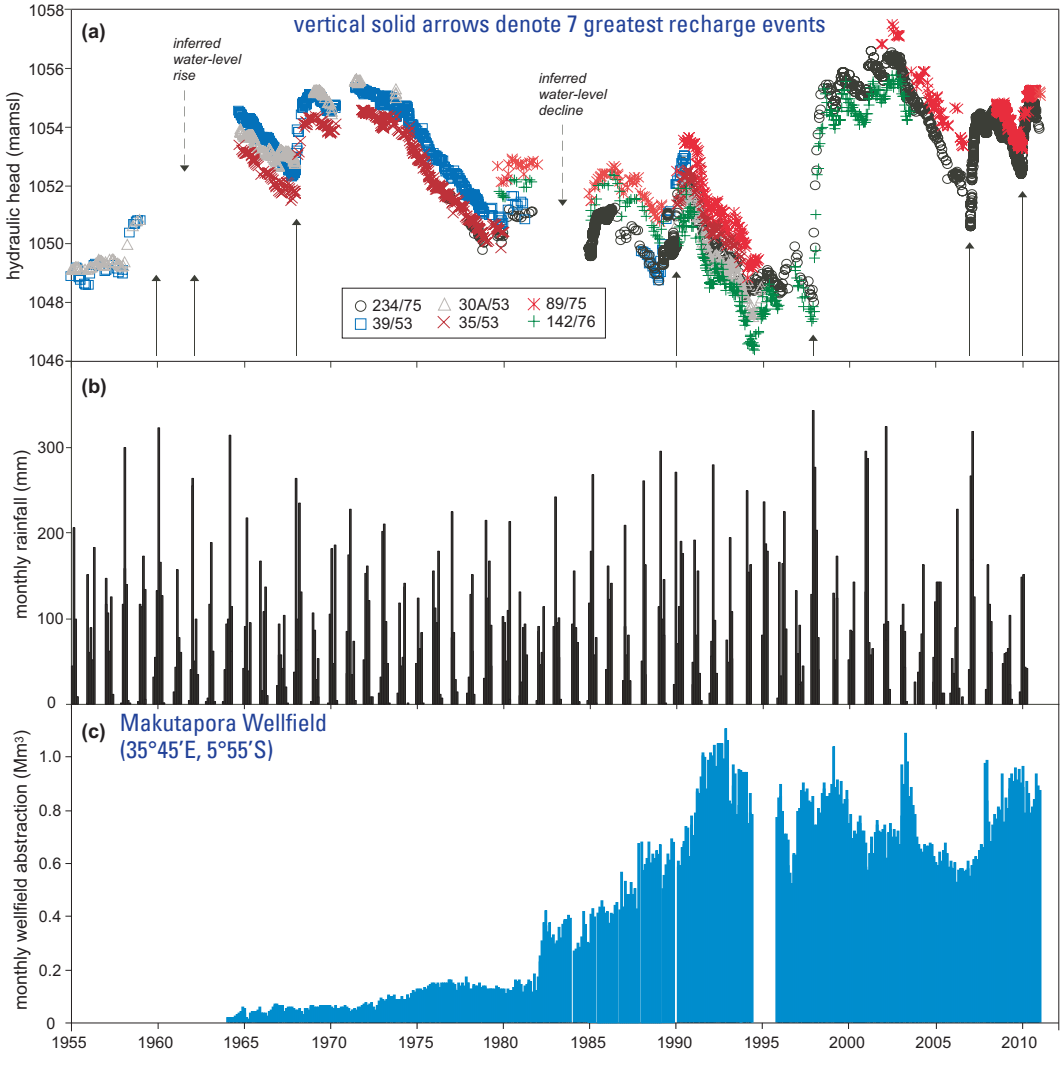

Figure 1. *The Makutapora Record* of: (a) groundwater-level observations, (b) monthly rainfall, and (c) monthly groundwater abstraction, starting from 1955.

For more information, please contact: Alloice Kaponda, Groundwater Unit, Ministry of Water (alloicekaponda@yahoo.com). Compilation and analysis of *The Makutapora Record* was conducted by the Ministry of Water, University College London, University of Sussex and the British Geological Survey with support from the Department for International Development (DFID, UK).

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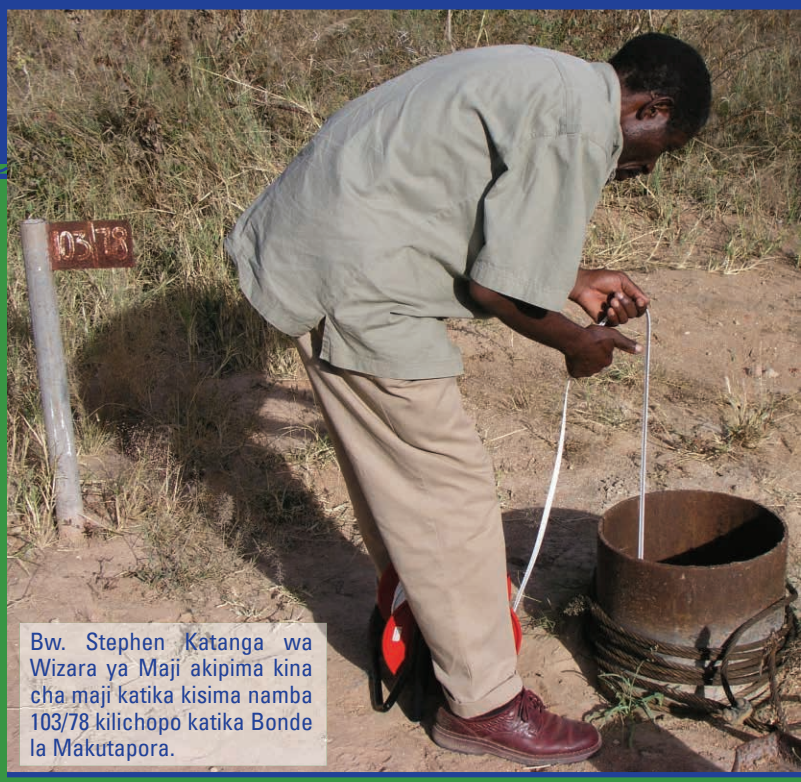
Further details can be found in:
Taylor, R.G., Todd, M., Kongola, L., Nahozya, E., Maurice, L., Sanga, H. and MacDonald, A., 2013. Evidence of the dependence of groundwater resources on extreme rainfall in East Africa. Nature Climate Change, Vol. 3, 374-378. doi:10.1038/nclimate1731.

Matumizi ya Maji ya Chini ya Ardhi na Hali ya Hewa

Bonde la Makutapora – Dodoma



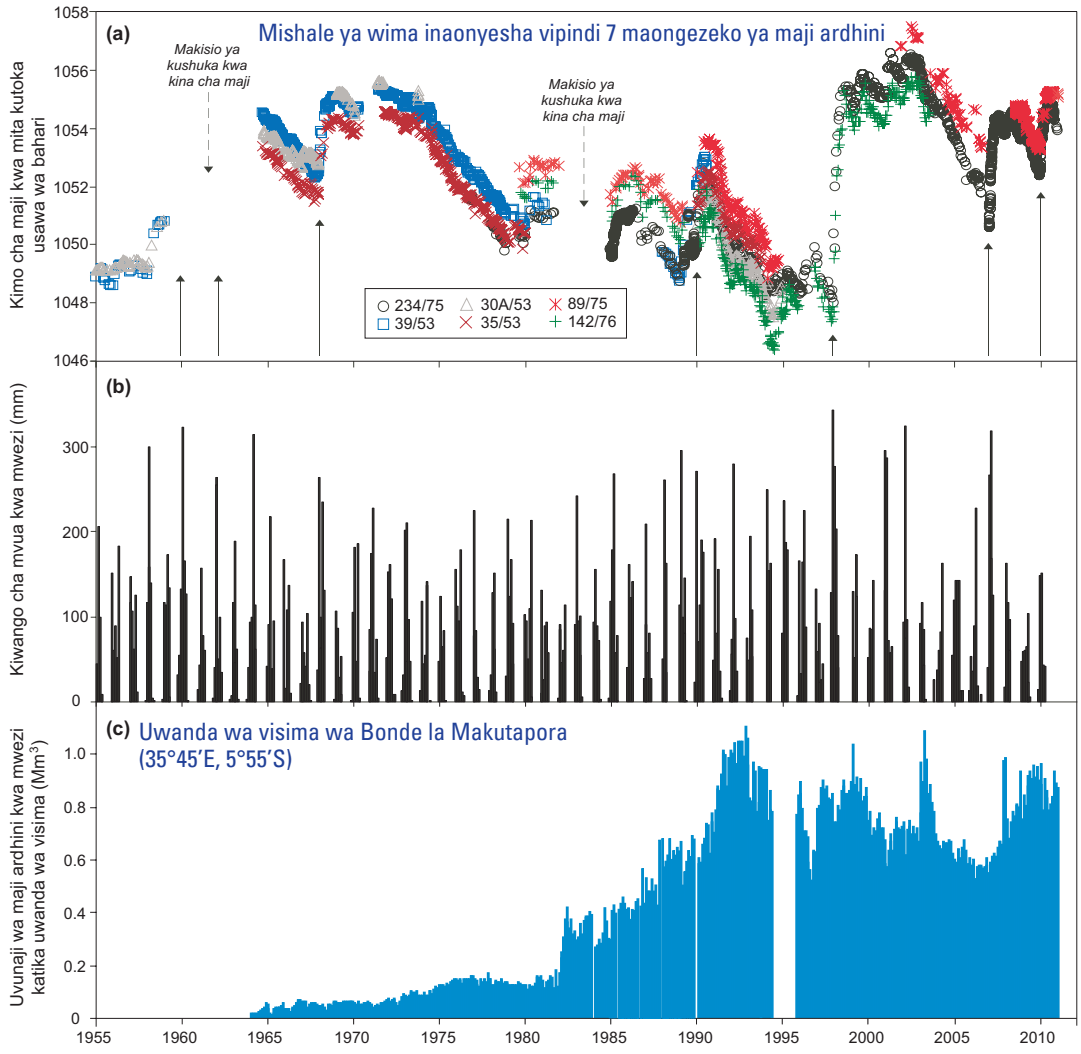
Bw. Stephen Katanga wa Wizara ya Maji akipima kina cha maji katika kisima namba 103/78 kilichopo katika Bonde la Makutapora.

Kwa zaidi ya miongo mitano Wizara ya Maji, Mamlaka ya Majisafi na Majitaka Dodoma (DUWASA) na Mamlaka ya Hali ya Hewa Tanzania (TMA) zimekuwa zikifuatilia matumizi ya maji chini ya ardhi, vina vya maji katika visima na viwango vya mvua katika uwanda wa visima wa *Bonde la Makutapora* (Mchoro na. 1). Ufuatiliaji huu ni moja ya uliochukua muda mrefu katika ukanda wa tropiki na unaonyesha uhusiano wa karibu baina ya matumizi ya maji chini ya ardhi, hifadhi ya maji ardhini na kiwango cha maji kinachoongezeka ardhini kulingana na maji ya mvua.

Kwanza taarifa za ufuatiliaji katika *Bonde la Makutapora* zinaonyesha kuwa pamoja na matumizi makubwa ya maji (kiasi cha zaidi ya mita za ujazo 30,000 kwa siku) kwa ajili ya mji wa Dodoma, lakini hayajaathiri hifadhi ya maji ardhini. Hali hii inasababishwa na mvua nyingi ambazo hunyesha kila baada ya wastani wa misimu mitano ya mvua.

Pili taarifa za ufuatiliaji katika *Bonde la Makutapora* zinaonyesha kuwa uwanda wa visima unahifadhi kiasi cha mita za ujazo milioni 3.8± 0.4 kwa kila kina cha mita 1. Hivyo kutokana na takwimu hizi inawezekana kutabiri kuwa kwa kila mita za ujazo milioni 1.1 zinazovunwa kwa mwezi hivi sasa kina cha maji kitashuka kwa mita 3.5± 0.4 kama hakutakuwa na ongezeko lolote la maji ardhini.

Kutotabirika kwa ongezeka la maji ardhini kunaongeza changamoto katika usimamizi endelevu wa uwanda wa visima wa *Bonde la Makutapora*. Hali hii inajidhihirisha kutokana na ukame wa miaka ya 1970 ambapo kina cha maji katika bonde kilishuka sana. Takwimu zinaonyesha kuwa kuna uhusiano wa karibu sana baina ya misimu ya mvua nyingi (El Niño Southern Oscillation - ENSO) na ongezeko la maji ardhini. Kwa kuwa misimu ya mvua nyingi hutokea kila baada ya miaka 3 hadi 7 hivyo ongezeko la maji katika *Bonde la Makutapora* litatokea katika vipindi hivyo tu. Mabadiliko ya tabia ya nchi kwa mkoa wa Dodoma yanaonyesha kuwa kutakuwa na vipindi virefu vya ukame vikifuatiwa na mvua nyingi ambazo zitaongeza hifadhi ya maji ardhini kwa wingi.



Mchoro 1. *Bonde la Makutapora*: (a) kina cha maji chini ya ardhi, (b) viwango vya mvua kwa mwezi na, (c) uvunaji wa maji ardhini kwa mwezi kuanzia mwaka 1955.

Kwa taarifa zaidi:
Kitengo cha Maji Chini ya Ardhi Wizara ya Maji (Dodoma). Imetayarishwa na Wizara ya Maji, University College London, University of Sussex na British Geological Survey kwa hisani ya DFID, UK.

Maelezo zaidi yanapatikana katika:
Taylor, R.G., Todd, M., Kongola, L., Nahozya, E., Maurice, L., Sanga, H. and MacDonald, A., 2013. Evidence of the dependence of groundwater resources on extreme rainfall in East Africa. Nature Climate Change, Vol. 3, 374-378. doi:10.1038/nclimate1731.

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