

The Great Chyulu Hills Reservoir



That water is the essence of life is both a familiar cliché and an inescapable truth. Such is the importance of water that Section 43(d) of the Kenyan Constitution says that “every person has the right to clean and safe water in adequate quantities” With increasing threats to water security, Kenya is recognising the vital role played by its upland areas, many now designated as “water towers” through the Kenya Water Towers Bill (2018).

The Chyulus water tower is one of the more encouraging stories. Gazetted as a national park in 1983, the southern boundary borders Tsavo West National Park. Part of the eastern side has the Kibwezi Forest Reserve, owned by Kenya Forest Service and managed by the Sheldrick Wildlife Trust.

The western flank is protected by the four Maasai group ranches, Kuku, Kuku A, Mbirikani and Rombo, all of which have undertaken conservation programmes in partnership with two NGOs, the Maasai Wilderness Conservation Trust and Big Life Foundation.

These nine organisations formed a partnership, formalised as trustees of the Chyulu Hills Conservation Trust (CHCT) that successfully



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BELOW: The water stored in the Chyulus is equivalent to a lake 10km long by 3 km wide by 20m deep.

developed and implemented the Chyulu Hills REDD+ Project. This project specifically aims to reduce carbon emissions from deforestation across the Chyulus landscape to generate carbon credits being sold on the international carbon markets. Between them, these organisations have been remarkably successful in conserving the Chyulu Hills landscape even though there are significant threats and there has been some deforestation and loss of wildlife.

As a water tower, the Chyulu Hills are an important water catchment with its most visible manifestation being the sparkling and clear water that bubbles up at Mzima Springs. Although there are a number of springs around the Chyulus, recent modelling of the aquifer suggests that 80-90 per cent of the total water captured emerges through Mzima.

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PHOTO BY: TRICIA CRUZ





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The Chyulu Hills rise up to a height of about 7000 ft at the highest summits to create a rainfall gradient ranging from 1200 -1700mm to 300-400mm at the lower altitudes. The height of the hills and the forest cover also creates conditions that promote cloud formation and interception, promoting the growth of the dense moist cloud forest along the ridges.

The geology of the Chyulus, characterised by recent permeable volcanic lavas overlaying impermeable early pre-Cambrian rocks, results in most of the rain and cloud moisture percolating down and then flowing along with the impervious layer, emerging to create the oasis of Mzima and other minor springs. Importantly, the recharge process of the Chyulu aquifer shows the importance of forest and vegetation cover in preventing run-off, maintaining the integrity of the aquifer and its ability to maintain its spring outflows.

In the latter half of the 1950s, the pipeline from Mzima to supply Mombasa with water was constructed. Now, some 60 years later, the Mzima pipeline provides a critical contribution to the water budget for Mombasa, accounting for about

TOP: World famous hippo pools formed by water from the Mzima Springs. Bubbling forth from the Chyulu Hills volcanic boulders is a famous site in Tsavo West, Mzima Springs, where 225 million litres of water a day feed into crystal clear pools that are home to crocodile and hippo. The water may take 4 years to reach Mzima after the initial rainfall on the hill tops.

one-third of total current supply. From available data, the total average outflow from Mzima has remained remarkably constant over the past 70 years at about 3.8 m³ per second (cm/s) (= 328,000 cm³ per day) with a total variation over the years in the range of about 2.5 -5.5 cms.

Lagged multiple regression analysis shows that variation in spring flow is most highly correlated with rainfall occurring 3-4 years earlier but there is also a correlation with rainfall up to 10 years earlier. This shows that the Chyulus are in fact like a giant sponge creating a huge underground reservoir that stores incoming water and releases it at a very constant rate.

So how much water is stored in those green hills? Given that Mzima accounts for 80 per cent of the total flows, it is possible to calculate the total outflow across the whole aquifer. This is 4.75 cm/s. If it is assumed that the average retention period is 4 years then the aquifer is storing about 600 million cubic metres. How much water is that? A bathtub or Lake Victoria? The answer is a lake about 10km long, 3km wide and 20 metres deep. That is about the surface area of Lake Nakuru but 20 metres deep rather than 1-2



PHOTOS BY: CAMPI YA KANZI



metres. And this remarkable reservoir was all constructed by nature: no infrastructure and no World Bank loan!

Interestingly, the catchment area for the Chyulu aquifer is almost one hundred per cent overlain by the project area of the REDD+ project. This means that the REDD+ project and the Trustee organisations of the Chyulu Hills Conservation Trust that own the REDD+ project are protecting the forest and surrounding habitats and are by default also the guardians of the Chyulu aquifer.

Such conservation is of course not without cost and yet in the 60 years since the Mzima pipeline has been in operation, Mombasa water users have not paid a single shilling towards conservation of the Chyulu landscape and support for its local communities. Meanwhile, the CHCT trustee organisations are raising at least \$5 million per year for conservation of this landscape. The vision developed by the CHCT and its Project Office, the Maasai Wilderness Conservation Trust, is to expand funding for Chyulu landscape

TOP: Chyulu Hills landscape with forested summits and grasslands and woodlands on the slopes.

INSERT: Chyulu is a corridor for animals that live in Tsavo and Amboseli. The park shelters a wide variety of wildlife and huge concentrations of plains game such as wildebeest, zebra and eland as well as elephants which normally wander in from neighbouring Amboseli.

conservation and to increase its predictability. In this context, the strategy is to develop a portfolio of Payments for Ecosystem Services (PES).

In addition to ecotourism, other environmental “rents” such as payments for conservancies and compensation for livestock losses to predators, and carbon payments through REDD+, it seems appropriate that the value of aquifer protection should be recognised through payment by water users. Such an approach for payments for water is entirely consistent with the statutory functions of national water towers legislation that include “establish a framework for payment for environmental services for the purpose of sustainable management of water towers ecosystems.”

The logic for receiving some payment from Mombasa water users is inescapable but one question is pricing. Currently, bulk water is delivered down the Mzima pipeline to the Coast Water Service Board (CWSB), which pays nothing towards catchment and aquifer protection. CWSB sells bulk water to Mombasa Water Supply and Sanitation Company (MOWASCO) for 20 KES per cubic metre. MOWASCO provides treatment and the infrastructure for delivery of the water to the end consumers and charges an average of 101 KES per cubic metre though the price can



PHOTO BY: CHRISTOPHER TUIE

vary between 35 and 240 KES depending on the category of user and the volume consumed.

If a payment of 50 per cent of the price paid by MOWASCO to CWSB is used as a guideline, this equates to 10 KES per cubic metre. If the Mzima pipeline is delivering at its design capacity of 35,000 cubic metres per day then this payment would be just over 125,000,000 KES (\$1.25million) per year. This would represent a significant and fair contribution towards ensuring the future integrity of the aquifer. The Chyulu water is especially valuable because it is also the cleanest and purest water from any of Mombasa's supply sources and only requires simple chlorination.

Currently, Mombasa has a water deficit. Although there are plans to expand the off-take from Mzima with a second pipeline, this would not be sufficient to meet the coastal regions rapidly growing projected demand. The major project to significantly increase supply is the building of the Mwache dam to the south of Mombasa. Over 60 metres high, the dam is estimated to cost \$150 million. Even with such major new projects to increase supply with new

Mzima Springs are a series of four natural springs and one of the biggest attractions in Tsavo West. The source of the springs is a natural reservoir under the Chyulu Hills to the north. The Chyulu range is composed of volcanic lava rock which is porous, so rain water percolates down through the rock, spending years underground before emerging kilometres away at Mzima.

infrastructures, such as dams or desalination, Chyulu water will continue to be a critically important resource for the coast region, and in comparison to other sources it is pure, predictable, cheap, and climate change resilient!

The Chyulu water tower provides Kenya with an ideal test case for water PES. Since Mzima is delivering water reliably every hour of every day, the only barriers to implementation are political, legal, financial, and institutional. The Chyulu Hills Conservation Trust already provides the institutional structure to receive and distribute PES payments for catchment conservation. With the appropriate will and collaboration between the government, CHCT partners, and downstream water users, appropriate legal and financial structures can be developed, using models from a number of countries around the world.

The total costs for such an implementation would likely not be more than \$1 million. For an annual return of \$1.25 million that represents a pretty attractive investment for securing an important part of the future water supply for Kenya's second largest city and its surrounding areas. ●