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FOR SOCIALLY RESPONSIBLE
SUSTAINABLE DEVELOPMENT

WATER TREATMENT: TRANSPORTABLE SYSTEM FOR KENYAN VILLAGE

ENEREF INSTITUTE INITIATIVE SETS IN MOTION A WATER TREATMENT SOLUTION FOR RURAL VILLAGE IN KENYA

Access to safe drinking water results in tangible benefits to health, and every effort should be made to not only achieve its safety but improve access as well. According to the World Health Organization, 3.4 million people die each year from water-related disease, making unclean water a leading

cause of death. As part of the Water and Women initiative, Enerref Institute worked with CUBO Technologies, S.A., to deliver a self-contained, transportable water treatment system to Njiku village, located 15 kilometers north of Murang'a town in Murang'a County, central Kenya.

ENEREF'S WATER AND WOMEN INITIATIVE ADVANCES OPPORTUNITIES FOR GIRLS AND WOMEN IN KENYAN VILLAGE.

The new water treatment system will allow the girls living in the Njiku village a greater opportunity to participate in school, while also fostering better health for the entire community through safer drinking water.

NJIKU VILLAGE IN CENTRAL KENYA

The residents of Njiku village are part of the Kikuyu tribe and rely primarily on coffee farming for income, though many also engage in subsistence farming and livestock rearing. The average family in Njiku village—comprised of a married couple and four children—owns about an acre of land, a cow, and a few goats or sheep.

VILLAGE WATER USE

A typical Kikuyu family consumes roughly 21 gallons (80 liters) of water in household chores and another 34 gallons (128 liters) in livestock and farming consumption per day. Although most households have implemented techniques to capture rainwater, most of the residents of Njiku village source their water from the Mathioya stream that cuts across their village.

WATER AVAILABILITY

Despite the fact that Kenya's cycles of long droughts have been increasing over time, Mathioya stream does not dry up. Even with sparse rain and recently changing weather patterns, the

stream remains flowing. However, as other nearby streams dry up, Mathioya stream is forced to serve a larger and larger population, as the 5,000 – 6,000 residents of surrounding villages rely on it as well.

OBTAINING WATER IS PRIMARILY A FEMALE DUTY

In the Kikuyu tradition, chores are primarily assigned based on age and gender, and fetching water is a predominantly female duty. Women and girls are responsible for the daily water needs of the entire family, which includes water used for cooking and cleaning as well as what's needed for farming and livestock.

The women of Njiku village have been fetching water together at Mathioya stream for generations. Fetching water is as much a chore as it is a social event, where women walk together from the village to the stream. The walk back and forth allows the women to socialize, catch up on each other's lives and collectively induct their female children into this daily ritual.

For young girls, training in fetch-

ing water starts at age 5, when they begin to accompany female relatives to the stream. At first, young children use smaller containers such as soda or juice bottles to carry water. As they get older, the size of the containers and the frequency of their visits to the stream significantly increase.

By age 12, most girls have learned to balance 20-liter containers on their backs. On average, each 12-year-old girl fetches about 80 liters of water per day: 40 liters before school and another 40 immediately after. This strategy lightens the load for the mother to about 120 liters throughout the day.

Peak water-fetching times fall in the early morning and early evening, hours strategically chosen to avoid the exhaustion that comes with the hottest times of day.

The human resources required to cut, collect and transport firewood further compounds the challenge, as this chore also falls to the women. As a result of such culturally mandated domestic chores, school-age girls in Njiku village frequently stop their schooling before receiving an adequate education. Most girls in Njiku village face an incessant struggle between attending school and fulfilling cultural gender obligations.

HISTORY OF WATER-BORNE ILLNESSES

There are no health regulations

MATHIOYA STREAM

Women and girls are responsible for the daily water needs of their entire family



to govern the fetching of the water. While Mathioya stream is a year-round source of water, the water it provides is often contaminated upstream or downstream. It is not uncommon to see children with both feet in the stream, women washing clothes and dishes in the stream, people and livestock drinking directly from the stream, or people washing their hands at the stream. With so many people drinking this unsanitary water, water-borne illnesses are rampant—especially diarrhea, cholera and typhoid.

OVERCOMING VILLAGE SKEPTICISM ABOUT WATER SAFETY

Despite the public health concerns, regional sanitation campaigns have been dampened by cultural and economic obstacles. Cultural norms perceive the stream as *kiheo*

kia Ngai, “a gift from God,” as well as a free resource. Therefore, efforts to educate residents on water contamination have been met with cynicism. The skepticism is compounded by the intergenerational history of drinking from the stream, which most residents share.

THE NEED TO DISCOURAGE DEFORESTATION

GOK (Government of Kenya) has made efforts toward more effective education campaigns, particularly the practice of boiling drinking water. While a viable solution, the fact is that most residents are small-scale cash crop farmers who cannot afford the additional costs of boiling water. Firewood, the primary source of energy for most of the village, is a pricey and increasingly scarce commodity in this region. The additional expense of firewood has proved too hefty of an economic

burden, leaving most families to boil water only when they have surplus income.

FORESTS ABSORBING CO²

While boiling with firewood makes for safer water, it also contributes to deforestation in Kenya—a problem that has already caused erratic rainfall and increased water and food insecurity, forced migration and internal conflict. Burning firewood depletes already-vulnerable forests, crucial in their capacity to slow climate change by absorbing CO². Worse still, burning firewood releases CO². In fact, according to IPCC Climate Change Mitigation, 2007, 17 percent of carbon emissions worldwide come from deforestation. And, just as important, forests build more resilient landscapes through water flow regulation and the protection of plant and animal species.

Less rain, in part, is the result of less forest cover to trap moisture and attract cloud cover. Deforestation has caused many of the rivers and streams feeding Lake Naivasha (northwest of Nairobi) and other lakes to shrink or dry up. In Turkana County, more than 60 percent of wells are dry, according to the country's National Disaster Management Authority.

DROUGHTS ERODE THE FOREST ASSETS

Droughts erode assets and undermine livelihoods, culminating in a downward spiral of poverty and food insecurity. A 2008 – 2009 report by the European Union Delegation to the Republic of Kenya found that droughts directly impacted the household food security of over 10 million people.

CHOLERA, TYPHOID AND PARASITIC WORMS ARE EXTREMELY HIGH IN KENYA

According to a World Bank report, 42 percent of sub-Saharan Africans have no access to safe drinking water (Africa's Water and Sanitation Infrastructure: Access, Affordability, and Alternatives). The UNEP report Africa Environment Outlook explains that unsafe drinking water spreads common diseases that include diarrhea, cholera, typhoid, guinea worm and dysentery.

In Kenya specifically, the rate of exposure to cholera, typhoid and parasitic worms is extremely high. Approximately 19,500 Kenyans—including 17,100 children under

the age of 5—die each year from diarrhea, nearly 90% of which is directly attributed to poor water, sanitation and hygiene (according to the World Bank Water and Sanitation Program's report Economic Impacts of Poor Sanitation in Africa).

According to Karen Kotloff, MD, Head of the Division of Infectious Disease and Tropical Pediatrics at the University of Maryland School of Medicine, diarrheal diseases caused an estimated 2.3 billion illnesses and 1.3 million deaths worldwide in 2015, primarily from four pathogens: rotavirus, cryptosporidium, Shigella and enterotoxigenic Esherichia coli (ETEC). Ninety percent of these deaths occurred in sub-Saharan Africa and South Asia.

In addition to these deadly diseases, Kenyans are also overexposed to fluoride in the drinking water, potentially causing skeletal fluorosis and impaired brain development.

HEALTH-RELATED COSTS

In Kenya, health-related costs—including consultation, medication and hospitalization—place a heavy burden on both household and government spending. Around \$51 million is spent each year on diarrheal diseases directly, according to the World Bank's Economic Impacts of Poor Sanitation in Africa. The same report notes that Kenya loses \$2.7 million each year due to related productivity loss.

ENEREF INSTITUTE WATER AND WOMEN INITIATIVE

To resolve many economic, health and gender-equity-related impacts of unsafe drinking water in Njiku village, Eneref worked with Portuguese-based CUBO Environmental Technologies, S.A. The company developed a compact modular water treatment system ideally suited for the rural areas that Eneref's Water and Women initiative serves. CUBO's compact modular system removes suspended matter, dissolved compounds and disinfects water. It is simple to set up in remote areas and features a modular containerized structure, plug-and-play connections and a step-by-step assembly process.

In bringing their water treatment solution to Njiku village, CUBO faced the challenge of a skeptical community. As economist William Easterly points out in *The Tyranny of Experts*, technocrats involved in implementing developmental programs often attach little importance to history and cultural norms, spawning a wave of both opposition and cynicism.

To help overcome skepticism, Eneref and CUBO employed local labor to install and maintain the CUBO water treatment system. Also, one of the inherent advantages of the CUBO system is that the unit uses locally available chemicals to treat water, offering another opportunity to employ the local economy.

CUBO SOLUTION SELF-CONTAINED WATER TREATMENT

Eneref Institute worked with CUBO to organize a local team, the majority of whom come from the Kikuyu culture, to provide expert advice on village norms as well as serve as a liaison between the community and CUBO. To encourage village residents to support the water treatment system, Eneref recommended a communal approach involving highly regarded social structures like churches and schools, where every member of the community has a stake.

Led by Eneref's Outreach Liaison Gabrielle Mwangi, with the support of local contacts, Eneref contacted Njiku village elders and broached the idea of the water treatment system. Village elder Gerald Ngechu recommended using the local church property as a potential location for the system. Eneref's Nairobi-based staff then traveled to the village to meet with the council of elders to explain the CUBO system and answer any questions. The council raised several concerns including potential damage to the landscape and ecosystem; the need for a water analysis to ensure that the system produces uncontaminated water; the system's energy requirements; and how to secure the system to protect the community, especially curious chil-

dren, from electric shock. Over six weeks, negotiations brought in local water and energy experts, the church's executive administration, and members of the local government.

STRUCTURAL DELIVERY

Once the council of elders approved the system, the unit was shipped from Portugal to the Port of Mombasa in Kenya. The standard-dimension container-



THE *SciBox*:

WATER TREATMENT SYSTEM CHEMISTRY

Chlorine is an oxidizing agent the CUBO system uses to destroy organic contaminants and disinfect the water of microbes and pathogens.

WHEN MIXED WITH WATER, chlorine forms a strong oxidizing agent that is proficient at killing the microbial water-borne pathogens that can cause typhoid, dysentery, cholera and Legionnaires' disease. Chlorine also provides long-term residual protection while the water sits in the storage tank or distribution system, and it precipitates metal oxides, rendering them into sediment for filtering.

The large surface area of granular activated carbon and activated aluminum oxide react to eliminate unwanted or toxic chemicals, including bromine and fluorine, from unprocessed water. Aluminum oxide's tunnel-like pores and high surface-area-to-weight ratio adsorb fluoride, arsenic and selenium in drinking water.

WATER TREATMENT SYSTEM

CUBO Environmental Technologies delivered a self-contained, transportable water treatment system



ized structure allowed for easy maritime and terrestrial transportation, since the unit can be handled just like any standard shipping container.

Because all of the system's water treatment processes are of modular implementation, they can be replaced or switched out depending on site-specific water quality demands. Once delivered to Njiku village, there was only the need to connect the water inlet, water outlet and energy source, and the unit was ready to operate.

SYSTEM MECHANICS

A self-contained water treatment system, the unit purifies water by passing it through several layers of filtration medium with different porosity and chemical compositions. Suspended solids and precipitates are retained selectively in each media layer. As raw water passes through, several physical

and biological processes filter the water and eliminate contaminants such as amoeba, fungi, protozoans and worms.

The unit's storage and contact tanks are food-grade and BPA (bisphenol-A)-free to prevent bacterial growth. A forced ventilation system renews the air inside the structure every 10 minutes, optimizing the inside temperature and avoiding any volatile compound accumulation. The filter regeneration (cleaning) is done by a back flush of water that removes any retained suspended particles and precipitates.

Whenever control parameters fall outside the desired values, a final quality control measure kicks in, cutting the water from the supply and recirculating it back to the beginning of the treatment process. All of the mechanisms are automatic, and can be monitored, and managed, remotely.

ENEREF INSTITUTE INITIATIVE GOALS ACHIEVED

The goal of any Eneref Institute initiative, is to highlight technologies currently on the market that can protect natural resources in healthy ways and increase human well-being without causing further harm to our environment. The CUBO portable, self-contained water treatment system meets that goal. Bringing sanitized water to Njiku village significantly reduces the risk of water-borne diseases within the local population. The water treatment system also offers great economic benefits to families that no longer need to rely on firewood to boil water, while also reducing deforestation. Lastly, the unit installed in the village reduces the time girls will spend gathering water, giving them more time to attend school.



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the opportunity to improve
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