

**SUSTAINABLE MANAGEMENT OF RURAL WATERSHEDS:
BIOPHYSICAL, LIVESTOCK, AND HUMAN INTERACTIONS
IN THE RIVER NJORO WATERSHED
(SUMAWA)**

PROJECT DESCRIPTION

The GL-CRSP Sustainable Management of Rural Watersheds (SUMAWA) project is a multidisciplinary research effort focusing on biophysical, livestock and human-related factors governing watershed processes for the purpose of improving long-term sustainability of rural watersheds and threatened or endangered ecosystems in Kenya and East Africa. Through biophysical and human-oriented research, the SUMAWA team is creating a comprehensive watershed model that may be translated and transferred to stakeholders and policy makers who are the primary determinants of watershed and human health in the Njoro watershed of Kenya. On-going and completed activities such as workshops, participatory rural appraisal, school outreach, and watershed interventions continue to enhance project visibility and effectiveness.

LEAD PRINCIPAL INVESTIGATORS

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Marion Jenkins serves as the Lead Principal Investigator for two collaborating GL-CRSP projects:

Development and Marketing of Point-of-Use Household Filters for Drinking Water Improvement (POU-WID) expands upon prior SUMAWA research and seeks to develop, manufacture, market and monitor usage and health impacts of low-cost slow-sand water filtration devices to improve water quality at the point of use in households in the River Njoro watershed. The project targets rural mothers and their children in agricultural households who suffer from water-borne diseases, in particular diarrhea, from lack of access to improved and safe water supplies in the watershed.

Water and Sanitation-Related Conditions and Disease Burdens in the River Njoro Watershed (NJORO WATER) is tackling water and sanitation-related diseases in the River Njoro watershed, particularly diarrhea, as these diseases pose a development burden on poor rural agricultural households and have implications for water supply planning, environmental management, and development policy. Data collected under the SUMAWA project are being used to integrate and characterize domestic water source choice, water consumption and sanitation patterns in time and space across the watershed and analyze their relationships with patterns of water and sanitation-related diseases in the Njoro watershed.



SUMMARY OF ACHIEVEMENTS

- Diminishing lake levels in Lake Nakuru, Kenya, a primary water source for irrigation and household drinking water in the nearby town of Nakuru, threaten both ecological and agricultural sustainability as the lake provides critical habitat to a number of keystone species. The SUMAWA/NJORO WATER project developed a water budget model for the lake and River Njoro to understand the balance between upstream surface and groundwater sources in sustaining lake levels. This model enhances the capacity of managers and policy makers to make critical decisions on water resource management.
- SUMAWA has helped facilitate the formation of the Water Resources Users Association in the River Njoro watershed, Kenya. Membership consists of three representatives from each of the member communities. To promote the participation of women in watershed rehabilitation, at least one of each of the three representatives is female.
- NJORO WATER launched an extensive study in the River Njoro watershed in Kenya to measure fecal coliform bacteria in river water across the watershed and identify problem areas. Cattle were identified as the major source of contamination, thereby indicating that better feeding and water management plans need to be explored.
- Prior SUMAWA research found the BioSand Filter (BSF) to be the best water treatment option for poor agricultural and

peri-urban households in the Njoro watershed. Results of POU-WID's subsequent investigation into the use of BioSand Filters in 60 Kenyan households showed significant improvements in water quality, reductions in incidence of childhood diarrhea, and high levels of satisfaction and sustained use of the filters. At the end of the trial, 47 of the 60 households chose to buy the BSF, including 23 of the 30 control households. As a result, the health and well being of 235 vulnerable people in the Njoro Watershed have now been protected from drinking and using contaminated river water through the purchase and use of the BSF.

- Water treatment in the Njoro River watershed in Kenya is traditionally a female gender-specific role. Therefore, the POU-WID project's successful introduction of BioSand Filters as a sustainable water treatment technology has greatly impacted gender and labor roles at the household level, where men have increased their involvement with water-related chores due to filter appreciation, including taking responsibility for re-filling the filters.



Cattle watering at open access points along the River Njoro stream network are a common sight throughout the watershed. Photo by Sian Mooney.

- A total of 14 small-scale operators have now been trained and certified as BSF artisans, able to take up local production and marketing in their communities, in advance of the start-up of three local enterprises planned in the Njoro watershed for 2007-08. An additional 40 BSF filters were produced by these artisans for sale to control households at the end of the trial and for installation at three clinics and one restaurant in the watershed.

RESEARCH BRIEFS

GL-CRSP Research Brief 07-01-SUMAWA-NJORO WATER: Gross Fecal Pollution of a Rural Watershed in Kenya: Research Identifying Cattle as a Major Source in the River Njoro Watershed, Kenya

Author: *Marion W. Jenkins, University of California, Davis*

Summary. Elevated levels of fecal pollution in surface water pose significant health risks for humans as well as livestock and degrade aquatic ecosystems. This brief presents preliminary findings on pollution research in the River Njoro Watershed, Kenya and explores actions to reduce gross pollution found throughout. NJORO WATER conducted an extensive survey and launched a yearlong program to measure fecal coliform bacteria in river water to quantify pollution levels across the watershed, pinpoint problem areas and identify major sources. Genetic methods were applied to track fecal sources and test for *Cryptosporidium spp.*, a water-borne pathogen causing severe diarrhea in young, old, and immuno-compromised human and cattle populations. A common pattern of fecal pollution peaking in August, significantly higher levels detected when cattle were present at a site, and widespread detection of cow fecal genetic markers, all lead to livestock, in particular cattle, as the most likely cause of gross fecal pollution and source of *Cryptosporidium* in the Njoro Watershed. Elimination of the widespread practice of in-river livestock watering through provision of watering troughs would quickly reduce gross levels of fecal

pollution, bringing immediate health benefits for humans, livestock, and ecosystems. Tackling the complex web of human-livestock-animal, resident-migratory, and rural-urban combinations of sources and actors contributing to fecal pollution in this and similar rural watersheds throughout Kenya requires a long-term, multi-pronged engagement process of joint local community and government action.

GL-CRSP Research Brief 07-02-SUMAWA-POU-WID: Point-of-Use Treatment Options for Improving Household Water Quality among Rural Populations in the River Njoro Watershed, Kenya

Authors: *Sangam K. Tiwari and Marion W. Jenkins, University of California, Davis*

Summary. Rural access to improved water supplies in Kenya stands at 46%. Consequences are apparent in the River Njoro watershed, where a majority of households fetch and use polluted river water for some or all of their domestic water needs, suffering high rates of diarrhea, typhoid, and other water-borne diseases. Responding to expressed needs for improving water quality in the watershed, the SUMAWA project launched work to develop low-cost water treatment for household use. This brief reports findings from screening six point-of-use (POU) water treatment technologies applicable in developing countries. Operating characteristics, performance, costs, procurement, and local sustainability were reviewed, and suitability of use with river water by households in the Njoro watershed was assessed. Intermittent slow-sand filtration (known as the “BioSand Filter” or BSF), ceramic clay filtration (“Filtron” pot), and chlorine disinfection were identified as suitable. Among these, the BSF was selected as most promising for application development in the Njoro watershed on the basis of robust design, ease of use, no recurrent costs, high flow rate, and ability to treat highly turbid river water. A program to develop and test the BSF for use by high-risk households to treat polluted River Njoro water was launched in 2006 jointly with the Nakuru District Ministry of Health’s Public Health Division, Civil and Environmental

Engineering Departments of UC Davis, and Egerton University. As the program wraps up, results and practical learning will be shared in upcoming research briefs.

PUBLICATIONS

SUMAWA

Kibichii, S., W.A. Shivoga, M. Muchiri, and S.N. Miller. "Macroinvertebrate assemblages along a land use gradient in the upper River Njoro watershed of Lake Nakuru Drainage Basin, Kenya." *Lakes & Reservoirs: Research and Management* 12: 107–117, 2007.

Shivoga, W.A., M. Muchiri, S. Kibichii, J. Odanga, S.N. Miller, T.J. Baldyga, E.M. Enanga, and M.C. Gichaba. "Influences of land use/cover on water quality in the upper and middle reaches of River Njoro, Kenya." *Lakes & Reservoirs: Research and Management* 12: 97–105, 2007.

PRESENTATIONS AND PROCEEDINGS

SUMAWA

Baldyga, T.J., S.N. Miller, W.A. Shivoga, F. Lelo, M.W. Jenkins, G. Paige, and S. Mooney. "Rural planning in East Africa using a participatory spatial decision support system." *Proceedings of the ESRI Eastern Africa User Conference*. Kampala, Uganda, September 13 – 14, 2007.

Baldyga, T.J., S.N. Miller, W.A. Shivoga, F. Lelo, M.W. Jenkins, G. Paige, S. Mooney. "Development of a participatory spatial decision support system for East African rural planning." Paper and presentation at *AfricaGIS 2007*. Ouagadougou, Burkina Faso, September 17 – 21, 2007.

Bett, E.K. "Net present value analysis to assess the economic consequences of changing farming systems in the upper catchment of the River Njoro watershed." Presentation at the *Tenth Biennial Scientific Conference & Agricultural Forum*. KARI, Nairobi, Kenya, November 12 – 17, 2006.

Chiuri, W. and S.A. Ogalleh. "Integrating gender perspectives in water policies and institutions: realizing new options for effective water management." Accepted for publication in the *Proceedings of the CGIAR Gender and Water Forum*. Vientiane, Lao PDR, November 12 – 17, 2006.

Gichaba, C. "Community perceptions, priorities and participation in managing water and environmental resources in the River Njoro Watershed, Kenya." *Proceedings of the IUGG XXIV 2007*. Perugia, Italy, July 2-13, 2007.

Krupnik, T., M.W. Jenkins, S. Mooney, and E.K. Bett. "Net present value analysis to assess the economic consequences of changing farming systems in the upper catchment of the River Njoro watershed." Peer-reviewed paper and poster at *Tenth Biennial Scientific Conference & Agricultural Forum*. KARI, Nairobi, Kenya, November 12 – 17, 2006.

Martin, C., S.N. Miller, and L. Chiuri. "Split sex community based mapping using a 3-dimensional model of the River Njoro watershed." Poster presentation at *Society for Conservation GIS, 1st Conservation-GIS Conference*. Nairobi, Kenya, July 18-20, 2007.

POU-WID

Tiwari, S.K., M. W. Jenkins, C. Maina-Gichaba, W. Saenyi, and J. Darby. "Development of intermittent slow sand filtration for rural households in the River Njoro watershed, Kenya." Abstract and oral presentation to the Special Session "Point-of-Use Water Treatment Technologies for Developing Global Communities," *AEESP Education and Research Conference*. Virginia Tech University, Blacksburg, VA, July 28-August 1, 2007.

NJORO WATER

McCord, S. "Lake Nakuru water balance." Presentation and workshop with Lake Nakuru researchers, stakeholders, Kenya Wildlife Services, and students. CMRT, Egerton University, Njoro, Kenya, May 14, 2007.

McCord, S. "Preliminary results of Lake Nakuru water balance model." Presentation and workshop with Lake Nakuru researchers, stakeholders, Kenya Wildlife Services, and students. Kenya Wildlife Services Education Center Theatre, Lake Nakuru National Park, Nakuru, Kenya, June 13, 2007.

TEAM MEMBERS

Zakayo Akula, Egerton University
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 Jacynter Were, Water Resource Management Authority

COLLABORATING INSTITUTIONS

University of Wyoming, Department of Renewable Resources (*lead institution*)

Egerton University, Department of Environmental Science, Kenya
 Kenya Fisheries Department
 Kenya Wildlife Services
 Kenyan Ministry of Health
 Moi University, Department of Fisheries, Kenya
 River Njoro Water Resource Users Associations (WRUA), Kenya
 University of California, Davis, Department of Civil and Environmental Engineering

Non-Degree Training for 2006-2007			
Country	Male	Female	Total
SUMAWA			
United States	0	3	3
France	0	1	1
Germany	1	0	1
Kenya	49	15	64
Total	50	19	69
POU-WID			
United States	0	2	2
Germany	1	0	1
Kenya	19	9	28
Total	20	11	31
NJORO WATER			
United States	1	1	2
France	0	1	1
Japan	4	0	4
Kenya	18	2	20
Total	23	4	27

Degree Training for 2006-2007					
Name (Last, First)	Nationality	Gender (M/F)	University	Discipline	Degree
SUMAWA					
Baldyga, Tracy	USA	F	University of Wyoming	Rangeland Ecology & Watershed Management	PhD
Chitty, Carrie	USA	F	University of Wyoming	Rangeland Ecology & Watershed Management	MS
Huckett, Stephen	USA	M	Utah State University	Forest, Range, and Wildlife Sciences	PhD
Jepyeon, Emily	Kenyan	F	Moi University	Ecology	MS
Kamau, Duncan	Kenyan	M	Egerton University	Hydrology	BS
Kigen, Chariles	Kenyan	M	Egerton University	Ecology	MS
Kyalo, Daniel	Kenyan	M	Egerton University	Socio-Economics	MS
Mutswenje, Mark	Kenyan	M	Egerton University	Hydrology	BS
Ngari, Eunice	Kenyan	F	Egerton University	Gender	MS
Ngugi, Macharia	Kenyan	M	Egerton University	Hydrology	MS
Nyakach, Dennis	Kenyan	M	Egerton University	Hydrology	BS
Ogalleh, Sarah	Kenyan	F	Hebrew University	Hydrology	Dip
Tiwari, Sangam	Indian	F	UC Davis	Environmental Engineering	PhD
POU-WID					
Langenbach, Kilian	German	M	Center for Environmental Research, Leipzig	Environmental Engineering	PhD
Nyakach, Dennis	Kenyan	M	Egerton University	Civil & Environmental Engineering	BS
Scott, Beth	British	F	London School of Hygiene & Tropical Medicine	Public Health	PhD
Tiwari, Sangam	Indian	F	UC Davis	Environmental Engineering	PhD
NJORO WATER					
Keightley, Keir	USA	M	UC Davis	Geography/GIS	PhD

SUMAWA Funding for 2006-2007	
Total Core Funding	\$236,654
Total Cost Share	\$38,123
Leveraged Funding	\$68,262
USAID Buy-ins	\$52,865

NJORO WATER Funding for 2006-2007	
Total Core Funding	\$34,974
Total Cost Share	\$621
Leveraged Funding	\$27,750

POU-WID Funding for 2006-2007	
Total Cost Share	\$519
Leveraged Funding	\$11,500
USAID Buy-ins	\$35,905