# WATER, LAND AND ECOSYSTEMS **SOLUTIONS FOR** THRIVING ECOSYSTEMS

CGIAR RESEARCH PROGRAM ON



**Research Highlights 2017-2018:** 

**RUAF** FOUNDATION ROLAF FOUNDARION C BISAT





Online 2017-2018 highlights: wle.cgiar.org/highlights17

and partners, and supported by CGIAR, a global research the International Water Management Institute (IWMI)

system resilience and human well-being. WLE is led by

is a prerequisite to agricultural development, food

sustainable intensification in which a thriving ecosystem

solutions. The program promotes an approach to

regional and international partners to find integrated

(FAO), the RUAF Foundation, and numerous national,

centers, the UN Food and Agriculture Organization

people who rely on them. WLE brings together 11 CGIAR solutions that protect our natural resources - and the program connecting partners to deliver agriculture

Ecosystems (WLE) is a global research-for-development

Thrive Blog: wie.cgiar.org/thrive

partnership for a food-secure future.

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CGIAR Research Program on Water, Land and Ecosystems

# **ANATOMY OF A THRIVING ECOSYSTEM Connected thinking, compelling solutions for our food future**

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Kenya loses about 19,000 hectares of forest each year, in part because of widespread use of charcoal for cooking. This is no different in the country's refugee camps, but the 185,000 people living in the Kakuma and Kalobeyei camps have few options for acquiring charcoal. Instead, women source firewood from surrounding woodlands, risking their safety and causing conflict with host communities. WLE supported training for women on how to make briquettes from organic waste. This economically empowered them, while reducing pressure on forests.

# RICH BIODIVERSITY

Doubling the number of ladybugs in Chinese cotton fields could yield an added value of \$300 million. Being the natural enemy of pests attacking cotton, ladybugs represent a green alternative to pesticides. WLE research found that decreasing pesticide use increases the number of ladybugs, pollinators and other important insects, adding economic value. The next step is to build awareness among farmers and policy makers of the hidden economic potential of biodiversity, paving the way for a virtuous cycle that benefits both farmers and ecosystems.

### EQUITABLE OPPORTUNITIES

83% of the women using a new water scheme in Nepal named not having to travel far to fetch water a main benefit. But, contradictory to initial assumptions, these women could not use the time they saved to generate income; they spent it doing regular housework. The truth about women in agriculture is often obscured by assumptions that derail well-intended development interventions. WLE research demonstrates that projects can only be successful in increasing gender equity when based on deep understanding of local contexts and gender dynamics.

When the value of banana exports in Laos more than tripled

excessive pesticide use, causing fish death and illness among

scientists to help draft a new policy on sustainable plantation

plantation workers. WLE scientists found particularly high

between 2013 and 2016, the leap was reportedly accompanied by

pesticide concentrations in soil and water on banana plantations.

When presented with the findings, the Lao government invited the

### LOCAL EMPOWERMENT

cing about 60% of the country's rice, the Mekong Delta is known as Vietnam's rice bowl. Here, farmers grow up to three rice crops each year, which is harming water, soils and biodiversity. WLE-supported researchers trialed a participatory research methodology that made villagers aware of how rubbish disposal, pesticide use and intensive farming harm local livelihoods. Realizing this, the participating farmers have made adjustments to put less pressure on natural resources.

### FERTILE SOILS

About 40% of soils in sub-Saharan Africa are low on nutrients. In western Kenyan villages, WLE scientists have developed digital maps, accessible through smartphones, that pinpoint areas of nutrient deficiency. Communities learned to use the maps to identify where to add nutrient supplements or lime to the soil. Researchers have also developed fast and low-cost soil analysis methods based on soil-plant spectroscopy to influence investments in and policies on soil health.

promise for carbon sequestration. Maps developed by WLE partners show where and how much carbon could potentially be stored in all

Potential exists for removing up to 6.8 billion tons of carbon dioxide from the atmosphere each year for several decades through better soil management. Techniques such as composting, mulching, zero tillage, agroforestry and other natural solutions are showing good available cropland soils globally. This could make a very valuable contribution towards the Paris Climate Agreement goals.

# CARBON STORAGE

SUSTAINABLE PRODUCTION

management.

### The CGIAR Research Program on Water, Land and WATER. LAND AND ECOSYSTEMS **CGIAR RESEARCH PROGRAM ON**









# **HEALTHY LANDS**

Restoring 12% of degraded agricultural land could increase smallholder incomes by \$35-40 billion. In the Ethiopian Highlands, WLE-supported scientists are working with local communities to reclaim deep gullies, caused by heavy rains, by filling them with stones and adding the right grasses and trees to prevent erosion. The Ethiopian Bureau of Agriculture has adopted the approach, applying it in two additional watersheds, and planning further expansion.

# FLOOD RETENTION

Floods in Sri Lanka led to an estimated \$4.3 million in damages and losses in 2016 alone, and worldwide urban floods cost billions of dollars each year. Wetlands—an under-valued piece of natural infrastructure—can help mitigate flood impacts. In Sri Lankan capital Colombo, wetlands can store enough water to fill 27,000 Olympic swimming pools. WLE partners are working to understand and raise awareness of the great value of urban wetlands—already recognized by Colombo, which is vying to become one of the first amsar-accredited 'wetland cities'.

### SMART SOLUTIONS ACROSS SECTORS

About 70% of the world's population will reside in cities by 2050, forcing us to confront climate impacts on urban food supply, volatile food prices, disrupted supply chains and changes in consumption patterns. WLE partners study the resilience of city region food systems in Ghana, Burkina Faso and Sri Lanka. They propose options for "short food supply chains," such as through urban agriculture, and private sector investments. These foster sustainable solutions for urban food security without trade-offs for rural hinterlands.

### **NUTRIENT CYCLING**

An area about the size of the European Union is under cultivation in and around the world's cities, and soils are deteriorating fast. In Sri Lanka, WLE-supported scientists are establishing sustainable models for replenishing soils by co-composting organic city waste and fecal sludge, turning it into safe, marketable fertilizer. This could enhance the financial sustainability of hundreds of existing municipal compost plants and boost urban food security, while also solving sanitation and environmental challenges.



### KNOWLEDGE OF INTERCONNECTIVITY

Ecosystem services-nature's contribution to water purification, pollination or nutrient provision-bring enormous economic benefits. Losses to services due to land use change alone have been estimated at up to \$20.2 trillion per year. WLE-supported researchers are promoting ecosystems-based approaches to agriculture that don't just do no harm, but add value to ecosystems. Training 112 people on how to use tools to determine what impact a certain decision might have on water provision, sediment retention or other ecosystem services led more than one third of trainees to use these tools in their work later on.

### **FLOURISHING RIVERS**

Nearly 1/4 of global rivers no longer drain year-long into the sea due to dams and other infrastructure obstructing flows. But a certain amount of water is needed in rivers for ecosystems to thrive—a concept known as environmental flows. WLE-supported scientists developed a new online tool to calculate the relationship between surface water, environmental flows in rivers, and groundwater replenishment. This data can underpin decisions on water in pursuit of the UN's SDGs.

# PLENTIFUL GROUNDWATER

Groundwater contributes to about 44% of irrigated food production worldwide, but over-pumping threatens this precious resource. In Vietnam, coffee farmers rely heavily on groundwater for irrigation, drilling ever deeper as they face more frequent droughts. WLE research is finding that by improving irrigation efficiency and recharging groundwater reserves, water use can be made more sustainable, without compromising the quantity or quality of coffee production.

# LIVELIHOOD PROVISION



## RISKS, TRADE-OFFS AND ECOSYSTEMS SOLUTIONS



### **PROGRAM ON** Water, Land and Ecosystems





Small-scale irrigation in Africa could be expanded to 7.3 million hectares, significantly boosting food security, nutrition and incomes. But smallholders struggle to access energy to run pumps. Small, solar-powered pumps provide a cheaper, climate-smart alternative. WLE-supported researchers developed viable, attractive business models for solar irrigation to avoid over-dependence on public funds as well as maps that identify sustainable groundwater pumping zones.

# **WLE BRINGS CONNECTED THINKING, COMPELLING SOLUTIONS**

#### MESSAGE FROM OUR PROGRAM DIRECTOR

When you picture a "thriving ecosystem," what comes to mind? Your inner eye may turn to images of free-flowing rivers snaking through lush deltas and farm plots heavy with prospering crops.

Sadly, the degradation of ecosystems and natural resources is proceeding like never before. Pressure on land and water, pollution from pesticide overuse, and changing weather patterns are among the many factors that impact the livelihoods and food security of millions. The poorest and most marginalized bear the brunt of these burdens.

But it doesn't have to be this way. At the CGIAR **Research Program on Water, Land and Ecosystems** (WLE), we connect global scientists to find ways for sustainable agriculture to add value to the environment, while also delivering sufficient food, nutrition and income. Many new opportunities for producing safe and nutritious food in thriving ecosystems are emerging.

We are developing a portfolio of solutions across ecosystems, sectors and scales—and I invite you to explore some of them on this poster. What they share is the recognition that our ecosystems are intrinsically interlinked. Water use upstream affects food production downstream, while pesticide use on one crop decreases pollination of another. We know that these links exist, and finding ways to address trade-offs and synergies is increasingly urgent for developing the right solutions for sustainable agriculture.



A thriving ecosystem is also highly reliant on the policies and institutions that govern it. We must ensure equitable access to knowledge and resources for women, men and marginalized communities. We also need to build capacity to navigate complex uncertainties.

Now is time for transformational change. At WLE, we bring together researchers, farmers, implementers and policy makers to ensure innovative technical and policy solutions are **developed and implemented**. We believe in solutions that provide these partners with the right incentives for change. Only then can the most promising solutions be scaled for the widespread benefit of ecosystems and the people who rely on them.

To succeed, the world must move forward on agriculture solutions that don't just solve one problem, but that are able to consider ecosystems as a whole. Connected, we will **Thrive**!

#### Izabella Koziell **Program Director**

CGIAR Research Program on Water, Land and Ecosytems

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#### LAND AND ECOSYSTEMS SOLUTIONS



"Your calculations are good on paper, but reality on the ground is very different."

These were the words of Pauli Chelangati, a maize farmer on the slopes of Mount Elgon in eastern Uganda, when a land management scientist tried to convince him to add fertilizer to his farm plot.

Despite calculations showing that doing so would triple Mr. Chelangati's profit, the farmer stood his ground, not wanting to risk the up-front expense on fertilizer. What could allay his worries? Researchers concluded that improved access to cash and markets, and greater capacity among government advisors could reduce the risk of investment enough for the farmer to take the leap.

WLE has found that land restoration efforts must start with the communities who occupy, use and know the land. That's why WLE scientists collaborate with farmers, extension workers and other partners to develop solutions that actually work.

In India, for example, researchers have revised government-issued soil health cards to make them more helpful to farmers. In Ethiopia, other researchers made sure to recommend that land rehabilitation initiatives include immediate benefits for local communities to gain their buy-in and support.

One step up from the community level, WLE is developing a growing suite of tools that can support national planners, investors, farmers and others to pinpoint where to prioritize and focus soil health rehabilitation. Soil nutrient deficiency maps piloted in western Kenya is one example, and similar efforts are ongoing in the Ethiopian Highlands, where scientists are recommending even more precise targeting of fertilization.

On an even larger scale, the Africa Soil Information Service continues to expand its database, recently adding soil nutrient maps for all of sub-Saharan Africa. Decision makers are already using them, including in the Ethiopian government, which used them to improve their fertilizer recommendations.

Finally, soils could also be turned into carbon sinks, helping to meet climate targets: up to 6.8 billion tons of carbon dioxide could be removed from the atmosphere each year for several decades through better soil management.

The health and prosperity of future generations depend on the success of current efforts to restore degraded lands. With proper incentives, knowledge, investments and policies, soils can be restored and thriving landscapes can continue to underpin global agricultural systems.

WLE's partners in this work include IFPRI, IWMI, CIAT, ICRISAT and ICRAF.

#### LAND RESTORATION EFFORTS IN ETHIOPIA START WITH AND DEPEND ON THE SUPPORT OF LOCAL COMMUNITIES. CREDIT: GEORGINA SMITH/CIAT



#### WATER AND ECOSYSTEMS SOLUTIONS

"Our first round of irrigation lasts two days and there is plenty of vater, so we irrigate non-stop. But during the second and especially we have to get from the well, and we have to deepen it in dry years."



Pham Thi Tuyet, a coffee farmer in Dak Lak, aptly describes how farmers in Vietnam's Central Highlands are experiencing the consequences of groundwater depletion. WLE scientists are trialing solutions for more sustainable water use, including a method for recharging farmers' wells. A system of collection canals and filtering tanks captures rainwater and directs it into groundwater reserves, thus building resilience to water scarcity.

Likewise in sub-Saharan Africa, improving farmers' access to irrigation helps them adapt to changing rainfall and

#### INCLUSIVITY AND CAPACITY SOLUTIONS



"We still work now. We do household work now. The work we used to leave for another day—we complete it today."

This woman, who lives in Nigali village in western Nepal, is one of several supposed to benefit from a new water scheme. Implementers assumed that placing a water source nearby would free up time for women, allowing them to produce vegetables and become economically empowered. But that is not how it worked out: the women simply spent their newly gained time on more housework.

The experience from Nepal underscores the conclusions of several years of WLE research on gender equity in agriculture: myths can derail otherwise well-intended development efforts. It is always essential to challenge existing assumptions and to investigate the true local context, including barriers to women's participation in agriculture.

Scientists have proposed four undervalued lines of inquiry that can shed light on how to effectively work with women, and WLE is developing a growing suite of tools that can give decision makers a better foundation for achieving greater gender equity.

Investing in understanding the constantly changing realities in agriculture is increasingly important. Migration plays a big role as men are leaving rural areas in favor of jobs in urban centers. This sometimes leaves women with greater control over decisions and resources, but sometimes they suffer additional burdens.

In other cases, migration is a coping mechanism for dealing increasing weather variability, as in Uganda, where a majority of youth might be interested in agriculture, but lack the support to break into what's considered an increasingly risky sector. In any case, youth moving away from farms might have some positives.

Building capacity for dealing with these new and often complex realities is critical: scientists evaluating water users

#### **RURAL-URBAN ECOSYSTEMS SOLUTIONS**

growing water scarcity. Investments in agricultural water management technologies could double, or even triple, yields of crops that are currently rain fed, and irrigated areas could be sustainably expanded by 15 million hectares. But, many past investments in irrigation have been fraught with failure, which is why scientists recommend developing viable, sustainable and inclusive business models for small-scale irrigation.

Which is exactly what another team of researchers has done for Ethiopia, where only 14% of the population are connected to the electricity grid. A set of newly developed solar irrigation business models, coupled with maps that identify best bet zones for irrigation, seek to encourage investments in this green and climate-smart technology. By considering different mechanisms of adoption, payment, financing and governance, the models lay out how to make access to solar technology more inclusive, especially of the poorest farmers.

But there are challenges too: solar-powered pumps are essentially free to use, which implies a risk of over-pumping and groundwater depletion. A number of safeguards have been proposed, including creating financial incentives for responsible use via the energy sector. A tool to assess environmental flows in rivers globally can also help decision makers assess how much water is being replenished and thus the limits for sustainable abstraction.

Finally, with climate change likely to have increasing impacts on water availability—and in turn food production and smallholders—scientists have set out to determine how climate resilience can be quantified, measured and achieved. With climate change impacts intensifying, developing and sharing attractive, viable solutions to safeguarding water on a large scale is increasingly urgent.

WLE's partners in this work include IWMI, IFPRI and ICRISAT.



"This will help sensitize the next generation of decision makers to the opportunities inherent in the circular economy."

That's how Guy Hutton, senior advisor at UNICEF and previously senior economist at the World Bank, describes a recently published book filled with insights on different ways to harness valuable resources from waste. In it, WLE scientists profile 24 innovative business models for using waste to fulfill the world's need for fertilizer, water and energy.

Safely and wisely managing waste is one of several challenges offered up by rapid urbanization. Scientists recently estimated that the use of untreated urban waste-

A GHANAIAN WOMAN SELLING YELLOW MELONS ON THE STREET CONTRIBUTES TO THE CITY'S FOOD SUPPLY, CREDIT: HAMISH JOHN APPLEBY/IWMI



#### **RISKS, TRADE-OFFS AND ECOSYSTEMS SOLUTIONS**



"We cannot afford to lose one more inch."

Nadeera Rajapakse Rubaroe, wetlands ecologist and consultant for the World Bank, considers wetlands in Sri Lankan capital Colombo to be providing such vital ecosystem services that further encroachment is simply unaffordable.

In Colombo, urban wetlands stretch across more than 22,000 hectares. They regulate temperatures, improve air quality, foster biodiversity, provide opportunities for urban farming, and retain floodwaters.

WLE scientists work with relevant government departments to promote the value of wetlands and ensure that they are adequately integrated as part of future urban planning. This is particularly important as urban settlements eat away at the green spaces that could help protect cities from the effects of climate change.

In Thailand, for example, flooding of Bangkok in 2011 cost around \$41 billion. In response, scientists are advocating the concept of sponge cities – using wetlands and green spaces in urban environments to reduce flood risks.

But floods don't just strike cities. In the Indian state of Bihar, nearly 17 million people, many of them smallholder farmers, faced flooding in 2017. A successful pilot of an index-based flood insurance scheme allowed insurers to use data from satellites to quickly provide compensation to households that lost crops to floods.

Wetlands, forests, flood plains and other environmental systems can all be considered part of the natural infrastructure that supports thriving landscapes. Treating river basins as interlinked portfolios of natural and human-built structures, such as dams and irrigation schemes, can make it easier to manage water to everyone's benefit. This approach is being piloted in Kenya's Tana River Basin where a multitude of users—farmers, fishers, industries and the city of Nairobi—share one river.

water for irrigation is 50% more widespread than previously thought.

Unfortunately, treating all wastewater is out of reach for many developing countries, and therefore scientists have been studying various business models that leverage private capital to address waste management challenges by turning waste into wealth.

All these business models are based on existing cases, including a WLE-supported public-private partnership in the city of Tema, Ghana, that turns fecal sludge and organic waste into safe compost pellets. The compost can replenish starved soils in and around the city, closing nutrient loops between urban and rural areas, while providing an incentive for waste collection. Other similar partnerships are currently taking off in Ghana, India and Sri Lanka.

Waste can also be harnessed for energy, relieving pressure on forest and land resources. In and around Kenyan refugee camps, researchers trained women on how to produce briquettes from waste scraps. Provided with an alternative energy source, women are free from the hazards of seeking fuel far from their homes.

Using waste to sustainably intensify agricultural production can help make urban food supply more resilient. Other options for city planners include diverse food sources, including using short supply chains, and finding ways for businesses to contribute to city region food systems through new enterprises and public-private partnerships in production, processing, logistics, recycling and more. Only when tapping into the principles of circular economy and applying them at scale will a thriving ecosystem be able to provide for current and future urban dwellers. WLE's partners in this work include IWMI, RUAF

Foundation and ICRAF.

Turning to nature is also proving worthwhile for regulating pests attacking valuable crops, such as cotton. Ladybugs are the natural enemy of cotton-munching pests, and scientists have found that doubling the number of ladybugs in Chinese cotton fields could yield an added value of \$300 million. The total value of pest regulation provided by natural enemies has been estimated to represent a worldwide value of \$100 to \$400 billion per year.

Recognizing the value of nature-based solutions, whether wetlands or ladybugs, has the potential to boost not only livelihoods and economies, but also the resilience of the entire ecosystem. It's high time to consider nature a key player in sustainable development.

WLE's partners in this work include IWMI, CIAT and IFPRI.

SRI LANKAN CAPITAL COLOMBO IS OFTEN STRUCK BY FLOODS, BUT THE CITY'S WETLANDS HAVE A STORAGE CAPACITY EQUIVALENT TO 27,000 OLYMPIC-SIZE



# ABDULAIVA UGULOI IS THE HEAD OF ONE OF THE ALMOST 400 WATER USER ASSOCIATIONS IN TAJIKISTAN—ONLY 7 ARE LED BY WOMEN. CREDIT: MADDY DAHM/WLE



associations in Tajikistan found that those receiving training for a longer period perform better and that female farmers need more training in the face of male emigration.

By being engaged in participatory research in Vietnam's Mekong Delta, communities realized that their intensive farming was detrimental to ecosystems and changed their ways. Finally, some development practitioners and researchers trained on ecosystems-based approaches started using related tools in their work, showing their appreciation of the value of ecosystems.

Leaving no one behind is a prerequisite to sustainable intensification of agriculture. In this perspective, equity and social inclusion are essential elements of a thriving ecosystem.

WLE's partners in this work include IFPRI, IWMI and Bioversity International.