



Solutions for Thriving Ecosystems

2017-2018 Research Highlights

CGIAR Research Program on Water, Land and Ecosystems

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WLE brings connected thinking, compelling solutions

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.

WLE is a global research-for-development program connecting partners to find these solutions.

Through the International Water Management Institute (IWMI) and 12 other core partners, WLE ensures thriving ecosystems go hand-in-hand with agricultural development, food system resilience and human well-being.

Discover our solutions by exploring the stories and publications below.

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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 and resilient ecosystems are emerging.

We are developing a portfolio of solutions across sectors, scales and ecosystems—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 Ecosystems

Water and Ecosystems Solutions

"Our first round of irrigation lasts two days and there is usually plenty of water, so we irrigate non-stop. But during the second and especially third and final round of the season, water is much more limited. Water for the household we have to get from the well, and we have to deepen it in dry years."



Vietnamese farmer Pham Thi Tuyet's groundwater well runs dry at the end of the coffee-growing season. Credit: Alisher Sharypau/Hanns R. Neumann Stiftung.

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 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.

Explore related content:

- [More for less: improving groundwater use for increased coffee production in Vietnam](#)

- [Here comes the sun: solar technology for agriculture](#)
- [How to keep Africa's solar irrigation boom from going bust](#)
- [Feeding millions from the ground up – the promise of groundwater-fed irrigation in Africa South of the Sahara](#)
- [African smallholders can double their yields with half the water](#)
- [Grow with the flow](#)
- [Groundwater over-abstraction in the MENA region: 5 problems and some solutions](#)
- [Measuring progress toward climate resilience – Inside the toolbox](#)

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.



Land restoration efforts in Ethiopia start with and depend on the support of local communities. Credit: Georgina Smith/CIAT.

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.

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.](#)

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

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](#).

Explore related content:

- [Ethiopian Highlanders unleash traditional practices on a modern land scourge](#)
- [Designing a better Soil Health Card for farmers in India](#)
- [Soil nutrient maps of Sub-Saharan Africa at 250 m resolution](#)
- [Breathing life into dying soils in harsh landscapes of the Ethiopian Highlands](#)
- [Guest post: Improving Africa's soils to cut emissions and boost food security](#)
- [New study: Up to 7 billion tonnes of Carbon Dioxide can be removed from the atmosphere each year through better soil management on farm land](#)
- [Sink more carbon in the soil? It's not that easy](#)
- [Overcoming farmers' resistance to climate-smart agriculture in Africa](#)

Rural-Urban Ecosystems Solutions

"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 wastewater 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.

Scientists are also advising governments on how to tackle waste challenges, helping for example to revise the National Sanitation Policy in Sri Lanka to include options for safe waste recovery and reuse.

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.



A Ghanaian woman selling yellow melons on the street contributes to the city's food supply. Credit: Hamish John Appleby/IWMI.

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](#).

Explore related content:

- [Press Release: Is waste the next big business opportunity?](#)
- [The Power of Rubbish: Making Money from Waste](#)
- [Press Release: New compost plant to aid the greening of Ghana's economy by recycling waste and delivering a safe, nutrient-rich fertilizer for food production](#)
- [Press Release: Global use of wastewater to irrigate agriculture at least 50% greater than previously thought, says new study](#)
- [Why the local food trend won't cut it in a climate change future](#)
- [The role of private sector in city region food systems](#)
- [Farm small, think big: How agriculture can help in today's global refugee crisis](#)
- [Women in Host, Refugee Communities Supporting Energy, Climate Change Integrated Planning](#)

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.



Sri Lankan capital Colombo is often struck by floods, but the city's wetlands have a storage capacity equivalent to 27,000 Olympic-size swimming pools and provide an important buffer. Credit: Shaoyu Liu/IWMI.

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.

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.

Explore related content:

- Fighting floods with 'sponge cities'
- 15 ways wetlands are vital for cities, food and people

- Re-conceptualizing dam design and management for enhanced water and food security
- Flood insurance in the climate change era: can science and tech help women get a better deal?
- Index-based flood insurance: torchbearer for reducing agrarian distress in India
- WISE-UP to climate: water infrastructure solutions for the Tana Basin
- Rethinking the role of nature in dam planning and management

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.



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.

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

Explore related content:

- [What's the truth about the role of women in agriculture today?](#)
- [Still marginalized after all these years... Why are things not changing for women in irrigation?](#)
- [Experimental games test efficacy of subsidies to encourage farmers to invest in natural ecosystem services](#)
- [Migration, water and the trajectory of rural change in South Asia](#)
- [New forms of empowerment and old axes of power - the complex reality of agricultural feminization](#)
- [Maybe the future of rural youth isn't in agriculture](#)
- [Have ESR-sponsored training courses stimulated uptake of ecosystem service science?](#)
- [Mending Asia's broken rice bowls](#)

Publication Highlights

Journal articles

- [Global sequestration potential of increased organic carbon in cropland soils \(*Nature*\)](#)
- [Long-term livestock enclosure did not affect soil carbon in southern Ethiopian rangelands \(*Geoderma*\)](#)
- [Probabilistic decision tools for determining impacts of agricultural development policy on household nutrition \(*Earth's Future*\)](#)
- [Valuing ecosystem services in semi-arid rangelands through stochastic simulation \(*Land Degradation and Development*\)](#)
- [Applications of satellite-based rainfall estimates in flood inundation modeling: a case study in Mundeni Aru River Basin, Sri Lanka \(*Remote Sensing*\)](#)
- [Hydropower versus irrigation—an analysis of global patterns \(*Environmental Research Letters*\)](#)
- [A coupled modeling framework for sustainable watershed management in transboundary river basins \(*Hydrology and Earth System Sciences*\)](#)
- [India's on-grid solar power development: Historical transitions, present status and future driving forces \(*Renewable and Sustainable Energy Reviews*\)](#)
- [Exploring the productivity and profitability of small-scale communal irrigation systems in Sub-Saharan Africa \(*International Journal of Water Resources Development*\)](#)
- [A global, spatially-explicit assessment of irrigated croplands influenced by urban wastewater flows \(*Environmental Research Letters*\)](#)

- Integrating wood fuels into agriculture and food security agendas and research in sub-Saharan Africa (*Facets*)
- Reframing women's empowerment in water security programmes in Western Nepal (*Gender & Development*)

Books

- Resource recovery from waste: business models for energy, nutrient and water reuse in low- and middle-income countries
- More people, more food... worse water? - Water Pollution from Agriculture: a global review
- Reutilización de aguas para agricultura en América Latina y el Caribe
- Fostering food security and climate resilience through integrated landscape restoration practices and rainwater harvesting/management in arid and semi-arid areas of Ethiopia

Briefs

- Reducing vulnerability among smallholder farmers through index-based flood insurance in India: equity matters
- The role of the private sector in City Region Food Systems
- Integrating gender into small-scale irrigation
- Gender-equitable pathways to achieving sustainable agricultural intensification
- River deltas: scaling up community-driven approaches to sustainable intensification
- Upper river basin watersheds: sustainable, equitable and profitable interventions
- Piloting managed aquifer recharge (MAR) in the Central Highlands of Vietnam to sustain groundwater supplies for irrigated smallholder coffee production
- Urban food-waste-energy nexus and the private sector (UA Magazine no 32)

Reports

- Guideline and indicators for Target 6.6 of the SDGs: "Change in the extent of water-related ecosystems over time"
- Groundwater governance: A synthesis
- Business model scenarios and suitability: smallholder solar pump-based irrigation in Ethiopia
- Mapping irrigated areas in the Limpopo Province, South Africa
- Beyond "more crop per drop": Evolving thinking on agricultural water productivity
- Multiple Uses of Small Reservoirs in Crop-livestock Agro-ecosystems of the Volta River Basin with an Emphasis on Livestock Management
- What happens after technology adoption? Gendered aspects of small-scale irrigation technologies in Ethiopia, Ghana, and Tanzania
- Wastewater: the untapped resource

In the News

- [Asia's environment is at a tipping point | The Diplomat](#)
- [India's water-logged farmers try out revamped flood insurance - Thomson Reuters Foundation](#)
- [Wastewater crop irrigation risks health of nearly a billion people - Deutsche Welle](#)
- [Gujarat's solar irrigation cooperative has a solution for India's groundwater crisis - India Spend](#)
- [Sink it or lose it: the carbon trade-off - Thomson Reuters Foundation](#)
- [Can solar pumps give Nepal's women farmers a brighter future? - Thomson Reuters Foundation](#)
- [Water crises are hitting our economies: Time to hit back with natural infrastructure - Thomson Reuters Foundation](#)
- [How dirt can clean the air - Scientific American](#)

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CGIAR Research Program on Water, Land and Ecosystems

The CGIAR Research Program on Water, Land and Ecosystems (WLE) is a global research-for-development program connecting partners to deliver agriculture solutions that protect our natural resources – and the people who rely on them. WLE brings together 11 CGIAR centers, the UN Food and Agriculture Organization (FAO), the RUAF Foundation, and numerous national, regional and international partners to find integrated solutions. The program promotes an approach to sustainable intensification in which a thriving ecosystem is a prerequisite to agricultural development, food system resilience and human well-being. WLE is led by the International Water Management Institute (IWMI) and partners, and supported by CGIAR, a global research partnership for a food-secure future.

Email: wle@cgiar.org

Website: wle.cgiar.org

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