CGIAR RESEARCH PROGRAM ON WATER, LAND AND ECOSYSTEMS

RESEARCH HIGHLIGHTS 2015-2016

CGIAR RESEARCH PROGRAM ON Water, Land and Ecosystems

LED BY: IWMI International Water Management Institute

AGRICULTURE 2.0: TOWARDS A GLOBAL REVOLUTION FOR SUSTAINABILITY

Farmers cultivating lettuce, while another farmer digs a small chanal (marrwa) with a donkey.
Hamish John Appleby (IWMI)

> "Sustainable management of water and land is not a matter of conserving nature and sacrificing productivity and incomes for farmers. Rather, it is the very entry point to be able to raise productivity and improve livelihoods."
>
> Johan Rockström, WLE Steering Committee Chair

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PHOTO: STEPHANIE LEDER/IWMI.

Gender highlights: Rural migration, the feminization of agriculture and empowerment

In Khoksar Parbaha village, in the Terai region of Nepal, Musandi is trying to haggle over the price of fertilizer with a middleman. She feels uncomfortable doing this.

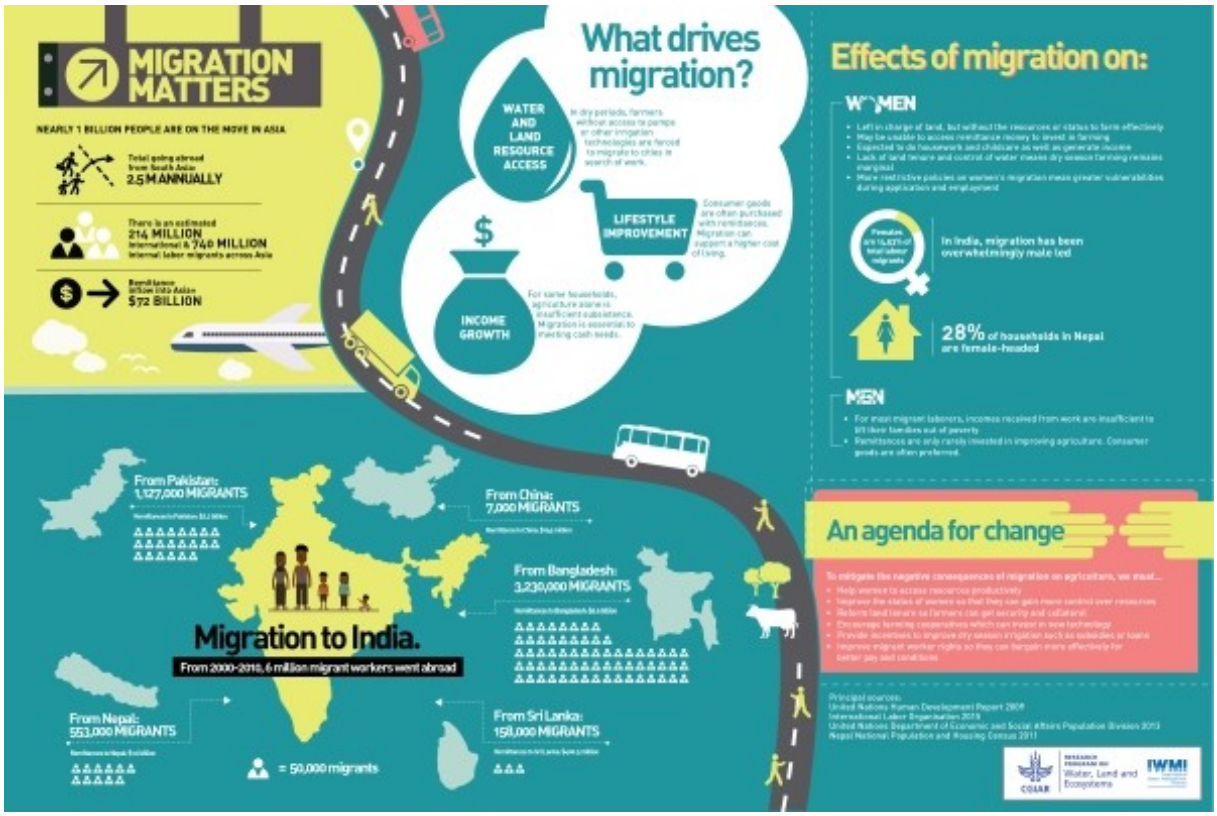
> "Since my husband left to look for work in Delhi, I have to deal with many "man" things for the farm. People listen more to my husband; he apply pressure so we get water for the fields on time, or negotiate for the right inputs. For a woman, it is not easy."

The rapid economic and social changes in remote, rural areas of the Eastern Gangetic Plains, like the Terai region, have fuelled a fast out-migration of young males towards the cities, resulting in an aging and feminizing of agriculture. Unfortunately, this 'feminization' has not led to significant changes in gender relations regarding access to and control over water, land and farming, as made evident by Musandi's situation.

"Addressing gender inequalities is certainly one of the most complex and challenging questions in the development arena. It involves changing mindsets and transforming power dynamics, which are deeply rooted in local social norms," explains Dr. Nicoline de Haan, lead of the Gender, Poverty and Institutions research theme for the CGIAR Research Program on Water, Land and Ecosystems (WLE).

Migration matters

In Asia alone, nearly one billion people are on the move. Because migration is an important issue, a conference held in Delhi in November 2015 explored the consequences of out-migration on the families and communities left behind by male migrant workers. In large parts of South Asia, a majority of families pursue a dual livelihood strategy: farming in the rainy season, often under highly unfavorable conditions; and low-wage migrant labor in Indian cities during the dry season. Remittances are not enough to lift families out of poverty and are often not invested in agriculture. For the women who are left behind, poor access to irrigation water, extension services or inputs makes farming very challenging.



IWMI.

The conference attracted great interest from development organizations and policy makers. New research is being explored to improve the access of female-headed households to land and other productive means. For example, groups of landless women could sign a joint lease on a piece of land and farm it as a collective, making larger irrigation investments more feasible.

Accounting for gender in policy and practice

Although governments and development organizations have had gender mainstreaming on the agenda for decades, there is often a gap between policy/strategy narratives and true impact on the ground.

The Poverty Squares and Gender Circles project assessed six development programmes in three countries in the Eastern Gangetic Plains (Nepal Terai, North Bengal in India and North Bangladesh), or the infamous "poverty square." The assessment found that initiatives had failed to reach the most vulnerable and did not address or act on deeply rooted social inequalities.

For women like Musandi in Khoksar Parbaha, speaking out in public spaces could lead to social opposition from the community. When her husband is absent, a brother or male in-law would be expected to speak for her, maintaining gender divisions of labor, knowledge and skills.

Many institutions, like the strategic irrigation water organizations, remain predominantly controlled by outspoken wealthy men who have the last say on how natural resources are to be managed. In a major water management publication, WLE research demonstrates that existing water governance structures lack mechanisms that make them accountable to poor and vulnerable water users on the ground, most importantly women.

To bring about real change, simplified measures such as setting quotas for women's participation in decision-making committees (like water user associations) are not enough to address underlying power differences. Involvement does not mean true empowerment.

In Africa, in Ghana's Upper East Region, a review of two prominent programmes in Bawku West and Bongo districts showed that there is a disconnect between how gender is perceived at the national policy level and women's actual aspirations at local level. Many women aspire to stop subsistence farming and participate in off-farm activities, like processing and trading. As such, they are looking for access to financial services, while

donors and national government are still focused on land rights, which may not be the most alienating factor.

Bringing about real change and empowerment

WLE researchers have facilitated training in villages of the Eastern Gangetic Plains, like Khoksar Parbaha, where male, female and mixed groups discussed differentiated gender roles in the farming and domestic sphere. Inversed role playing is one technique used in these trainings, and helps women strengthen their bargaining skills while allowing men to realize the constraints women face when farming on their own.

> "Critical awareness of gender divisions is the first step towards women's empowerment" explains Stephanie Leder, a gender and poverty specialist from WLE and the International Water Management Institute (IWMI). "To make a real difference on the ground, trust and true participation are crucial. We have a lot to learn from these women and men, so we can adjust our interventions according to their reality."

Participatory gender training for farmers in the Eastern Gangetic Plains.

Stephanie Leder/IWMI.

A good understanding of the differentiated access to natural resources, like water for irrigation between men and women, can lead to better designed development initiatives. The project, Giving Latecomers a Head Start in the Volta Basin, has demonstrated that small reservoirs with built-in canals are the most functional for women, and that women often benefit more from informal schemes.
Increased access to knowledge and skills builds women's self-esteem and social position. Collective women's initiatives, like setting up women cooperatives or saving groups, are good vehicles to voice out women's demand for better land and water access.

Back in Khoksar, things are moving in the right direction. The 24 members of a community forest group, which includes 16 men, have just elected Musandi as their leader, after the previous male leader had misused the collective's savings. The men are confident they have made the right choice: "Musandi is our Ministry; she knows how to save and manage the group's money."

Acknowledgments

- A gender-sensitive approach to dry season irrigation: Piloting a participatory gender training for farmers in Saptari; Lead Center: IWMI; donor: ACIAR
- Migration matters, a regional dialogue on the impact of rural migration on women, New Delhi, November 2015
- Giving Latecomers a Head Start project is part of the WLE Volta and Niger regional program and is led by the Ghana Irrigation Development Authority in collaboration with the International Water Management Institute, the University for Development Studies and the department of Women in Agricultural Development from the Ministry of Food and Agriculture.
- G7: Poverty squares and gender circles: unravelling agriculture gaps, challenges and opportunities in the Eastern Gangetic Plains (Bangladesh, India, Nepal); partners: International Water Management Institute, Nepal Madhesh Foundation, Bangladesh Agricultural University, North Bengal University, South Asia Consortium for Interdisciplinary Water Resources Studies, Katalyst

PHOTO: NEIL PALMER/IWMI.

Waste to wealth: Solutions that recover resources and costs for a circular economy

We have a growing and seemingly unstoppable appetite for natural resources like land, water, forests and minerals. With steady population growth, changing diet and consumption patterns, an increasingly urban population, reckless overuse of finite resources, and rising pollution due to excess nutrient run-off, humans are taking a heavy toll on the environment. To lower our ecological debt, it is urgent to start mining resources from waste instead of nature.

Pit latrine emptiers in Bangladesh collect and transport human waste to a site where it is processed into fertilizer.

Neil Palmer/IWMI.

The total value of resources recovery, not just the market value

Farmers need phosphorous; the 'P' in NPK fertilizer is an essential nutrient for plant growth, building cells and transferring energy. However, this very strategic mineral resource is localized in a small number of countries and may be depleted in a few decades.

Some experts from the CGIAR Research Program on Water, Land and Ecosystems (WLE) argue that agriculture can be a sustainability change-maker by shifting from consuming the largest amount of phosphorous (currently about 90% of mined P) and instead, start recovering and efficiently reusing phosphorous from food and urban waste.

Unfortunately, recycled P cannot currently compete with the relatively low cost of mined P. WLE scientists are therefore working to demonstrate the total value of phosphorous recovery to shift the perspective of policy makers and agri-business. Recovering phosphorous brings invaluable

ecosystems services, like preserving the water quality of rivers and avoiding destruction of downstream marine stock, which helps preserve the livelihoods of coastal fishing communities. Such benefits are not monetized, but economists are working to make the values of P recovery into a bankable proposition.

A business case to lower urban food and energy bills using city sewage and waste bins

By 2050, two thirds of the global population will live in cities, the majority in developing countries. Given the greater density of consumption and waste in urban areas, municipal costs will continue to increase. As such, cities are looking for options that decrease waste, reduce environmental pollution and recover costs. Resource recovery and reuse (RRR) can offer all three benefits at once.

Pay Drechsel of WLE and the International Water Management Institute (IWMI) believes that RRR should become a necessary part of future sustainable city planning.

> "Instead of seeing wastewater as a source of pollution and an annoyance to be disposed of, cities could ensure it becomes usable water and creates employment opportunities. The same goes for food and solid waste, which are potential sources of organic fertilizer."

If urban and peri-urban agriculture sourced its irrigation water and fertilizer from bins and sewage, cities could reduce their environmental footprint, create jobs and help preserve scarce resources.

While many technical options for RRR are commonly known, taking an RRR initiative from idea to full-scale development is difficult, partly because they are highly dependent on public subsidies. To break this pattern, WLE and partners have developed a framework for exploring the feasibility of RRR business models based on experiences in six mushrooming cities in the global South (Lima, Bangalore, Kampala, Hanoi, Accra and Colombo). These business models account for the financial, economic and institutional realities in each location, which helps investors decide which RRR business option is the most feasible to implement.

In 2015, WLE supported and monitored the establishment of three public-private partnerships (PPPs) in Ghana, including the production of fuel briquettes from municipal solid waste, which at scale will recycle waste

from 150,000 inhabitants. Another PPP was Fortifer, organic fertilizer pellets made from municipal sludge, which was established as a brand after being officially recognized by the government of Ghana.

Fortifier pellets made from human waste in Ghana, West Africa.

Josiane Nikiema/IWMI.

Consumers and governments are unfortunately often not ready to go the extra mile or spend the extra penny to support fair pricing of RRR products while less sustainable, more cost-competitive options exist. For recycling initiatives to take off, convincing everybody – from governments to citizens and the corporate sector – is key to get the necessary policy and financing support.

An effective partnership to reuse wastewater for food in India

In India, there are around 550 sugar industries using 3.2 Mm3 water and generating 0.6 Mm3 of effluent per day. This water intensive industry in

the semi-arid state of Andhra Pradesh is leading the way for wastewater reuse and sector integration.

The RRR team has set up an innovation platform, gathering leading food companies, researchers, governmental institutions, and civil society groups to showcase and debate the pros and cons of different bio-refinery wastewater treatment options. The goal was to make the treated water safe for irrigation or fish production.

Wastewater collection pond and wastewater irrigated field at Muduvatti village from Kolar district of Karnataka, India.

Water4Crops/ICRISAT.

By integrating a constructed wetland to treat its effluents with a carefully designed mix of algae and bacteria for bio-treatment, a sugar plant in Lakshmipuram has become a source of freshwater for fisheries, a lucrative livelihood activity for women in the area. Irrigated by the treated water, yields of okra, aubergines and chilies have also increased by up to 40%. The constructed wetlands build on mechanisms from natural ecosystem services recommended by WLE researchers, and therefore does not require expensive treatment technology. This low-cost decentralized system has already been installed in 28 sites across India. In fact, at a recent review meeting, Indian policy-makers expressed their will to scale up such green technologies, in line with the Swachha Bharat (Clean India) governmental initiative.

As the progress in Ghana and India shows, RRR is taking off where there is interest and the right institutional and financial support. From

technological innovations to facilitation and implementation of new RRR models, WLE and its partners will continue to work towards full cost recovery and reuse of precious resources.

For WLE results on RRR, see our related publication series, in particular:

- Co-composting of solid waste and fecal sludge for nutrient and organic matter recovery, RRR Series 3
- Recycling and Reuse of Treated Wastewater in Urban India, A Proposed Advisory and Guidance Document, RRR Series 8
- Testing the implementation potential of resource recovery and reuse business models: from baseline surveys to feasibility studies and business plans, RRR Series 10

Acknowledgments

- Design and development of bio-treatment technique for Decentralized Wastewater Treatment system, India, under the EU/ India Water4crops research programme coordinated in India by ICRISAT with the following partners: MS Swaminathan Research Foundation (MSSRF), National Environmental Engineering Research Institute (NEERI), The Energy Research Institute (TERI), University of Agriculture of Dharwad, University of Agriculture of Bangalore; JAIN Irrigation, KCP Sugar Industries Corporation Ltd, SAB Miller India, Ugar Sugar Works, Euro India Research Center; contact persons: Mukund Patil (m.patil@cgiar.org), Suhas P Wani (s.wani (at) cgiar.org).
- RRR Business models, lead center: IWMI; partners: Makerere University, Indian Institute of Science, Hanoi University of Agriculture, Department of Water and Sanitation in Developing Countries at the Swiss Federal Institute of Aquatic Science and Technology, International Centre for Water Management Services, Swiss Tropical and Public Health Institute, GRUPO GEA; contact persons: Miriam Otoo & Solomie Gebrezgabher (m.otoo (at) cgiar.org).
- RRR Business models in West Africa, lead center: IWMI; partners: Jekora Ventures Ltd., Volta Ghana Investment Co. Ltd., Training Research and Networking for Development, Kumasi Metropolitan Assembly, Tema Metropolitan Assembly, RUAF Foundation, International Livestock Research Institute; contact person: Nikiema, Josiane (j.nikiema (at) cgiar.org).

PHOTO: GEORGINA SMITH/CIAT.

SOLUTIONS FOR SUSTAINABLE INTENSIFICATION OF AGRICULTURE

Healthy soils for healthy agriculture

As Heads of States were signing the Paris Climate Agreement last December, the 4p1000 global initiative was launched with the aim to increase the amount of organic carbon in soils by four parts per thousand every year. Such sequestration could quell the rise of global CO2 in the atmosphere.

Enriching soils with organic carbon is not only about mitigating climate change; it is a precondition to preserving soil health. And it matters a lot. Healthy soils are the foundation of our food security, providing important ecosystem services, like retaining water and nutrients for crops, protecting against soil erosion, and playing host to more soil microorganisms and worms. With healthier soils, farmers get higher crop yields; increasing the soil organic carbon sink in degraded soils by 1 ton per hectare increases crop yields of maize by 100 to 300 kg/ha.

Deborah Bossio took part in a panel discussion on soils at a COP21 side event.

CIAT.

Soil health and economic development are strongly interconnected. Malawi, one of the poorest countries in Africa, loses an estimated 11% of its GDP because of land degradation. Soil health is a prerequisite for the long-term sustainable impact of agricultural development programs in the global South.

> "The trouble is that we don't know much about soil health because quantifying it usually involves expensive and cumbersome methods", says soil scientist Keith Shepherd who leads WLE's Decision Analysis and Information Systems cross-cutting theme, "but this is changing as soil research is undertaking a big data

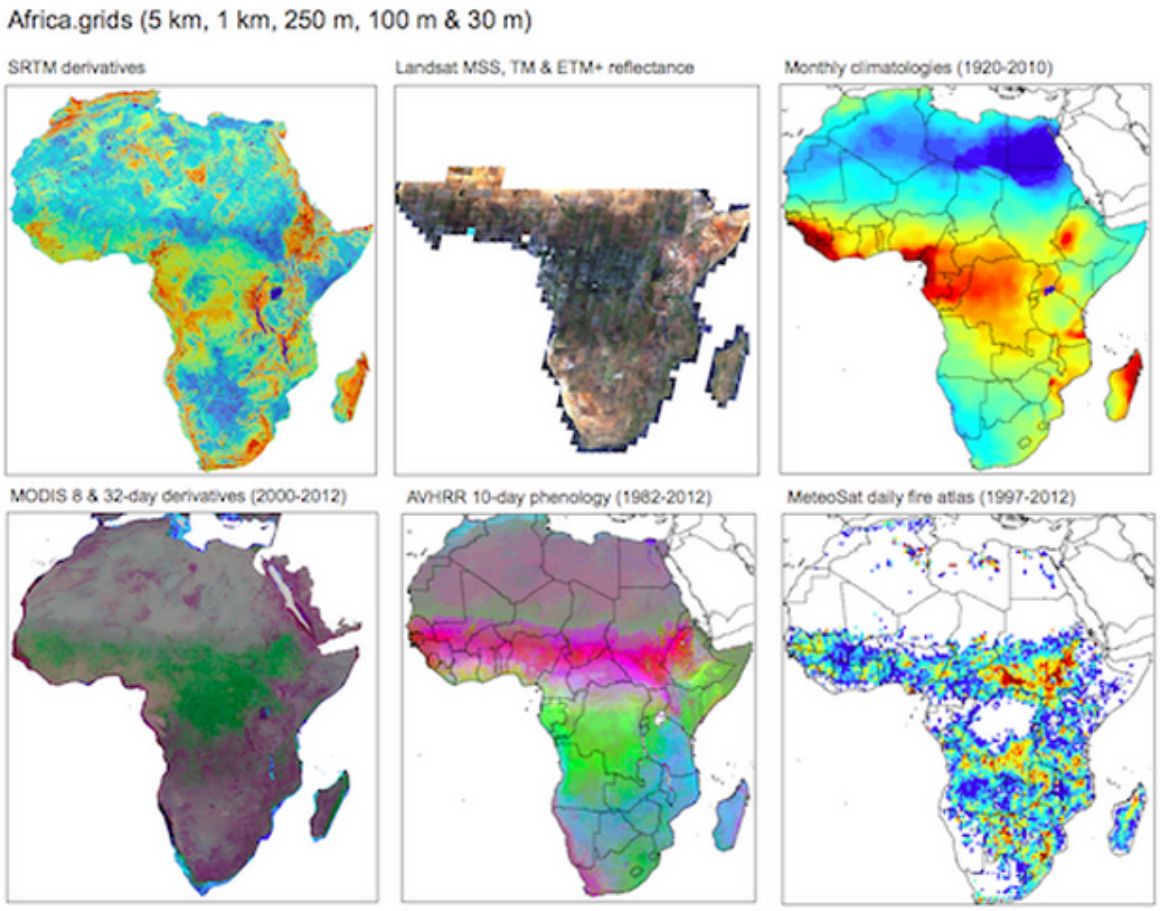
revolution to map soils faster and at lower cost."

Let there be light! Building low-cost, user-friendly soil information systems

Instead of measuring a long series of chemical reactions in laboratory test tubes, imagine being able to characterize soils by simply measuring the quantity of light reflected from a sample. Infra-red spectroscopy is fast – a sample can be analyzed in just 30 seconds – and provides a unique spectral signature on a computer screen, like a unique fingerprint, according to the mineral and organic matter composition of the soil sample. Once you have calibrated the method using a library of diverse soils, the cost per sample is greatly reduced.

Through the African Soil Information Service project (AfSIS), WLE has set up Soil-Plant Spectral Diagnostics Labs in ten African countries, and is helping Ethiopia, Ghana, Nigeria, and Tanzania conduct their first-ever soil health baseline, using this groundbreaking soil testing technique.

Over the last 6 years, AfSIS has built the most comprehensive soil sample database to date for Africa, with over 28,000 sampling locations. AfSIS gives accurate localized predictions of soil properties relevant for agricultural extension, such as organic carbon content and pH, as well as nutrient content, like total nitrogen or extractable potassium.



A sampling of maps being used to produce the first generation of continent-wide soil property maps.

Africasoils.net.

Development agencies have started using the benefits of these new soil testing methods for better planning. WLE is assisting the World Bank to improve soil health data monitoring in the household socio-economic panel surveys in Ethiopia and Uganda as part of the Living Standards Measurement Study (LSMS). Comparing farmer knowledge of soil quality – often based on soil color and texture - and data from spectral soil tests, a study in Ethiopia has shown that farmers are unable to discriminate between "poor" and "good" soil fertility levels, and are often overly optimistic about soil quality. The infrared method is seen as a feasible way to bring about better decision-making for future farming programs. WLE has also helped set up a soil lab for the NGO One Acre Fund in rural Kenya, which performs thousands of spectral soil tests per month, enabling them to assess the long-term impact of their agricultural programs.

WLE researchers have also developed the Soil Organic Carbon (SOC) Application, which calculates the quantity of organic carbon captured in a specific soil profile. The SOC App is able to quantify the impact of soil conserving practices on sequestration over time, and at different scales. This open-access application will help decision-makers assess to what degree land restoration efforts would contribute to carbon sequestration and climate change mitigation.

From more accurate soil health mapping to better farming

Some countries, like Ethiopia, have started investing in these new soil information systems because they understand that they could boost their agricultural production. The Ethiopian Soil Information System (EthioSIS), with the support of AfSIS, has been able to analyze agricultural soils in 570 districts to date, revealing significant deficiencies in nitrogen, phosphorus, potassium, sulfur, zinc, boron and copper. A Soil Fertility Status and Fertilizer Recommendation Atlas for 136 woredas (districts) has just been released, with visual maps for each woreda. These show thing like where potash fertilizer use is recommended, or where application of lime could help rehabilitate acidic soils.

It is estimated that if accurate fertilization recommendations were implemented at full scale, farmers' yields would increase by about 65 per cent on average. A large-scale extension scheme now needs to be rolled out. In order to start convincing the 4.5 million smallholder farmers to adopt these recommendations, 40,000 fertilizer demonstrations have already been carried out in collaboration with development partners and the Regional Bureaus of Agriculture.

With the right prescription to restore the soil health of their fields, farmers can reap more bountiful harvests while helping to reduce carbon emissions in the atmosphere.

Acknowledgments

- DAI 2: Information Systems for Land, Water & Ecosystems - Soil Information Systems: Lead center: the World Agroforestry Center (ICRAF) with the following partners: Earth Institute, University of Columbia, Columbia Global Centers- Africa, Ministry of Agriculture, Nigeria, Ministry of Agriculture, Food Security, and Cooperatives, Ministry of Agriculture, Ghana, Ethiopia Soil Information Service, Agricultural Transformation Agency, Ministry of Agriculture, Ethiopia, India Council of Agricultural Research.
- African Soil Information Service (AfSIS): AfSIS is funded by the Bill and Melinda Gates Foundation and is supported by close scientific, operational and implementation partnerships with the Agriculture

and Food Security Center (AgCenter) and the Center for International Earth Science Information Network (CIESIN) at the Earth Institute of Columbia University, the World Agroforestry Centre (ICRAF), and ISRIC – World Soil Information.

- Soil Organic Carbon (SOC) Application: led by CIAT under WLE, with support from Deutsche Gesellschaft für Internationale Zusammenarbeit, GIZ.
- Ethiopia Land and Soil Experimental Research (LASER) project under the World Bank's Living Standards Measurement Study (LSMS) Methodological Validation Program funded by UK Aid: implemented by the Central Statistical Agency of Ethiopia and the World Agroforestry Center (ICRAF).

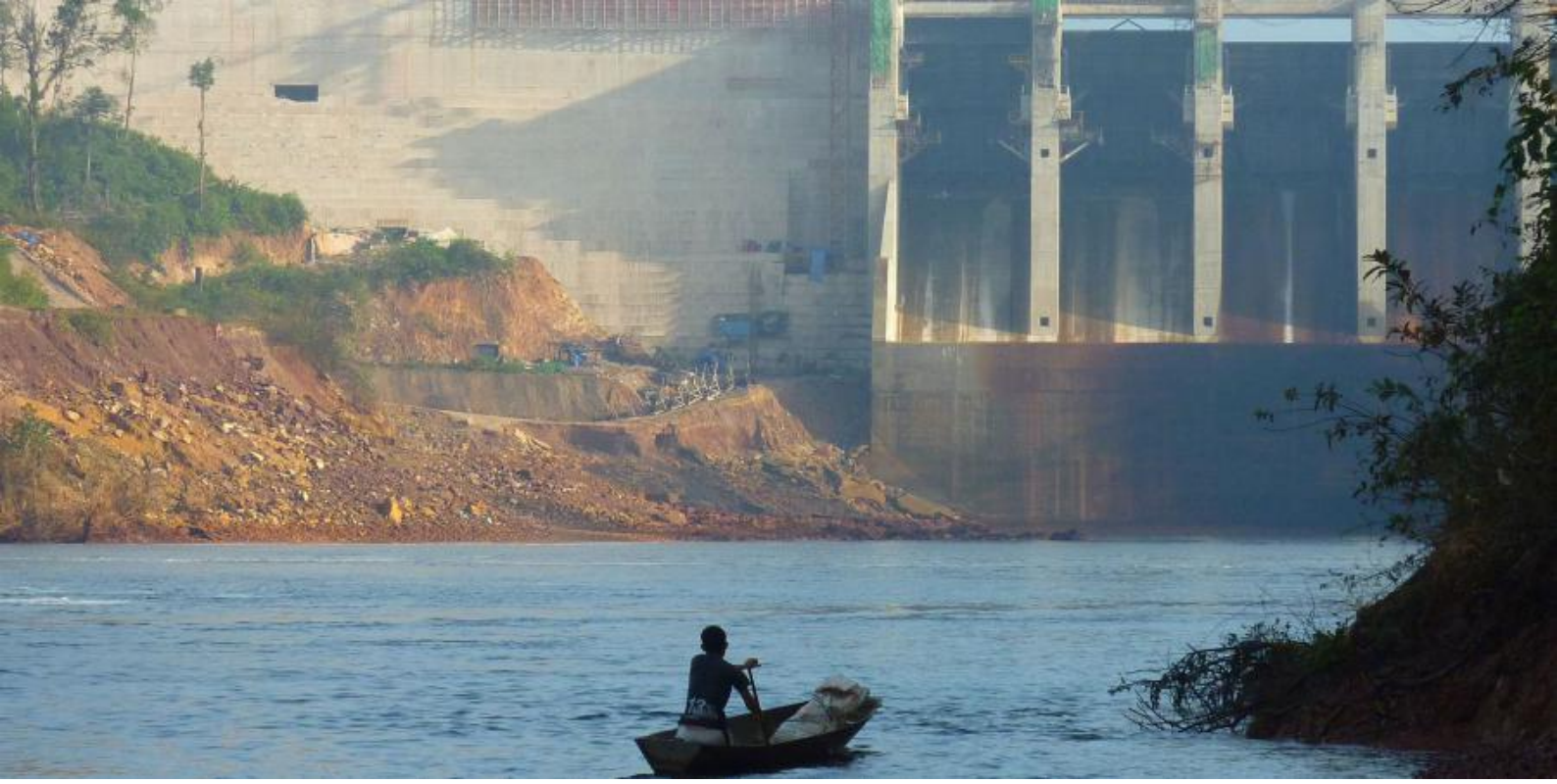


PHOTO: ERIC BARAN/WORLDFISH.

From conflicting demands to constructive solutions in the Greater Mekong region

> I feel like I'm losing the river, the place we used to live, catch fish and food. Once we have moved away, my grandparents will lie deep under water.

This is how Deng Kai, a villager in northeastern Cambodia expresses her loss. Her village, along with three others, is about to be resettled to make way for the Lower Sesan 2 hydropower dam, currently under construction.

Increased competition for access to rivers and related ecosystem services is one outcome of an ongoing hydropower boom in the Greater Mekong region. The demands placed on the region's rivers are often contradictory: a village might rely on a river for fish; all the while, a hydropower turbine upstream is impeding fish migration for energy production.

Scientists from the CGIAR Research Program on Water, Land and Ecosystems (WLE) are working to identify trade-offs in the water-food-

energy nexus looking for potential win-win solutions. Their aim is to support decision makers and investors to better share the benefits and services provided by rivers.

Unintended consequences of unchecked hydropower development

The Mekong River basin is home to one-third of the world's freshwater fish species, and is host to the world's largest inland fishery, with some 40 million people relying on fishing for food and income.

However, the health of these fisheries may be under threat.

A recently updated series of maps, developed by WLE scientists, illustrates the scale of current hydropower development in the Greater Mekong: of the 755 current and planned dams tracked on the map, about half (392) are for hydropower generation. This development is driven by an ever-growing regional demand for energy.

> "The maps offer a starting point for analyzing trade-offs," explains Kim Geheb, leader of WLE's focal region program in the Greater Mekong. "For example, one could start looking at economic trade-offs between land loss and agricultural productivity or economic benefits arising from electricity provision and supply to rural areas."

While hydropower does indeed provide benefits, it is also widely acknowledged that, if not very carefully managed, it could adversely impact both local livelihoods and biodiversity.

Sorting fish caught in Tonle Sap

In fact, scientists say that unless hydropower planning and management changes, species extinctions and basin-wide declines in fisheries and other ecosystem services are certain. Similarly, another recent study has revealed that planned dam development could result in a 60 to 96% reduction in sediment flow to downstream Mekong waters, leading to a significant reduction of fisheries and soil nutrients in the Mekong Delta, resulting in adverse impact on livelihoods and potential increase in tension in the region

New livelihood solutions for resettled communities

It would seem that the risks to local communities would outweigh the benefits when communities are resettled for hydropower development. In point of fact, WLE researchers have found that the trade-offs between energy generation and livelihoods -- both in terms of risks and benefits -- are very complex.

For example, in Laos, a study of four resettled villages located upstream from the 60 MW Nam Gnouang dam showed that the villagers' loss of access to the riverbanks meant loss of income from vegetable gardens and loss of livestock. On the other hand, access to the new reservoir meant easier access to water and a more stable fish catch throughout the year as well as more organized fish trading activities.

Scientists developed recommendations for how to establish alternative livelihood activities for all four resettlement communities and shared them with the hydropower company. As a result, the company has agreed to allow the communities to withdraw reservoir water for small-scale irrigation purposes. Furthermore, the company has expressed interest in providing support to improve fisheries management and wetland habitats for fish in the reservoir.

Innovative fish passage design to minimize trade-offs

While piloting livelihood alternatives is a large part of the WLE program, scientists are also working with the private sector to make water infrastructure more sustainable.

In Cambodia, the Lower Sesan 2 dam has been predicted to cause a 150,000 ton reduction in fish migration per year, which would dramatically threaten the food security of millions.

To limit the dam's adverse impacts, WLE and its partners have proposed a fish passage option that could be implemented without significantly compromising the dam's energy generation potential. The channel, which follows a naturally occurring waterway, would allow more fish to pass

unharmed, would consume at most 1.2% of the reservoir water, and result in no more than a 1.1% loss of planned power production. Scientists say that this type of fish passage could easily be retrofitted to other existing dams.

Villagers of Sre Kor village, Se San District, Steung Treng Province, travel on the river near the under-construction Lower Sesan 2 hydropower dam.

Samonn Mith/WorldFish.

Taking on the recommendation made by WLE scientists, the Cambodian Fisheries Administration, in partnership with the European Union, is now commissioning a six-month feasibility study to assess the efficacy of a fish passage solution for the Lower Sesan 2, alongside monitoring and evaluation of fish migration in the river basin.

Finally, WLE supports improved dialogue about hydropower and related trade-offs. Primarily, the program's annual forum on water, food and energy in the Greater Mekong brings together diverse stakeholders who have in the past struggled to engage in constructive exchanges. The aim is to foster constructive dialogue and support decision makers to successfully navigate the trade-offs along the nexus and create benefits for people and the environment, while leveraging water resources for energy production.

For women like Deng Kai, the costs of development are real and highlight the need for more inclusive ways to identify trade-offs and then fully identify solutions that provide the basis for all stakeholders to benefit. WLE scientists have taken a multi-pronged, solution oriented approach to water, food and energy related challenges. This recognizes that technocratic processes to managing water for diverse purposes need to be complemented with more deliberative processes that take into account social and political realities.

Acknowledgments

The solutions mentioned in this article are being developed by the following projects:

- Informing the design of fish passes in the Mekong led by WorldFish in partnership with the International Center for Environmental Management and other local institutions.
- Trade-off analysis and mitigation strategies for fisheries and aquatic ecosystem services affected by water development infrastructure led by WorldFish in partnership with local institutions.
- Creating reservoir wetlands for fisheries and other ecosystem services led by the International Water Management Institute in partnership with the International Center for Environmental Management and other local institutions.
- The Greater Mekong focal region, funded by the Australian government.

PHOTO: FASEEH SHAMS/IWMI.

Solutions fit for farmers and ecosystems can help double food production

The Sustainable Development Goal (SDG) on zero hunger is a top priority on the international agenda, and eliminating hunger globally is naturally and inevitably tied to farming. Therefore, the SDGs have set a target to double agricultural production by 2030.

Doubling production in less than 15 years requires wide-scale transformation of food production systems. Since 80 percent of food consumed in large parts of the developing world is provided by 500 million small farms worldwide, innovations will need to be suitable and profitable for smallholder farmers.

At the same time, growing pressure on ecosystems and natural resources necessitates that such new solutions—whether institutional, social, biological or technological—be sustainable. The CGIAR Research Program on Water, Land and Ecosystems and its partners are testing new innovations and technologies that support efforts to increase food production, improve livelihoods and enhance ecosystems.

Access to information facilitates adaptation, reduces conflicts

Technologies that increase farmers' access to information are proving to be effective in strengthening their incentives to adopt new, more efficient and more sustainable farming practices. Information allows farmers to make smart, low-risk choices, enabling them to produce more food while spending resources more efficiently.

In Ghana and Ethiopia, scientists are testing "wetting front detectors," a soil moisture measuring device that helps farmers to irrigate less. These are small tubes buried in the soil that contain a calibrated float; when the soil reaches a certain level of moisture saturation, the float rises, making it easy for farmers to tell when their fields have been sufficiently watered.

So far, wetting front detectors are proving successful in maintaining or even increasing crop yields while reducing irrigation frequency, consequently saving time, labor costs and precious water resources.

Kelil Melekeso, a development agent, demonstrates a wetting front detector in Ethiopia.

Apollo Habtamu/IWMI.

"In the past, we have experienced that farmers, especially the poorest and most vulnerable, have been unable to take up new practices, such as irrigating less," explains Jennie Barron, co-leader of WLE's Sustainably Increasing Land and Water Productivity theme. "Access to information that provides greater certainty about a new practice can be a tipping point for farmers, giving them sufficient confidence to change."

Information sharing has also proved an effective strategy for reducing conflicts over water. This is the case in Pakistan, where farm productivity is affected by an imperfectly designed irrigation canal system. Particularly as the population grows, the canals no longer deliver an adequate amount of water for each farm plot. This has led farmers to believe that the canals are unfairly managed.

In order to test this theory, scientists introduced a simple technology for recording water levels along canals. Each day, data is collected, analyzed and translated into useable information by a computer software. Notices about the amount of water received along the canal are posted in the area weekly, allowing farmers to see that, while the canals may be inadequate, they are fairly managed. This, in turn, has reduced conflicts over water and provided incentives for increased cooperation.

New technologies increase yields, save resources and effort

In other cases, innovative technologies themselves reduce the amount of both labor and resource inputs required, thus making production more efficient.

For example, the development of an affordable, small, new plough has made it much easier for resource-poor smallholders in the Nile Delta to adopt raised-bed farming, which conserves water and soil. Scientists working with farmers to test the plough are reporting remarkable results, including a 25 percent saving in applied water, a 25 percent decrease in farming cost and a 15 to 25 percent increase in crop yields.

One farmer in the Nile Delta, Abdullah Sheikh, said: "For a thousand years, my family has been working the land the same way - flooding fields and planting seeds by hand. But this machine saves us much labor, seeds and effort." By using the raised-bed plough, Sheikh has nearly doubled the yields of his two acres of wheat, while using about a third less water. The plough is being put into use all over Egypt, as well as to other countries in the region such as Ethiopia, Eritrea, Iraq, Jordan, Morocco, Nigeria, Uzbekistan and Sudan.

A new plough makes easy raised-bed farming, which conserves water and soil.

ICARDA/CGIAR.

In Kenya, Uganda and Ethiopia, biofertilizers are being tested as an alternative or complement to chemical fertilizers. Biofertilizers such as rhizobia inoculants are cost effective and environmentally friendly. These natural-occurring microorganisms are intentionally multiplied and added to a carrier material like peat. Adding these kinds of biofertelizers not only boost yields, but also increase soil fertility by fixing nitrogen in soils, increasing crops' uptake of nitrogen, or both.

National and international agricultural research institutes across sub-Saharan Africa have been working with farmers and local businesses to establish markets and enabling policy frameworks for biofertilizers. In 2015, about 15,000 smallholder farmers used biofertilizers on their farms, which increased their yield and, by extension, food security.

> "Globally, the greatest opportunity for reaching the SDG on zero hunger is to invest in smallholder farmers' role in transforming

food production systems. This is where we have opportunities for production increases as well as water, land and labor productivity gains," says Barron. "The gap we have to overcome has nothing to do with farmers' willingness to change, but everything to do with researchers' ability to make knowledge and innovations accessible for the transformation."

Acknowledgments

The solutions presented in this article have been developed by the following projects:

- Enhancing Ecosystems Services through Dialogue led by the International Water Management Institute
- Innovation Lab for Small-Scale Irrigation in Sub-Saharan Africa led by the Texas A&M in collaboration with International Water Management Institute, the International Livestock Research Institute and the International Food Policy Research Institute and funded by the US Government initiative on Feed the Future
- A fact-checking approach towards strengthening evidence-based policy and technology implementation in the Nile Delta led by the International Center for Agriculture Research in Dry Areas
- Institutionalization of quality assurance mechanism and dissemination of top quality commercial products to increase crop yields and improve food security of smallholder farmers in sub-Saharan Africa – COMPRO-II led by the International Institute of Tropical Agriculture and funded by the Bill and Melinda Gates Foundation. Read more about the project's WLE-specific activities.

PHOTO: GEORGINA SMITH/CIAT.

SOLUTIONS FOR SUSTAINABLE INTENSIFICATION OF AGRICULTURE

Collective, integrated efforts and diversification for farmer resilience

Andrea Maji, a Tanzanian farmer from Seloto village in Babati district, looks in despair at the stream that used to flow through his farm and irrigate his crops during the dry season. The riverbed is parched, meaning his maize plants are drying out; yet another lost harvest because of this year's El Nino induced drought that struck East and Southern African countries in 2015.

Like many neighbouring farmers, Andrea can do little but watch his entire crop waste away as he is not insured against weather hazards. In addition to food security worries for him and his family, he will have less capital to invest in the next growing season, and if another disaster strikes, fewer resources available to cope with it.

Researchers work with extension agents and farmers to scale up more sustainable and climate resilient farming practices. Babati district, Tanzania.

IITA/Gloriana Ndibalema.

Improving resilience of smallholders is key for poverty reduction

Farmers are finding innovative ways to adapt to climate uncertainties but it is often the poorest farmers that are both the most vulnerable and have least capacity to deal with unexpected events. While 2.5 billion smallholders rely directly on agriculture to survive, their resilience – i.e., being able to absorb and recover from shocks and stresses while adapting to cope with them the next time – is highly uneven. Scientists from the CGIAR Research Program on Water, Land and Ecosystems (WLE) are working with local partners to identify, test and scale up actions that increase the resilience of smallholder production systems and livelihoods.

> "Any initiative aiming at improving farmers' resilience should also take into account the resilience of the ecosystems," Bioversity International landscape ecologist Sarah Jones reminds us. "Only healthy and resilient ecosystems can continue to deliver services

> that are valuable for sustaining local livelihoods, such as nutritionally diverse food supplies, good quality water and healthy soils."

CIAT agronomist Fred Kizito explains that the impact of a climate shock like the 2015 drought will be felt differently in different farming systems.

> "When designing solutions to help a farmer like Andrea cope better in the future, we have to take into account his local climate, environment and socio-economic conditions."

Fred is studying water dynamics in places like Seloto to get the bigger picture of how water is used and give better advice on what crops would produce the best yields with less water.

A collective effort to build resilience for farmers

While having farmers adopt practices and technologies that improve their personal resilience is worthwhile, building meaningful collective resilience requires an adequate extension strategy. WLE scientists working in Tanzania have found that, in order to scale up more sustainable and climate resilient farming practices in places like Seloto, it is essential to target suitable agro-ecologies and work together with established outreach networks (e.g., agro-dealers). 150 farmers are now implementing WLE recommendations in Babati district, and the approach has spread to five other districts as well.

A farmer-to-farmer video in Kenya further emphasizes that resilience at the landscape level can only happen through collective action. For instance, to effectively tackle an infestation of striga (a parasitic weed that can be especially harmful for maize and sorghum cultivation), all farmers in a landscape have to follow a strict control and restoration recommendations and work together. If even a few farmers do not follow these recommendations, rain will sweep their striga seed infested topsoil downhill and contaminate neighboring fields.

Resilience is more than adopting new technologies or practices

Resilience is not just a technical issue; it is also dependent on social,

economic and institutional factors, like domestic dynamics, market access, government policies, and existing institutions. For instance, in parts of the world where women have poor access to capital or education opportunities, they are likely to have a lower capacity to handle shocks and stressors than their male counterparts.

Community Seed Bank in Uganda that is part of Bioversity International's Pest and Disease initiative.

D. Jarvis/Bioversity International.

For farmers to choose resilient options like crop diversification, setting up the right market conditions and policies is essential. Under WLE guidance, over 20,000 farmers from Kabwohe, Uganda have established a community seed bank that includes over 50 common bean varieties and 40 banana varieties, giving farmers reliable access to crop biodiversity. This community gene-bank received a national award for seed management excellence from the government of Uganda.

In a time of growing uncertainty, to ensure that farmers are better

equipped for the next shock, communities and decision makers have to consider the multiple factors that influence resilience. WLE has developed a monitoring instrument for resilience to better track changes in resilience in any agricultural initiative, including monitoring the adaptive capacity of farming and fishing communities, as well as changes to ecosystem services and livelihoods.

For Andrea, preparing for further disaster is critical. He is now one of two farmer representatives in the Babati multistakeholder Research for Development platform, JUMBA, which includes not only farmers, but two representatives each from local and regional government, national and international research institutions, extension services, Non-Governmental Organizations (NGOs), the private sector and policy makers. JUMBA was established to speed up the response of research and extension to new threats. Andrea is reassured that farmer voices are being heard and that, by working together, the platform can plan a more resilient future for farming.

Resilience for smallholder farmers requires a multidisciplinary, integrate approach that not only promotes better technologies and farming practices, but also a suitable socio-economic and ecological context. Initiatives like JUMBA are a step towards ensuring positive futures for agricultural communities in the face of uncertainty.

Acknowledgments:

- Regulating current and future damage from pests and diseases through enhanced use of intra-specific crop diversity in agricultural production landscapes; Lead Center : Bioversity. Partners: Unión de Organizaciones Campesinas Indígenas de Cotacachi, Institut Agronomique et Vétérinaire Hassan II, National Agriculture Research Laboratories, Sichuan Academy of Agricultural Sciences, Yunnan Academy of Agricultural Sciences, Yunnan Agricultural University; Donor: IFAD
- CIAT participatory video in Kenya was produced under a GIZ-funded Scoping studies on soil research and management project
- Monitoring instrument for resilience, CCAFS, WLE and FTA
- Water dynamics study in Tanzania, CIAT under Africa Rising initiative

PHOTO: GEORGINA SMITH/CIAT.

SOLUTIONS FOR SUSTAINABLE INTENSIFICATION OF AGRICULTURE

Cooperation for long-term landscape health

A camera crew is filming a field of stunted maize plants in Malaswa village, Ntcheu District, Malawi. They interview a farmer who explains that the seasonal heavy rains washed away seeds and fertile topsoil from his fields again last January, leaving him and his family of five with great food insecurity.

This is not your usual film crew; Eliasi, Maria, Baison, Hana and Kagolo are farmers from Malaswa village. The have been trained by CIAT in partnership with a CGIAR Research Program on Water, Land and Ecosystems (WLE) project during a six day participatory video workshop to present, via film, their own vision of how land degradation could be reversed in their community.

Malaswa, like many villages in sub Saharan Africa, suffers from severe land degradation, with red sandy fields lacerated by gullies. These fields are unable to efficiently absorb the flashflood rains that come after long dry periods. What can be done to stop severe soil erosion in Malawi, where 50 tons per hectare of soil are lost every year?

Capturing farmer perspectives

> “One condition for success is to first ensure that farmers have a say in designing land restoration programs,” says Juliet Braslow, an agronomist from the International Center for Tropical Agriculture (CIAT).

Juliet has facilitated many farmer-led development consultation exercises in Malawi using participatory mapping and video. She knows that projects wanting to disseminate better soil conservation practices could easily fail if there is no input from the farmers. Discussions with Malaswa farmers about land restoration strategies revealed that, a decade ago, a tree plantation project failed to take hold due to lack of clear roles and responsibilities for tree care and the distribution of benefits.

Youth in Malawi discuss their water resources before mapping them.

Juliet Braslow/CIAT.

Farmers’ land use decisions, which may affect long-term soil health, depend on many social and economic factors. WLE and CIAT have

developed the Evaluating Land Management Options (ELMO) tool to help communities and development practitioners better understand local perceptions and explanations of the advantages, disadvantages and trade-offs of different land management options. In combination with more traditional surveys like household questionnaires, using ELMO can help farmers and decision makers identify what factors will make sustainable land management a more viable, desirable and profitable option at the local level.

Ethiopia pioneers the potential of land restoration

Ethiopia has already started investing in land restoration; the goal is to restore 15 million hectares by 2030 with strong involvement from local communities. It's ambitious, with aims to double agricultural production by 2023 in 3,000 watersheds.

For instance, in the Debre-Mawi watershed North West of Addis Ababa, farmers were mobilized to build soil bunds with 50cm deep infiltration ditches in order to conserve soil and water. WLE scientists evaluated the impact of the watershed program 5 years later, and found remarkable results. Water run-off had decreased by up to 71% and sediment loss by up to 81% across the watershed. The impact of the intervention differed depending on the location within the watershed, clearly indicating that conservation techniques should be tailored to each landscape, soil type and farming system.

In drier Amhara Regional State, in the 7,500 ha Yewol watershed, severe soil erosion has been successfully slowed, thanks to an integrated community-based watershed management program started in 2011 and piloted by WLE and its partners ICRISAT, Wollo University and the Ethiopian Institute of Agricultural Research (EIAR). Youth mobilization, terrace landscaping with rock hedges and greater legume cultivation have reduced erosion from the upstream to the lowlands.

ICRISAT scientist Tilahun Amede describes the step-by-step process that was undertaken to gain the approval and trust of the community and all key stakeholders.

> "We started by collecting baseline evidence and supporting quick impact solutions, like introducing improved crop varieties and sheep breeds. We then moved on to tackling more complex research issues. Gradually, seeing results on the ground, the regional government came on board and has since recognized Yewol as a learning site for the 14 other districts of Amhara."

Sharing the benefits of ecosystem services can mean healthier landscapes for all

Participatory action research on the status of ecosystem services at the landscape level could contribute towards solving challenging socio-political situations. In Myanmar, for example, a WLE project initiated a dialogue to assess how the (mis)use of natural resources in Kachin State – a conflict zone in the upper Ayeyarwady river basin – directly impacted the livelihoods of the local population. By conveying this evidence to local decision-makers, the project team hopes to promote more equitable benefit-sharing of land, water and other natural resources.

The launch of the first African Water Fund, the Tana-Nairobi Water Fund, in 2015 shows that different water users along a river basin can collectively define a reward system based on ecosystem services to promote sustainable basin management. Large water users downstream (like beverage companies) pay for upstream farmers to scale up good soil conservation practices so that the water quality is preserved. In this scheme, research plays the important role of monitoring the impact of the intervention on sedimentation so everyone sees and understands the value of the land restoration efforts, and the fund remains operational in the long term.

The Tana River watershed is Kenya's life blood. CIAT and partners are

exploring ecosystems trade-offs to benefit both the environment and improve farmer incomes and livelihoods.

Georgina Smith/CIAT.

Back in Malaswa, it's the final day of the video workshop. Eliasi, Maria and the crew have chosen to call their film "Let's conserve the environment by finding solutions to end poverty" to show the intimate link between land degradation and development. The film screening in front of the community is well received, and has fueled a conversation between farmers and the Forestry Department. Maria speaks for the group:

> "We are eager to invest more time in replantation projects but the timing for receiving seedlings is not correct. We also want more of a say in the type of tree we plant."

The Forestry district officials are listening to her. Hopefully, next time a forestry project is implemented in Malaswa, tree seedlings will flourish and help combat soil degradation.

Acknowledgments

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- Participatory mapping and video, and development of ELMO tool has also be done through EC-IFAD funded project Restoring degraded landscapes through selective investments in soil quality in West, East, And Southern Africa; and WLE Focal region projects in Malawi, Tanzania, Ghana and Kenya.
- Methods for sustaining soil and water conservation measures in Ethiopia, impact study of Debre-Mawi watershed land restoration program: Lead center: IWMI; this research has been supported by USAID (AID-OAA-A-11-00012), IFS (W/5565-1), Higher Education for Development (HED), USDA, Cornell University, the Norman E. Borlaug LEAP 2015, UC Davis, the First Presbyterian Church in Ithaca, the Blue Nile Water Institute, the Quarit Woreda office of

Agriculture and the CGIAR Research Program on Water, Land and Ecosystem's East Africa focal region program.

- Facilitating watershed management in Yewol Watershed of the Nile Basin, Ethiopia and Angonia-Moatize transect of Zambezi Basin, Mozambique for Improved Food Security and Ecosystem Services; Lead center: ICRISAT with Wollo University and Amhara Regional Agricultural Research Institute, Ethiopia as partners.
- MK 29: Working together for a better Kachin landscape - A landscape approach to the upper Ayeyarwady river basin: Building inclusive governance processes to address resource conflicts; Lead center: IWMI. Partners: Water Security Research Centre, School of International Development, University of East Anglia (UK), Friends of Wildlife, Yangon / Myitkyina, IUCN Myanmar, Yangon, London School of Economics, University of California, Berkeley, Shalom Foundation.
- WLE has contributed to the work on the Tana-Nairobi Water Fund, led by the International Center for Tropical Agriculture and The Nature Conservancy.

PHOTO: PRASHANTH VISHWANATHAN/IWMI.

SOLUTIONS FOR SUSTAINABLE INTENSIFICATION OF AGRICULTURE

Managing floods by balancing risks and opportunities

In November and December of 2015, the South Indian states of Tamil Nadu, Puducherry and Andhra Pradesh suffered from historically destructive flooding. These El Nino-induced floods inflicted an estimated $3 billion loss on the Indian economy and displaced more than 1.8 million people.

Globally, floods and droughts cause hundreds of billions of dollars of crop damage and loss of livestock and human lives each year. Unfortunately, the frequency and scale of extreme weather events like the floods in India are expected to increase due to climate change. Yet research also shows that, if effectively managed, floodwaters can be leveraged to intensify agricultural production, for example by supporting irrigation and additional crop cycles.

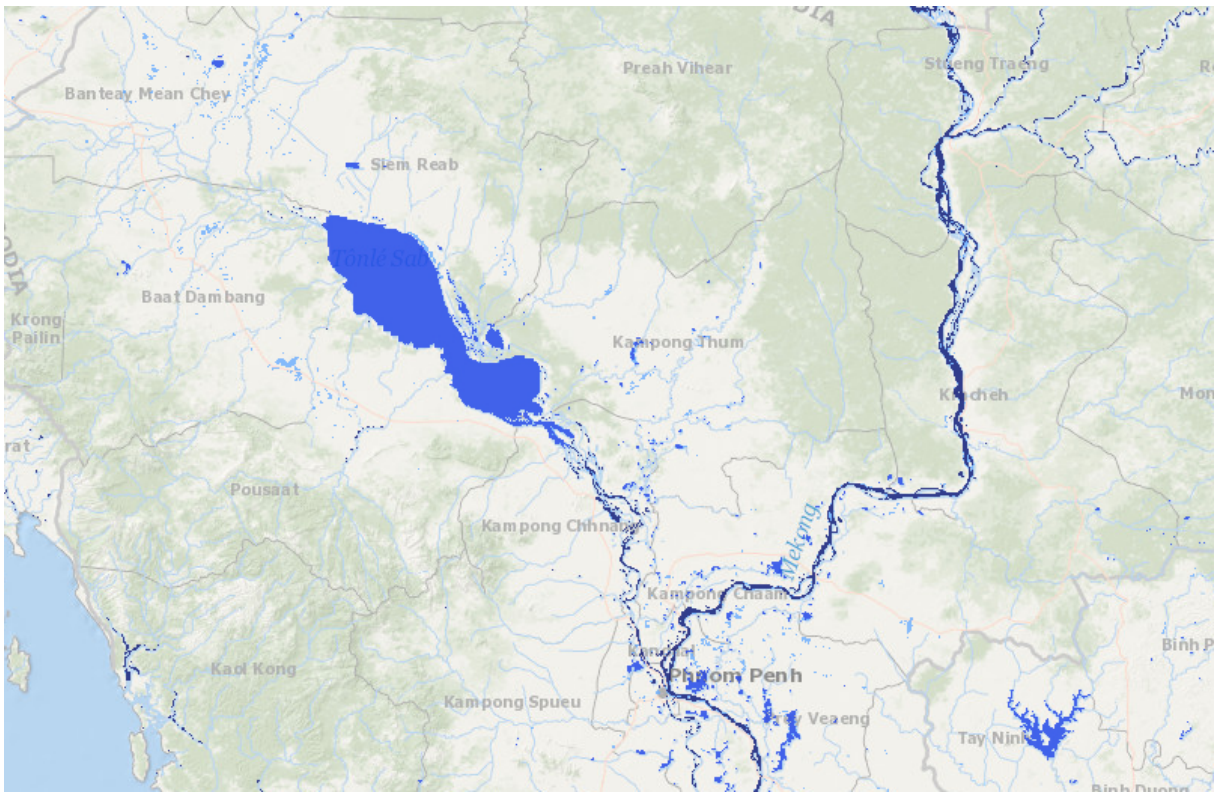
National governments and other decision-making bodies are increasingly seeking ways to manage water variability brought on by increasingly volatile weather. Scientists from the CGIAR Research Program on Water, Land and Ecosystems (WLE) are working to address flood-related risks and to find ways to harness floodwaters for productive use.

Information can provide early warning, improve planning

One avenue for increasing societies' resilience to, and productive use of,

floods is to provide access to information about flood events.

In South and Southeast Asia, scientists have developed a geospatial flood inundation mapping approach that, based on satellite images, can show floodwater extent and depth on land in near real time, with accuracy down to ten meters. Such maps have proved their worth as a tool for disaster relief planning, by helping authorities make immediate, medium and longer-term plans for recovery and reconstruction.



Flood risk mapping, Cambodia.

IWMI.

The maps can also support governments assess a flood event's total economic impact after the fact and inform their future decisions on, for example, where to put preventive measures in place.

Another promising aspect of this research is flood insurance.

> "Affordable insurance for flood-related crop loss is rarely available, but remote sensing and flood modeling tools could be used to identify critical parameters like flood duration, depth and

> inundation extent," explains Giriraj Amarnath of the International Water Management Institute (IWMI). "With this information, insurers could more accurately identify recurring patterns of floods in a particular area and thereby be able to offer farmers reasonably priced products for extreme weather events."

Scientists believe that information and communication technology can help mitigate the adverse impacts of floods by giving farmers and other users fast access to precise information. For example, a new application for handheld devices, called WetIn, provides users with early flood warnings for the Niger-Benue river systems in Nigeria. The application is expected to support local authorities' flood response planning by predicting rises in water levels three to four days in advance of floods.

Innovative solutions leverage floods for good

Beyond finding ways to more readily access and share information about floods, scientists are also piloting large, nature-based solutions for harnessing flood waters.

For example, a new concept called *underground taming of floods for irrigation* is being tested in India and will be piloted in Bangladesh. It is an innovative, community-based approach that aims to address the double challenge of floodwater destruction and groundwater depletion in areas where both are problematic at different times of the year. When water runs high in rivers and canals and flooding is imminent, scientists propose to divert this water into groundwater aquifers via small ponds or dams.

> "Essentially, the idea is that it would work like a community savings bank," explains Paul Pavelic of IWMI. "Local communities deposit water underground when there is an excess and withdraw it later, such as during the dry season, when it can be used for irrigation."

The solution is being piloted in Rampur district in northern India, and government officials have earmarked the concept for implementation across the district under a water management program led by the government.

In a similar vein, WLE scientists are promoting the perspective of

safeguarding natural infrastructure for managing and benefiting from floods. For example, giving space for rivers to flow over their floodplains can provide opportunity for exploiting the benefits for fisheries, flood recession agriculture and grazing.

In the Tana River basin in Kenya, such benefits of flooding are being compared with those obtained from more regulated flows, like those required to maximize hydropower production, to fully assess the trade-offs and synergies that may be achieved through alternative development pathways. The idea is that by harmonizing the planning and management of both built and natural infrastructure, it is possible to achieve the best of both worlds: maximizing the benefits and minimizing the costs of flooding.

Women transplant rice in an flooded paddy field following the traditional rice planting techniques in Karnal State in Haryana, India.

Prashanth Vishwanathan/CCAFS.

The incredible economic, human and environmental costs from extremes in weather and water insecurity can be managed if the right tools and approaches are utilized. WLE scientists continue to support national

governments and other decision makers by developing new tools that can increase access to information about floods and by piloting innovative, nature-based solutions that can leverage floods for poverty reduction and food security.

Acknowledgments

The solutions mentioned in this article are being developed by the following projects:

- Assessment of floods and droughts: Improved solution for mitigation and risk management in South Asia led by the International Water Management Institute (IWMI) in partnership with regional institutions. See also IWMI's rapid emergency response mapping website.
- Mitigating major floodwater impacts in Asia: The subsurface solution for damage control and livelihood enhancement led by the International Water Management Institute in partnership with the government of India and other regional institutions. And, Piloting and upscaling an innovative underground approach for mitigating urban floods and improving rural water security in South Asia, supported by the CGIAR Research Program on Climate Change, Agriculture and Food Security.
- Water infrastructure solutions from ecosystem services underpinning climate resilient policies and programmes (WISE-UP to Climate) led by the International Union for the Conservation of Nature in partnership with International Water Management Institute and other institutions.

PHOTO: NEIL PALMER/IWMI.

Research can underpin improved decision making in an era of uncertainty

In southern Burkina Faso, a small reservoir, about 300 by 1,300 meters, supplies eight communities with water for livestock, domestic uses and irrigation of vegetable gardens during the dry season. But the reservoir is filling with sand. Since constructed in 2002, a three-meter thick layer of sediment has been deposited, which both obstructs the supply of water and continues to reduce the reservoir's storage capacity.

Several possible solutions are being considered, including dredging the stream inlet, constructing check dams, which can filter out sediments, or instating buffer zones around the reservoir. But each solution comes with its own potential benefits, costs and risks, so how can reservoir managers select the best option, the one that leads to the best possible outcomes?

When the Ladwenda reservoir is full, it provides a host of benefits.

Denis Lanzanova/University of Bonn.

This question is increasingly relevant during an era when agricultural development is becoming more and more complex. Too often, agricultural challenges are approached as singular issues that can be addressed in isolation, stalling progress and sometimes causing adverse effects. Strategies for incorporating multiple objectives in supporting development decisions, while acknowledging risks and uncertainties, are urgently needed.

Scientists from the CGIAR Research Program on Water, Land and Ecosystems (WLE) are working to promote a new, integrated approach to decision making for sustainable intensification, which acknowledges underlying complexities and uncertainties. The goal is to arm decision makers with tools and methodologies that can support improved decision making for development outcomes.

Laying the foundation for good decision making

One issue that challenges good decision making is lack of data, or lack of access to data, on which to base choices. This problem is especially

apparent when it comes to management of river basins that span several countries, in which case decision makers must rely on national, fragmented sources information.

The Nile River basin, for example, is shared by eleven countries. Here, comprehensively measuring basin-wide flows of water has historically been difficult. That's why WLE scientists have been testing the concept of *water accounting+* across the basin, seeking to share and validate public domain remote sensing data and outputs from global hydrological models in an easily understandable and standardized way.

A water distribution canal in the Nile River basin.

Loney, Prue/IWMI.

Water accounting+ quantifies how much water is in a system, where, when and in what quality it is available, how much is demanded and consumed in time and place, and how well it is currently managed with respect to meeting those demands.

The accounts are aimed at a wide range of users across the water sector. They allow donors to identify the impact of their investments; water managers to define and track targets; water planners to assess the impact of drought, climate and land use change; basin authorities to get a better understanding of what is happening in their basins; and government agencies to measure baselines and identify progress towards national level targets.

> "By having more complete information and providing up-to-date, transparent and politically independent data in a consistent and coherent format, we hope to help governments and river basin authorities to make better and more informed decisions. This is the ultimate objective of the open access water accounting+ platform," says Lisa-Maria Rebelo of the International Water Management Institute.

Embracing complexity essential to achieve development outcomes

Another issue is complexity. Agricultural systems are very complex and therefore predicting the outcome of changes to the system – such as instating a buffer zone around the reservoir mentioned above – is difficult. To address this challenge, WLE scientists are exploring the field of Decision Analysis, which offers a holistic, systems-level approach.

Simply put, the decision analysis approach suggests to focus research on a particular decision, use the current state of knowledge to forecast decision impacts, draw on the knowledge of experts and stakeholders, take into account uncertainty, consider everything that matters, and use indications of uncertainty to identify information needs.

For example, in the case of the Burkinabe reservoir, scientists conducted a series of stakeholder consultations during which participants considered a wide range of risk factors – everything from costs of solutions to potential corruption – and detailed the degree of uncertainty for each factor. This data will be compiled in a model that projects the range of plausible losses and benefits for each decision and for each stakeholder. Ultimately, the model offers decision makers a clearer view of likely outcomes.

> "The significant difference here is that we try to include everything into the analysis, even what we can't quantify," explains Denis Lanzanova of the Center for Development Research (ZEF) at the University of Bonn. "Expressing the degree of uncertainty enables

us to distinguish between important and less important unknowns, giving direction for where to gather more information."

In the past, WLE scientists used a similar approach to assess a Kenyan water-transfer project designed to supply the county capital of Wajir with drinking water. The analysis predicted a significant risk of a negative investment return in the project.

Current pressures on the planet imply a need for sustainable intensification of farming practices, and the transformation needs to happen fast. But making such fundamental, global changes hinges on smart decision making. WLE scientists are providing options that allow flexibility to deal with issues at different scales, whether that be to communities in Burkina Faso, at basin level in Wajir County in Kenya or at the transboundary level in the Nile River basin.

Acknowledgments

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- Targeting agricultural innovation and ecosystem service management in the northern Volta basin led by Bioversity International.
- DAI: Water Metrics and Indicators for shaping policies and practices led by the International Water Management Institute.
- DAI 1: Decision Analysis and Risk Assessment – Stochastic Impact Evaluation led by the World Agroforestry Centre in collaboration with international partners.

PHOTO: AREGASH BACHA PUMPS WATER FROM HER PRIVATE WELL, NEAR MEKI, ETHIOPIA.

SOLUTIONS FOR SUSTAINABLE INTENSIFICATION OF AGRICULTURE

Ensuring women's access to irrigation for food security

Despite significant progress toward food security targets over the past couple of decades, more than 200 million people in sub-Saharan Africa remain undernourished. Increasing access to irrigation is proving to be one strategy toward reducing food insecurity on the continent.

Irrigation has been linked with higher crop yields and incomes. Small pumps, farm ponds and other affordable technologies could give millions of farmers access to water during the dry season, giving them opportunities to cultivate crops and earn money when other agricultural opportunities are limited.

Expanding irrigation is considered a major, untapped poverty alleviation strategy, and the potential for scaling up irrigation, especially in sub-Saharan Africa, is enormous. An estimated 39 million hectares are suitable for irrigation, while current groundwater use accounts for less than 20 percent of the available supply.

Overcoming constraints to include women in Africa's irrigation boom

It is good news that irrigation in sub-Saharan Africa is expanding. Yet,

research by scientists from the CGIAR Research Program on Water, Land and Ecosystems (WLE) is revealing that access to irrigation is not yet an opportunity equally available to all.

Women and resource-poor farmers are often constrained from enjoying the benefits of the ongoing irrigation boom due to a wide host of constraints and dynamics. WLE scientists have been working to identify specific constraints, understand why those constraints exist, and explore how they can be alleviated.

Research from the Volta and Niger river basins has identified opportunities, such as improving the design of technologies and facilitating women's access to finance and land, as well as introducing less labor intensive irrigation technologies.

WLE researchers have developed a gender in irrigation learning and improvement tool that can help strengthen gender integration in irrigation scheme planning. The tool was tested in Malawi and Uzbekistan in 2015, and several organizations, such as the National Smallholders Association of Malawi, have subsequently expressed interest in using the tool in their planning processes. Overall, researchers hope the tool can help decision makers ensure gender equity in irrigation small and large-scale investments and policies.

Irrigation technology and capacity development for food security

WLE is also working to improve women's access to irrigation through technological innovations, provision of investment mechanisms and capacity development.

In Ethiopia, for example, researchers have designed a "pail lifter", a device that makes it easier for women to access water from narrow wells because its simple pulley system reduces the brute force needed to lift water to the surface. The retrieved water is stored in a nearby tank and then used for drip irrigation. In the villages where this technology is being tested, women's improved access to water has resulted in increased production of vegetables, such as tomatoes and onions.

Likewise in Ghana, scientists have introduced irrigation technologies that use stored rainwater in a locally produced drip system to water homestead gardens. Here, both women and men farmers consider small-scale irrigation technology important to household food security, and report that they consume a percentage of the vegetables they grow. This, in turn, saves women time and money because they no longer have to go to the market to purchase vegetables to accompany meals.

Overall, scientists are beginning to explore an emerging hypothesis that access to irrigation could lead to benefits beyond improved food security, including improved nutrition, health, and resilience to climate shocks. For example, money saved as a result of growing vegetables at home instead of buying them at the market could be used to purchase more nutritious food.

In order to achieve sustainable intensification, which achieves goals beyond productivity, it is essential that agriculture benefits reach beyond measures of yield. WLE researchers continue to explore approaches and technologies that can help ensure equal access and opportunity for women and men to experience the benefits of irrigation.

Acknowledgments

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- Innovation Lab for Small-Scale Irrigation in Sub-Saharan Africa led by Texas A&M University, in collaboration with International Water Management Institute, International Livestock Research Institute and International Food Policy Research Institute with national partners and supported by USAID's Feed The Future initiative.
- V9: Giving 'latecomers' a head start: Reorienting irrigation investments in the White Volta Basin to improve ecosystem services and the livelihoods of women and youth led by the International Water Management Institute in collaboration with other partners.

PHOTO: PILAR VALBUENA FOR CIFOR.

ENGAGING WITH THE GLOBAL AGENDA

Thinking about landscapes at COP21 and GLF

World leaders convened for the 21st Conference of the Parties (COP21) in December 2015 to set the global climate agenda and ratify the SDGs. At the same time, the CGIAR Research Program on Water, Land and Ecosystems (WLE) was participating in the Global Landscapes Forum (GLF), an annual event held concurrently with COP where over 3000 practitioners and expert discuss land-use in relation to climate change. This platform allows participants to leverage the opportunity provided by the COP in order to shape the world's development trajectory to be more holistic, inclusive, and equitable.

WLE scientists contributed to both COP21 and GLF with evidence and experience on how landscape approaches can contribute to climate change mitigation and sustainable intensification of agriculture.

At GLF, WLE in cooperation with the International Food Policy Research Institute (IFPRI) and the International Center for Tropical Agriculture (CIAT) organized a high level panel on gender and land tenure. The panel focused on the practical requirements for implementing gender-sensitive land restoration while moving beyond the usual rhetoric on gender issues for practicable and equitable solutions.

During CoP21, WLE through researchers at CIAT was involved in the launch of an important 5-year program, which is part of the 4‰ Initiative: Soils for food security and climate. The program aims to mitigate climate change through soil carbon sequestration in at least five countries while improving agricultural production by increasing soil organic carbon and restoring soil health and fertility. According to Deborah Bossio, director of Soil Research at CIAT and co-leader the Regenerating Degraded Agricultural Ecosystems research theme, understanding the numbers is very important. 0.4% (four parts per thousand) a year is the rate of carbon sequestration in soil that is needed to help mitigate climate change. This would mean sequestering 3.5 Gigaton (Gt) of carbon per year, 0.4 – 1.2 Gt of which can be achieved in croplands. As such, it is necessary to think about agricultural lands interact with other land types, such as pasture, grasslands, forests and peat lands.

Some methods that have the potential to achieve the win-win of climate change mitigation and productive sustainable agriculture are: no-till agriculture; improving foraging practices in degraded pastures; evergreen agriculture, which would mean incorporating more trees into farming systems; better irrigation management; and recycling nutrients from waste produced in urban and peri-urban areas.

PHOTO: WLE.

Emphasizing biodiversity and ecosystem services in science and policy

Biodiversity and the ecosystem services it provides are being depleted at unprecedented rates. Modeled after the Intergovernmental Panel on Climate Change (IPCC) and established in 2012, the Intergovernmental Panel on Biodiversity and Ecosystem Services (IPBES) works to bridge the gap between science and policy on the topics of biodiversity and ecosystem services.

The Ecosystems and Resilience Theme of the CGIAR Research Program on Water, Land and Ecosystems (WLE) coordinated the engagement of more than a dozen scientists from multiple partner institutions with the IPBES. As part of this, WLE was assigned to work on a number of studies in preparation for the forthcoming Global Assessment.

These studies will touch on some important topics that are central to WLE's work, including an analysis of changes in agricultural ecosystems and the water-food-energy nexus. Doing this explicitly creates the critically important but often underemphasized connection that agriculture is part of ecosystems, not separate from it. As such, agriculture and agro-ecosystems have great potential to positively influence human well-being through the

delivery of beneficial ecosystem services.

> "The nominations of WLE scientists in IPBES underscore the strength of the program's ecosystem services-based research and the integral role of agriculture as a provider and beneficiary of ecosystem services", says Fabrice DeClerck of Bioversity, co-leader of WLE's Ecosystem Services and Resilience research theme. "IPBES provides an important opportunity for our scientists to both share and learn from these global assessments, while strengthening connections with existing national partners from our regional programs."

WLE scientists also contributed to the scoping document on the Sustainable Use of Biodiversity, which was finalized in August of 2016.

PHOTO: NANA KOFI ACQUAH/IWMI.

Influencing and contributing to the sustainability agenda

The launch of the Sustainable Development Goals (SDGs) in September 2015 marked a historic commitment to further strengthen sustainability across all levels of government, development, and the private sector.

The CGIAR Research Program on Water, Land and Ecosystems (WLE) has played an active role in shaping many of the SDG indicators and contributing to national implementation plans. The program has employed three main approaches to engaging in the establishment of targets and indicators over the past two years.

The first is through UN processes where WLE, through the International Water Management Institute (IWMI), has proposed or assisted in the final formulation of targets under Goal 6, regarding water and sanitation. WLE is working through the UN-Water Global Expanded Water Monitoring Initiative (GEMI), which is funded by SDC. A large part of this work is operationalizing SDG plans at the national level by participating in the GEMI "proof of concept" initiative, which tests the implementation of Goals 6.3 6.4, 6.5 and 6.6 in Uganda, Peru, Senegal, Jordan and the Netherlands. IWMI in particular is closely involved in the Ugandan case study and is using the data generated there to examine the ways that the information can be reported in an integrated way, linking water resources

to food security and agriculture.

The second avenue has been through the Sustainable Development Solutions Network. Researchers from the World Agroforestry Center (ICRAF) proposed five key principles for implementing a decision analysis approach that were published in Nature:

- Replace targets with measures of return on investment: decision makers should invest where the likelihood of positive returns for people and environment are the highest
- Model intervention decisions: instead of starting out by defining indicators, consider the interventions needed to reach a certain goal first, then identify relevant indicators Integrate expert knowledge: expert knowledge can help fill gaps and improve decisions where data is sparse
- Include uncertainty in modeling activities: considering the unknown, including social and behavioral factors, is key to making sound assumptions
- Measure the most informative factors: don't waste money measuring and tracking indicators that have little relevance

The third approach is to carry out research on relevant SDG processes. For example, in Ghana, WLE is rolling out the Mapping Ecosystem Services to Human Well-Being (MESH) model. This integrative modeling platform calculates and maps ecosystem service supply under different landscape management scenarios. MESH comprises built-in scenario generation tools, multiple ecosystem service supply evaluations, visualization of output maps and automated reprogramming functionalities. The Volta Basin Authority is testing the model's usefulness in supporting implementation of its 2012-2025 Strategic Action Programme (VBA SAP). The Volta Basin Assessment serves as the baseline documentation of the state of natural resources in the region.

PHOTO: WLE GREATER MEKONG.

ENGAGING WITH THE GLOBAL AGENDA

Creating a meaningful dialogue in the Greater Mekong

The large river basins of continental Southeast Asia shared by numerous nationalities and ethnic groups. The Mekong Basin alone spans six countries: Cambodia; China; Laos; Myanmar; Thailand; and Vietnam. Coordinating the development of these rivers is enormously difficult and fraught with disagreement, not only between nations, but also between sectors. With massive investment and rapid development of the region, communication, coordination, and mutual understanding is very important for maintaining ecosystems and livelihood activities that are equitable and sustainable.

The CGIAR Research Program on Water, Land and Ecosystems (WLE) in the Greater Mekong has research projects in four major transboundary river basins: the Mekong; the Irrawaddy; the Red; and the Salween. Working through partnerships with local and international organizations on the challenges that face the region, the program sees a need for dialogue spaces where people from all regional countries and all backgrounds can discuss these challenges.

As such, it has planned – in collaboration with regional partners and government ministries – the Greater Mekong Forum on Water, Food and Energy as an annual event. It is the largest event of its kind in the Mekong

Region focuses on regional knowledge-sharing, improving water-related discussions between stakeholders with differing interests, and interfacing innovative evidenced based solutions with non-technical participants from all sectors. The forum is also meant to be a safe space where difficult and controversial water-related topics can be discussed in a non-judgmental and informal way.

> "This is not a research conference," says Focal Region leader, Kim Geheb. "The forum is designed for knowledge users: government and development agencies, the private sector and research-for-development practitioners. We emphasize deliberation and listening, query and debate."

In 2015, the forum was held in Phnom Penh, Cambodia and was attended by 306 participants, representing 139 institutions. Of the institutions that participated, 13% were Cambodian, 9% Chinese, 13% Lao, 17% Myanmar, 13% Thai, 17% Vietnamese and 19% international; 20% were regional universities, 13% were regional NGOs, 12% were international NGOs, 10% were international universities, 9% were regional government, 7% were international research agencies, and the remainder other types of agencies (including 3% who were private sector, and 4% international government).

PHOTO: WLE.

PRACTICAL APPROACHES TO REGIONAL PROBLEMS

Improved infrastructure and governance increase productivity of polders in Bangladesh

About half of the coastal zone of Bangladesh is enclosed in polders, which are low-lying tracts of land surrounded by embankments incorporating water control structures, or sluice gates. Constructed in the 1960s and 70s, the polders were built to protect the people who depend on the land for their livelihoods from saline water intrusion and tidal floods. To these ends, the polders have been somewhat effective, but despite continued investment in the physical infrastructure of the sluice gates and embankments, poverty in the polders is rampant and agricultural productivity is low.

Scientists from the CGIAR Research Program on Water, Land and Ecosystems (WLE) and its predecessor, the CGIAR Challenge Program on Water and Food, identified poor water management as the major constraint to adoption of improved production systems in the polders. In particular, conflicting interests of water users within the polders leads to uncoordinated water drainage. This lack of coordination prevents the production of high yielding, shorter duration rice varieties and the timely

establishment of dry season crops.

By introducing technical solutions alongside new ways of collectively managing and governing sub-polders, the project has been able to increase agricultural and economic productivity and provide proof of concept. The project worked with local villages to implement the infrastructure improvements that were needed, and to collectively agree on which high yielding varieties of rice and fish would be farmed in the wet season, as well as which high value crops would be grown in the dry season.

Discussing polder management in the coastal zone of Bangladesh.

Duckrabbit.

Importantly, these interventions coincided with collectively made crop and water management decisions that would allow all farmers to benefit. Small water management units were delineated based on existing rural infrastructure and modified a bit to help farmers have control over and be accountable for their own small production areas. This reduced the number of conflicts stemming from who controlled the sluice gates and who was in charge of making decisions about draining or introducing tidal water.

The project has been so successful that USAID has agreed to fund a new initiative that builds on the work. This new project will work with the local communities from the entire pilot sub-polder to evaluate various cropping options with climate resilient and nutritious crops and further unlock the productive potential of the region.

Learn more

This project is part of WLE's work in its Ganges focal region. Established in 2015, the research for development projects in the focal regions are designed to address local challenges to sustainable intensification of agriculture. The projects are led and carried out by local partners.

PHOTO: ABBY WALDORF/WLE.

Harnessing floods for food production and environment in Sudan and Ethiopia

The semi-arid areas of sub-Saharan Africa do not immediately seem like sites of great opportunity. The Gash Die in Sudan, where the Gash River meets the desert in an inland delta, is a difficult place to secure water, not only because the resource is scarce, but also because agricultural schemes of the past have fallen into disrepair and new demands for water have emerged. In the Tigray Region of Ethiopia, the wet seasons bring floodwaters, but little is done to retain them for use during the dry months. Managing these scarce, seasonal floodwater resources more effectively for agriculture could help to improve local livelihoods and economies, while also benefiting the environment.

Scientists from the CGIAR Research Program on Water, Land and Ecosystems (WLE) are looking at how specific investments in infrastructure for flood based farming systems impact livelihoods and interact with the rest of the ecosystem. The goal has been to make the best use of floods for agriculture and nature in very specific biophysical and socio-economic landscapes. An important component of the project is working with local partners in order to collect data to show the economic value of floods, and how floods can be better managed to meet new demands. This data will

then be used to analyze investment scenarios for the upper and lower basins to show how the various scenarios impact the ecosystem services and livelihoods of local communities.

Researchers monitor the canal flow in the Gash irrigation scheme. Kassala State, Sudan.

Abby Waldorf/WLE.

In Sudan, the project has been researching how to make use of the vast fertile land in the Gash Die and looking at how to rejuvenate past water management initiatives that were able to re-route upstream flood water into the area. Part of this process is filling a financial and governance void by proposing revenue generation methods to fund the agricultural system while strengthening water user associations in the region. So far, the Gash Water User Associations, the Gash agricultural directorate and the state ministry of agriculture have endorsed the model and methodology proposed by the project.

In Ethiopia, the project has worked to pilot how different types of floodwater storage – for instance, shallow tube wells versus dug wells – work in different areas. Knowing the efficacy and impact of specific

technologies provides options to local decision makers and stakeholders.

Learn more

This project is part of WLE's work in its Nile and East Africa focal region. Established in 2015, the research for development projects in the focal regions are designed to address local challenges to sustainable intensification of agriculture. The projects are led and carried out by local partners.

PHOTO: NEIL PALMER/IWMI.

Inclusive, participatory process makes for more equitable planning in Laos

Communities and stakeholders affected by development investments in Laos, especially investments connected to the use of water and land resources, are commonly excluded from consultative processes. In addition, existing institutional settings, geared to single-sectors solutions, make it difficult to coordinate across sectors and government departments. A lack of agency coordination generally precludes consideration and understanding of sectoral interactions, which can have adverse and unforeseen economic, social and ecological consequences.

Scientists from the CGIAR Research Program on Water, Land and Ecosystems (WLE), who are working in the Greater Mekong, are trying to bridge this knowledge gap in the Nam Xong River Basin. They are accomplishing this by deploying a participatory process for making decisions on water, land and energy investments more inclusive and better coordinated. The objective is to enable decision makers to discover their own sustainable, novel and cross-sectoral solutions.

The Mekong Futures Research Institute (MERFI) is working with the National Economic Research Institute (NERI) of the Lao Ministry of

Planning and Investment, and the Department of Water Resources (DWR) under the Ministry of Natural Resources and Environment to identify competing and diverse water and land demands in the basin. In so doing, they hope to identify how livelihoods, the environment, and long-term basin productivity will be impacted by policy and how this policy interacts with investments. The project team have partnered with participants from different governance levels and sectors to create a coordinated planning process. This coordinated process enables the participants to identify and address unexpected feedbacks and consequences from existing investment proposals. The process allows them to discover new solutions, usually in the form of policy initiatives, which take into account the needs of various water and land users, as well as the needs of the environment, in order to collectively create a better balanced investment plan for the basin.

By working with representatives from NERI and DWR to implement the participatory planning process, collect data on household livelihoods, and identify specific impacts of development interventions, the project aims to improve the governmental understanding of how investments will bring about various livelihood, ecological, and economic trade-offs within the Nam Xong basin. An anticipated outcome is that this will improve inter-agency consultation and coordination when designing policy and planning for development of the basin.

To date, the project has facilitated the discovery by relevant stakeholders of completely new options for agricultural intensification that don't compromise ecosystem function, i.e. how to maintain minimum flows, improve livelihoods, and make basin management more gender equitable. These options take into account the needs of communities and sectors that have competing demands and interests, and integrate these needs in an inclusive way. This was made possible, in part, by the unprecedented coordination and cooperation between NERI and DWR in regards to data and knowledge exchange, which was catalyzed by the project design.

Learn more

This project is part of WLE's work in its Greater Mekong focal region. Established in 2015, the research for development projects in the focal regions are designed to address local challenges to sustainable intensification of agriculture. The projects are led and carried out by local partners.

PHOTO: NEIL PALMER/CIAT.

PRACTICAL APPROACHES TO REGIONAL PROBLEMS

Small-scale irrigation to counter food and nutrition insecurity in Ghana

Agriculture in Northern Ghana is heavily dependent on rainwater, but the region is prone to seasonal water variability and is at an increased risk of flood, sustained drought and waterlogging due to climate change. As such, it is estimated that only one third of the agricultural production potential has been reached in this important breadbasket region.

With limited access to irrigation facilities, communities in the area are prone to reoccurring food insecurity, malnutrition among children, and low household incomes. In order to ensure better sustainability and productivity in the area, it is important to secure a more reliable source of water for irrigation in the dry season, while also reducing the risk of flooding and water logging in the wet season.

Researchers from the CGIAR Research Program on Water, Land and Ecosystems (WLE) are piloting Bhungroo Irrigation Technology (BIT) in the region to try to improve water security, and by extension, food production and nutrition. Developed in India, BIT captures and store excess water on small-scale farms during the wet season by injecting it into unsaturated layers of soil. This water is then used for dry season vegetable irrigation,

the excess of which can be sold for additional household income.

Demonstrating Bhungroo technology.

WLE.

According to the experiences using the technology in India, the Bhungroo has the potential to capture and store at least 4000m3 of water per unit. The WLE project will work on validating these claims through its cropping and monitoring work during 2016's dry season. Trainings in target communities are ongoing to ensure that farmers, especially women and youth who have poor access to irrigation technologies, can operate and manage the Bhungroos themselves and reap the benefits of BIT.

Learn more

This project is part of WLE's work in its Volta–Niger focal region. Established in 2015, the research for development projects in the focal regions are designed to address local challenges to sustainable intensification of agriculture. The projects are led and carried out by local partners.

PHOTO: ADITI MUKERJI/ICIMOD.

PRACTICAL APPROACHES TO REGIONAL PROBLEMS

Tackling water scarcity in the mid-hills and plains of Nepal

Although Nepal is known for its rich water resources, there is great water scarcity in the mid-hills and the plains where the majority of the population lives. People in the mid-hills depend on springs, but spring sources are drying up for a variety of biophysical and social reasons, putting the water security of millions at risk.

In the Nepal Terai (plains), groundwater is plentiful and available at shallow depths, creating an opportunity for agricultural intensification. However, very little groundwater is used for irrigation due to erratic availability of electricity and the high financial and environmental cost of diesel. Cropping intensity is low, migration is rampant and land is kept fallow in winter and summer – all for want of affordable energy for irrigation.

A CGIAR Research Program on Water, Land and Ecosystems (WLE) project, led by the International Center for Integrated Mountain Development (ICIMOD), is working on reviving springs in the mid-hills and providing innovative financing for solar-powered irrigation pumps (SPIP) in the plains.

In the mid-hills, the project used an innovative and holistic methodology

to revive springs. Simple to follow, the eight-step method consists of: 1) mapping springs; 2) data collection; 3) understanding the social and governance aspects; 4) hydrological mapping; 5) conceptual hydrological layout; 6) identifying spring types and aquifer recharge; 7) developing management protocols; and 8) measuring impacts.

This method can be adopted by a diverse range of stakeholders, including local communities, researchers and local NGOs, and has been deployed in two sites in Nepal and one site in India. Partner organizations have already started adopting the methodology in their own work with encouraging results. Given the number of households depending on the estimated 4-5 million springs in the Hindu Kush Himalayas, mapping, understanding and reviving springs will have a tremendous impact on the livelihoods of people in the region.

A woman uses water from a spring for daily needs.

Tom Van Cakenberghe.

In the Nepal Terai, the project conducted a pilot study by providing three SPIPs to farmers as replacements for diesel pumps and carefully tracking their performance and impacts. Over the course of one year, the pumps

irrigated 9.1 hectares of land and resulted in diesel savings of more than USD 1,000 with no repairs or maintenance. They enabled a 30% increase in cropped area, allowed for cultivation of dry season vegetables, and doubled the number of farmers who benefited from the irrigation source from 15 to 30. This pilot attracted a great deal of government attention, to the point where a conversation between the former Minister of Irrigation and one of the project farmers influenced the current SPIP policy in Nepal.

The second phase of the pilot is estimating demand for SPIP by first testing three financial models: a) a benchmark model that offers a 60% grant (70% for women) to farmers with the rest paid up front; b) a 'grant cum loan' model that offers a 3 year loan for half of the farmer's amount; c) and a 'pay as you go' model that allows farmers to pay a monthly fee, resulting in pump ownership after three years.
The project reached a total of 2,573 farmers (25% of whom women) through an awareness campaign involving media and on-site demos. Within two weeks, the project received 143 purchase applications for of SPIP, 60% from women farmers. This is a dramatic figure given that that there are currently only 25-30 SPIPs in all of Nepal, most of which are installed by developmental organizations.

Learn more

This project is part of WLE's work in its Ganges focal region. Established in 2015, the research for development projects in the focal regions are designed to address local challenges to sustainable intensification of agriculture. The projects are led and carried out by local partners.

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