RESEARCH PROGRAM ON Water, Land and Ecosystems

CGIAR

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CGIAR Research Program on Water, Land and Ecosystems Strategic Research Portfolios:

Activity Cluster Descriptions

Updated as of March 8, 2013

WLE Strategic Research Portfolio (SRP) Activity Clusters

Contents

IRRIGATION SRP

Preamble

Irrigation has significant potential to stabilize agricultural production systems and associated economies against water scarcity and climate variability, which threatens to become even more problematic due to increasing demands for water by other sectors. Reliable and adequate irrigation improves crop yields, makes year-round cropping and farm employment possible, and enables growers to take on high value crops and its associated risks. Currently just 20% of the world's cultivated area is irrigated, yet these lands are responsible for 40% of global food production. In other words irrigation yields are 250 – 300% more than rainfed yields on the average. Irrigation, which accounts for 70% of fresh water withdrawals globally, can have negative impacts on landscapes, ecosystems, soils and biodiversity. Today, many irrigation systems are neglected or compromised by groundwater overdraft, sedimentation of dams, ponds, and canals, soil salinization and/or waterlogging.

There is enormous scope to improve irrigated agricultural productivity globally by expanding irrigated areas in Africa, and by rehabilitating and maintaining existing irrigation systems in Asia for the benefit of poor farmers. This must be done with due care and attention to ensure that these systems contribute to the provisioning of ecosystem services. Our research will lead to development of policies, practices and processes, and build capacity of irrigation managers resulting in an increase in food security at household and national levels, and increased incomes of small holders, without compromising ecosystem.

Theory of change

Public investment in irrigation systems is politically motivated. Private investment at commercial scales is motivated by profits, while at small holder level motivated by food security and income generation. Creation of an enabling environment for investments in irrigation by the public sector, commercial farmers and small holders, is the responsibility of policy makers. In order to influence the policy arena there is a need for evidence based information that incorporates both social and technical aspects of irrigation that influence the creation of an enabling environment. These enabling conditions will include incentives and free of the obstacles – both for farmers and government workers – to better the performance of irrigated agriculture. Sustainability of enabling conditions will require building institutional capacity of irrigation management agencies, through collecting and disseminating information and knowledge.

Title

AC 1.1 Irrigation in sub-Saharan Africa (SSA)

Problem to be addressed:

An estimated 70% of the 400 million poor that reside in sub-Saharan Africa live in rural areas and are dependent on the raising of crops and livestock. The Comprehensive Africa Agriculture Development Program (CAADP), prepared in 2002 under the New Partnership for Africa's Development (NEPAD), adopted land and water management as the first of its four pillars for priority investments. Pillar 1 aims to extend the area under sustainable land management and reliable water control systems to 20 million hectares by 2015, up from its current 7 million hectares. In response, several countries all ten SADEC countries have expressed a renewed interest in irrigation.

Expansion of irrigation is risky and requires appropriate information and knowledge to increase its chances of success while reducing social and environmental impacts. Large public schemes in Africa have a mixed success rate, while large irrigation companies are thriving. Recognition of small holders as viable irrigators – either from harvested water from rainfall or from groundwater is relatively new in many countries, requiring scaling out. Transformation of rain-fed landscapes into smallholder irrigation schemes at an increased rate will be essential to reduce rural poverty and increase food and nutrition security in the region. The impact of large private irrigation companies on small holders is unclear. Consequently, sustainable models of management where large scale developments benefit small holders need to be identified. As such it is incumbent on to ensure that existing livelihood support, particularly for disadvantaged groups, and the natural resource base are not compromised.

Intermediate Development Outcomes

1. Food and nutrition security will be improved in semi-arid and drought-prone areas by extending irrigation technologies to smallholders.
2. Institutional mechanisms will be developed in collaboration with irrigation agencies to operate and maintain public and private large schemes in a sustainable manner.
3. Rural poverty reduced by incremental establishment of smallholder irrigation, ensuring access to women and disempowered groups through balanced development.

Research outcomes

1. Plans that ensure building of social capital for development of smallholder irrigation are in place in 3 to 6 countries under the auspices of national ministries in SADEC countries, Ethiopia, Ghana, Kenya, Nigeria and Tanzania. Details include: prospective development areas; change processes; negotiation methods; water resources study; irrigation value chain analysis; social development policy; micro-finance, tenure arrangements.
2. Resource implications and potentials for food productivity; analysis of investment potential ; social and environmental impact are quantified

Research outputs

1. Assessment of irrigation potential in four regions (the Nile, Volta and Limpopo River basins) which identifies areas beneficial to smallholders, particularly women and disadvantaged groups
2. Alternative technologies and institutions are evaluated with a focus on increased resource-use efficiency for water, land and energy;
3. Analysis of socially differentiated irrigation impacts on food, nutrition and livelihood security, and on ecosystem services;
4. Recommendations for high-level investment opportunities are presented to policy makers, investors, NGOs and other development planners;
5. Capacity of local organizations is improved to plan, manage and maintain local irrigation.

Approximate timescales for delivery: Evaluation and planning (3 y); Implementation design (5y); Performance review and improvement (10y)

Budget over next 3 years: 2012 3m; 2013 5m; 2014; 8m.

Title

AC 1.2 Revitalizing Public Canal Irrigation

Problem to be addressed

Well-managed canal irrigation systems in the developing world have been a powerful force for poverty alleviation within and outside agriculture. Investments in large, public irrigation systems increased steadily during the 1970s and 1980s and impacts for food security and poverty alleviation have been significant. At the same time, most of the water resources in the region have become polluted and the productivity of systems varies greatly. Moreover, as financial resources available for public systems have declined, many have become part of a build-neglect-rebuild syndrome, and suffer from poor maintenance, resulting in low delivery performance. Insistence on farmers' willingness to pay sufficient irrigation service fee to recover the cost of operation and maintenance (O&M) has failed. There is a need to develop alternative models to recover O&M cost along with their implementation.

Recent appreciation of the extent of recycling of canal water and improved reliability due to introduction of groundwater pumps, is requiring irrigation managers to view irrigation system performance on the basis of contribution to system level outcomes (SLOs), instead of traditional indices of delivery performance. In other words, we need to know how canal irrigation contributes to food security, agricultural income generation, and whether it leads to environmental degradation such as decline of groundwater levels, water logging and salinization, given growing water, energy and land scarcity and degradation, how they may be increased in the near future.

Today canal irrigation management has become a highly professional discipline. Existing irrigation bureaucracies are unsuitable to meet new demands for new skills. Modern day managers need to manage the change, improve capacity and skills, and should be rewarded accordingly.

Intermediate Development Outcomes

1. Adequacy, reliability and equity in access to water for irrigation and multiple other uses of irrigation water in canal commands is improved through better operation and maintenance of canal systems, and promotion of conjunctive water management in canal irrigated areas.
2. Food and water productivity and equity of access to water in selected irrigation schemes in Pakistan, India, Central Asia, Sri Lanka, and SE Asia increased through improved incentives, management, operation and maintenance of canal commands
3. Resource use efficiency (water/land/energy) within ten canal commands will be enhanced to benefit of at least 50 million people.
4. National food security will be improved by developing institutional mechanisms to operate and maintain large schemes in a financially sustainable manner.
5. Improved and financially sustainable management capacity of all stakeholders including agency personnel and WUAs in ten canal commands.

Research outcomes

We will provide the scientific knowledge, policy tools and investment recommendations that will help interested governments to improve adequacy, reliability and equity in access to water across space and time within ten canal commands. We will promote conjunctive management of canal and groundwater while minimizing demand for energy for pumping.

1. Strategies to improve operation and maintenance of ten canal commands in Asia identified .
2. Adequacy, reliability and equity in access to irrigation water with respect to time and space among irrigators improved in ten canal commands in Asia.
3. Improved capacity of irrigation agency personnel in selected canal commands in Pakistan, India, Sri Lanka, Nepal, Uzbekistan, Laos and Cambodia to manage canal irrigation in a financially sustainable manner.

Expected activities & outputs

During the first five years of our research, we will focus on canal commands in Pakistan, India, Sri Lanka, Nepal, Cambodia, Laos and Uzbekistan.

Working closely with our partners in each basin, we will:

1. Evaluate the performance of irrigation schemes and develop models to assess changes to food production, income generation and environmental decline in canal commands, in addition to identifying opportunities for improvement.
2. Determine alternative models to raise sufficient funds for operations and maintenance of canals.
3. Evaluate alternative technologies and institutions to promote adequacy-reliability and equity in access to irrigation water.
4. Define and recommend high-impact investment options, especially for smallholders.
5. Assist in building capacity to strive for constant improvement in the management of canal commands.

Partners: FAO, Punjab irrigation department, MRCS.

Title

AC 1.3 Water Management in the Eastern Gangetic Plains

Problem to be addressed

Poverty levels in Eastern Uttar Pradesh, Bihar, West Bengal, Assam, the Nepal Terai and Bangladesh are similar to those in sub-Saharan Africa. The region also suffers from devastating floods. Evidence indicates that adverse flood impacts can be reduced through wiser groundwater management that enhances the regulating services of the basin's natural and agricultural ecosystems.

The Eastern Gangetic Plains is supported by one of the most prolific aquifers in the world, but our lack of understanding of physical processes deters our ability to manage the aquifer in such a way to minimize floods and droughts. Furthermore, during dry months, despite the presence of groundwater at shallow depths, approximately a third of the farmers do not have access to water. Reasons for this include shortage of capital, lack of energy for pumping, and the fact that small landholdings can be deemed uneconomical for investments.

In summary, better information and knowledge of water availability, social and institutional constraints affecting access and achievement with irrigation water is required to devise and support technical interventions and policies to support sustainable intensification of agricultural production in this trans-boundary plains.

Intermediate Development Outcomes

1. Access to irrigation water is improved during droughts and the mitigation of seasonal flooding in the Eastern Gangetic Basin will enhance food security and household incomes of approximately 20 million rural men and women.
2. The adequacy-reliability and equity in access to irrigation water, along with increasing the capacity of regional aquifers to absorb floods during the monsoon will be improved through development of alternative technologies and institutions which will help improve food security and rural income in a sustainable manner.

Research outcomes

1. Policies are formulated which facilitate equitable access to groundwater, and adequate energy to pump groundwater at affordable prices.
2. Practices for the appropriate use of water under complex socio-agro-ecologies are developed and used by government agencies and development planners.
3. Farmers' capacity to manage surface and groundwater resources and adaptation to climate change will be strengthened through better access to information and training.

Expected activities & outputs

1. Physical processes determining sustainable yields of the aquifer are identified and

quantified.

2. Scientific knowledge, policy tools and investment recommendations will be produced to help interested water resources management agencies in India, Nepal and Bangladesh to manage the aquifer to mitigate floods and provide adequate water for irrigation.
3. We will assess optimal ground water management and development options for poverty alleviation while minimizing demand for energy for pumping.
4. Alternative technologies and institutional arrangements to support their out-scaling will be assessed.

Partners: NGOs involved in irrigation development in the area

Title

AC 1.4 Combating and convalescing irrigation induced salinity at field and regional scales

Problem to be addressed:

Salinization is an inevitable process in irrigated areas, because irrigation water invariably carries varying quantities of salt. As the water is lost through evaporation, salt concentration in soil water will increase, resulting in salinization. Long term productivity of irrigated lands may only be assured when salts are removed from the root-zones continuously. Failure to do so has resulted in 34 million hectares impacted by salinity, representing 11% of the total area equipped for irrigation. This represents an estimated forgone potential production loss of US$ 42.7 billion annually notwithstanding the significant underutilization of investments in infrastructure required to equip an area to deliver water.

To date the general approach to managing salinity has been one of accepting it as an inevitable consequence of irrigated agriculture, particularly when practiced in semi-arid and arid regions. In this activity cluster we take the counterfactual that salinity can be sustainably managed through novel technical and institutional interventions and innovative business models that increase the economic value of saline waters. The paradigm shift is to view salinity and saline drainage water as an opportunity rather than a problem. We argue that it is financially viable and ecologically sustainable to bring these lands back into production.

Intermediate Development Outcomes

1. Food productivity in South and Central Asia improved through slaine irrigated lands being brought back under production.
2. Lands within irrigation canal commands and drainage waters are managed in sustainable and profitable manner.

Research outcomes

1. Novel technical interventions and innovative institutional and business models that increase the economic value of saline lands and marginal quality waters developed.
2. Nature is harnessed to minimize drainage volumes and salinized areas.
3. Local institutions are developed to take advantage of negative externalities of irrigated agriculture.
4. Selected stakeholders' capacity to manage salinity and drainage water improved.

Research outputs

1. This activity will provide the scientific knowledge, bio-physical interventions, policy tools and investment recommendations that will transform salinized lands into profitable production systems. In these areas, our outputs will lead to a reduction in drainage volumes and salinized lands at field, farm and regional scales. Our outputs will provide guidance to

minimise drainage volumes and salinized areas within irrigation areas. Working closely with our partners, we will evaluate alternative technologies and institutions to promote
Approximate timescales for delivery: Evaluation and planning (2 y); Implementation design (3y); Performance review and improvement (5)
Budget over next 3 years: 2013 2m; 2014 3m; 2015; 3m.

RAINFED SYSTEMS SRP

Preamble

Support and encourage processes of change and intensification in rainfed farming landscapes with integrated solutions that mitigate degradation and maintain ecosystem services to serve the needs of those who depend on agriculture for their livelihoods.

The majority of the world's poorest people depend primarily on rainfed agriculture for their livelihoods and food security. Many rainfed farming landscapes are very fragile, affected by land degradation, climate risk, and poor infrastructure, contributing to extreme poverty and malnutrition. Smallholder rainfed systems are also under heavy pressure from current and increasing population density.

These rainfed systems are also undergoing rapid change due to a range of local, national and global drivers. For example, climate change will have huge implications for the millions of smallholders who rely on rainfed agriculture in water-scarce areas. Changes in local, regional and even global investment policies and trends have implications for national poverty reduction efforts as well as new challenges for resource management.

The goal of this activity area is to achieve the sustainable intensification of agriculture in rainfed landscapes. It will work in areas where on-going land-use change threatens the environmental foundation upon which agriculture depends, and thus also the welfare of those who depend on the land. Our research will inform a new vision for rainfed landscapes, by providing evidence for how sustainable intensification and mitigating degradation can alleviate poverty and achieve social-ecological resilience. We will provide tools and methods for targeting interventions in landscapes, that account for tradeoffs and synergies amongst ecosystem services and impacts on livelihoods. This research will design new incentives that will enable change in communities and in institutions to achieve better land management.

Our attention to change will look at multiple scales, from local to regional and include global drivers that 'land' in local places, to which local people have to adapt. Focus will be both on understanding social and institutional environments to design pathways for change, and the biophysical realities of changes, such as in ecosystem services. Thus this research portfolio will combine analysis of institutions, policy and livelihood portfolios with a focus on biophysical realities and understanding of ecosystem services.

The Intermediate Development Outcome for Rainfed Systems in the Water, Land and Ecosystem Program is therefore that:

National agencies or development donors and implementers in at least 15 countries use enhanced knowledge of how poverty reduction strategies could have maximum impact across different rainfed farming landscapes to enhance livelihoods without undermining ecosystem services.

Theory of change

Over the last decade, new and potentially very powerful drivers of change in rainfed systems have emerged. Foreign investment in land, cross border capital flows including remittances and renewed investment by governments and the private sector, and in line with CAADP policies in sub-Saharan Africa all affect land use decisions at various scales. Increased prices of food drive the development of new lands, and the feasibility of food security programs. Investments in hydropower and mining continue to transform ecosystems and landscapes. Poverty Reduction Programs supported by national Governments and international donors have to consider the potential positive and/or negative impacts of these developments on farming systems, and learn to navigate these drivers and adapt policy and implementation of development interventions to support sustainable outcomes. Our research will allow us to better anticipate environmental challenges and target interventional by forecasting the impact of alternative investment and development interventions. We will bridge the interests of the development and environmental conservation communities to bring about innovation and new solutions.

Rainfed activities will have the following characteristics:

Employing a ***social-ecological landscape*** approach that grounds specific interventions in the spatial and temporal variability of the landscape; integrates understanding of interactions in space and time amongst interdependent ecosystem services and livelihood strategies; and builds that understanding into decision-making processes through threshold and tradeoff scenarios.

A ***transformative knowledge*** approach that focuses on advocating innovative processes involving active engagement with multiple stakeholders necessary for better planning and implementation of development interventions to build resilience. These approaches must be grounded in an understanding of social and political processes that underlie decision-making.

Integration of multidisciplinary science and research *to* include advanced land and degradation assessment, environmental economics, landscape and ecosystem services modeling tools, and innovative tools for participatory engagement and social learning.

A ***Theory of change*** embedded in on-going processes, and a focus on areas where changes in policy can be supported by knowledge.

Title

AC 2.1 Reducing land degradation in rainfed landscapes

Problem to be addressed

At Rio +20 Conference in 2012, the global community set out key principles for sustainable development, one of which was a land-degradation neutral world. This principle will guide renewed efforts to define and monitor progress towards 'zero net land degradation' in the coming decades. New approaches and solutions are needed for many agricultural ecosystems that have suffered decades of progressive degradation resulting in persistently poor productivity as a result of a degradation of ecosystem services such as biomass production, regulation of water cycles, and soil health. Nearly 50% of farmland in Africa suffers from erosion and nutrient depletion. The value of nutrients lost in Africa is estimated at $4 billion per year (CAADP 2009). Other systems are continuing to follow this path today because the problem of degradation remains unappreciated or is masked by increasing inputs.

Slowing or reversing land degradation is a difficult research/impact area as it must (1) tackle the conditions that cause land degradation and (2) provide the incentives for farmers and governments to invest in degraded land. The investment needed to stop or reverse degradation is significant and often out of reach of individual farmers and also involve collective action. Clarifying why, where, and how governments or others can address resource degradation, and the costs of inaction, will be critical in enhancing the productivity of these agroecozones and building resilience into farming communities. New approaches to understand, monitoring and evaluate degradation, and incentive schemes such as pro poor credit schemes, carbon credits, subsidies, and payments schemes for environmental services can provide important opportunities.

Intermediate Development Outcome

1. Reduced land degradation and increased resilience of smallholder farming communities in target landscapes in sub-Saharan Africa, Latin America and Southeast Asia through policy interventions and incentives.

Research outcomes

1. Advanced RS/GIS and IR technology for land assessment used to characterize degradation in selected landscapes, and this knowledge built into agricultural development planning strategies in east and southern African nations to reduce or reverse degradation.
2. Surveys of degradation and research in selected landscapes in SSA and Latin America inform decision-makers about causes of degradation and improve targeting of recommendations to recuperate the degraded areas.
3. Appreciation of current trends, particularly in insidious soil fertility loss, and the consequences of 'business as usual' influences design of development investment plans.
4. Full cost of degradation of ecosystem services, biodiversity loss, and implications for poverty assessed and understood by stakeholders in selected landscapes and plans and implementation of interventions adapted accordingly.
5. Known and new methodologies and incentives, including payment for ecosystem services

schemes are assessed by partners for their suitability to combat degradation in the selected landscapes.

Research outputs

1. Land degradation and its trends and causes assessed and evaluated, based on new landscape tools for rapid assessments and evaluation of the causes of land degradation.
2. Spatially-explicit integrated solutions to recuperate degraded lands that provide incentives for adoption by smallholder farmers.
3. Incentives designed and processes tested for institutional change to restore degraded landscapes.
4. Generic lessons on linkages between degradation, ecosystem services and poverty drawn from case study landscapes.
5. Impacts of degradation and trade-offs amongst services assessed including cost of action vs. non action in restoring land.

Title

AC 2.2 Sustaining productive landscapes by increasing biodiversity

Problem to be addressed

The intensification of agriculture often threatens important biological diversity and associated ecosystem services such as fuel and fruit trees, medicinal plants, pollinators, predators and useful below ground organisms. The sustainability of production and livelihoods depend on these services in the long term. A current debate pits the notion of 'land-sparing,' where agricultural production is maximized on cultivated lands, allowing some land to be put aside for biodiversity conservation, against the notion of 'land sharing' in which landscape mosaics are thought to ensure the sustainability of agricultural production. It is very likely that neither approach will fit every bill: different circumstances do require different types of intervention, and scale is an important factor. It is important to ensure that agricultural intensification does not compromise biodiversity and associated productivity and resilience in the landscape, but instead conserves or even enhances it.

This activity will study the ways in which both farmed and non-farmed biodiversity can contribute to sustainability of agricultural systems. Expanding diversity by increasing the number of varieties and breeds used in agriculture and by planting trees, for example, can improve resilience and reduce risk. Significant research has demonstrated that in some places schemes for payment for ecosystem services can function and support ecosystem services, although long-term sustainability of these schemes is yet to be demonstrated. As appropriate, this activity will support the development of policies and frameworks to protect access to biodiversity.

Intermediate Development Outcome

1. Increased agricultural resilience, reduced risk and biodiversity maintained over the long-term by smallholder as well as commercial farmers through adoption of regulatory and management frameworks for maintaining ecosystem services and handling tradeoffs between farmed and non-farmed components of landscapes.

Research outcomes

1. Government, research partners and communities are involved in design and implementation of the co-management of multi-functional landscapes.
2. Raised awareness and increased knowledge on the role of biodiversity for sustainable agricultural production and ecosystem service production in agricultural development communities.
3. Increased collaboration between conservation NGO's and agricultural development actors in target landscapes leads to better integration of environmental and livelihood goals.
4. Management of ecosystem services is mainstreamed in development programs in target landscapes.
5. Regulatory frameworks are established or strengthened in landscapes in meso- and Latin America for protected and restricted areas or management activities that support protection of vulnerable lands and ecosystem services.

6. Farmscape management and landscape co-management frameworks for harnessing biodiversity in production of ecosystem services, including ecosystem service incentive mechanisms such as schemes for payment for ecosystem services, adopted by development programs.

Research outputs

1. Integrated tools and frameworks for assessment and diagnosis of landscape integrity: livelihoods and wellbeing of people; food security and income; composition and structure of the landscape, and ecosystem services, including biodiversity.
2. Analyses and diagnoses of land health, landscape composition and structure as a determining factor for ecosystem functioning and human wellbeing.
3. Models and tools for landscape design; participatory design and implementation of options to diversify and/or maintain diversity while increasing food production in farming landscapes.
4. Assessment of the relative advantage of 'land sparing' compared with landscape mosaics in supporting rural communities and increased food production in representative landscapes. Participatory methods for landscape and environmental planning; evaluation of options for Payment for Environmental Services and sharing benefits from natural resources.
5. Engagement in international initiatives and conventions, specifically the Ramsar Convention and IUCN, and conservation NGO's, CI, WI.

Title

AC 2.3 Reducing risk and tackling productivity/environment challenges in farming landscapes

Problem to be addressed

Increasing the production of food, fiber and fuel is the most obvious need in many smallholder farming landscapes of sub-Saharan Africa. In the short term production can be increased and yield gaps lessened at the field scale with known technologies. National-level intensification strategies and input and output market development are proceeding rapidly. However, farmers and pastoralists are constrained by a variety of on- and off-farm factors from adopting such technologies and continue to suffer from risk from limited and variable rainfall along with competing demands for water, biomass and nutrient resources.

Introducing small-scale and supplemental irrigation in combination with nutrients in a landscape is one of the most transformative changes that can occur. Improved water management through supplemental irrigation and other agricultural water management options can reduce risk and stabilize productivity and even lessen yield gaps in farming and pastoral systems, and at the same time improve overall ecosystem services. Significant out-scaling of these options has been hard to achieve in development programs, though farmer driven small-scale irrigation is expanding rapidly in many countries in sub-Saharan Africa. With this expansion, there is a danger of losing critical landscape niches and their associated ecosystem services, such as wetlands. Furthermore, water quality may become degraded and access to irrigation may be limited thereby creating groups of winners and losers in a community.

On the other hand many options for balancing multiple goals, and supporting sustainability of gains through integrated green-blue water and integrated nutrient management are possible, if they are identified and articulated in planning processes. For example, in order to achieve sustainability without off-site impacts, variability in water availability in space and time, and impacts of out-scaling can be taken into account when designing intervention strategies.

Intermediate Development Outcome

1. Improved water and nutrient management in rainfed landscapes reduces risk of crop failure, reduces unproductive losses of water, increases overall biomass production, income, and ecosystem services to secure and sustain the livelihoods of farmers.

Research outcomes

1. Water resources development plans of government and development donors include and finance a range of small-scale water management options, include attention to required nutrients or soil amendments, and provide incentives for adoption.
2. Planning departments incorporate meso-scale water resources assessment and ecosystem services objectives into planning processes.
3. Development implementers design and adopt incentive systems that lower uncertainty and

support beneficial change in target landscapes.

4. National agricultural intensification strategy frameworks (such as CAADP), and poverty reduction strategies, and CGIAR research programs and partners use improved quantification of yield gaps, associated indices and landscape evaluation tools to prioritize and target interventions.
5. Understanding factors involved in decision-making of men and women farmers and youth is incorporated into intervention recommendations for specific landscapes.
6. Planning and implementation of water resources development takes account of larger scale and off-site impacts on affected people and ecosystems.

Research outputs

1. Lessons from factors influencing and enabling farmer-driven initiatives in agricultural intensification, to enhance the productivity of these systems and achieve scale.
2. Improved landscape and yield gap assessment tools, including soil and water information that underpin sustainable intensification strategies, and assist in targeting scalable agricultural water management and appropriate soil management interventions.
3. Intervention packages and adoption frameworks integrated solutions to increase eco-efficiency of production systems and enhance ecosystem services and livelihoods.
4. Tools for analyzing tradeoffs and ecosystem services monitoring in landscapes; analysis of landscape impacts of solutions including conservation agriculture, fertilizer micro-dosing, integrated soil fertility management, biological nitrogen fixation, and watershed development.
5. A matrix of factors affecting farmers' choices and inhibiting intensification; institutional analysis at multiple scales; analysis of policy formation and implementation to design incentive systems that support sustainable land management.
6. Policy advice to secure rights to water and land and create incentives to optimize agricultural water management in agro-ecozones without damaging the ecosystem or creating negative impacts on off-site or downstream users of water.
7. Engagement with actors at various scales in target countries (CAADP teams, IFAD programs and others) to develop pathways towards eco-efficient intensification in landscapes

RESOURCE RECOVERY AND REUSE SRP

Preamble

In poor countries, increasing urbanization is placing greater pressure on already strained land and water resources. Rural-urban food flows result in the degradation of farmlands, while waste accumulates in urban centers, resulting in severe sanitation problems. With little or no treatment, waste is dumped into landfills or streams, rivers and lakes. Only 20% of the wastewater collected in Asia and virtually none of the wastewater in sub-Saharan Africa receives treatment, making urban landscapes and passing streams significant health hazards. Unsafe water and poor sanitation is directly responsible for disease, malnutrition and death, especially among children in poor countries.

Meanwhile, millions of farmers struggle with depleted soils and lack of water. Until now, there has been little successful effort to recapture resources from waste, although their potential value for reuse in agriculture has been known for years. Indeed, significant quantities of water, nutrients and energy can be recovered from domestic and agro-industrial waste materials and wastewater, reducing pollution, improving sanitation management and enhancing food security for millions of poor households in the rural-urban corridor in developing countries.

Theory of Change

The theory of change is based on three pillars: a) business modelling, b) a focus on the global hot spots of development, the peri-urban areas, and c) strategic partnerships.

In its central activity cluster the program is learning from commercial approaches to RRR which are slowly emerging across low-income countries. It is analysing, testing and promoting across regions the most promising business models considering their geographical context. Many of the models are being charted in the informal sector or as public-private partnerships, tapping into entrepreneurial initiatives to leverage private capital to help realize commercial value in waste. The program will try to shift the common paradigm of treatment for waste disposal to treatment for reuse, aiming at revenues from reuse for the benefit of entrepreneurs as well as the provision of better sanitation services.

The peri-urban interface is a very dynamic area that is critical for urban development but suffers from multiple pressures draining and polluting its resources. In national development plans as well as in its administration it is often falls into the ‘grey zone’ between rural and urban authorities

and tends to be neglected. RRR will give special attention to this area and attempt through multi-stakeholder processes to support smart decision making in land and water resources management across the rural-urban interface. Given the dynamic nature of the peri-urban areas, the modelling of development scenarios will have an important role.

The program is based in all its components on strategic linkages for maximum impact. This includes affiliations to business schools and the private sector as well as national and global change agents (WHO, FAO, UNEP, BMGF, IWA, and national policy makers) targeting (inter)national guidelines and capacity development efforts with global outreach and replication potential.

Title

AC 3.1 Business opportunities for resource recovery and reuse

Problem to be addressed

Humans generate millions of tons of organic waste including excreta every day. This waste is rich in water, nutrients and organic compounds. Yet, waste is not being managed in a way that permits us to derive value from its reuse, whilst millions of farmers continue to struggle with depleted soils or water scarcity. Although resource recovery and reuse (RRR) could support ecosystem services at various levels, create livelihoods, enhance food security and contribute to cost recovery in the sanitation chain; most waste ends in landfills or pollutes the environment. Projects aiming at RRR seldom survive their subsidized pilot phase.

The RRR program identified the lack of business thinking as major bottleneck for attracting private capital and scaling up RRR efforts far beyond the household scale in low income countries. While business planning and modeling appear to be an oxymoron in a landscape dominated by public subsidies, they have the potential of being a game changer in the rural-urban or sanitation-agriculture interface.

Focus is on safe wastewater and excreta reuse in crop farming and aquaculture, co-composting of agro-industrial and domestic waste sources and waste-based energy systems.

Intermediate Development objective

Increased RRR from organic and liquid waste supports ecosystem services, system resilience and food production.

> Over 10 years, RRR activities will multiply to the benefit of 23 million (m) market-oriented smallholders in sub-Saharan Africa and South Asia, improving food supply for over 100m consumers, and enabling a cost reduction in waste management which could help to serve additional 34m households, in both regions.

Research outcomes

1. Enabled business schools, donors and the private/public sector to understand water, nutrient and energy recovery from waste as a business opportunity.
2. The program will inform over 10 donor programs and 20 business schools about reuse-based business opportunities at scale, and explore the feasibility of recommended business models in up to 10 peri-urban pilot sites across Asia, Africa, MENA and Latin America.

Expected activities & outputs

Activities:

1. Analysis of about 150+ successful business cases ranging from fecal sludge composting and

energy generation to agro-waste valorization and wastewater reuse, across peri-urban Africa, MENA, South America and Asia.
2. Multi-criteria feasibility studies of business model implementation incl. market, institutional and perception analysis, and development of investment plans in 10 defined locations; including WLE benchmark basins, accompanied by support of safe reuse guidelines and sanitation safety plans, policy analysis and dialogue with public and private sectors.

Outputs:

1. Catalogues of 50 promising RRR business cases and about 20 models for nutrient, water and energy recovery.
2. Assessment of health and environmental risks and options for risk mitigation.
3. Investment plans to enable the replication of business models at scale across Asia, Africa, MENA and Latin America

Partners: Business schools, RRR enterprises, public sector, SANDEC/EAWAG

Approximate timescales for delivery: 5-10 years

Budget over next 3-5 years: 6 m

Title

AC 3.2 Safe wastewater and excreta use

Problem to be addressed

Due to poor sanitation, globally about 20 million ha under irrigated crop production (nearly ten per cent of the permanently irrigated area) receive highly polluted water in Africa, Asia and LAC. In nine out of ten cases the water is contaminated with untreated or only partially treated wastewater posing risks to farmers and consumers. The highest risk is related to pathogens from fecal matter supporting a variety of diarrheal diseases.

Due to a lack of resources, including flushing water, larger sewer systems will not be feasible in many parts of the world, limiting the coverage of wastewater treatment plants. Alternative, cost-effective options for health risk reduction suitable to on-site sanitation systems, and applicable along the farm to fork pathway are needed in line with the WHO guidelines for the safe reuse of wastewater, excreta and grey water. These options have to be accompanied by risk awareness creation, and incentives for farmers and other stakeholders to change their behavior towards safe irrigation and food handling practices.

Intermediate Development objective

Improved food security, safety and nutrition through policies and guidelines supporting urban and peri-urban farming and safe wastewater and excreta use downstream of towns and cities. Estimated beneficiaries over 10 years will be 21m farm workers and 100m consumers currently exposed to water and food contaminated by fecal matter in South Asia and sub-Saharan Africa.

Research outcomes

1. National level: Improved urban agriculture and wastewater reuse through research, behaviour change and policy dialogues (focus: South Asia, West Africa).
2. International level: Safe wastewater and excreta use promoted through global reuse guidelines, multi-regional capacity building and international public goods.
3. Training workshops covering 30 countries in collaboration with WHO and UN-Water, at least two major international guidelines (WHO, USEPA) cite frequently our input, and policy dialogues on the productive management of faecal sludge facilitated in South Asia.

Expected activities & outputs

Activities:

1. Policy research with stakeholder dialogue;
2. Comparative health risk assessments,
3. Action research on safety measures, sludge pelletization, and crop responses.
4. Regional training workshops, and reuse guideline development.

5. Global mapping of informal wastewater irrigation and sludge use

Outputs:

1. Joint publications with WHO, FAO, USEPA and/or being clearly referenced.
2. National and regional stakeholder and policy dialogues
3. Guidelines on options and regulations for safe wastewater and excreta use drafted e.g. for India, Ghana and Sri Lanka.

Partners: WHO, FAO, UNU-INWEH, UNW-AIS, USAID, national authorities.

Approximate timescales for delivery: 5-10 years

Budget over next 3-5 years: 3 m

Title

AC 3.3 Efficient water and land management in peri-urban areas

Problem to be addressed

Between 2011 and 2050, the world population is expected to increase by 2.3 billion, passing from 7.0 billion to 9.3 billion of which about 67% will live in urban areas. The urban areas of the world are expected to absorb this population growth while at the same time drawing in some of the rural population. As a result, the world rural population is projected to start decreasing in about a decade, with SSA following around 2050. Already today, countries such as India are more peri-urban than rural.

This development has major implication for rural-urban resource allocations, the provision of ecosystem services and the economy at large. It places multiple pressures on the peri-urban areas necessitating careful strategies for resources management in the interface of different sectors. Major issues arising in these rapidly developing cities are water, food and energy security, and an increasing number of poor at the margins of cities. Formal and informal water transfers from peri-urban and rural areas towards cities are increasingly common. Feeding the cities will require supporting infrastructure and new intensive production approaches while attempting to minimize negative impact of the urban footprint, in particular from pollution. Contrasting this there are opportunities for off-farm employment but also new markets supporting specialized urban and peri-urban farming systems with a high degree of intensification. The activity cluster will assist authorities and decision makers with scenarios and pilot studies supporting sustainable natural resources management for urban food and water security, while carefully balancing possible trade-offs.

The Activity Cluster has a high potential to link with other SRPs, such as irrigation and rainfed, and will also strongly support joint activities with the WLE crosscutting work on Ecosystem Services.

Intermediate Development objective To contribute to urban food and water security through sustainable natural resources management in the rural-urban interface.

Research outcomes

We will provide a knowledge base, policy tools and investment recommendations that will help interested authorities to improve adequacy, reliability, efficiency and equity in land and water resources management across the rural-urban interface, with a special focus on:

1. Irrigated urban and peri-urban farming.
2. Pro-poor rural-urban water allocations.
3. Reducing the negative urban footprint on ecosystems and livelihoods
4. Multi-stakeholder dialogues for urban water resource use planning.

Expected activities & outputs

Activities:

1. Resources mapping along the rural – urban trajectory.
2. Institutional and policy analysis related to land and water resources management.
3. Development of scenarios for sustainable water and land allocation, and pollution control, under different urbanisation and climate change scenarios.
4. Stakeholder engagement and dialogue across the urban/rural gradient.
5. Analysis of linkages between water, energy, food and the environment.
6. Analysis of options on how to support poor migrants and women to gain market access through urban and peri-urban farming.
7. Simulation modelling of various water-nutrient interactions and flows to increase resource use efficiency in urban and peri-urban farming systems.

Outputs:

1. Decision support and knowledge base for sustainable resource allocation supporting increasing urban and rural needs.
2. Policy dialogue and scenario analysis for holistic planning processes.

Partners: City authorities, RUAF, UN-Habitat, FAO 'Food for the cities' Program

Approximate timescales for delivery: 5-10 years

Budget over next 3-5 years: 3 m.

RIVER BASINS SRP

Preamble

River basins include a mosaic of ecosystems, including diverse components of land and water use. Basins provide a range of ecosystem services that are used to a varying degree of effectiveness by different groups with mixed results. They provide both provisioning (food, medicinal plants, energy) and regulating (carbon sequestration, air and water purification, crop pollination) ecosystem services. Each river basin is unique, with different challenges and characteristics and with contrasting systems of governance.

The world's river basins have tremendous resources to sustain human and environmental needs. The way we develop, manage and share these resources is critical. An ecosystem services perspective would enable a research and policy approach to basins that respects their unique nature and the broad range of food, power and environmental functions they support. How people choose to manage river basins in the future, for multiple uses and across scales, while protecting vital ecosystem functions and the rural poor, can make the difference between environmental disaster and poverty and sustained growth.

Theory of Change

Efforts to improve effective water management are inextricably linked to fluctuations in water availability over time and these are predicted to increase with climate change. The activity area on river basins will stress the issue of variability for policy-makers and resource managers and will propose options for dealing with it at the basin level. It will study how to allocate and manage basin water and land to raise productivity, improve equity and protect ecosystem services. It will recommend the investments in infrastructure needed to support complementary land and ecosystem management. The activity will also give emphasis to the establishment of policies and mechanisms that ensure equity in water rights, benefit-sharing and decision-making, and to reduce tradeoffs among various water users and uses, including energy and food.

Title

AC 4.1 Managing water resources' variability and re-thinking storage

Problem to be addressed

Variability of water resources in time and space is the major natural impediment for sustainable agriculture and development at large. It is the primary determinant of water scarcity, and is increasing with changing climate. The extremes of variability – floods and droughts – are the primary "agents" of destruction, causing severe crop damages and loss of human life. In 2011, these extremes killed tens of thousands of people, primarily in developing countries, and resulted in an estimated global damage of $200 billion. Yet, they may also have beneficial aspects: floods can benefit fisheries and floodplain agriculture, while droughts may kill pests. The issue is therefore to mitigate negative impacts of variability while simultaneously exploiting its benefits.

New information and solutions are required to deal with increasing variability through the technical and economic appraisal and design of diverse water storage "portfolios" (combining both human-made and natural "infrastructure") that safeguard essential ecosystem services (ES) and maximize the development benefits, underground storage of excessive water during large floods for subsequent use in extended drought periods, conjunctive surface and groundwater management, non-structural solutions, enhanced collaboration of farmers and water resource managers, and guiding the associated investments by sound economic, social and environmental principles..

Intermediate Development Outcomes

This research focuses primarily on *increasing* the *supply* of water and associated benefits through variability management and *reducing damages* from extremes.

Geographical focus: South and South-East Asia, with additional activities in West (Volta), East (Nile), Southern Africa (Limpopo/ Zambezi), and Central Asia.

It will aim to achieve:

1. Increased and more reliable water supply for crop production, livelihoods and ecosystems: in the order of 300 km^3 of additional water annually in South and South East Asia alone, i.e. some 60% of the Mekong long-term average annual river flow or half of the current water use in India), with associated increase in irrigated area in the order of 1 mill ha (e.g. about 20% of total irrigated area in Thailand at present), and over $1 bill of annual income to small farmers, and enhanced ES.
2. Reduced crop, infrastructure and life losses through alleviation of negative consequences of floods and droughts (crop and infrastructure damage reduction by some 50% in cost terms).

Research outcomes

1. Investors in basin water resources will be informed about the development benefits and impacts provided by investments in research on variability management, and will factor this into their programs.
2. Plans for innovative flood capture and storage or conjunctive flood / drought management will be piloted in at least 2 countries /river basins. With adequate co-investment and support from beneficiary partners, these interventions will provide evidence and support needed for upscaling these interventions to larger/ other areas.
3. Major investors, Development Banks and basin commissions will become aware of methodologies, livelihood, agricultural production and environmental outcomes of storage "portfolio" design and evaluation, and conjunctive flood-drought management in a basin-wide context. This will reduce adverse impacts on ES from both traditional storage (dams,

reservoirs) and non-traditional/natural storage development (underground stores, natural / man-made wetlands).

Expected activities & outputs

Activities:

1. *Ganges:* the main group of activities can center around the idea of making the Ganga "Water Machine" work (in close collaboration with the Irrigation strategic research portfolio (SRP)) for improved water supply and access benefiting the poor, targeting to moderate, and ultimately – eradicate the devastating impacts of recurring flooding in the entire region.
2. Assessment of priority geographies for enhanced water variability management, supply augmentation and mitigation of drought and flood extremes
3. Options/methodology paper on technical, economic and institutional forms of variability management, supply augmentation and mitigation of drought and flood extremes
4. Identification and assessment of the role of water storage and other variability management measures for ES (including flood control, drought management, biodiversity, food production, fisheries, etc.) in selected river basins (building on ongoing work in the Mekong, Nile and Ganges)
5. Assessment of the costs and benefits of alternative water storage options and related policies and institutions on ES
6. Evaluation of flood harvesting potential (how much water can be stored, where hydrogeology is suitable, social landscape is ripe and what are the costs) – regionally and in selected river basins; Pilot implementation of flood harvesting in 2 demonstration sites in SEA and SA.
7. Development of guidelines /protocols for application of promising variability management interventions and for socioeconomic appraisals of such interventions at different scales.

Outputs:

1. Research outputs will be promoted through FAO Disaster Risk Reduction for Food and Nutrition Security Program, Hyogo DRR Process, RAMSAR Convention and other international framework programs and outlets.
2. Understanding of key hotspots for variability management
3. A catalogue of promising structural and non-structural variability management interventions in specific basin/ country contexts.
4. Improved understanding of natural and built infrastructure in basins, ES they provide, their inter-linkages and role in supporting livelihoods, reducing poverty and enhancing food security; Enhanced understanding of i) extent and magnitude of the opportunities to harvest floods in major river basins ii) surface and subsurface characteristics that most favor its implementation iii) how to exploit positive benefits of floods and droughts while mitigating their negative consequences.
5. Demonstration of the technical performance of underground solutions and wetlands in terms of mitigation of flood risks, new irrigation potential created, and ability to mitigate subsequent droughts in rainfed and irrigated areas.
6. Tools and approaches for managing floods and droughts conjunctively in the same river basins.
7. Estimates of investments needed to make flood harvesting work, and the costs and benefits associated with the impacts that arise from those investments.
8. Example investment plans for replication of large-scale variability management interventions in 4 to 6 selected Asian and African basins.

Partners: CS, FAO, GWSP, IAHS International Network on Prediction in Ungauged Basins, Mekong River Commission Secretariat, NBI, Water and Disaster Management Ministries, UNSDRR.

Approximate timescales for delivery: 3-5 years

Budget over next 3-5 years: 3 mill annually over the next 3 years starting 2013

Title

AC 4.2 Resource allocation and sharing for the benefit of all

Problem to be addressed

Today, 36% of all people, 39% of grain production, and 22% of global GDP are at risk due to water stress. By 2050, these figures could grow to 52%, 49% and 45% respectively. Increasing population, urbanization and economic growth in less-developed countries, resulting in more resource-demanding consumption patterns, exacerbates the problem. Inadequate policies and institutions result in poor sharing of resources and their benefits. This is at the heart of continued poverty, food and nutrition insecurity, and environmental degradation in many developing countries.

It is essential to ensure that currently available resources are used more productively and efficiently, and that their benefits reach the most disadvantaged users, generally rural women and men, while preserving natural ecosystems and biodiversity. Water can be reallocated in basins from less to more productive uses with appropriate attention to environmental needs, rights and compensation. Moreover, the productivity of water in different uses is affected by land management practices - a link which is often missing in planning. Also, upstream land and water management practices affect the quantity, quality and reliability of natural resources available to downstream users, such as urban communities, fisheries and aquatic environment at large, hydropower and irrigation. The trans-boundary nature of many large world basins complicates sharing of benefits. Policy mechanisms for ensuring sustainable and equitable allocation of resources are seldom developed or used.

Intermediate Development Outcomes

1. Increased resource-use efficiency of food production in “closed/ closing”, highly populated Asian river basins.
2. Increased access by the poor to basin water resources in “open” basins in SSA.
3. Enhanced cooperation of riparian countries in Central Asian river basins to reduce poverty and environmental stress.
4. Improved natural resource status and livelihoods’ base in at least 2 areas/ basins through demonstrated established benefit-sharing or Payment for Ecosystem Services (PES) mechanisms.
5. Improved flow of ecosystem services from basin ecosystems in at least 2 river basins resulting from environmental water management policies that are included in national legislation and implemented in at least 3 countries, as informed by this research.
6. Enhanced water quality management in key water stressed river basins.

Research outcomes:

Basin commissions and national governments will become aware of tradeoffs in water/ land allocation decisions and implications / costs of such decisions to poor people and the environment.

Guidelines and tools developed in this cluster will be used by these stakeholders to support their water allocation decisions, including in trans-boundary settings, to assess tradeoffs of water and land allocation and use decisions for the poor and the environment.

The set of activities and outputs will vary by basin and regions, but will assess which policies, institutions and investments can enhance water-related outcomes for the poor and the environment under global environmental change using an ecosystem services lens.

Example activities and outputs may include:
sub-Saharan Africa - assessment of groundwater availability at basin scale and in large transboundary aquifers (ground water is untapped source which can give a push to local small-

holder agriculture), establishing ecological thresholds for groundwater use (still possible prior to major harvesting of groundwater), and relevant governance models.

This cluster will also undertake to develop transboundary policy analysis, including the impacts of large irrigation projects that are being built across boundaries, sharing the benefits from such projects, and basin level implications of alternative development paths on the irrigation and rainfed front.

Central Asia: Work directly with governments across borders and investment agencies to implement tailor –made solutions for specific areas (e.g. in basins of small rivers), for re-operation of large water infrastructure projects, and, in particular – to realize in practice the potential of completely underused groundwater for immediate water security relief.

Andean basins: In this region the focus continues to be on developing and implementing practical benefit-sharing mechanisms that alleviate poverty by conserving fragile upland areas, reducing sediment flow and improving water availability.

Approximate timescales for delivery: 5 years

Budget over next 2 years: 2013 – $3 mill; 2014 - $5 mill

Title

AC 4.3 Water and Energy for Food (WE_4FOOD)

Problem to be addressed

Increasing natural resource scarcity and degradation links food security of the poor and most vulnerable rural men and women inextricably to developments in the water and energy sectors, all influenced, in turn, by climate and environmental changes. Water can create energy (e.g. hydropower). Energy can "create" water (lifting, pumping, desalination). Agriculture itself creates energy, often at the expense of food (e.g. biofuels), while energy creates food through processing, transit, manufacturing of fertilizers and other farming inputs. Biofuel plantations, driven by energy security and climate policy, compete with food crops for land and water. Rural electrification changes the pattern of groundwater use in irrigation. And, clean renewable energy development trends can radically change water supply to agriculture and cities globally.

At the basin level, hydropower competes with irrigation and other energy-intensive users, influences aquatic ecosystem services upstream and downstream of power generation nodes, promotes evaporation from reservoirs and can create deep irrigation water shortages during the reservoir filling stage. The trans-boundary nature of many large river basins further complicates water-energy nexus. Thus, agricultural, water and energy policies influence each other and jointly determine outcomes for the poor and the environment. As countries develop, and energy consumption increases, tensions between water for energy - for food and the environment - will increase.

This cross-SRP research cluster will identify and quantify linkages, tensions and tradeoffs across these sectors using water as an entry point. It will examine alternative water management, technology and governance options to reduce tradeoffs and adverse consequences across the nexus.

Intermediate Development Objective

Water, energy and food security improved by 10-20% over baseline developments by 2020 for the key indicators of water, energy and food security in 3 regions where the energy-water-food security nexus is most prevalent: the Mekong River Basin, the Aral Sea Basin and India.

Research outcomes

1. Assessment frameworks developed in this cluster can guide investment banks and policymakers for the assessment of water-energy-food tradeoffs.
2. Guidelines and tools developed in this cluster will be used by stakeholders in the two basin countries to support their water, food security and energy development plans.

Expected activities & outputs

Activities:

1. Review of literature on the linkages between water, energy, food and the environment in Review of literature on the linkages between water, energy, food and the environment in various geographical and political settings and at different scales. Review of the past and current policy environment in case study areas affecting energy use in agriculture
2. Collection of primary and secondary data on inputs to agricultural production and the role of energy. Assessment of energy use and cost in agriculture across case study areas, gender- and crop-disaggregated as feasible
3. Simulation modeling of various water-energy interactions at local, basin and global scales and assessment of associated environmental impacts. Optimization modeling of water-energy nexus in various basin settings to achieve "water and energy smart" agricultural intensification (e.g. how to reduce energy consumption at basin scale by optimizing irrigation – adapting water

saving technologies, shifting to conjunctive use of groundwater and canal water or conservation agriculture in lift irrigation zones).
4. Stakeholder dialogues and desktop analyses of i) most promising technologies, policies, institutions and investment alternatives that can address potentially adverse outcomes for the poor and hungry; ii) water, energy and environmental implications of producing energy through biofuels, hydropower and other means; iii) substitution possibilities across the nexus at different spatial scales; and iv) nexus implications of sustainable agricultural intensification on irrigated vs rainfed lands.

Outputs:

1. Tools to assist with managing hydropower reservoirs and their cascades with inclusion of ecological and livelihood considerations, quantified impacts of possible hydropower development scenarios on livelihoods, and quantified scenarios for large-scale irrigation development
2. Tools for holistic assessment of technologies, policies, institutions and investments that cover all key sectors in the nexus to reduce tradeoffs and increase overall benefits for enhanced water, food and environmental outcomes

Partners: IEA (International Energy Agency), IFDC (International Fertilizer Development Center), Global Water System Project (GWSP), Mekong River Commission Secretariat (MRCS), UN-Water.

Approximate timescales for delivery: 5 years

Budget over next 3-5 years: USD 3 mill/yr over 5 yrs.

Title

AC 4.4 Water Data and Accounting in Basins

Problem to be addressed

Despite a vast amount of synthetic water data generated worldwide by various groups and programs, our ability to accurately predict how much water we have at any location, scale and time, how it is used, and by whom, remains impaired. Data quantity and quality have further deteriorated in the last 2 decades due to lack of investments in both developed and developing regions of the world. We still [inaccurately and inconsistently] only measure water flows on some 50+% of the land mass, hence why we still "guess" global water resource availability and flows, as well as resources of large, individual river basins, rather than assessing them.

Uninformed water management results in frantic and short-sighted decisions, and ill-designed investments, the consequences of which are eventually borne, first and foremost by the poor. You cannot manage what you do not measure. In addition, even available data are not freely shared, and economic losses to crops, infrastructure, human lives and political stability – due to lack of accurate data – are only continuing to increase with increased variability triggered by climate change.

Agriculture uses up to 80% of global water withdrawn from rivers and aquifers; thus, it is only natural that accurate data will drive Agricultural Water Management (AWM). Linked to this is the absence of detailed, reliable and regular water accounts in agricultural basins showing, similar to financial accounting, where the water is used beneficially and productively, how it is associated with land uses, among others.

"Green accounting" advocated by many countries at present, and accurate water resources change detection through existing metrics (e.g. indicators developed by WWAP for WWDR4) also face this data barrier. It is unlikely that conventional, ground-based, measures and ways of augmenting data availability will succeed in resolving the above problems.

Intermediate Development Outcomes

1. Basin managers and investors will improve infrastructure planning and investment decisions for the irrigated agriculture and other sectors in 8 basins in Africa and Asia
2. Improved national food security in countries of selected Basins through reduced crop and livelihood losses due to informed planning, monitoring and prediction

Research outcomes

1. 5 years- all, or most of the countries sharing the selected basins will have basin or country-wide water accounting procedures in place routinely used for water resources planning and monitoring and water dispute resolutions, with capacity to produce regular water audits. Advances in satellite derived estimates of ET, soil water, groundwater and river discharge, developed by this cluster with partners - feed into these accounts.
2. 10 years -National Hydrometeorological Services in African and Asian countries start to subscribe to Remote Sensing approaches for measurements of all agriculture-relevant hydrological components..
3. Community-based ground observation networks, advocated by this cluster, are established in 3 Basins and supplement such high-tech approaches with the provision of detailed local water data.
4. Donor programs will be informed about the development benefits and poverty alleviation impacts provided by investments into better water data acquisition and sharing. Major investment agencies will be informed about the new water monitoring and accounting methodologies and datasets developed for individual basins. This will result in better coordination of donor policies and more targeted investment. Major international investment banks double their investment in observational infrastructure in 10 years.

Expected activities & outputs

Activities

1. Developing new methods and protocols for improved availability of various water data describing surface and ground water resources and processes (PPT, ET, Soil moisture, groundwater storage, recharge, various water uses) with partners (methods paper)
2. Developing and testing new methods of agricultural and water information delivery and data collection to /from farmers and communities - through mobile technology, crowd sourcing, etc. (testing/pilot paper)
3. Establishing and testing community-based water monitoring programs as supplement to high-tech ones in one basin in Africa (e.g. Blue Nile) and one basin in Asia (possibly part of Ganges) (pilot case study report)
4. Assimilation of all of the above into a Water Accounting (WA+) framework that summarizes water resources conditions and management at the basin level, for each of the CRP5 basins, with a minimum focus on 4 major Basin in the next 3 years, e.g. Nile, Ganga, Indus and Mekong as major concentrations of poverty
5. Evaluating RS approaches for monitoring water use flows in selected major irrigation schemes, and evaluating possible water savings due to better monitoring – in collaboration with Irrigation SRP
6. Contributing to global water resources metrics maintained by UN agencies.

Outputs: - As per activities above

Partners: UN-WATER, FAO, World Meteorological Organization (WMO), World Water Assessment Program, Global Water Systems Project, NASA, , Consortium of Universities for the Advancement of Hydrologic Science, Inc,; International Association of Hydrological Sciences, International Association of Hydrogeologist, Global Water Partnership, Water Ministries in All major Focal Basins of this Cluster; e-Leaf, Telecom Companies.

Approximate timescales for delivery: 5 years

Budget over next 3-5 years: $ 2 mill annually over the next 3 years

INFORMATION SYSTEMS SRP

Preamble

It seems obvious that current and accurate information on land use and the environment is needed to underpin land and water planning and management. Yet the information available for most developing countries lacks substance, is difficult to compare because it has been gathered using in consistent collection methods and tends to focus on natural ecosystems rather than on agro-ecosystems. Inadequate information limits evidence-based planning and prevents reliable feedback on what works and why. Today, modern surveillance technologies allow us to monitor and measure resource trends, risks and impacts as never before. Remote sensing techniques enable us to model and map vegetation conditions, soil fertility and groundwater levels. Mobile phones permit two-way information flow between development workers and resource-poor land and water users in remote areas. The challenge is how to apply these technologies to the management of land, water and agricultural systems.

This activity area will focus on identifying priorities for high value information products to support decision-making at national levels and within basins. Measurement systems will be designed to target critical information needs whose resolution has a high potential to impact on CGIAR system-level outcomes. It will support the other strategic research portfolios in the Water, Land and Ecosystems Program, as well as other consortium research programs, by co-developing and applying methods and metrics to help set priorities, target development interventions and evaluate the impact of the work.

Theory of Change

In the area of information systems, this activity area will attempt to bring about change in three ways:

- Develop frameworks and build capacity in quantitative methods for decision-making under uncertainty and conduct trade-off analysis to support evidence-based decision making on agricultural intensification strategies at global to basin scales;
- Develop methods and platforms for low cost capture and easy access to data on agroecosystem health metrics, using consistent protocols to provide the evidence base for regional, national and basin-level decision making on agro-ecosystem management;

- Institutionalize evidence-based decision making approaches and methods in national programs and with other relevant stakeholders.

Currently, policy-makers and development practitioners are often forced to make decisions on agricultural intensification, land and water management and livelihoods improvement virtually in the dark because they lack systematic methods for coherent, evidence-based decision making and sufficient information on context and the implications of particular intervention options. The cost of sub-optimal decision processes or uninformed decisions can be very high; at the least they risk the waste of resources and the incomplete success of the development action. More seriously, they represent a lost opportunity for implementing programs that could have brought multiple wellbeing and environmental benefits. Building capacity for evidence-based decision-making will be an important pathway for improving information use, supported by applications that provide the required information for major decisions in the right form, in the right place and at the right time.

Title

AC 5.1 Connecting information to development decisions

Problem to be addressed

A major impact pathway for the CGIAR is supporting stakeholder decisions on interventions, i.e. programmatic activity where the primary intent is to improve water, land and ecosystem (WLE) management and the livelihoods that depend on them. But given limited resources, how does the CGIAR and its stakeholders determine which interventions will increase productivity, reduce risk, increase security and improve lives the most? What CGIAR research and information products will have highest value in supporting intervention investment decisions? What metrics should be monitored to assess whether interventions are on track and achieve intended development outcomes? A systematic approach to analyzing intervention decisions under uncertainty, using decision sciences, would help to answer these questions.

Intermediate Development Objective

WLE intervention and investment decisions by governments, research and development organizations and the private sector in Asia, Africa and Latin America are improved as a result of better identification of the most critical information constraining those decisions:

1. Accelerate and improve return-on-investments in smallscale irrigation in sub-Saharan Africa by 10%, by reducing critical uncertainties on where to invest and on risks of system failures (Volta, Niger, Nile, Zambezi).
2. Improve productivity of rainfed farming systems in four sub-Saharan Africa countries by 10%, by improving the design of integrated interventions that improve resilience to climatic and other variability and accelerating adoption by addressing critical information needs of farming households.
3. Increase security and return on investment by 10% in schemes for recovery, reuse and recycling from organic and liquid waste in sub-Saharan Africa and South Asia, by identifying critical risks and key decision uncertainties.
4. Increase amounts and reliability water supply for crop production from captured flood waters in selected Basins in Asia by 10%, by reducing critical uncertainties in systems design.
5. Maintain agrobiodiversity and other ecosystem services in African and Asian river basins (e.g. Mekong), by integrating environmental valuation in plans for agricultural intensification.

Research outcomes

1. WLE information systems research is focused providing additional evidence on WLE interventions that has highest societal benefit.
2. WLE researchers and stakeholders make better-informed and more effective and efficient intervention and investment decisions (in terms of increased returns of land and water productivity, ecosystem services and human well- being, with reduced risk)
3. Increased capacity of the CGIAR, Governments, universities, development NGOs, and conservation groups to apply such decision analysis methods for evaluation and monitoring of WLE interventions.

Expected activities & outputs

Activities:

1. Apply a Bayesian decision analysis framework for value of information analysis to the

portfolio of WLE intervention decisions:

I. Small-scale irrigation
II. Productive and sustainable rainfed agricultural systems
III. Business models for resource recovery and reuse
IV. Basin water allocation and management
V. Agrobiodiversity and ecosystem services

Outputs:

1. A Probabilistic Intervention Decision Modelling Platform for (i) estimating the development impacts of WLE interventions, (ii) determining how to measure and monitor development outcomes, and (iii) showing the value of information systems research.
2. In participation with other SRPs and their stakeholders, risk/return analysis of a set of key WLE interventions at different scales leading to (i) clarification of development objectives, (ii) quantification of uncertainties along the intervention pathway, (iii) value of information analysis to indicate the societal value of further research, and (iv) design criteria for high value metrics and monitoring systems.

Partners: Hubbard Decision Research; other SRP scientists and stakeholders

Approximate timescales for delivery: Modelling framework and 4-6 case studies in Year 1; comprehensive analyses of interventions in 3 years; Comprehensive modelling platform and monitoring systems for routine use in 5 years.

Budget over next 3-5 years: $1 million/y increasing to $3 million/y over 5 years. Assumes 50% co-investment from other SRPs.

Title

AC 5.2 Measuring agro-ecosystem health

Problem to be addressed

There is increasing availability of data on the status and trends in agro-ecosystem health and the livelihoods that they support. New advances in earth observation and proximal sensing in the field and laboratory are transforming our ability to provide accurate information over large areas. However, there are vast combinations of data that could be gathered and analyzed and not all metrics are of equal value when it comes to supporting intervention decisions. Furthermore most initiatives ignore uncertainties, and omit important variables because they are difficult to measure, and resulting analyses misrepresent the real costs, benefits and risks associated with interventions.

There is need for design of new data systems that have the capability to support probabilistic forecasting of intervention impacts and monitoring of their impacts towards development outcomes.

Intermediate Development Objective

Agricultural interventions and investments by governments, research and development organizations in Asia, Africa and Latin America are improved as a result of better measurement systems and data that are targeted to address key decision uncertainties:

1. Accelerate and improve return-on-investments in smallscale irrigation in sub-Saharan Africa by 10%, by providing better measurements and information targeted to reducing critical uncertainties on where to invest and reducing risks of system failures (Volta, Niger, Nile, Zambezi).
2. Improve productivity of rainfed farming systems in four sub-Saharan Africa countries by 10%, by improving soil information services and capacity, and meeting other critical information needs of interventions designed to support farm decisions.
3. Increase security and return-on-investment by 10% in schemes for recovery, reuse and recycling from organic and liquid waste in sub-Saharan Africa and South Asia, by measurements to address key decision uncertainties on benefits and risks.
4. Increase amounts and reliability water supply for crop production from captured flood waters in selected Basins in Asia by 10%, by providing data to reduce critical uncertainties in systems design.
5. Maintain agrobiodiversity and other ecosystem services in African, Asian and Latin American river basins (e.g. Mekong) by quantifying ecosystem service benefits as part of interventions design and implementation..

Research outcomes

1. CGIAR researchers and stakeholders use new agro-ecosystem health metrics databases, measurement approaches and protocols for planning and ecological-economic evaluation of WLE intervention options.
2. Increased capacity of the CGIAR, Governments, universities, development NGOs, and conservation groups in collection and use of agro-ecosystem data for intervention planning and evaluation of WLE interventions.

Expected activities & outputs

Activities:

1. Design of agro-ecosystem health metrics databases, protocols and measurement systems to support key WLE interventions (see Decision Analysis activity cluster) in

irrigation, rainfed and pastoral systems, resource recovery and reuse, river basin management, and agrobiodiversity conservation and use.

Outputs:

1. Review of indicators, metrics and monitoring systems for agriculture, poverty and environment.
2. Measurement systems and spatially explicit databases, including standardized probability distributions (DISTs), to support WLE intervention decision modelling.
3. Global Information and Knowledge Facility for Agrobiodiversity Conservation and Usage
4. Soil information and communication technology to improve agricultural productivity and sustainability in sub-Saharan Africa (AfricaSoils).
5. Protocol for soil health monitoring in the World Bank Living Standards Measurement Study
6. Agro-ecosystem health surveillance system for the Mekong basin
7. Capacity development of national scientists, universities and development organizations in measurement systems to support intervention decisions. Includes soil health surveillance systems institutionalized in Africa (Ethiopia, Ghana, Nigeria, and Tanzania); support to CRP6 sentinel landscapes, Vital Signs, sustainable land management projects on Africa, network of soil infrared spectroscopy labs, and private sector soil testing labs.

Partners: CIESIN and Earth Institute of Columbia University; Hubbard Decision Research; African governments; Vital Signs; World Bank, other SRP scientists and stakeholders

Approximate timescales for delivery: 2-5 years

Budget over next 3-5 years: $2 million/y over 2 years, expanding to $3 million/y in years 3-5. Assumes 50% co-investment from other SRPs.

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