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ECOSYSTEM-BASED ADAPTATION THROUGH SOUTH-SOUTH COOPERATION

Enhancing Capacity, Knowledge and Technology Support to Build Climate Resilience of Vulnerable Developing Countries

Ecosystem-based Adaptation (EbA) Good Practice Case Studies














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UN environment programme

Ecosystem-based Adaptation (EbA) good practice case studies

"Ecosystem-based Adaptation through South-South Cooperation (EbA South)" GEF-funded project (2013-2019) has developed an online database of good practice case studies related to Ecosystem-based Adaptation (EbA). The aim is to collect, analyse and disseminate good practices that can be shared amongst developing countries. The database is accessible via http://www.ebasouth.org/knowledge-centre/good-practices.

The database had been developed according to a set of criteria for case study selection. This analysis is based on the "principles of good practice", representing critical cross-cutting issues shared by the majority of climate change projects, regardless of focus, scope and scale. They are intended to encourage critical reflection and help project developers and decision-makers draw out relevant lessons. The principles consist of Knowledge building; Community participation and inclusiveness; Political ownership, collaboration and approval; Financial sustainability; Achieving co-benefits and balancing trade-offs; Building local capacities; Transferability; and Monitoring and Evaluation.

The database now comprises 15 case studies with full analysis and additional shorter case studies. The case studies are not interventions supported by the EbA South project; they are projects from which lessons are collated, synthesised and disseminated. All of them are from developing countries, among these 10 from China. All case studies analyse projects with climate change adaptation, sustainable land use and biodiversity implications.

ECOSYSTEM-BASED ADAPTATION THROUGH SHOUTH-SOUTH COOPERATION

GOOD PRACTICE CASE STUDY

Community-based adaptation to climate change through coastal afforestation

Case study compiled and edited by: C4Ecosolutions, May 2015

Bangladesh is not a significant contributor to climate change. However, it is one of the countries considered most at risk from the predicted effects of climate change. In particular, communities in the coastal areas of Bangladesh are vulnerable to increased frequency and severity of climate-related events such as cyclones, tornadoes and floods. The vulnerability of coastal communities is exacerbated by high levels of poverty and a heavy reliance on natural resource-based livelihoods. The Government of Bangladesh (GoB) implemented the first global GEF-LDCF (Least Developed Countries Fund) adaptation project, entitled "Community-based adaptation to climate change through coastal afforestation (CBACC-CF)" to reduce climate-induced vulnerability in coastal areas though enhancing resilience of communities and protective ecosystems.

Under this project, the GoB implemented multiple climate change adaptation interventions in four pilot sites, focusing on restoration and replanting of degraded mangrove and wetland areas. The project resulted in the creation of paid work opportunities for community members while generating multiple socio-economic and environmental benefits.

Project outcomes

- Livelihood diversification for over 85,000 people through training in plantation techniques and management, as well as implementing cash-for-work programmes.
- Increased siltation and coastal surge protection in mangrove plantations at pilot sites, providing improved protection against climate change-related storms, tidal surges and other disasters along an extent of 14 km of coastline.
- A new rational land use model that offers a new way to restore barren coastal lands productive.
- Generation of lessons and best practices to inform replication and up-scaling across Bangladesh, in the region and internationally.

Key lessons

- This project was jointly implemented by multiple agencies and managed by various stakeholders. Consequently, cooperation between all stakeholders – including government ministries – is integral to the implementation of adaptation projects.
- Support from local communities was an important aspect contributing to the success of this project. Community participation can be promoted through the overlap of EbA and community-based adaptation – i.e. reducing the vulnerability of relevant ecosystems while empowering local communities.
- Educating and training local communities on EbA – and thereby increasing their adaptive capacity to climate change – promotes the success of adaptation projects.
- Adaptation to climate change can be integrated into existing restoration activities.
- Limited community support for the project is a potential barrier to its successful implementation.

GOOD PRACTICE DESCRIPTION

LOCATION: Four coastal forest districts in Bangladesh, including Chittagong (Eastern Region), Noakhali (Central Region), Bhola (Central Region) and Barguna and Patuakhali (Western region). The selected upazilas within these districts include Anwara, Hatia, Char Fassion and Barguna Sadar respectively.

IMPLEMENTATION PERIOD: March 2009–April 2013 (extended to 2014)

OPERATIONAL BUDGET: US$5.4 million

KEY STAKEHOLDERS: GEF, UNDP and Government of Bangladesh. Implementing partners of the project are: Bangladesh Forest Department, Bangladesh Forest Research Institute, Ministry of Land, Department of Agriculture Extension, Department of Livestock Services and Department of Fisheries.

Background information and climate change vulnerabilities

Mangroves are integral to coastal ecosystems in Bangladesh because they provide a physical barrier that protects against damage from severe cyclones and tidal surges. However, many mangrove areas in Bangladesh have been degraded as a result of: i) cyclonic wind damage; ii) succession or regeneration failure; iii) human demand for livelihoods; and iv) commercial shrimp farming. Consequently during 1960–2000, the spatial extent of mangroves in Bangladesh decreased from 142,853 ha to 132,000 ha. The loss of mangrove vegetation negatively affects the coastal ecosystems and the well-being of local communities whose livelihoods depend upon mangroves for forest products, agriculture and fishing.

The threat of climate change to Bangladesh's socio-economic development and well-being is described in the country's National Adaptation Programme of Action (NAPA) – which identifies national priorities and threats to be addressed as part of a national climate change response – and Initial National Communication (INC) – which reports on the current and projected effects of climate change in the country. These national documents identified economic constraints and widespread poverty as two important limitations to the country's ability to adapt to climate change and climate-related hazards. Consequently, the NAPA prioritised coastal afforestation through community involvement as a simple and cost-effective approach to adapt to the negative effects of climate change in coastal areas.

Intervention technologies

The project was implemented in four coastal forest districts which were identified as being particularly vulnerable to extreme weather events, the frequency and intensity of which were expected to increase. Traditionally, a single pioneer mangrove species, *Sonneratia apetala*, has been used extensively in Bangladesh in newly accreted lands because of its ability to withstand immersion for 3-4 days. However, climate change has negatively affected the growth rate and survival of monoculture mangrove areas. Therefore, the project implemented enrichment planting within mangrove areas. Nine commercially important mangrove species were introduced to monoculture mangrove areas. The purpose of this planting was to increase the density of the trees and prevent damage from high winds and other weather events. A variety of adaptation measures were promoted and demonstrated during the project's implementation, including *inter alia*:

- mangrove plantations on newly accrued lands. These plantations were established on mounds created from soil cuttings. This soil is extracted from one side of the mound, resulting in the formation of a pit in close proximity to the mound. Gradually, this pit will be filled with silt as a result of the movement of tide water. This technique protects seedlings from water logging and water stress. In addition, the mounds are covered by sods, helping to protect them from soil erosion caused by rain or tidal water;

- model plantation of nine new mangrove varieties;
- non-mangrove mound plantations on newly accreted lands;
- dyke plantation including the Forest, Fish, Fruit (FFF) model in moderate to highly accreted lands. This technique is suitable for sites near saline water sources. A dyke is created by excavating earth to form a sloped structure, consisting of a ridge and ditch. The ridge is used to support plantations while the ditch can be converted into a pond for fish culture. This multi-functional dyke and ditch technique is termed the “3F Model”; and
- strip plantation on roadsides in project sites.

Description of the results

The adaptation interventions and livelihood development measures expanded the livelihood options for coastal communities and supported the conservation of coastal resources. Consequently, this project increased the ability of coastal communities to adapt to climate induced threats while simultaneously mitigating the effects of climate change.

The project’s accomplishments – as at the end of 2013 – included the establishment of:

i) 8,500 ha of mangrove areas by engaging 178,500 man days in cash-for-work programmes;

ii) 112 ha of dyke plantations by engaging 66,630 man days and involving 896 families through land allotments;

iii) 322 ha of mound plantations by engaging 97,260 man days and involving 554 beneficiaries through long-term benefit sharing agreements;

iv) 615 km of strip plantations have been completed with the involvement of 3,075 beneficiaries; and

v) 150ha model demonstration plantation of nine mangrove species. In addition, over 12,000 people were trained in mangrove nursery production and community-based nursery and plantation management. Furthermore, ~1,400coastal beneficiaries were trained in improved technologies for agriculture, aquaculture and livestock.

GOOD PRACTICE ANALYSIS*

Knowledge building

How has the project built upon or applied the findings of specific research projects? How has the project actively contributed to international understanding on Ecosystem-based Adaptation?

An important feature of this project was the participation of coastal communities in the implementation of Ecosystem-based Adaptation (EbA) activities, with simultaneous investments in enhanced capacity and knowledge. Implementation of the FFF model supported knowledge building as it promoted adaptation interventions that improved proactive planning and the exchange of information to manage the risks of climate variability. Moreover, the FFF created an institutional interface to provide climate change information in an integrated manner, thereby providing guidance to government and the general public to support information-based adaptation planning.

Various publications and web information were produced through the project's knowledge management activities. Project information has been added to the global Adaptation Learning Mechanism for public dissemination. In addition, field trips and field visits were organised with national and international delegates to communicate the innovations and successes of the adaptation practices.

The planned establishment of a Coastal Adaptation Learning Centre (CALC) will institutionalise on-the-ground experiences of adaptation practices in Bangladesh. The CALC will be instrumental in promoting collaboration among academics and researchers. Moreover, it will be beneficial for sharing knowledge and first-hand experiences of adaptation.

Political ownership, collaboration and approval

How has the project secured support from political-level stakeholders and aligned its activities with wider development agendas to trigger further collaboration opportunities?

Climate change and climate-related hazards are recognised by the Government of Bangladesh as a limitation to economic growth. In addressing climate change, the project focused on: i) developing partnerships with stakeholders to strengthen institutional capacity; and ii) mainstreaming sustainable environmental management into policies and planning. Therefore, the project was aligned with Bangladesh's national priorities and received strong support from stakeholders at the central, district and local levels.

The management of restored mangroves provided opportunities for the development of land use models. Since the project's inception, land has been made available for community initiatives. Landless people and marginalised groups of society – including female headed households – have been granted access to government lands through a benefit-sharing model, thereby providing landless households with a resource to support livelihoods such as agriculture. Beneficiaries entered into a ten year land ownership agreement, with the option for renewal dependent on their performance. The opportunity for landless households to increase their income increased the financial security of these previously marginalised communities.

* This analysis is based on the "principles of good practice" developed by the EU/FP7-funded project AfriCAN Climate (2011-2014). These principles represent critical cross cutting issues shared by the majority of climate change projects, regardless of focus, scope and scale. They are intended to encourage critical reflection and help project developers and decision-makers draw out relevant lessons. Source: http://africanclimate.net/en/good-practice/8-principles-good-practice

The community management approach is conducive to members sharing their knowledge and good practices among themselves. They are also able to exchange information with other groups in the area and other parts of the coast. The community management of coastal land resources contributes towards the development of equitable ownership and inclusive resource governance.

The project organised meetings with local government departments to share lessons learned and to sensitise these stakeholders to the importance of promoting alternative livelihood models and replication of successful adaptation practices identified by the project. As a result, the coastal land use policy is under review to delineate land ownership and incorporate climate change considerations in dynamic coastal zone management.

Building local capacities

How has the project ensured that local capacity was built during implementation phase? Explain how training programmes were integrated into core project activities and the measures taken to assure that built human capacity is maintained beyond the project's lifetime.

The technical capacity of government staff has been strengthened through the development and implementation of: i) several communication materials; ii) three training modules; and iii) eight technical training modules. In total, the project provided training to 153 district and 233 upazila officials. In addition, 60 district officials have visited the project implementation sites.

Activities that strengthened the technical capacity of local communities included providing training in mangrove nursery production and plantation to ~12,000 people received training in mangrove nursery production and plantation. In addition, 1,142 people received instruction on improved agricultural technologies. Furthermore, 220 households participated in demonstrations, 60 households received training in aquaculture and 470 households received training in livestock livelihoods.

Co-management committees (CMCs) were established. These include representatives of local government, local community leaders and concerned government agencies and are headed by the Chief Executive Office of sub-district. The purpose of these CMCs is to facilitate the implementation of project activities, manage conflict resolution and provide policy and legal support as needed by the project.

ECOSYSTEM-BASED ADAPTATION THROUGH SOUTH-SOUTH COOPERATION GOOD PRACTICE CASE STUDY

Cambodia Adaptation Fund Project– Enhancing Climate Change Resilience of Rural Communities living in Protected Areas

Case study compiled and edited by: C4EcoSolutions (www.c4es.co.za), October 2015

The majority of rural Cambodians are reliant on traditional livelihood practices that include subsistence-based agriculture, fishing and other livelihoods based on ecosystem goods and services. As a result of the limited socio-economic development of Cambodia's rural areas, and the limited financial resources and technical capacity of rural communities, there are very few alternative livelihood options for these communities to adopt. A consequence of the widespread reliance on livelihoods based on ecosystem goods and services is that Cambodia's rural population is likely to experience particularly severe negative impacts as a result of climate change. The effects of climate change in Cambodia are anticipated to include increasingly erratic rainfall, and increased frequency and severity of climate-related hazards such as droughts and floods. The negative effects of climate change have already been experienced by rural Cambodian households, for example the reduced productivity of agriculture as a result of erratic rainfall. As a result, these communities are increasingly reliant on forest ecosystems to provide supplementary food sources and income from collecting and selling non-timber forest products (NTFPs) and fuelwood. Widespread degradation of forest ecosystems, however, is reducing the efficacy of this adaptation response. The combined effects of climate change and ecosystem degradation will result in multiple negative socio-economic impacts as a result of reduced agricultural yield, complete destruction or failure of crops, and reduced generation of goods and services by degraded ecosystems, thereby undermining the ongoing efforts of the Government of Cambodia to meet national objectives for socio-economic development and poverty alleviation.

To respond to this challenge, an Adaptation Fund (AF) project was developed by UNEP and Cambodia's Ministry of Environment entitled "Enhancing Climate Change Resilience of Rural Communities living in Protected Areas in Cambodia" for the period 2013-2017. This project aims to enhance the climate change resilience of communities living around five community protected area (CPA) intervention sites (as well as downstream communities) through implementation of the ecosystem-based approach to adaptation (EbA). In particular, this AF-funded project promotes the EbA approach through demonstration of eco-agriculture and establishment of homegardens in participation with CPA communities. The project has prioritised the inclusion of local community members in the project's activities, thereby creating short-term work opportunities through employment in nurseries, reforestation and establishment of home gardens. In the long term, the project's investments will generate a diverse range of useful and commercially valuable products to be consumed or marketed by local households as a climate-resilient supplement to traditional livelihoods.

Project outcomes (by 2015)

- Establishment of three community-run nurseries in Beung Per, Phnom Kulen and Phnom Prich wildlife sanctuaries, respectively, employing ~126 community members. Nursery management staff has been provided with training in nursery management and seedling propagation.
- Distribution of various fruit tree species to ~1,900 households.
- Establishment of biodiverse food homegardens for ~250 households.
- Demonstration of various climate-resilient rice varieties in participation with ~65 households.
- Extensive training and capacity building of ~3,500 community members, including through 35 training events on nursery management and seed propagation, climate change, ecoagriculture, sustainable livelihoods, livestock farming, land tenure and financial management.
- Establishment of a knowledge base on EbA through the development of 14 technical assessments and reports, training of government staff at the commune and nature reserve level, and implementation of a long-term research and monitoring programme.

Key lessons

- The involvement of high-level government staff in project activities has ensured that the project enjoys sustained political support. For instance, the Minister of Environment inaugurated the first community-run nursery established.
- Activities which generate immediate tangible benefits for local communities early in the project (e.g. short-term work opportunities, construction of water supply infrastructure) encourage community participation and buy-in.

- EbA interventions and selection of sites should directly respond to community requests and knowledge (for example distributing sought-after fruit trees together with indigenous tree species) to promote community ownership and encourage the participation of additional households.
- It is important to include indigenous knowledge in the design and implementation of adaptation interventions. Rural communities have developed coping strategies over time, and often require only additional resources and training to convert these practices into sustainable alternative livelihood strategies.
- The involvement of experienced government staff members, who have worked with target communities for several years and have earned their trust, facilitates the implementation of adaptation interventions.
- Be aware of language barriers. Communities may often understand a concept, but are unaware of the technical language that may be used to describe it. For instance, certain local communities in the target CPAs already practice elements of conservation agriculture, but are completely unaware of the term.
- It is valuable to include local academic institutions in the research, monitoring and evaluation of project activities. In this project, at least ten MSc students will conduct research related to the adaptation interventions.

GOOD PRACTICE DESCRIPTION

LOCATION: Five Community-Protected Areas in the Kingdom of Cambodia

IMPLEMENTATION PERIOD: 2013-2017

OPERATIONAL BUDGET: US$ 4.95 million (Adaptation Fund)

KEY STAKEHOLDERS: Ministry of Environment (Cambodia), UNEP, Adaptation Fund, Community Protected Area committee members

Background information and climate change vulnerabilities

The AF project “Enhancing Climate Change Resilience of Rural Communities living in Protected Areas in Cambodia” aims to reduce the vulnerability of communities to the specific climate change related hazards which threaten livelihoods in rural Cambodia through demonstration of EbA. In particular, the project’s approach to EbA will target vulnerabilities related to the impacts of climate change on rural smallholder farmers, particularly increased food insecurity and reduced household income. In addition, the project’s EbA interventions aim to increase the generation of ecosystem goods and services, despite the predicted future climate trends, that will support the livelihoods and wellbeing of local communities.

Intervention technologies

The AF project implements several complementary activities that collectively increase the availability of useful or commercially valuable products to benefit local communities while increasing the generation of ecosystem services from restored areas that will safeguard local livelihoods against the impacts of climate change. These activities include *inter alia*:

- Establishment of diverse food homegardens that will generate food and useful products throughout the year;
- Distribution of fruit-producing trees for households to supplement existing annual agricultural production;
- Restoration of bare and/or degraded areas with a diverse selection of climate resilient indigenous tree species to reduce soil erosion and rainwater runoff; and
- Promotion of alternative improved agricultural practices such as use of climate resilient crops and cultivars, planting of nitrogen-fixing trees adjacent to rice paddies, and livestock husbandry.

An innovative aspect of the AF project’s approach to EbA is the promotion of homegardening as a climate change adaptation strategy. Homegardening is an approach to agriculture that has been practiced in various forms in both tropical and temperate climates. In general, homegardens are relatively small-scale (~30m²) and are maintained by individual households. The selection of plant species and methods of cultivation are variable according to the needs and knowledge of the homegardener.

One of the primary social benefits of homegardening is its contribution to household food security. Plant and animal products sourced from these gardens usually complement staple crops, and thereby help families save money that would usually be spent on food. Research has also shown that the provision of vitamin-rich fruit and vegetables, as well as medicinal plants from homegardens, greatly improve household health. An additional benefit is the establishment of new local livelihoods through cottage industries[i] selling surplus homegarden products e.g. fruits and vegetables.

Unlike conventional agricultural practices, homegardens are closely linked to natural ecosystems in that many indigenous local plant species are used by the gardeners. In addition to their many social, economic and biodiversity benefits, homegardens provide a wide array of ecological services, such as maintaining soil fertility and soil structure, minimizing soil moisture loss, providing shade and increasing the pollination of crops[ii]. The considerable density of plants within homegardens also provides habitat for wildlife species such as birds, small mammals, reptiles, and insects.

Description of the results

The AF project has provided ~3,500 rural community members with diverse training and awareness raising materials related to *inter alia* climate change (and potential strategies to adapt), homegardening, conservation/eco-agriculture, livestock husbandry, entrepreneurship and financial management. As a result, these communities have an increased capacity to respond to climate change, including through adopting improved agricultural practices as well as climate resilient alternative livelihoods.

The homegardens established by the project are already generating direct benefits such as increased availability of food for ~250 households, with an objective of including an additional 250 households in the future. The increased availability of food and commercially useful products generated by these homegardens increase household food security and cash income. Critically, at least some of these food and income benefits can be realised outside of the conventional agricultural harvest season, when households are traditionally at their most vulnerable and food-insecure.

In addition to the environmental benefits generated by the project's EbA activities, a direct tangible benefit for communities was generated through the creation of employment opportunities. The project prioritised the employment of local community members wherever possible, for example in the establishment of nurseries and preparation of restoration sites, thereby creating additional opportunities for income. At present, the project's three nurseries employ ~160 people.

[i] This refers to small-scale industries undertaken at home by family members.

[ii] Source: Kumar, M & Takeuchi, K. 2009. Agroforestry in the Western Ghats of peninsular India and the satoyama landscapes of Japan: a comparison of two sustainable land use systems. Sustainability Science 4, 215-232.

GOOD PRACTICE ANALYSIS*

Knowledge building

How has the project built upon or applied the findings of specific research projects? How has the project actively contributed to international understanding on Ecosystem-based Adaptation?

The project has a strong focus on developing a local evidence-base on the long-term effects and benefits of EbA, both as a means of informing an adaptive management approach to the project's interventions as well as to inform the development of future EbA initiatives. The project has generated a total of 11 assessment reports and studies that have been incorporated into the design of the project's interventions – including *inter alia* identification of appropriate plant species to be prioritised, options for alternative livelihoods, protocols for operation and maintenance of nurseries etc. – and which can be used to replicate and upscale the project's approach. Furthermore, the project has provided grants to five post-graduate students to generate socio-economic and biophysical research on the effects of the project's interventions. The findings of the scientific research undertaken will be published in peer-reviewed scientific journals, thereby ensuring that the project's findings will be permanently available to international researchers.

Building local capacities

How has the project ensured that local capacity was built during implementation phase? Explain how training programmes were integrated into core project activities and the measures taken to assure that built human capacity is maintained beyond the project's lifetime.

The project's approach to implementation strongly emphasises the participation and simultaneous capacity building of local communities as an important means of securing the sustainability of the project's investments. The design of project activities, for example the selection of species to be included in the EbA protocols, was informed by community needs and priorities to ensure that communities would support and maintain the project's investments. To further support the sustained involvement of community members, the project undertook diverse training and awareness raising activities to increase the capacity of communities to respond to climate change. Awareness raising activities included general information on climate change and potential strategies to adapt to the predicted climate changes, including through adoption of EbA. Training activities also included specific technical or vocational topics such as eco-agriculture and conservation agriculture approaches, alternative livelihood activities such as beekeeping and animal husbandry, and skills such as entrepreneurship and business management.

The three nurseries established by the project employ ~160 local people who have been provided with training on nursery management, seed collection and plant propagation. The horticultural skills provided to these community members will support the sustained operation of the nurseries beyond the project implementation period.

* This analysis is based on the "principles of good practice" developed by the EU/FP7-funded project AfriCAN Climate (2011-2014). These principles represent critical cross cutting issues shared by the majority of climate change projects, regardless of focus, scope and scale. They are intended to encourage critical reflection and help project developers and decision-makers draw out relevant lessons.
Source: http://africanclimate.net/en/good-practice/8-principles-good-practice

Maximising co-benefits

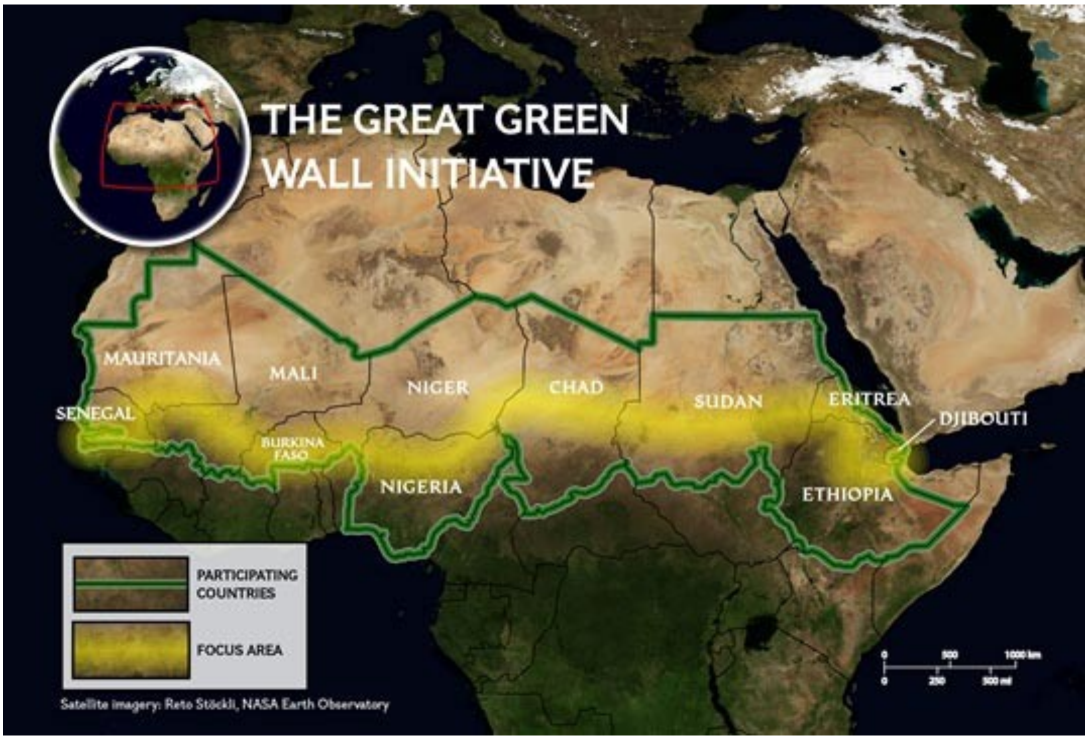
How have the interventions of the project promoted additional benefits?

The biodiverse homegardens, agroecosystems and restored forest ecosystems in the project intervention sites generate multiple socio-economic and environmental benefits in the short- and long-term. To compensate for the slow rate of generation of ecosystem goods and services, the project has included measures to generate short-term benefits for participating communities – for example, through promotion of improved rice cultivars and creation of paid work opportunities for local communities. The establishment of homegardens and restoration of degraded areas emphasises the generation of multiple products at different times of year from a diverse range of plant species, thereby providing a perennial buffer against severe climate shocks (e.g. crop failure). Another important co-benefit generated by the project's activities is the improved ecotourism potential in the broader Community-Protected Area, as a result of the improved aesthetics and increased availability of habitat for local biodiversity.

ECOSYSTEM-BASED ADAPTATION THROUGH SOUTH-SOUTH COOPERATION GOOD PRACTICE CASE STUDY

Great Green Wall Initiative

Case study compiled and edited by: C4EcoSolutions (www.c4es.co.za), May 2015



The Sahel – located between the Sahara Desert to the north and the Sudan in the south – is vital for the future welfare of ~40 million people. However, poverty and food insecurity are pervasive in this region. Efforts to eradicate socio-economic challenges in the Sahel need to include strategies to manage natural resources and address the drivers of poverty. One such strategy is the Great Green Wall Initiative. This initiative improves livelihoods of rural communities by promoting sustainable agricultural development and improved land management practices.

Project outcomes

- Employment of ~400 people in eight nurseries in Senegal.
- Increased food production and household income– particularly for women –through combining tree nurseries with vegetable gardens in Senegal.
- Planting of 30,000 hectares of trees in Senegal.
- Increased tree cover by 50% over 50,000km^2 of marginal, degraded dryland in Maradi, Niger.
- Establishment of semi-annual market days to promote the adoption of the *zai* technique as an approach to conserve topsoil and water in arid farming systems.
- Establishment of a *zai* school to train local farmers on the use of the *zai* method of land preparation for climate-resilient agriculture and rangeland management.

Key lessons

- Communities living in arid and semi-arid regions (hereafter “drylands”) have succeeded in increasing their incomes by innovating and experimenting with agricultural and natural resource management practices.
- Innovation by researchers, farmers and/or project staff has contributed significantly to the success of projects that focus on drylands. Some projects are successful because they implement adaptive management, thereby allowing initiatives to innovate.
- Increased land productivity and improved goods and services provided by restored drylands contribute to increased income for rural households.

GOOD PRACTICE DESCRIPTION

LOCATION: Sahel-Saharan region, stretching from Dakar to Djibouti, including Burkina Faso; Chad, Djibouti, Eritrea, Ethiopia, Mali, Mauritania, Niger, Nigeria, Senegal and Sudan

IMPLEMENTATION PERIOD: 2007 - present

OPERATIONAL BUDGET: GEF: US$100.8 million (GEF Trust Fund US$81.3 million and LDCF US$19.5 million)

KEY STAKEHOLDERS: The governments of Burkina Faso, Chad, Djibouti, Eritrea, Ethiopia, Mali, Mauritania, Niger, Nigeria, Senegal and Sudan

Background information and climate change vulnerabilities

The objective of the Great Green Wall Initiative (GGWI) is to provide people living in drylands, including nomadic communities, with additional livelihoods while enhancing their food security. The original concept of the GGWI was to establish a physical barrier of trees from Dakar to Djibouti, focusing on a strip of land 15 km wide and 7,100 m long. The purpose of this barrier is to slow the advancement of the desert and impede the hot winds that increase erosion, thereby improving the ecosystems of the Sahel. The concept has since evolved into a mosaic of interventions that consider sustainable livelihoods and the interests of the local populations. Each country addresses problems within its own local context, including inter alia: i) land degradation; ii) climate change adaptation and mitigation; iii) biodiversity; and iv) forestry. The GGWI is therefore a resilience programme with integrated actions that address challenges in sectors such as: i) natural resource management; ii) infrastructure; and iii) sustainability of rural production systems, including agriculture, breeding and forestry.

Intervention technologies

The GGWI implements activities that improve the ability of both human and natural systems to absorb or recover from the effects of a climate-related event. A mosaic of sustainable land use practices are being implemented based upon the following principles:

- diversify production to reduce economic risk (e.g. agroforestry and crops);
- implement safety nets (e.g. increased use of rangelands, consumption and/or sale of wild products collected from the landscape); and
- promote alternative or additional employment (e.g. off-farm labour, small forest enterprises).

Traditional land rehabilitation practices include the Sahelian *zai* technique, which is a popular adaptation method in arid and semi-arid areas of West Africa (areas with an average annual rainfall of ~300-800 mm). This technique includes digging holes (20-30 cm in width, 10-20 cm deep and spaced 60-80 cm apart) to retain manure and water in the plant root zone. In Burkina Faso, Niger and Mali, *zai* pits are filled with organic matter to increase the availability of nutrients for crops. The excavated earth is formed into ridges below the pits, which maximises the capture of rainwater. Stone lines and contour bunds are also constructed – usually collectively by village organisations, but sometimes can also be constructed by individuals. These techniques slow down the rate of water run-off, prevent erosion and increase the rate of groundwater recharge. The resultant improved infiltration of water and increased nutrient status of the soil are beneficial for crop growth. In combination with water harvesting techniques, degraded lands have been restored and facilitate higher levels of productivity. Thousands of hectares of degraded and unproductive land have been rehabilitated using this approach.

A co-benefit of the above rehabilitation technique is that the on-farm trees that grow from seeds are eaten by livestock and deposited in the manure used in the *zai* pits. The seedlings are protected and managed, promoting new agroforestry plots or "regreening". The newly established trees and bushes are important in restoring the productivity of degraded farmlands and provide multiple benefits, including : i) fodder for livestock; ii) fruit; iii) firewood; iv) poles for construction; v) improved micro-climate for agriculture; vi) improved soil fertility; vii) higher groundwater levels; and viii) decreased soil erosion.

Trees are better able to withstand climatic variability than annual crops and can be grown as a permanent source of valuable products. Furthermore, they require minimal maintenance and are able to tolerate drought once established. Income from sales of wood and other tree products enable farmers to buy food from more reliable sources – i.e. grown in areas that have consistent rainfall events. In addition, trees act as a natural barrier against desert winds and help to reduce evapotranspiration. Other benefits of tree planting include reduced erosion, enhanced biodiversity and the provision of additional sources of fodder

Since 2008, Senegal has been a pioneer of the GGWI, employing ~400 people in eight nurseries. During August each year, ~1,000 people are mobilised to plant out rows of ~2 million seedlings over one month. These newly planted seedlings are protected by fencing for a period of six years. During particularly harsh years, the protected parcels of planted land are made accessible to livestock. Six indigenous tree species have been chosen by local people and scientists for their hardiness and their economic value, these include *Acacia senegal*, which can be tapped for its gum Arabic: a stabiliser and emulsifying agent. The desert date, *Balanites aegyptiacus* is a source of food, forage, cooking oil, medicine and cosmetics. Another focus of the GGWI is to teach villagers to plant market gardens and use drip irrigation, whereby a small elevated water tank is connected to perforated pipes that deliver small amounts of water to crops.

With the support of multiple international organisations and conventions – including FAO, the European Union and UNCDD – the focus of GGWI was expanded in 2010 to include activities such as: i) recuperation and protection of degraded silvopastoral ecosystems; ii) increased knowledge on the environment, natural resources and human capital; iii) development of business opportunities, mechanisms and instruments to secure reliable incomes and more adequate livelihoods; and iv) management of silvopastoral ecosystems and safeguarding of diversified and sustainable production.

Description of the results

One of the most successful activities has been the establishment of tree nurseries combined with vegetable gardening by women's organisations in four locations in Senegal's GGWI area. These activities have increased household income and food production, and have significantly improved livelihoods within the selected areas. In Mbar Toubab, over 130 women are participating in the market gardening and have produced lettuce, tomatoes, onion, potatoes, okra, aubergines, watermelons, carrots, cabbages, turnips, mango and orange trees. Furthermore, research has been undertaken on improved nursery and planting techniques by introducing locally adapted crop species, as well as management and harvesting methods.

As of 2014, Senegal has planted 30,000 hectares – the majority of which is planted with Acacia species. Preliminary results indicate that clumps of four to eight small trees can have a positive effect on temperature. In addition, the trees slow the rate of soil erosion caused by the wind thereby reducing the dust and restricting the sand-laden winds from the Sahara. The regreening of these areas also has a positive effect upon wildlife with the reappearance of migratory birds.

In Niger, Mali and Burkina Faso, natural regeneration is managed by farmers. The widespread adoption of farmer managed natural regeneration (FMNR) is attributed to small initial investment from the farmers – i.e. benefits are obtainable at minimal costs. There are no expenditures beyond additional labour and it is therefore cost-effective for poor farmers. Progress is particularly apparent in Niger, where tree density has increased drastically. In Maradi, Niger, farmers increased tree cover by 50% over 50,000km^2 of marginal, degraded dryland. Natural regeneration activities within the region benefit both local communities and the environment by: i) increasing crop yield; ii) improving soil fertility; iii) reducing land erosion; iv) improving fodder availability; v) diversifying income-generating activities; vi) cutting the wood collection time for women; vii) strengthening resilience to climate change; and viii) increasing biodiversity.

The most innovative projects are designed by the pastoralists. For example in Niger, settlements sites have been established for migratory pastoralists. These sites include health and education services, as well as trees and market gardens. Combining nomadic and sedentary lifestyles is considered the most risk-averse survival strategy as it limits the opportunity for tension between nomads and local sedentary communities as a result of overgrazing.

GOOD PRACTICE ANALYSIS*

Knowledge building

How has the project built upon or applied the findings of specific research projects? How has the project actively contributed to international understanding on Ecosystem-based Adaptation?

During the 1970's and 1980's, several projects in drylands did not perform adequately because they did not communicate with rural communities. Past initiatives did not include land users in the design and implementation of projects and promoted technologies that were not acceptable to resource-poor land users. However, there has since been a shift towards projects that include relevant communities. As a result, more attention is being paid to learning from success stories in natural resource management in the West African Sahel. These include:

- increased involvement of land users in all stages of the project cycle;
- new techniques for management of soil and water;
- new approaches to research and extension; and
- innovations in community-based natural resource management.

A flexible approach has been adopted which makes the most effective use of best sustainable land management practices learning from results and lessons.

The GGWI project provides a novel approach to funding and information-sharing. In this context, Senegal has created a framework for other countries to start GGWI implementation.

Political ownership, collaboration and approval

How has the project secured support from political-level stakeholders and aligned its activities with wider development agendas to trigger further collaboration opportunities?

The project is based on different regional and national ongoing efforts to improve livelihoods in the Sahel and Sahara regions. Each country has adopted various programmes and initiatives related to land degradation, climate change adaptation and mitigation, biodiversity and forestry within their own local context. Many of these projects have the same objectives. The aim of the GGWI is therefore not to duplicate but rather to improve the efficiency of these programs in arid and semi-arid systems. This is promoted by GGWI through encouraging synergy and coordination between the activities of various national and sub-regional bodies working against land degradation and desertification. In addition, the GGWI promotes collaboration at regional and national levels between organisations that share the common objective of reducing land and natural resource degradation.

Building local capacities

How has the project ensured that local capacity was built during implementation phase?

By encouraging decentralisation, the project ensures the participation of the local communities. This is enhanced through the promotion of: i) simple village structures (e.g. rural markets); ii)

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*This analysis is based on the "principles of good practice" developed by the EU/FP7-funded project AfriCAN Climate (2011-2014). These principles represent critical cross cutting issues shared by the majority of climate change projects, regardless of focus, scope and scale. They are intended to encourage critical reflection and help project developers and decision-makers draw out relevant lessons. Source: http://africanclimate.net/en/good-practice/8-principles-good-practice reinforced management training for members of village structures, including women; and ii) setting up a suitable institutional framework for fiscal and land use planning. Therefore decentralisation is a mechanism to strengthen the local resource management planning and develop control capacities.

Farmer innovations are central to the development of rehabilitation techniques. Innovative farmers are identified through a process of participatory rural appraisal. Exchange visits and study tours are then arranged whereby innovative farmers can learn from each other.
Furthermore, knowledge is shared within communities through meetings and family networks. In addition, farmers have established semi-annual market days to promote the implementation of planting pits, which have been adopted by more than 100 villages in Burkina Faso. A *zai* school for training local farmers has also been established. This training programme includes 20 schools and approximately 1,000 members, who are trained to take responsibility for rehabilitating their own piece of degraded land.

Crop production farming systems are increasingly being established in less arid parts. To preserve crop diversity, crop production is often combined with pastoralism in mixed crop or in sedentary systems that use crops and livestock. Because crop failure frequently occurs in drought years, diversifying crops through mixed systems reduce the risk of production loss.

Inclusiveness

How has the project made provisions to include traditionally disenfranchised community members?

In Senegal – which is primarily a patriarchal society – gender inclusiveness has been promoted in politics and policy through measures such as the introduction of the gender parity law.
However, at present the majority of women in rural communities remain disempowered as a result of limited access to financial capital or alternative livelihood options. Therefore, by combining the establishment of tree nurseries with vegetable gardens rub by women's groups, this project promotes gender inclusiveness by generating benefits such as increased food production and income among women.

The success of vegetable gardens managed by women's groups in Senegal can be used as a model for other countries participating in GGWI to promote inclusiveness of previously disenfranchised members of rural communities.

Maximising co-benefits

How have the interventions of the project promoted additional benefits?

By supporting interventions that result in the generation of multiple benefits and useful products, this project has maximised co-benefits of investment. The generation of multiple benefits is exemplified by the example of *zai* pits, wherein manure containing seeds from established trees is used to enrich soils. The seedlings resulting from the germination of these seeds contribute to the "regreening" of degraded farmlands and ensure a sustained supply of non-timber forest products that will benefit farmers, such as firewood, fodder, fruits and fibre.

ECOSYSTEM-BASED ADAPTATION THROUGH SHOUTH-SOUTH COOPERATION

GOOD PRACTICE CASE STUDY

Ecosystem-based adaptation and mitigation solutions for Farmers' Clubs in Zambezi basin, Mozambique

Case study compiled by ACTS for EbA South, July 2016

To address the nexus challenges of poverty, food insecurity, climate change and ecosystem degradation in Zambezi basin, Mozambique, this UN Environment-funded project promoted the ecosystem-based adaptation (EbA) approach of conservation agriculture (CA), with interventions such as; i) no tillage and minimum tillage farming; ii) mixed farming; iii) crop diversification and the introduction of drought resistant crops; iv) introduction of agroforestry systems; and v) reforestation of degraded areas.

Key lessons

- Participatory planning and decision-making is an effective strategy for capacity building. Involving local community members in the entire project cycle, from planning to execution of activities, provides apprenticeship learning thus the capacity of the community is built to ensure sustainability of project outcomes.
- Peer-to-peer learning is important for enhancing knowledge sharing and scaling up actions. The farmer clubs model allows for wide-scale knowledge sharing through peer learning techniques, especially field visits and joint implementation of activities. The farmer clubs spread across the country convene farmers in an area for joint engagements. These facilitate knowledge sharing, capacity building and skills transfer within a farmer club. Field visits between different clubs facilitate wide knowledge application to catalyze upscaling.

GOOD PRACTICE DESCRIPTION

LOCATION: Caia District, Sofala Province in the Zambezi basin in central Mozambique.

IMPLEMENTATION PERIOD: February 2015 - June 2016.

OPERATIONAL BUDGET: US$ 55,000.

KEY STAKEHOLDERS: Donor: UNEP. Implementation / executing partners: farmer groups, CBOs, community leaders.

Background information and climate change vulnerabilities

The project was implemented in Caia District, Sofala Province, in the Zambezi basin in central Mozambique. Central Mozambique is reported by the World Bank as having the highest rural poverty headcount in the country at 71.2%, with Sofala, the project site, being higher at 76.7%. This is because historically, the area experienced the largest impacts of the country's 16-year civil war, which took a heavy toll on local forests and ecosystems; collapsed local agriculture; and increased poverty, food shortages, disease and malnutrition. In addition, the area is prone to extreme weather events leading to regular droughts and flooding. Communities also engage in charcoal burning for income generation, especially during droughts and due to poor agricultural productivity. Charcoal burning has resulted in an immense decline in tree cover.

This project addressed the nexus challenges of poverty, food insecurity, climate change and ecosystem degradation.

Activities included: i) training of farmers in conservation agriculture (CA) techniques; ii) capacity building through participatory planning and decision-making; iii) establishment of agroforestry systems and reforestation campaigns; and iv) value-chain analysis, undertaken to establish the most marketable value chains, which will then guide the crops that farmers will be trained to grow to promote high earnings.

To support vertical upscaling of project results, the project emphasized close engagement with the Government, including through the Ministry of Agriculture and the Ministry of Coordination and Environmental Action.

Tools and methods

To address the nexus challenges of poverty, food insecurity, climate change and ecosystem degradation, this project promoted the ecosystem-based adaptation (EbA) approach of CA, with interventions such as; i) no tillage and minimum tillage farming; ii) mixed farming; iii) crop diversification and the introduction of drought resistant crops; iv) introduction of agroforestry systems; and v) reforestation of degraded areas.

Description of the results

As of June 2016, key achievements in building community climate resilience through restoration of the ecosystems and entrenching sustainable practices included the following:

- A total of 1350 farmers mobilized, organized into 30 farmer clubs through which EbA techniques of CA and reforestation were implemented.
- Farmers adopted CA on their fields, especially agroforestry which is improving soil fertility and sustainably, and increasing productivity of the small-holder farmers. The

increased adoption of agroforestry systems could potentially provide benefits of decreased erosion, carbon sequestration and more sustainable agricultural ecosystems. Agroforestry also leads to rehabilitation of degraded forest areas to further strengthen biodiversity.

- A total of 30 demonstration fields (half a hectare in size) for dry land crops were established, one in each club.
- 1350 farmers were trained in new CA technologies, with emphasis on the economic, social and environmental benefits of agroforestry.
- Reforestation efforts to strengthen biodiversity. The project established 30 tree nurseries, each with 1200 planting bags, from which 35,000 seedlings of fruit trees and agroforestry trees were planted.

GOOD PRACTICE ANALYSIS*

Community participation and inclusiveness

Has the project consulted with local communities in the formulation, implementation and decision making process? How were gender issues incorporated?

Explain how the project mobilized local interest and ownership in order to ensure its activities responded to the needs of local beneficiaries.

The project involved communities in planning and decision making to enhance project sustainability after handover.

Through the network of small-scale farmers in Mozambique, the project mobilized 1350 farmers, organized into 30 farmer clubs participating in project activities.

On gender-specific themes, the project delivered components of the Agriculture Sector Gender Strategy of 2005. At the operational level, the farmer clubs program prioritized gender equity in delivery of its mandate. For instance, it advocated for gender equity in extension services. This was done by mobilizing women through the farmer clubs. A total of 757 women farmers were mobilized, representing 59% of participating farmers.

Political ownership, collaboration and approval

How has the project secured support from political-level stakeholders and aligned its activities with wider development agendas to trigger further collaboration opportunities?

To secure high-level support, the project entry point was through the government-endorsed farmer clubs. Government officials were also involved in the project. The project was managed by a steering committee that included government workers – specifically provincial Directors of Agriculture and Directors of the District Services of Economic Activity from all the districts involved in the project. Besides the steering committee, the project was overseen by a High Level Consultative Board, where a representative of the Ministry of Agriculture was a member. The project also built on key Mozambique government policies and strategies. It supported two key policies on agricultural productivity, infrastructure and markets, and land and natural resources. It was also in line with the National Strategy on Food and Nutritional Security, Extension Master Plan of 2007.

Going forward, the project also aims to influence relevant country and regional policies. For vertical upscaling, project results, outcomes and experiences were shared with policy makers at the Ministry of Agriculture and the Ministry of Coordination of Environmental Action through the farmer club program's high level consultative board. This will ensure the project informs both current and future policy.

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Building local capacities

How has the project ensured that local capacity was built during implementation phase? Explain how training programmes were integrated into core project activities and the measures taken to assure that built human capacity is maintained beyond the project's lifetime.

Training was a core project activity. The project trained farmers on three CA principles, namely: i) minimal soil disturbance (no tillage and direct seeding); ii) mulching (maintenance of mulch or carbon-rich organic matter covering the soil); and iii) crop rotations, including using nitrogen-fixing legumes.

Capacity building was achieved through involving communities in planning and decision making to build their management capacity.

To ensure built capacity is maintained beyond the project, trained farmers will be involved in the project operation after handover. Most importantly, policy makers were also involved to ensure CA is integrated into mainstream policies to facilitate wide-scale dissemination.

ECOSYSTEM-BASED ADAPTATION THROUGH SHOUTH-SOUTH COOPERATION

GOOD PRACTICE CASE STUDY

Building resilience to climate change impacts on the livelihoods of the fishing and fish farming communities in the Lower Shire River, Zambezi basin

Case study compiled by ACTS for EbA South, September 2016

Aquaculture is a water intensive activity. In the Lower Shire Basin, Malawi, fishing and fish farming are major sources of employment, income and food security for poor, rural households. However, in recent years, annual fish catches have declined by 65%. This decrease in fish catches is a concern both locally and nationally as demand for fish is on the rise.

Declining fish catches have a negative impact on livelihood and food security in the area. For example, reduced fish catches are projected to result in a direct loss of employment for more than 3,500 fisherfolk and an indirect loss of employment for an additional 10,000 people dependent on the fishing and fish farming value chain, such as processors and marketers. As a result of a reduced proportion of fish in local diets, protein intake in local communities is expected to decline, resulting in nutrition related illnesses. Exacerbating these anticipated trends is the limited capacity in local communities to implement efficient post harvest processing of fish.

To address the challenges of ecosystem degradation, unsustainable use of ecosystem goods and services, loss of livelihoods and food insecurity, project interventions target three thematic areas:

I. ecosystems governance,
II. value addition, and
III. sustainable ecosystems management.

Key lessons

For effective policy integration, there is need for:

- broad based stakeholder involvement in project planning, design and implementation. When local community buys in to policies, there is a higher chance of effective implementation. Their involvement throughout the project cycle is critical for enhancing awareness on how vital policies are to their wellbeing and achieving community ownership hence willingness to implement them; and
- collaboration between key stakeholders in government, the private sector, nongovernmental organizations, local communities, and researchers. To effectively bridge the policy-implementation action gap, there is need to involve cross-cutting stakeholders in policy research, awareness raising and implementation.

GOOD PRACTICE DESCRIPTION

LOCATION: Malawi – Lower Shire River, Zambezi basin.

IMPLEMENTATION PERIOD: November 2014 - October 2015 (extended to 2016 due to late funds disbursement).

OPERATIONAL BUDGET: US$ 55,000.

KEY STAKEHOLDERS: Donor: UNEP. Implementation / executing partners: senior local government officials, local government extension staff, academics and researchers, private sector organizations (including media representatives), NGOs, CSOs, CBOs, community leaders and women and youth groups.

Background information and climate change vulnerabilities

Aquaculture is a water intensive activity. In the Lower Shire Basin, Malawi, fishing and fish farming are major sources of employment, income and food security for poor, rural households. However, in recent years, annual fish catches have declined by 65%. This decrease in fish catches is a concern both locally and nationally as demand for fish is on the rise.

The primary causes of the decline in fish catches include:

- reduced water levels caused by competing water uses between crop farming and aquaculture;
- overfishing resulting from intensive fish farming practices and an increased number of fisherfolk;
- increased violation of fishing regulations, for example, by using mosquito nets for fishing;
- inadequate enforcement;
- gaps in policy and legislative frameworks; and
- variable rainfall patterns that result in frequent droughts and floods which affect the flow rate and volume of the Shire River.

Declining fish catches have a negative impact on both livelihood and food security in the area. For example, reduced fish catches are projected to result in a direct loss of employment for more than 3,500 fisherfolk and an indirect loss of employment for an additional 10,000 people dependent on the fishing and fish farming value chain, such as processors and marketers. As a result of a reduced proportion of fish in local diets, protein intake in local communities is expected to decline, resulting in nutrition related illnesses. Exacerbating these anticipated trends is the limited capacity in local communities to implement efficient post harvest processing of fish.

To address the challenges of ecosystem degradation, unsustainable use of ecosystem goods and services, loss of livelihoods and food insecurity, project interventions target three thematic areas:

I. ecosystems governance,
II. value addition, and
III. sustainable ecosystems management.

Tools and methods

I. Ecosystem governance: policy is the biggest driver of change and functional institutions are critical to policy implementation towards good governance. Through policy and institutional strengthening, the project seeks to enhance governance around ecosystem goods to minimize unsustainable practices that degrade ecosystems.
II. Value addition: increased technical capacity to implement traditional fish preservation

approaches and hence avoid spoilage and minimize food waste. Specifically, the project is training stakeholders to make and deploy fish smoking kilns.

III. Sustainable ecosystems management: this is accomplished through ecosystem restoration activities and livelihood diversification to reduce pressure on fisheries and hence conserve local river ecosystems.

Description of the results

To date, key achievements have been made in: i) ecosystem-based adaptation (EbA) policy and institutional strengthening; and ii) implementation of on the ground EbA interventions to build community climate resilience and conserve and enhance the functioning of local ecosystems.

Please see specific achievements below. Policy upscaling and institutional strengthening:

- Formulated by-laws and a Participatory Fisheries Management Plan;
- Conducted a debriefing session with district authorities including District Commissioner, Councilors, Traditional Authorities on the project themes.

Enhancing ecosystem productivity and building climate resilience:

- Constructing fish ponds to facilitate alternative livelihoods and relieve pressure on aquatic ecosystems;
- Constructing smoking kilns to reduce wastage of fish;
- Capacity building on adaptation: Training of Trainers (ToT) course for community extension agents on Climate Change Adaptation in Fisheries.

GOOD PRACTICE ANALYSIS*

Community participation and inclusiveness

Has the project consulted with local communities in the formulation, implementation and decision making process? How were gender issues incorporated?

Explain how the project mobilized local interest and ownership in order to ensure its activities responded to the needs of local beneficiaries.

Project inclusivity

The project has fostered broad-based community and stakeholder engagement during its implementation. Key stakeholders involved included community leaders and women and youth groups. These stakeholders were mobilized through public information in form of distributing leaflets about the project and convening workshops, field days and meetings, where the project objectives, activities, expected results, and long term outcomes (i.e. how the communities will benefit in the near and long term) were discussed.

Gender issues

To address gender-specific vulnerability, the project includes a vulnerability assessment study that gathers gender-disaggregated data to provide relevant information on both the nature and levels of vulnerability and the various coping mechanisms employed by different social groups. Such information will feed into the policy and decision-making processes to enable a better understanding of how different categories of communities are affected and what kind of capacity and support is needed by each group.

Mobilization

500 leaflets/brochures were distributed within the project site at Lower Shire in Nsanje district targeting policy makers, local fisherfolk, as well as fish farmers in other areas of the country.

Political ownership, collaboration and approval

How has the project secured support from political-level stakeholders and aligned its activities with wider development agendas to trigger further collaboration opportunities?

The project has mobilized support of key policy makers at local level to facilitate implementation. This was achieved through various meetings, including a debriefing session with district authorities including the District Commissioner, Councilors and Traditional Authorities. During these meetings, project themes were discussed in addition to deciding on suitable institutional arrangements for the project's implementation.

* This analysis is based on the "principles of good practice" developed by the EU/FP7-funded project AfriCAN Climate (2011-2014). These principles represent critical cross cutting issues shared by the majority of climate change projects, regardless of focus, scope and scale. They are intended to encourage critical reflection and help project developers and decision-makers draw out relevant lessons. Source: http://africanclimate.net/en/good-practice/8-principles-good-practice

Building local capacities

How has the project ensured that local capacity was built during implementation phase? Explain how training programmes were integrated into core project activities and the measures taken to assure that built human capacity is maintained beyond the project's lifetime.

The project includes training activities for local fisherfolk on fish processing, integrated fish farming, and climate change adaptation. To ensure that the enhanced capacity catalyzed by the project is sustained, local trainers are being upskilled through a ToT course for community extension agents. This ToT course focuses on climate change adaptation in fisheries, aquaculture, participatory fisheries management, fish quality, planning and monitoring. Gender considerations have also taken centre stage with stakeholders promoting gender sensitive approaches.

ECOSYSTEM-BASED ADAPTATION THROUGH SHOUTH-SOUTH COOPERATION

GOOD PRACTICE CASE STUDY

The Green Wall in the heart of the Takalamakan Desert

Authors: Anthony Mills, Jian Liu, Boni Biagini, Ermira Fida, Arthur Hanson Case study compiled and edited by Silvia Cazzetta, January 2015

Over a period of more than 2,500 years, China constructed and maintained its Great Wall to repel invasions and control its borders. Despite stretching over more than 21,000 km, this wall was often unsuccessful in holding back northern attackers. More recently, China has built a more successful wall, a 'Green Wall' comprising a dense plantation of indigenous desert plant species adjacent to the highway cutting through the Taklamakan desert, which protects the road infrastructure from being covered in sand.

Key lessons

- The Green Wall of the Taklamakan Desert shows how human ingenuity and science can overcome tremendous environmental barriers to develop new, green ecosystems that provide adaptation services such as protection of infrastructure, as well as an increase of biodiversity
- EBA is cost effective: the total cost of investment on the Green Wall is significantly lower than the estimated total cost of removing sand from the road
- Long-term ecological research is of fundamental importance for EBA implementation
- Applied research should be conducted in collaboration with both the private and public sectors to trigger up-scaling of EBA interventions
- EBA good practices and technologies can be shared and transferred to Africa, in particular in support to its Great Green Wall of the Sahara and the Sahel

GOOD PRACTICE DESCRIPTION

LOCATION: Taklamakan Desert, Xinjiang Uygur Autonomous Region in northwest China

IMPLEMENTATION PERIOD: 1991-2006

ESTIMATED INVESTMENT COSTS: $10,000 per hectare, with total maintenance cost of $4.7 million per year

Background information and climate change vulnerabilities

The Taklamakan Desert covers 337,000 square kilometers and is the world's second largest desert after the Sahara. The desert is dissected from north to south by the Tarim Desert Highway, constructed to transport oil and gas from the centre of the desert. The blowing of sand is a serious problem in this extremely dry area. As a result of climate change, the air temperature of the Taklamakan Desert is increasing. Future climate change impacts on the desert ecosystem and water regimes are still poorly understood, but it is anticipated that, as a result of warming, sands will become increasingly mobile.

Intervention technologies

Applied research was undertaken to determine which plant species could tolerate the extremely saline groundwater of the Taklamakan Desert. The Taklimakan Desert Research Station (TDRS) of the Xinjiang Institute of Ecology and Geography (XIEG), Chinese Academy of Sciences, tested the growth of 173 species of plants under desert climate and irrigation with saline water. Of these, only 88 species were able to grow well under these harsh environmental conditions. Three plant genera from the 88 species were selected as having optimal characteristics for the construction of a Green Wall, namely *Calligonum*, *Haloxylon* and *Tamarix*. These characteristics include extreme drought tolerance, rapid growth, capacity to withstand damage from wind-blown sand and capacity to grow using saline water.

Description of the results

The Green Wall, which stretches for 436 km through the heart of the Taklamakan Desert, was constructed over a period of 16 years from 1991 to 2006. *Calligonum*, *Haloxylon* and *Tamarix* are planted in rows, alongside drip irrigation pipes, in belts of 72-78 meters wide on each side of the road. This creates a barrier that protects the road infrastructure from being covered in sand.

The success of the Green Wall has catalyzed public sector expenditure to reclaim the desert and develop highly productive agricultural landscapes in the Hotan prefecture, situated on the southern border of the Taklamakan Desert. Drip irrigation systems, using groundwater, are being installed into the desert over thousands of hectares and new agriculturally productive landscapes are being created.

GOOD PRACTICE ANALYSIS*

Knowledge building

How has the project built upon or applied the findings of specific research projects? How has the project actively contributed to international understanding on Ecosystem-based Adaptation?

The Green Wall in the Takalamakan desert builds on 50 years of scientific research conducted by the Xinjiang Institute of Ecology and Geography (XIEG) within the Chinese Academy of Sciences (CAS). This research, driven by the demands of communities and industry, has been conducted by numerous research stations, including those from the Chinese Ecosystem Research Network (CERN). Two important players in the EBA interventions in and around the Green Wall are the Turpan Botanical Gardens, which function as a research base for conserving the germplasm of many Chinese desert plant species, and the Cele National Field Research Station (CNFRS), located 100 kilometers from Hotan City, which develops technologies to control desertification and movement of sand dunes into urban and agricultural areas.

This knowledge can be used and shared to manage climate change risks, such as increasing temperatures and more intense and frequent droughts, that China and the entire world face.

Political ownership, collaboration and approval

How has the project secured support from political-level stakeholders and aligned its activities with wider development agendas to trigger further collaboration opportunities?

This experience has shown that applied research should be conducted in collaboration with both the private and public sectors to ensure that appropriate up-scaling of EBA interventions is triggered. For example, research on appropriate EBA interventions started at a plot scale in the Turpan Botanical Garden and then reached thousands of hectares through the collaboration with the industrial sector on the Green Wall, and finally, after influencing public policy, it has been up- scaled in the Hotan prefecture, where thousands of hectares of desert are being reclaimed to yield verdant agricultural fields.

Financial sustainability

How has the project secured financing for sustaining and/or expanding its impacts?

Twenty million plants were planted over a 2 year period to form this green infrastructure, at a cost of ~$10000 per hectare, with total maintenance cost of ~$4.7 million per year. The investment has been deemed very cost-effective because the cost of removing sand manually from the road on a daily basis is estimated at $15 million per year. The total cost of investment – including establishment and maintenance – of the Green Wall over a 20 year period is estimated to be ~$125 million. By comparison the total cost of removing sand from the road – including all expenditure on equipment – has been estimated to be more than double this cost (~$300 million).

The Green Wall is also expected to generate an income stream, based on research by the Taklimakan Desert Research Station (TDRS) into the production of a medicinal plant, the desert

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ginseng (*Cistanche deserticola* and *Cistanche tubulosa*). These plants are root parasites that live off the shrubs of the Green Wall. Their roots are chipped, dried and then sold into the large domestic market across China. TDRS is conducting trials on the desert ginseng to determine how to maximize the income from this agricultural production. The research has shown that it is feasible to produce desert ginseng across the entire Green Wall and this up-scaling is in the process of being rolled out. It is anticipated that between $1500 and $7500 per hectare per annum will be generated through sales of the desert ginseng once it is in full production across the Green Wall.

Achieving co-benefits and balancing trade-offs

How were the costs and benefits external to the project taken into consideration, e.g. on employment, environment, health, poverty levels, food security etc?

The benefits of the Green Wall go beyond merely stopping sand from moving onto the road. For example, there has been an increase in indigenous biodiversity, including mammals and birds.

In new desert reclamation projects in the Hotan prefecture, drip irrigated *Tamarix* plantations used to control movement of sand from the desert are also used to produce roots of the valuable medicinal plant, *Cistanche*, for export. The production of *Cistanche* is undertaken by local villagers, providing them with a new income stream that is boosting the local economy.

Transferability

How has the project ensured that its activities can be transferred beyond the specific contexts in which they were implemented?

The development of the Green Wall has triggered many other green infrastructural developments, and numerous lessons have been learned through the XIEG's long-term, applied research.

Indeed, an EBA approach using green infrastructure designed by XIEG has already started in the Hotan prefecture.

The XIEG is now sharing expertise with developing countries across Africa and Asia. The Great Green Wall of the Sahara and the Sahel (GGS) is one pertinent example of how XIEG's research knowledge could be applied to great effect. This green wall was initiated by the African Union and the Community of Sahel-Saharan States to address the detrimental social, economic and environmental impacts of land degradation and desertification in the Sahel and the Sahara. The lessons learned by XIEG during the construction of China's Green Wall through the Taklamakan Desert and the transformation of thousands of hectares of desert into productive agricultural landscapes in the Hotan prefecture are likely to be of great benefit to the GGS developers. This is because Africa's green wall will also go far beyond simple tree planting. It will be exploring ways to generate income, adapt to climate change, develop new livelihoods, establish new value chains and provide food security for vulnerable local communities. There are consequently considerable synergies between the two green walls in China and Africa.

ECOSYSTEM-BASED ADAPTATION THROUGH SOUTH-SOUTH COOPERATION

GOOD PRACTICE CASE STUDY

Promoting Agroforestry in the Mountains of Southwest China - Improving Climate Change Adaptation Practices for Vulnerable Rural Communities

Compiled by: Diwen Tan (EbA South Project Management Unit), Wansu Xu[a] and Bo Liang[a] Edited

by: Pierre Begat (C4 EcoSolutions)

10 December 2018

Ganpu Village ©Heng Wang

[a] Formerly worked at Conservation International

Summary

In southwestern China, on the eastern edge of the Qinghai-Tibet Plateau, lies a mountain range known as the Hengduan Mountains (in simplified Chinese: 横 断 山). Uplifted over the last 8 million years, the Hegduan Mountains region displays drastic altitudinal variations and harbours one of the richest temperate floras. Dry valleys in the Hengduan Mountains in west Sichuan and northwest Yunnan Provinces, are characterised by a striking landscape of high mountains, deeply dissected rivers, and desert type of vegetation due to low rainfall but high potential evaporation. The ecological environment is very barren and fragile. This environment is under major threats from the changing climate and human activities: soil erosion caused by the cultivation on the steep slopes, desertification and semi-desertification aggravated in increasing droughts, land degradation by overgrazing and overuse of chemicals, etc.

This case study presents a project in a dry valley that applies an eco-friendly agroforestry system in Ganpu village to create a diverse, productive, profitable and sustainable land-use system, in order to restore the soil, increase climate resilience and improve livelihoods for local community. Main interventions include: i) agroforestry system; ii) community forest management; iii) capacity building; and iv) monitoring.

Main project outcomes:

- An agroforestry demonstration site of 12 ha has been set up on the abandoned farmland, with fruits trees, crops and animals integrated at the same time.
- Livelihood options were diversified through the agroforestry system.
- Awareness of villagers on ecosystem protection, eco-friendly framing, recycling, and ecosystem-based adaptation has been significantly improved.
- Regular monitoring results showed that the agroforestry system could increase the diversity of birds and thus contributing to the recovery of local biodiversity, habitat and the restoration of ecosystem.

Key messages:

- Development of small-scale agroforestry ecosystem is a possible method to relieve the severe food security problem in China through livelihoods diversification and sustainable increase in productivity.
- Activities of involving communities in both project planning and implementation phases, giving continued support in technologies and information (e.g. market information), and bringing them to other good demonstration sites proved effective in motivating community’s interests and participation.
- Regular monitoring to measure the effectiveness of the interventions provides scientific evidence for the application of agroforestry system.
- Being cost-effective at project level requires an overall work plan with activities and timelines which should be followed closely. In this project, the delay of livestock farming caused additional cost of purchasing manure at the beginning of project.
- A financial system associated with the agro-forestry activities can help farmers sustain the approach after the project’s termination.

GOOD PRACTICE DESCRIPTION

TITLE: Promoting Agroforestry in the Mountains of Southwest China - Improving Climate Change Adaptation Practices for Vulnerable Rural Communities

LOCATION: Ganpu Village, Li County, Aba Prefecture, Sichuan Province, P.R. China

IMPLEMENTATION PERIOD: October 2014 to September 2017 (phase one)

OPERATIONAL BUDGET: $300,000

KEY STAKEHOLDERS: The project is operated by Conservation International (CI) with funding from Daikin Industry ltd. The pilot project in Li County is implemented by Environmental Protection and Forestry Bureau of Li County, Ganpu village committee, and Ganpu fruit and vegetable cooperative, with technical support from Chengdu Academy of Agriculture and Forestry Sciences, Chengdu Institute of Biology, Chinese Academy of Sciences, and CI.

Background information and climate change vulnerabilities

In southwestern China, on the eastern edge of the Qinghai-Tibet Plateau, lies a mountain range known as the Hengduan Mountains (in simplified Chinese: 横 断 山). The mountains run generally north-south with a slight tilt toward the west at their northern end (NASA, 2007), which forms a natural barrier effectively separating the lowlands in northern Myanmar from the lowlands of the Sichuan Basin (Fig 1). Uplifted over the last 8 million years (Xing and Ree, 2017), the Hegduan Mountains region displays drastic altitudinal variations (from 1000m a.s.l. in deep valley floors to numerous peaks above 6000m a.s.l.) and harbors one of the richest temperate floras (Wu, 1988; López-Pujol et al., 2011; Sun et al., 2017). It has estimated 12,800 species belonging to at least 1767 genera, of which there are at least 3300 endemic species and 89 endemic genera (Sun et al., 2017).

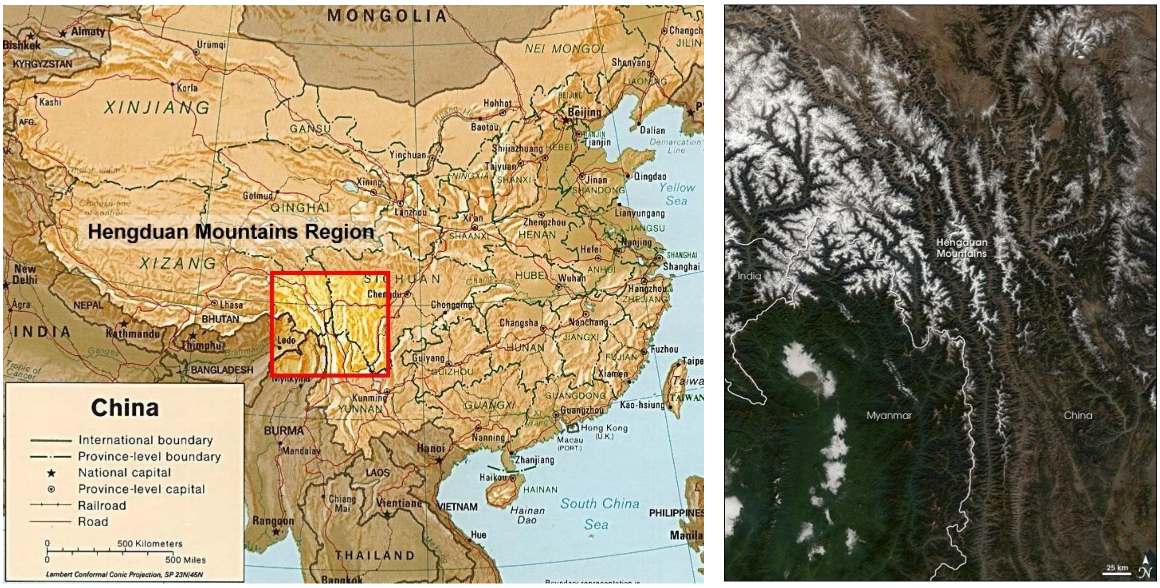

Figure 1. Location of Hengduan Mountans (left) ©Harvard University Herbaria, NASA image of Hengduan Mountains on October 5, 207 (right) ©Jesse Allen

Dry valleys, concentratedly positioned in the Hengduan Mountains along Nujiang (Salwen River), Langcang (Mekong River) and tributaries of upper reach of Chang Jiang (Yangtze River) in west Sichuan and northwest Yunnan Provinces (Yang, 2000), have very barren and fragile ecological environment, with a striking landscape of high mountains, deeply dissected rivers, and desert type of vegetation due to low rainfall but high potential evaporation (Tang et al., 2004). It has been under major threats from the changing climate and human activities: increasing droughts, strong rainfalls, overgrazing, firewood collections and development.

Ganpu village, Li county, Aba prefecture of Sichuan Province had a population of 959 (in 2015), most of which are Tibetan. It is located along Zagunao river, a major tributary of Minjiang river (upper reach of Yangtze River). In this valley, the average annual rainfall is only 400mm to 600mm whereas the evaporation is 2-4 times of it (Feng et al., 2010). In addition to the soil erosion caused by the cultivation on the steep slopes, a trend of desertification and semi- desertification was aggravated in an increasingly drought climate (Yan et al., 2006; Liu et al., 2018). The mean annual water content in a depth of 20cm of soil decreased from 7.6% in 1983 to 3.6% in 2000 (Yan et al., 2006).

Livelihoods in this area rely on agriculture through massive Chinese cabbage plantation since 1987, goat pasturing, and the recent ever-growing tourism on Tibetan culture and agritainment. In 2013, the average annual income per person is RMB 6,253, with about 38% main contribution from tourism (CI, unpublished). Impacts from the climate variability and environment change in the last few years have significantly affected communities' livelihoods: severe droughts caused production reduction; grazing of goats threatened the community forest; the overuse of chemical fertilisers and pesticides led to soil degradation which in turn affected the productivity. Furthermore, other factors such as the fluctuations of the market price on Chinese cabbage and the increased pressure on resources brought by the tourism made it worse.

In this context, a project was developed with the aim to apply an eco-friendly agroforestry system in Ganpu village, which combines forestry, agricultural and husbandry productions, to create a diverse, productive, profitable and sustainable land-use system, in order to restore the soil, increase climate resilience and improve livelihoods for local community. Main interventions include: i) agroforestry system; ii) community forest management; iii) capacity building; and iv) monitoring.

Intervention technologies

<u>Agroforestry system</u>

Agroforestry is defined as a dynamic ecologically based natural resource management system that diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels (FAO, 2015). As shown on Figure 2, this broad concept of an integrated farming system with trees, crops and animals combined was employed in the project and has three main pillars: 1) agroforestry; 2) agro-pastoralism; and 3) use of nitrogen-fixing plants, mulching and organic manure for soil conservation.

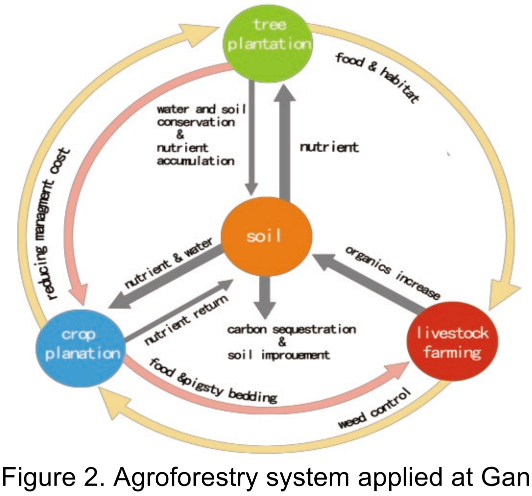

Figure 2. Agroforestry system applied at Ganpu Village, Li County ©CI

1) **Intercropping fruit trees and crops (agroforestry)**. In spring 2016, after one year of soil conservation practices (see point 3), fruit trees including apples, cherries, plums, persimmons, pears, and walnuts were firstly planted on a demonstration site - abandoned farmland, and then intercropped with beans, leafy vegetables and solanaceous fruits (i.e. tomatoes, tomatillos, eggplant, bell peppers and chili peppers). Intercropping of plants aims to stimulate interspecific below-ground interactions, which may result in improved nutrient availability and increased yield of crops (Wieshammer et al., 2007). In addition, mulberry was also widely planted on the slopes, interval zones and part of the forest (where animal farming was allowed) for water retention and soil replenishment, and also used as fodder for animals and fruits for household consumption.
2) **Livestock farming under forest (agro-pastoralism)**. As opposed to fenced-in pastures, the free-range livestock including Tibetan fragrant pigs and wild pheasants were allowed to roam in the primeval forest. Forest provides food and amiable habitat for animals and livestock farming in turn would provide soil organics and at the same time increase communities' income by selling organic products which can support the village's tourism very well.
3) **Use of nitrogen-fixing plants, mulching and organic manure for soil conservation.** In 2015, at the beginning of the project, beans (i.e. white beans, broad beans, soybeans, black beans and red adzuki beans) were planted on the demonstration site (abandoned farmland) as cover crops to prevent erosion and a legume to fix nitrogen in the soil. These species selected by experts are able to withstand the local harsh and cold climates. Other technologies including mulching and composting manure from livestock farming were used as well to improve the agriculture ecosystem with healthier soil.

<u>Community forest management</u>

In response to overgrazing by goats in the surrounding forest (mostly community forest), a community conservation agreement was signed between the village committee and the Environmental Protection and Forestry Bureau of Li County, to protect the community forest particularly the young plants. A protected area of about 10,000 acres (4,047 hectares) was established as non-commercial forest for revegetation, which would allow them to benefit from the national programme - Compensation for Forest Ecological Services. At the same time, production under the primeval forest was encouraged, which refers to the 'livestock farming under forest', to gain community's buy-in.

<u>Capacity buildings</u>

Various training workshops and site visits were provided to villagers on eco-friendly techniques, such as physical control of pest, orchard management skills, earthworm raising and probiotic fermentation, to enhance their capacity to convert business-as-usual agricultural model into a sustainable and ecosystem-based model. Besides, as a training material, a technical handbook on agro-forestry was developed to provide guidance to practitioners on how to manage different parts of agroforestry systems.

<u>Monitoring</u>

To measure the effects of interventions, regular monitoring on biodiversity using bio-indicators was designed and implemented as part of the project. In addition to four sampling plots in the agroforestry demonstration site, a control area was set up with five sampling plots. The control area was located at the nearby woodland which had been remediated for years and where the dominating vegetation is composed of small trees and shrubs. From 2015 to 2017, surveys were conducted annually by experts and students from Chengdu Institute of Biology, Chinese Academy of Sciences and CI to record the observed species and number of birds.

Description of the results

This agroforestry system constitutes a transformation from the traditional cabbage mono- cultivation farming to an integrated production system that helps farmers to control soil erosion and water retention through growing of crops integrated with fruit trees, to control chemical pollution and increase soil quality through livestock manure and nitrogen-fixing plants, and to enhance food security though diversified livelihoods. The wide range of social-economic and ecological benefits thus leads to a more resilient ecosystem and community to adapt to the climate change.

Below is the impact analysis from June 2017. Social-economic

1) **An agroforestry demonstration site** of 12 ha has been set up on the abandoned farmland, with fruits trees, crops/vegetables and animals integrated at the same time. It has been well managed by the Fruit and Vegetable Association in Ganpu village, acting as a community cooperative.
2) **Livelihood options were diversified.** Compared with previous income relied on massive Chinese cabbage, the alternative livelihoods being practiced through this project such as selling fruits, under-trees beans, vegetables, and livestock allow farmers to benefit throughout a whole year and withstand the uncertainty and variety of climate and market (Fig 3). According to the Chengdu Academy of Agriculture and Forestry Sciences, the estimated income from the agroforestry demonstration site in 2017 was around RMB 203,000, which equals the investment in years 2015 and 2016. All 249 households in the village equally shared the income/venue via the cooperative system. In addition, converting the barren land to productive agro-forestry provides temporal employment opportunities: around 100 low- income households gained RMB 80 per day from agricultural activities subsidised by the project.

Figure 3. Products at the agroforestry demonstration site ©CI

3) **Awareness** of villagers on ecosystem protection, eco-friendly framing, recycling, and ecosystem-based adaptation has been significantly improved through various trainings, exchange visits and active involvement in the agroforestry practices. Some of villagers started to adopt organic fertilisers voluntarily.

Ecological

The monitoring results showed that both abundance and richness of birds and insects increased through the adoption of agro-forestry practices: the observed number of birds increased from 11 (in 7 species) in 2015 before interventions to 68 (in 16 species) in 2017, close to the investigation results in the control area (Wen et al., 2017); the observed number of insects also increased by 11% annually at the demonstration site (CI, unpublished). It suggested that the system of agroforestry could increase the diversity of birds and thus contributing to the recovery of local biodiversity, habitat and the restoration of ecosystem (Wen et al. 2017).

GOOD PRACTICE ANALYSIS†

Knowledge building

How has the project built upon or applied the findings of specific research projects and/or vulnerability studies? How has the project actively contributed to an international understanding Ecosystem-based Adaptation?

The project has engaged largely the experts from different universities and research institutions. For example, the technical consultants from Chengdu Academy Agriculture and Forestry Sciences (CAAFS) provided technical advices in the design phase. The Chengdu Institute of Biology, Chinese Academy of Sciences (CIB, CAS), together with CI, has conducted a baseline survey on ecological and socio-economic status quo, and set up a monitoring system. This paved the way for future research on the effectiveness of agro-forestry.

In addition, drawing on the practices in Ganpu village, a technical handbook (in Chinese) for application of the agro-forestry related techniques for practitioners was developed by various experts and successfully disseminated to broader audience.

Community participation and inclusiveness

Has the project consulted with local communities in the formulation, implementation and decision making process? How were gender issues incorporated?

Local communities participated throughout the project.

At the planning phase, they were fully engaged in the consultation and activities design process that coordinated by experts. They showed a strong desire to adopt new practices to reduce chemicals cost and increase productivity, and also asked for relevant knowledge, technology and financial support, which has been well considered in project through developing eco-friendly agriculture.

During the implementation phase, local communities were encouraged to lead the activities by themselves with monitoring and technical guide from CI and local government departments. The agroforestry demonstration site is managed by the Fruit and Vegetable Association of Ganpu village, as a community cooperative where all villagers equally share the income from the site.

This active engagement help people gain ownership which is essential for the long-term maintenance beyond the project.

Political ownership, collaboration and approval

How has the project secured high-level political support for its activities? How the aims and activities were aligned with wider development agendas.

According to the "Notice on Printing and Distributing the National Main Functional Zone Plan" issued by State Council (Guo Fa [2010] No. 46), Aba Prefecture was selected as a key national ecological function zone. Located in the upper reaches of the Yangtze river and Yellow river, it is considered as an important water conservation area. This project contributes to the provincial

† This analysis is based on the "principles of good practice" developed by the EU/FP7-funded project AfriCAN Climate (2011-2014). These principles represent critical cross cutting issues shared by the majority of climate change projects, regardless of focus, scope and scale. They are intended to encourage critical reflection and help project developers and decision-makers draw out relevant lessons. Source: http://africanclimate.net/en/good-practice/8-principles-good-practice

government programme of establishing “Northwestern Sichuan Ecological Economic Demonstration Area”, through promoting eco-friendly agriculture. The project was therefore fully supported by the provincial forestry department when it was initiated. The Environmental Protection and Forestry Bureau of Li County also became a key partner of this project.

Building local capacities

How has the project ensured that local capacity was built during the implementation phase?

Trainings, exchange visits and expertise support were provided to enhance local capacity:

- Around 400 villagers and officials (person-times) from Forestry Bureau of Li County have received trainings with lectures and hands on activities, facilitated by CI. Experts from different institutions were invited including Chengdu Academy of Agriculture and Forestry Sciences, China West Normal University, and Chengdu Institute of Biology, CAS. The trainings focused on agro-forestry as well as specific farming technologies (e.g. pruning, pests control, livestock farming, and intercropping).
- Visits to other eco farms for knowledge sharing were organized twice per year. For example, around 10 representatives from the village and county forestry bureau visited to Beijing Ecological Farm in 2017, to learn and share knowledge on the farm management and technology on fruit and vegetable cultivation, composting, and pest control.
- Technical handbook on agro-forestry to guide on what, when and how to manage different parts of the system was developed and delivered to all villagers. Meanwhile, several experts were involved as consultants to provide long-term technical support.

Monitoring and Evaluation

How has the project demonstrated its impacts in terms of achieving objectives, outcomes, and outputs? How M&E plans were developed, and how effectively they have been applied?

As described previously, a monitoring system with a control area and sampling plots has been set up and regular surveys on biodiversity using bio-indicators were conducted annually by experts and students from CIB and CI. The results supported positively of the adoption of agroforestry practices in terms of the ecological effects. The monitoring activities would continue beyond the project and an evaluation on both ecological and economic effects would be undertaken by CI and research institutes through analysis on costs and outputs.

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ECOSYSTEM-BASED ADAPTATION THROUGH SOUTH-SOUTH COOPERATION

GOOD PRACTICE CASE STUDY

Three Integrated Farming-Grazing Systems in Tibetan Plateau

Compiled by: EbA South Project Management Unit (Beilu Duan)

Edited by: C4 EcoSolutions (Ashley Robson, Anthony Mills), EbA South Project Management Unit (Diwen Tan, Tatirose Vijitpan, Silvia Cazzetta)

4 May 2017

The region of Tibet in Southwest China is located on the Qinghai-Tibet Plateau, the highest and largest plateau in the world with an average elevation of over 4,000 m and an area of 1.2 million km^2. It is extremely vulnerable to climate change. In recent decades, average temperature and precipitation has increased regionally, while locally southern Tibet has observed a decrease in precipitation. The changing climate has caused shrinking permafrost and wetlands as well as impacts on alpine grassland, farmland and forest on which most people rely heavily. Moreover, poverty further exacerbates the sensitivity of local people to climate impacts.

This project targeted three villages in Tibet and aimed to increase the household's income by improving ecosystem services and local capacity to manage their natural resource-based livelihoods. The interventions included: i) improving agricultural techniques; ii) building integrated farming-grazing technology systems; iii) establishing community-based cooperatives and industries; and iv) training. This project successfully helped the villages in the aspects of economy, ecology, livelihoods and human capacity, among others, and all of those contributed positively in adapting to climate change.

Key lessons

(1) Improvement of ecosystem services

- For farming systems in Tibet: Multiple cropping in August to September and mixed seeding are two ways of increasing the productivity of croplands.
- For grazing systems in Tibet: First, in order to restore degraded grassland, seed selection of forage works more effectively than building irrigation systems due to the seasonally concentrated precipitation. Second, fencing with shallow tillage or without tillage is an optimized management method that could increase the productivity of forage cropland and also reduce the loss of carbon storage. Third, forage-feeding is a supplement of grazing. It helps in reducing the pressure of grazing pastures.
- For farming-forestry-grazing systems: Models of 'raising geese in corn farmland' and 'raising Tibetan pigs in the understory of forest' could increase the productivity of related ecosystems. Corn farmlands without fertilizer or pesticide may reduce the productivity of corns but would improve the ecological function and maximize profits from the integrated system.

(2) Livelihood diversification

Diversified livelihoods could help to adapt to climate change. In Bailang village, it developed the model of ‘when rain is ample, sell forage; when drought occurs, feed sheep’. These two livelihoods help locals deal with different weather patterns.

(3) Establishment of cooperatives

- Establishing cooperatives is an important method that helps improve livelihoods of the communities by diversifying their livelihood options with consideration of traditional local knowledge, creating more profits by selling their products directly to the customers, and building social connections. These benefits are important to reduce the vulnerability to the impacts of climate change for locals.
- Cooperatives also have their own risks. According to the experience of Jina village, a good cooperative relies on its managers and the management of risk from the market. Therefore, improving the human capacity and the mechanisms of training are important for the development of cooperatives.

GOOD PRACTICE DESCRIPTION

LOCATION: Three villages in South Tibet and Southeast Tibet: Jina, Bailang and Zhangmai

IMPLEMENTATION PERIOD: 2013-2016

OPERATIONAL BUDGET: RMB 22.8 million

KEY STAKEHOLDERS:

The project was developed and funded by the Chinese Academy of Sciences (CAS), and was implemented by the Institute of Geographic Sciences and Natural Resources Research, CAS, and the Tibet Research Center for the Engineering and Technology of Alpine Grassland. Additionally, this project forms a part of the 'Science Technology Service Network Initiative'.

Partners: Institute of Microbiology, CAS; Institute of Subtropical Agriculture, CAS; China Agricultural University; Nanjing Agricultural University; Tibet Academy of Agricultural and Animal Husbandry Sciences; and Lanzhou Institute of Husbandry and Pharmaceutical Sciences, Chinese Academy of Agricultural Sciences (CAAS).

Background information

The region of Tibet is located on the Qinghai-Tibet Plateau in Southwest China. The plateau is the highest and largest in the world with an average elevation of over 4,000 m and an area of 1.2 million km^2. The region is also the origin of multiple vital rivers which affect approximately 40% of the world's population. The unique geology and topography of the plateau generate a rich biodiversity and considerable influence on the climate in southern Asia. Qinghai-Tibet Plateau is one of the most important hotspots of biodiversity in the world due to its unique topography and species (Myers et al., 2000). Studies showed that the early intensive uplifting of plateau, together with other factors like climate change, generated unique bio-geological environment in Himalayas, which in turn bred unique biotas, diverse ecosystems and ecological process in the region (Favre et al., 2015, Zhang et al., 2002). The plateau also induces and enforces the Southwest Monsoon in Asia (Ye & Gao, 1979).

Tibet has a total population of ~3 million, with 90% of the population being Tibetan (Sixth National Census, 2010). Approximately 32.95% of population live in poverty (Tibet Poverty Alleviation Office, 2014). In addition, as the dominant ecosystem in Tibet is alpine grassland, most people rely on traditional farming and grazing for their livelihoods.

This project consists of three subprojects. They were launched in the southern and south-eastern areas of Tibet at three selected Tibetan villages: Jina village, Bailang village, and Zhangmai village. The region is located in the Yarlung Zangbo River basin and ranges in elevation from 3,000 m to 4,000 m.

(1) Jina village is located at the Gangdui town, Gongga county (‰ pfifi). It is 20 km away from Gongga airport and 80 km from Lhasa (the capital of Tibet). The dominant ecosystems are alpine semi-arid shrubland and grassland. Jina village has 268 households with a total of 1,133 people. The average income of the village is similar to an average Tibetan farmer, who earns 5,000 RMB per year. Local people grow food crops and forage crops to make a living.

(2) Bailang village is located in a mountainous area of the Kazi, Linzhou county (:¼ ƒ }$ fi). It is also 80 km away from Lhasa. It is covered by the temperate semi-arid shrub and grassland. Bailang village has 155 households with a total of 877 people. The villagers' average annual income is 4,155 RMB, 17% lower than an average Tibetan farmer. Apart from the basic farming, the other main agriculture in Bailang village is grazing, which is supported by 93 km^2 of grasslands.

(3) Zhangmai village is located in the suburb of Bayi town, Linzhi county (= ¿ ~ ø@fi). The Bayi town is the centre of the Linzhi county and is famous for tourism. The dominant ecosystem is subalpine forest. The village has rich forest resources. Zhangmai village has 60 households and 160 people, with an average annual income of 5,500 RMB, which is higher than the average level of Tibetan farmers. Young people from the village make a living by taking temporary jobs in the city nearby.

Climate change vulnerabilities

Tibet is extremely vulnerable to climate change. In recent decades, average temperature and precipitation has increased regionally, while locally southern Tibet has observed a decrease in precipitation. The changing climate has led to a shrinking of permafrost and wetlands, an increase in runoff, and an increase in the occurrence of natural disasters such as snowstorms and drought (Chen et al., 2015). Studies show that the warm-wet climate accounts for more than 80% of the change (increase) in grassland productivity between 1982 to 2001, while its effects decreased from 2001 to 2010 as the warm-dry climate reduced the productivity of alpine grassland (Chen et al., 2014).

In the three project villages, people rely heavily on farmlands, grasslands and forests to make a living. While affected by the impacts of climate change on their natural lands, poverty also exacerbates their sensitivity to climate impacts. Therefore, this project aims to increase locals' income by improving ecosystem services and local capacity to manage their natural resource-based livelihoods.

Intervention technologies

The project consists of four different types of interventions, namely: i) improving agricultural techniques; ii) building of integrated farming-grazing technology systems; iii) establishment of community-based cooperatives and industries; and iv) training. Separated but similar interventions have been taken in the three villages according to specific types of livelihoods.

(1) Improving agricultural techniques

- Applied multiple cropping to food cropland: Multiple cropping is a practice of farming intensification through various forms, such as intercropping, crop rotation and agroforestry. By increasing the diversity of crops, it improves nutrient cycling (e.g. nitrogen), soil fertility and thus the provision of agriculture products (Agriculture for impact, 2016, Gliessen, 1985, Vignola et al., 2015). In Jina village, CAS developed and applied five models of multiple cropping. For example, they applied crop rotation in the form of second-round cropping of legumes during August and September as to improve the nitrogen cycling and soil fertility in the farmland (Figure 1).
- Restored grassland and pastures: By applying different technologies, such as fencing, irrigation and fertilization, Bailang village restored 80 ha of spring/summer pastures and 67 ha of winter pastures from degraded grassland. These pastures are used for alpine transhumance of every family. In Zhangmai village, CAS restored the grassland through a type of rye (ƒ@$), which is resilient under the dry and extreme weather. They also applied several technologies related to the management of grassland and pastures. These methods include increasing the diversity of forage grass and improving the sowing techniques (Figure 1).

Figure 1. Alpine mixed forage cropland (left), second-round cropping with grassland management techniques (right) ©CAS

(2) Building integrated farming-grazing systems

- Integrated farming-animal husbandry model: In Jina and Bailang villages, CAS developed a livelihood model of integrated farming-grazing systems, combining the forage farming and animal husbandry together within the same village. It intended to support the intensive animal husbandry for livestock, such as cattle and sheep, through self-supplied forage. CAS sponsored seed drills and harvest machines for forage farming. It also introduced Total Mixed Rations (TMRs) forage-packing technology to help farmers to store the harvested forage and waste straw while maintaining the nutrient of forage during winter. For animal husbandry, CAS introduced five feeding formulae to the farmers as to maximize the use of forage.
- Integrated farming-forestry-grazing model: In Zhangmai village, two types under this model were developed: ‘raising geese in corn farmland’ and ‘raising Tibetan pigs in the understory of forest’. Suitable forage crops were planted in corn farmlands and the understory of forest. This model is intended to maximize the use of land and natural resources for agriculture.

Figure 2. Raising geese in corn farmland (left), raising Tibetan pigs in the understory of forest (right) ©CAS

(3) Establishing community-based cooperatives and industries

All three villages established their own agricultural cooperatives. In Jina village, farmers contributed a number of their own cows and part of their land to their cooperative. The cooperative is mainly responsible for cultivating forages; raising and managing livestock at 20 ha collective land; and selling its own milk and meat products. The profits were shared among the farmers based on their contributions of assets. In Bailang village, apart from managing the collective foraging-farming system, the cooperative also provided technical support of forage cultivation to villages in need. In Zhangmai village, the cooperatives served as platforms to connect farmers to teams of scientists, and companies that sell meat products.

(4) Training

CAS organized several training activities for the key staff of cooperatives in order to equip the locals with the knowledge and skills for managing the forage cultivation and intensive animal husbandry. The training topics included the technology and methods of machinery cultivation, packing of forage crops, and raising and management of intensive animal husbandry.

Description of the results

This project changed the villages in the aspects of economy, ecology, livelihood, human capacity etc. Meanwhile, these achievements of the project are helping locals to adapt to climate change. Following are the results of all three subprojects.

(1) *Improving livelihoods and food security:* By establishing three integrated farming-grazing systems, the project helped to increase agricultural productions therefore improve traditional livelihoods and the people's food security under climate change. In Bailang village, the productivity of grass and forage in restored grassland increased by three times. In Jina village, the productivity of meat and dairy products in integrated agriculture-grazing system increased by 30%. In Zhangmai village, the survival rate of Tibetan pigs increased by 10%. In 2015, although a severe drought hit the Bailang village, the produced forage was still able to meet the need of livestock due to the sufficient self-supplied forage.

(2) *Increasing financial capitals:* Apart from strengthening the income from the traditional livelihood, the project helped the locals generate income by building new alternative non-agricultural livelihoods. In Bailang village, after benefited from related training, young people in the cooperative were sent to provide technical support for the cultivation of forage in surrounding villages. These services now account for 60–70% of the income of the cooperative. Moreover, the cooperative helped to diversify households' livelihoods through collective forms such as meat processing. In this way, the profits from selling their products were received directly from the customers without sharing with intermediaries. At the end of 2014, in Zhangmai village, the profits from agricultural activities increased by 103%. On average, all households in these three villages had been helped to increase their income by more than 2,200 RMB (increased by more than 40%).

(3) *Enhancing social capitals by establishing new cooperatives:* Each of the three cooperatives involved more than 95% of households in their villages. Compared with companies outside of the community, local cooperatives manage their livelihoods better by integrating traditional local knowledge into the operation. Additionally, community-based cooperatives become important social connections or capitals for households which may buffer the impacts of climate change for locals. Cooperatives reduced the individuals' risk of raising sheep at the community level by buying the sheep from individuals. In addition, the cooperatives became a new place where people could borrow money from when in need. In Bailang village, cooperatives had already lent money to several villagers.

(4) *Capacity building*: During the project, more than 1,000 locals attended the training organized by CAS. In addition, eight core members in Jina village's cooperative participated in the special training for the management of cooperative and key technology of intensive animal husbandry.

(5) *Demonstration of integrated farming-grazing systems:* All three integrated systems and their related technologies were demonstrated to the public. The demonstrations were praised by Tibet Government and Central Government of China.

GOOD PRACTICE ANALYSIS*

Knowledge building

How has the project built upon or applied the findings of specific research projects? How has the project actively contributed to international understanding on Ecosystem-based Adaptation?

These projects were based on previous research on crop productivity and selection of seeds. From 2010, CAS have already conducted experiments in Tibet on the cultivation of a variety of seeds that were selected from Qinghai province. China Agricultural University, Nanjing Agricultural University, Tibet Academy of Agricultural and Animal Husbandry Sciences, and other research institutes support the technologies related to forage packing and animal husbandry.
The technical support from the previous research and other research institutes enabled the transformation of ecosystem services to livelihoods. As a result, this project also developed three models of integrated farming-grazing systems.

Furthermore, this is an ecosystem-based adaptation project with a focus on agricultural practices. It developed four key lessons and experiences for EbA in agricultural area specifically, and adaptation generally, as described above. Although some specific techniques of grassland restoration may only be applicable in the context of Tibet or other similar environment, the experience of cooperatives and methods of ecosystem management, such as multiple cropping and integrated farming-grazing systems could be applied in a broader context.

Community participation and inclusiveness

Has the project consulted with local communities in the formulation, implementation and decision making process? How were gender issues incorporated? Explain how the project mobilized local interest and ownership in order to ensure its activities responded to the needs of local beneficiaries.

Locals have been involved in the decision-making process and implementation. CAS organized community meetings to consult the locals on several issues, ranging from the establishment of cooperatives, the methods of sharing profits made by the cooperatives, to ways of managing the cooperatives.

The project successfully attracted the locals for two main reasons. First, as CAS funded the project and got support from several research institutes, the risk and cost of applying new technology and models of livelihood were responsible by the project and CAS themselves. Therefore, without much risk to take, the locals were willing to engage in the project. Second, the cooperative started to gain profits from the following year of the initiation of the project. It attracted the last un-involved group to join the cooperative.

For the government, CAS designed the project in consideration of one of the goals of central government, which is to increase Tibetan's income. Motivated by political achievement, local government coordinated and supported the project.

* This analysis is based on the "principles of good practice" developed by the EU/FP7-funded project AfriCAN Climate (2011-2014). These principles represent critical cross cutting issues shared by the majority of climate change projects, regardless of focus, scope and scale. They are intended to encourage critical reflection and help project developers and decision-makers draw out relevant lessons. Source: http://africanclimate.net/en/good-practice/8-principles-good-practice

Political ownership, collaboration and approval

How has the project secured support from political-level stakeholders and aligned its activities with wider development agendas to trigger further collaboration opportunities?

The project ensured support from the government by setting goals that were compatible with national policies. First, this project is in response to the Twelfth Five-Year Plan for National Economic and Social Development of People's Republic of China, which is issued by the central government of China. In this plan, one of its goals is to alleviate poverty by 2020. CAS designed the projects as to help to achieve this goal in response to the request of Tibet central government. Thus, the project received support from all levels of government in Tibet. Second, the central government also enacted The Plan of Protection and Establishment of Ecological Barrier in Tibet (2008-2030), in which protection of natural grassland is one of the five key ecological programmes. The restoration of grassland in two subprojects was aligned with this plan.

Besides, based on this pilot project, CAS suggested further projects with an aim of increasing the benefits of agricultural and grazing area in Tibet. One suggested project has already been adopted, and incorporated into *Tibet's Thirteenth Five-Year Plan*.

Financial sustainability

How has the project secured financing for sustaining and/or expanding its impacts beyond the initial project lifetime? Explain how the project secured national (e.g. government) and international (e.g. international donors) support for sustaining its impacts.

Funding for further development has been attained from two sources: self-supplied cooperatives and following projects. First, every year CAS and the cooperatives encouraged the locals to invest part of their profits generated from the cooperative to maintain or enlarge its activities. For example, in 2014, every household invested 400 RMB out of the 1,000 RMB profits to the cooperative. In 2015, each household invested 800 RMB/2,000 RMB to the cooperative. The reinvestment ensured the sustainability of the cooperative and thus activities that generate profits. Second, the success of the project and report attracted subsequent support from government and research institutes. In Bailang villages, the institute 'Tibet Research Center for the Engineering and Technology of Alpine Grassland' approved three new research projects for CAS to study the ability to restore natural grassland and ecosystem services. The agricultural and grazing bureau of Gongga County funded another project to support further development of the cooperative in Bailang village.

Achieving co-benefits and balancing trade-offs

How were the costs and benefits external to the project taken into consideration, e.g. on employment, environment, health, poverty levels, food security etc? Explain how the project aimed to maximizing external co-benefits from project activities and avoid/minimizing external costs and damages.

There are several benefits beyond the achievements of the project. Apart from the benefits shown in the project results section above, the project also increased the job opportunities for the villages. People were hired to construct the infrastructure for animal husbandry, to work for forage cultivation and animal husbandry and to manage the cooperatives. Furthermore, this project also generated more than twenty graduate students who conducted the research under these subprojects. Outcome of the research contributed to the knowledge on ecosystem services. In addition, indirectly, livelihoods were diversified in Bailang village. The locals learned from the model of the established cooperative. As a result, they organized four more small cooperatives based on their expertise. These cooperatives focus on artificial flowers; forage processing; wool product and a local teahouse.

Moreover, the three subprojects were designed with the goal of enhancing both livelihoods and ecosystems at the same time. Also, various aspects of the social-ecological systems have been considered as to minimize the cost. For example, in Jina village, the project included leguminous plants in the second-round crops in order to maintain the fertility of the cropland. In Bailang village, the cooperative refused a big investment from individual investors in order to guarantee that profits shared by each household remain high. CAS also adjusted the management plan of degraded grassland as to balance the land productivity and carbon storage of the land.
Additionally, in order to reduce the risk of the market of meat products, CAS planned for the cooperative in Jina to sell their products directly to restaurants, which are the end of the production chain.

Building local capacities

How has the project ensured that local capacity was built during implementation phase? Explain how training programmes were integrated into core project activities and the measures taken to assure that built human capacity is maintained beyond the project's lifetime.

Building local capacities to manage local livelihoods was a main part of the project. Firstly, CAS organized several training sessions for key staff of the cooperatives in order to increase their capacity to manage their livelihoods. Most of the training related to technology was organized at the cooperatives when experts visited the villages periodically. In addition, CAS sent two key technical support staff in Jina village into the cooperative to Changsha, Hunan Province, to receive systematic training of cow husbandry. In addition, the training given to the cooperative contributed to the local community in the long term. In Bailang village, the cooperative received extra income by sending young staff to instruct the villagers who wanted to learn the forage cultivation technologies. Secondly, the agricultural machines that CAS purchased during the project were left for these villages and thus would continue contributing to local's capacity of managing the ecosystems when the project is over.

The social capacity of local communities also increased as cooperatives played an important role in social linkages, providing livestock raising techniques, reducing risk of market price fluctuations for sheep raising, and providing loans. In this way, the cooperatives could buffer the communities from impacts of unexpected natural disasters and increase their opportunities for improving their well-being.

Transferability

How has the project ensured that its activities can be transferred beyond the specific contexts in which they were implemented? Explain how particular project measures, activities or concepts could be/have been applied in another contexts or regions and how successful these efforts have been.

One of the goals of the project is to demonstrate integrated farming-grazing systems that were built under the project. These pilot subprojects were designed and implemented in three typical types of villages in Tibet: villages relying on agriculture, on agriculture and grazing, and on agriculture and forestry. Based on these three pilot subprojects, government and CAS aimed to demonstrate three integrated farming-grazing systems and their related technologies to the whole of Tibet.

As a result, many of the products developed from the projects are transferable. First, these projects developed the formula and technology for forage cultivation and intensive animal husbandry in alpine ecosystems. These technologies may be applied to other areas of Tibet or even other cold regions with limited water resources and seasonal-concentrated precipitation. For example, Shigatse (one important city of forage cultivation in Tibet) has already incorporated the methodologies of forage cultivation from Bailang village into its own development plan. Also, Heilongjiang Province has broadly applied the model of 'raising geese in corn farmland'. Furthermore, these projects also developed the model of community cooperatives based on the livelihoods. This could also be applied to other areas in Tibet or other villages that have community-wide characteristic agriculture or livelihoods that are based on similar resources.

Monitoring and Evaluation

How has the project demonstrated its impacts in terms of achieving objectives, outcomes, and outputs? Explain how M&E plans were developed, and how effectively they have been applied.

CAS has plans of monitoring and evaluation for both ecosystems and subprojects. For the grassland ecosystem, CAS monitored periodically on its growth, biomass and biodiversity and the productivity of forage. The results of monitoring were mainly used to support the research of CAS. For the project operation, the operational team stayed at the pilot sites for six to eight months every year in order to monitor the project and coordinate it. The team monitored the production of forage and livestock by interviewing the cooperatives, which are the main source to generate additional income for the households. These staff communicated with the cooperatives every week during their stay. For the evaluation of the project, CAS reported the work and results of project annually. In 2014 and 2016, CAS developed two detailed reports of evaluation for the project.

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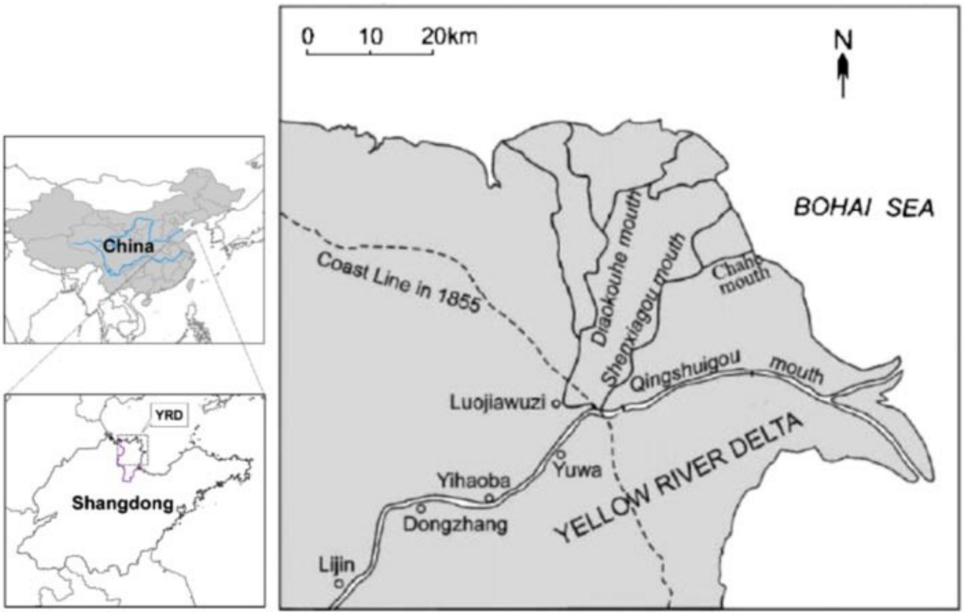
ECOSYSTEM-BASED ADAPTATION THROUGH SOUTH-SOUTH COOPERATION GOOD PRACTICE CASE STUDY

Water supplement for wetlands in the Yellow River Delta, China

Case study compiled and edited by: Xiubo Yu December 2015



In the project "Water supplement for wetlands in the Yellow River Delta", the Yellow River Delta National Nature Reserves Administration, in collaboration with project partners, is implementing climate change adaptation interventions in the Yellow River Delta, China. These interventions promote the restoration of degraded wetlands and enhance ecosystem functioning, specifically the recharge rate of water resources. The results of the project include *inter alia*: i) restored estuarine wetlands; ii) enhanced provisioning of wetland ecosystem goods and services; and iii) income generated through the ecotourism value chain.

Key lessons

- Crises present opportunities to motivate for the reform of water management policies.
- The trade-offs between in-stream versus consumptive water use can be understood through economic analyses of the benefits provided by ecosystem services versus water extraction.
- Water management plans should account for the inherent variability of water inflows (environmental and climatic variability) and outflows (variability in water user behavior).
- Centralized and nested water governance structures within catchment-wide management institutions can contribute to revisions of water allocations in response to variations in environmental conditions, scientific knowledge and societal values.

Although some positive results have been achieved with regards to water replenishment in estuarine wetland areas targeted by the project, further challenges remain, including *inter alia*:

- The limited integration of ecological water replenishment measures into water diversion and management policies and mechanisms.
- The extensive sedimentation in diversion channels continues to impede water replenishment.
- Limitations in the water replenishment infrastructure in estuarine wetland areas.
- The absence of a long-term institutional mechanism to promote ecological water replenishment in the estuarine areas.

GOOD PRACTICE DESCRIPTION

LOCATION: estuary of the Yellow River in China

IMPLEMENTATION PERIOD: Since 2008

OPERATIONAL BUDGET: US$2.26 million

KEY STAKEHOLDERS:

The project is an initiative of the Yellow River Delta National Nature Reserves Administration

Donors:

Yellow River Conservancy Commission of the Ministry of Water Resources; Municipal Government of Dongying, Shandong

Partners:

Shandong Yellow River Management Bureau; Shengli Petroleum Management Bureau; Yellow River Survey Design Research Institute; Water Conservancy Design Institute of Shandong Province; Forestry monitoring and Planning Institute of Shandong Province; Yellow River Estuary Management Bureau; Municipal Water Conservancy Bureau of Dongying; Yellow River Estuarine Research Institute

Background information and climate change vulnerabilities

The area of perennial waterlogged wetlands in Yellow River Delta including rivers, lakes, estuary waters, pits and ponds, reservoirs, channels, salt lakes, shrimp and crab pools, and tidal flats is 964.8 km², accounting for 63.1% of the total area of the Yellow River Delta. The area of seasonal waterlogged wetlands (i.e. heavily saline-alkalized wetlands in supra-tidal zones, *Phragmites australis* swamps, other swamps, woodlands, shrub wetlands, wet meadows, and rice fields) is 565.2 km² (Xu et al., 2002; Wang et al., 2004). There are more than 800 animal species, including199 species of bird. The Yellow River Delta has become an important over-wintering and breeding site for migrating birds from North-east Asia and the western Pacific Rim. Yellow River plays a very important role to maintain the Yellow River Delta ecosystem. The Yellow River Delta ecosystem is the result of the conjunct affection of unique water flow and sediment of the Yellow River and weak tidal of Bohai Sea (Wang et al. 2011c, d).

The Yellow River originates from the arid Tibet Plateau in western China and flows through the semi-arid Loess Plateau and the semi-humid North China Plain before entering the Bohai Sea. As the global and regional climate has been changing in recent decades (Fu et al., 2004; Liu et al., 2008), the source region of the Yellow River has been negatively impacted by environmental degradation: Climate changes (mainly the rising of temperature) not only intensified soil surface evaporation, but also caused the decrease of wetland area, and degradation of Alpine frigid meadow and swamp meadow. As a result, the supplies of surface runoff and groundwater level declined, which combined with overgrazing, reduced vegetation cover and led to grassland desertification. The dominant causes of ecological degeneration in the north-eastern margin of the Qinghai–Tibetan Plateau are rising air temperatures and degradation/removal of vegetation (Wang et al., 2001; Qian et al., 2006; Yang et al., 2006). The rate of discharge of the Yellow River has been reduced to zero numerous times since 1960, which has resulted in severe negative impacts on water resources and other ecosystems downstream. It has been speculated that the Yellow River source has had a negative water budget since 1990 (Zhang et al., 2004) as a result of increased temperatures and reduced runoff from highlands. Others have suggested that changes in precipitation patterns, namely decreased rainfall in summer and increased snowfall in winter, have resulted in a net decrease in runoff and river discharge (e.g. Gu et al., 2002).

The irrigated area sourced from the Yellow River has increased enormously from some 0.8 million ha before 1949 to 7.51 million hectares in 1997. Increased withdrawals can explain about 35% of the declining runoff observed at the Huayuankou station in the lower reaches over the last half-century (Fu et al., 2004; Grafton et al. 2013). This shows that, even for such a heavily managed river, climate is a dominant factor that influences runoff. Owing to the current pronounced warming, more than 80% of the glaciers in western China are currently in a state of retreat. Changes in glacier mass balance critically affect Yellow River runoff (Liu et al., 2006; Ding et al., 2006; Yao et al., 2007; Li et al., 2010).

The frequency of zero flow in sections of Yellow River has increased since 1969. These events have started earlier in the year, and their duration has increased such that during 1997 no water discharged to the sea for 330 days. Low flows of the Yellow River have led to a decrease in water supply to the wetlands. During the past 30 years, the wetlands in the Yellow River Delta decreased in extent by more than 300 km^2 (Zonget al. 2008). Water scarcity is therefore one of the biggest threats to the biodiversity and plant growth in the wetland. It has led to the ecosystem becoming imbalanced, causing reverse succession of ecological structure. In addition, the natural wetlands of mudflat and *Phragmites australis* swamps have declined in the Yellow River estuary.

The Yellow River Delta is also a famous oil production base in China. Significant road infrastructure was constructed between the river and wetlands in recent years, causing an increased disruption of water supply to the wetland. As a result, natural hydrological relationships between the river and its floodplain were destroyed. Increasing salinization of soils and groundwater has further exacerbated these negative impacts.

In recent years the Yellow River Delta, particularly the core area of mudflat in the estuary, has been widely affected by fragmentation of natural ecosystems, resulting in accelerated destruction of species habitat and loss of biodiversity. Due to incised channels and small flow in Yellow river, it has become increasingly difficult to divert water from the floodplain to the Yellow River Delta Nature Reserve. In order to raise the water level of the river within the nature reserve and divert water into the wetland area of the nature reserve, the flow of the Yellow River needs to increase to at least 2,000 $m^3 \cdot s^{-1}$. The diversion of water to replenish the Yellow River Delta Nature Reserve needs to be timed carefully according to seasonal variation in water availability.

Therefore, to respond to the climate change related challenges described above, one of the main adaptation measures demonstrated in the Yellow River was to supplement the River's annual water budget through: i) restoration of damaged wetlands; and ii) artificial supplementation of the River by diverting additional fresh water according to seasonal demand. Artificial recharge for ecological restoration (Donovan D J et al. 2014; Zhang et al. 2008) was considered synthetically from structure and integrity of ecosystem to restore the damaged wetlands. The ecological water demand of the Yellow River Delta wetlands is complex due to highly regulated discharge of the Yellow River, the hardly known “natural state” of the wetlands, the complex developments in land use and stream regulation, and the dynamic processes in the land-sea interface. The ecological and hydraulic models and assessment system were developed to calculate and evaluate the ecological water demand of reasonable protection target and the different water demand scenarios (Cui et al. 2009a; Cui et al. 2009b; Wang et al. 2011a).

In June 2002, a wetland restoration project (the “Five Acres Wetland”) covering 2,650 ha was initiated in the core zone of the Dawenliu Management Station. In 2006, another wetland restoration project (the “Ten Acres Wetland”) covering 6,700 ha was initiated adjacent to the first project. The approach to wetland restoration in both projects used water management measures such as dykes, control breaks, and pumps to increase freshwater delivery during the dry season and storage, with the goal of generating large stands of *Phragmites australis* and areas of open water suitable for waterfowl (Li et al. 2011). Based on the researches and tests of wetland restoration, Dongying Municipal Government prepared and implemented the project entitled "1 million hectares of wetland ecological water conservation planning (2010-2015)" focused on the replenishment of the Yellow River Delta's water resources.

Since 2008, Yellow River Delta Nature Reserve has been diverting water and sand from the Yellow River. The ecological water diversion area is located in the southern side of the estuary of Yellow River, with an area of about 13,300 ha. In recent years, the Yellow River Estuary Management Station has restored a total of 6,600 ha of wetlands through the implementation of wetland restoration projects. Five water diversion projects have been carried out since 2008 and have replenished a total volume of 100,966,700 m³ of water from the Yellow River. A total water volume of 118.72 million m³ (Zheng et al. 2012) has been replenished for the Northern Yellow River Delta Nature Reserve since 2010.

Intervention technologies

By making several discharge sluices in the original dams, and building separation dams in saline alkali soils, the water replenishment is achieved in two ways; firstly, a natural floodplain is formed with the rise of water level to replenish water. Secondly, culvert pipes are installed on weirs to replenish water.

Diaokouhe River Ecological Water Diversion Program and Experiment of Restoring Water for the Old Course of Yellow River draws off water from Cuijia Water Control Project

Description of the results

Through the repeated diversion of water from the Yellow River, the volume and surface area of the estuarine wetland has increased. This has helped to improve and maintain the ecological conditions in the local wetland areas (Wang *et al*. 2011b). The ecological benefits are as follows:

(1) The water surface area of the estuarine wetland has increased as a result of artificial and natural replenishment. In 2012, the water surface area of the wetland increased by 2,470 ha, while that of the river channel was increased by 920 ha through ecological water replenishment. The additional water provided habitat for *Phragmites australis,* the indicative vegetation of the Yellow River Delta wetland, during their period of sprouting and vigorous growth. Furthermore, replenishment of the aquatic environment provides an ideal habitat for many water birds such as *Grus japonensis, Ciconia ciconia, Cygnus cygnus, Cygnus colombianus*, and *Cygnus olor*.

(2) The underground water recharge for the estuarine area has increased and the underground water table has been raised. Following ecological replenishment, the underground water table was raised between 0.02-0.65 m in the area within 4 km of the riverbank. The recharge of underground water can help prevent sea water intrusion and reduce salinization.

(3) Freshwater in the coastal areas has been replenished, which not only maintains appropriate salinity in the offshore waters, but carries large amounts of nutrients and promotes the improvement of aquatic ecological conditions in the estuarine areas. The

figures show that approximately 50.6 billion m^3 of freshwater has been replenished through water and sand diversion. Consequently, conditions are favorable for the migration and spawning of fish in the estuarine areas.

Water birds in Yellow River Delta

GOOD PRACTICE ANALYSIS*

Knowledge building

How has the project built upon or applied the findings of specific research projects? How has the project actively contributed to international understanding on Ecosystem-based Adaptation?

The water replenishment for the Yellow River Delta builds on scientific research conducted by the Yellow River Delta National Nature Reserves Administration, the Yellow River Survey Design Research Institute, and relevant institutes and universities. To calculate the ecological water demand of reasonable protection target and the different water demand scenarios to adapt to climate change, the ecological and hydraulic models and assessment system were developed synthetically from structure and integrity of ecosystem. Driven by the demands of damaged wetlands restoration came from the stakeholders (Nature Reserve Administration, scientific institutions and experts, NGOs), numerous research experiments have been conducted – including eco water replenishment tests of 50,000 acres and 100,000 acres respectively in 2002 and 2006. The eco water replenishment tests achieved good results and influenced policy planning of the Yellow River delta. Eco water replenishment has been upscaled to thousands of hectares in this area. Research has been conducted simulating, valuating, and testing different plans of water replenishment for the Yellow River Delta.

Publications in academic journals and web information made the research freely available to the public. Field trips organized with scientific institutions and universities promoted the communication of the knowledge generated through this programme. The planned establishment of wetland museum will be beneficial for sharing success of the adaptation practices.

Financial sustainability

How has the project secured financing for sustaining and/or expanding its impacts?

The returns of the project include the increased annual ecotourism income and the increased ecosystem service value. These returns could be beneficial to the sustainable development of Dongying city. The sustainable development is very important for the future investment.

Transferability

How has the project ensured that its activities can be transferred beyond the specific contexts in which they were implemented?

The good practice of the initial wetland restoration in Dawenliu Mangement Station has been successfully applied for governmental sectors such as Doingying Municipal Government in up-scaling water replenishment of the Yellow River Delta.

In addition, the lessons learned (see "key messages") during the water replenishment of the Yellow River Delta, such as the success of trade-offs evaluations (between water consumption and uses) and 'share' system to conserve the watershed as well as sustain the social-economic benefits from ecosystems services, are likely to be of great benefit to other countries and regions to cope with the wetland degradation caused by climate change.

* This analysis is based on the "principles of good practice" developed by the EU/FP7-funded project AfriCAN Climate (2011-2014). These principles represent critical cross cutting issues shared by the majority of climate change projects, regardless of focus, scope and scale. They are intended to encourage critical reflection and help project developers and decision-makers draw out relevant lessons. Source: http://africanclimate.net/en/good-practice/8-principles-good-practice

Maximising co-benefits

How have the interventions of the project promoted additional benefits?

Based on scientific research and by making several discharge sluice in the original dams, and building some dams separating in saline alkali soil, several co-benefits can be achieved during the water replenishment.

The replenishment of the aquatic environment provides an ideal habitat for many water birds such as *Grus japonensis*, *Ciconia ciconia*, *Cygnus cygnus*, *Cygnus colombianus*, and *Cygnus olor*. The underground water recharge for the estuarine area has increased and the underground water table has been raised. The recharge of underground water can help prevent seawater intrusion and reduce salinization. Freshwater in the coastal areas has been replenished, which not only maintains appropriate salinity in the offshore waters, but carries large amounts of nutrients and promotes the improvement of aquatic ecological conditions in the estuarine areas. Conditions are favorable for the migration and spawning of fish in the estuarine areas.

With the increasing of water birds, many Chinese and foreign tourists are attracted come to visit. In the past 5 years, the growth rate of the annual ecotourism income of the Yellow River Estuary increased by 23.9%.

Monitoring and Evaluation

How has the project demonstrated its impacts in terms of achieving objectives, outcomes, and outputs? Explain how M&E plans were developed, and how effectively they have been applied.

The integrated monitoring and evaluation methods could make ecological water replenishment estimation more rational. The monitoring of the project include: hydrological monitoring work, the establishment of flow measurement cableway, check site, watchtowers, research center, wetland monitoring station, simple patrol terminal. Some research has been done to evaluate the ecological value of wetlands in the Yellow River Delta for different plans of make up water with landscape model.

Monitoring and evaluation results could assist people and government officials to “see” that a) the ecological benefits after water supplementing: the ecological function of the wetlands has been effectively recovered, wetlands value obviously increased and ecological benefits of make up water are remarkable; b) the amount of make up water does not have good linear relation with wetland value, showing water demand of the wetlands of the Yellow River Delta has a relevant range, not the more water the better.

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ECOSYSTEM-BASED ADAPTATION THROUGH SOUTH-SOUTH COOPERATION

GOOD PRACTICE CASE STUDY

Mitigation of soil erosion and water shortage in the Yangou watershed, Loess Plateau of China

Compiled by: Institute of Geographical Sciences and Natural Resources Research, Chinese Academy of Sciences (Yu Liu, Xiubo Yu) for EbA South

Edited by: C4 EcoSolutions (Ashley Robson, Anthony Mills), EbA South Project Management Unit (Diwen Tan, Tatirose Vijitpan, Silvia Cazzetta)

7 February 2017

Soil erosion is one of the most serious environmental problems in China. In 2000, the area prone to erosion by wind and water was 3.57 million km^2, accounting for 37.6% of the national territory, and the annual volume of soil erosion reached 5 billion tonnes (Li et al., 2009). This severe problem was partially due to the over-farming on steep slopes and continuous reclamation of forest and grassland for cultivation during the late 1900s. Devastating environmental and socio- economic impacts to communities were observed. The severe droughts in 1997 and the massive floods in 1998 have drawn the country's attention, and driven China to take strong initiatives.

In response, in 1999 the central government initiated the "Grain-for-Green programme" to combat soil erosion, ecological degradation and to alleviate poverty, through reconverting cropland back into forest and grassland as well as afforesting barren land. This programme started in the western China in three provinces – Sichuan, Shaanxi and Gansu – the most ecologically fragile areas after the serious flood in 1998 and with high levels of rural poverty. It became nationwide in 2002 (Liu and Wu, 2010) and is still ongoing until today. It is among the biggest programmes in the world (Liu et al., 2008), owing to its ambitious goals, massive geographical coverage, huge payments, and potentially enormous impacts.

Policy support and financial support provided from the national level are the two major significant interventions. The central government has issued laws to prohibit cultivation on steep slopes in ecologically fragile areas and to regulate the right of land management (Order No.367t of the State Council, China). In addition, China has adopted an innovative Payment for Environmental Services (PES) mechanism, providing farmers with, for example, cash and grain subsidies and tax incentives for converting cropland on steep slopes to forest and grassland (Liu et al., 2008; Gauvin et al., 2010).

Overall, this programme has generated both immense positive ecological and socio-economic effects. It has reduced surface runoff and soil erosion, enhanced carbon sequestration, reduced nutrient loss for maintaining soil fertility and ultimately increased food productivity (Lü et al., 2012; Liu et al., 2008). In the Loess Plateau region (covering parts of 7 Chinese provinces, including Shaanxi and Gansu), by 2008 surface water runoff has decreased with an average of 10.3 mm/year and around 3.44 billion tonnes per year of soil has been retained. Moreover, carbon sequestration in both soil and the rehabilitated vegetation has found to be 35.30 teragram (Lü et al., 2012). In addition, this programme has helped alleviate poverty through the PES mechanism, and supported numerous farmers to change their income structure by shifting farming to alternative industries, such as transportation and restaurant businesses.

Yangou watershed is located in a priority area for the programme, the Loess Plateau, where slope gradients are greater than 25 degrees and suffers soil erosion, ecological degradation, water scarcity and poverty, plus additional pressure from climate change. As an exemplary case, the project in Yangou watershed focused on a variety of interventions including: i) financial support set up; ii) land use adjustment on slopes; iii) water conservation for agriculture; iv) improvement of fertilizer efficiency; v) industrial structure adjustment; and vi) demonstrations.

Key lessons

- *Combining Payment for Ecosystem Services (PES) with laws* encouraged the participation of households and promoted the implementation of project activities. The financial support attracted local communities to participate in the project. Furthermore, funds were also vital for the sustainability of interventions as they were invested in the construction of infrastructure and ecosystem restoration.
- *Cooperation between research organizations and local government is fundamental* to seek solutions at the community level. This is vital for solving problems fundamentally. For the Yangou project, research-demonstration-transfer is a good-practice principle to mitigate watershed degradation. Research organizations provided both support for applying current technology and developing new technologies to solve challenges. To complement the work of research organizations, local government provided opportunities for local communities to participate in training and demonstrations as to encourage these communities to adopt new technologies.
- *A joint sponsorship from multiple sponsors is more realistic and necessary.* Multiple stakeholders including administrative departments at different levels played their own roles with relevance to their respective mandates. For example: The State Forest Agency of China sponsored the Grain-for-Green project, which promoted the sustainability of land use adjustment; The Ministry of Science and Technology of the People's Republic of China sponsored The National Key Technology Research and Development Programme; The Technology Department of Shanxi Province sponsored the key projects as to support scientists to conduct coordinated research experiments to demonstrate the necessary techniques in the Yangou watershed and transfer knowledge to local communities; Local government provided communities with basic infrastructure and funding to initiate activities. In addition, some private donors also sponsored certain mitigation actions.
- *Educating and training local communities* on multi-benefits of eco-restoration and relevant technologies – and thereby increasing their adaptive capacity to climate change.

GOOD PRACTICE DESCRIPTION

LOCATION: Yangou, a watershed located in the northern region of the Loess Plateau, China

IMPLEMENTATION PERIOD: 1997-2003

KEY STAKEHOLDERS:
Implemented by:
The Institute of Soil and Water Conservation (ISWC), Chinese Academy of Sciences (CAS)
Ministry of Water Resources (MWR) of the People's Republic of China
Yan'an Municipal People's Government
Donors:
State Forestry Administration of the People's Republic of China
Ministry of Water Resources of the People's Republic of China
Ministry of Science and Technology of the People's Republic of China
Science and Technology Department of Shaanxi Province
Partners:
Yan'an Municipal Bureau of Land and Resources
Yan'an Municipal Bureau of Agriculture
Northwest Sci-Tech University of Agriculture and Forestry

Background information and climate change vulnerabilities

Water shortages, soil erosion, ecosystem degradation and poverty are the four main concerns in the Yangou watershed of the Loess Plateau, China. Agriculture, especially the cultivation of food crops, is the main livelihood option of communities in the watershed. Most of the arable land consists of highly erodible loessial soil on steep slopes. Intensive rainstorms, though occurring at low frequencies, trigger floods which result in severe soil erosion and water loss. In this region, the annual precipitation during the period from 1950 to 2006 showed a decreasing trend (Liu et al., 2008), while the temperature increased from 1960 to 2013 (Yan et al., 2014). In addition to anthropogenic deforestation, climate change is causing a progressive decrease in land productivity and a loss of ecosystem functions, which further impact local livelihoods. As a result of the low productivity of arable land and the mountainous environment, poverty is a severe social problem. Starting in the 1990s, the national government intended to improve the ecology of the Loess Plateau through the Grain-for-Green programme, the National Key Technology Research and Development Programme.

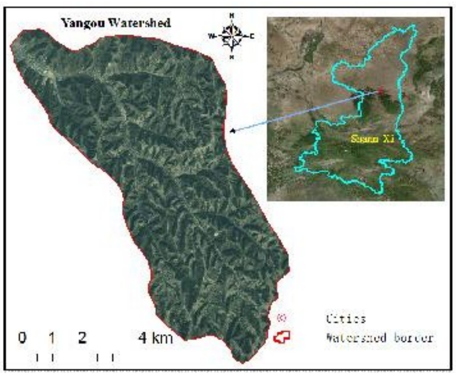

Fig. 1 The location (left) and typical landscape (right) of Yangou Watershed, Loess Plateau, China ©Yu Liu

Intervention technologies

- *Set financial and policy support*. In 1999, the central government launched the "Grain-for-Green programme", in order to combat deforestation, ecological degradation, over-cultivation of slopes and soil erosion. The Loess Plateau, with fragile loess ecosystem, was a priority area for the programme, where slope gradients are greater than 25 degrees. The government financed the investments needed for revegetation by adopting Payment for Environmental Services (PES) mechanism. The Grain-for-Green project provided compensation for the abandonment of crop planting in the form of both money and grain. In addition, the right of land management is guaranteed by the Act of Conversion of Degraded Farm Land into Forest (Order No.367t of the State Council, China) in 2002. In this Act, the right of management of contracted land extends from 30 years to 70 years. Local communities have the ownership of the timber on the revegetated land. They also have financial support for construction of small energy infrastructures and support of free tax for producing agricultural and forestry productions.
- *Eco-restoration and adjustment of land use on sloping lands*. The first step of the project was replacing sloped croplands with terraced cropland, together with the construction of dams in the incised valley to reduce the loss of water and soil. The ponds affiliated by dams also became sources of drinking water. The second step was revegetation of abandoned sloped cropland by increasing the coverage of grass, shrub and trees (see Fig 2).


Fig. 2 Ground picture (left) and satellite image (right) of revegetation in the Yangou Watershed ©Yu Liu

- *Multiple water trap techniques[1] employed to promote agricultural productivity*. Terraced farmland construction, deep furrows (Wang et al., 2001) and plastic mulch were applied to help to replenish and conserve water in the soil; ISWC selected drought-tolerant crop species as to promote agricultural productivity under climate change (i.e. reduced annual rainfall); ponds and cement tanks were built to collect rainfall runoff to increase water supply for irrigation and drinking. In addition, the "hole irrigation" technique was adopted for sustainable water consumption (Wang et al., 2001).
- *Improvement of fertilizer efficiency*. During the first 3 years, the fertilizer input increased 4-fold to provide nutrition, and corresponding fertilizer-use efficiency increased by 4.33% (Wang et al., 2001).

[1] Water trap techniques include infrastructures to buffer the through rainfall energy, improving of water infiltration, and runoff collection system. Mitigation of the rainfall energy technique refers to arrangement of vegetation vertically and horizontally. Terrace and shallow channel in the crop land and small ponds were constructed to improve the infiltration. Runoff collection system consists of channels and water tanks. It is used to collect runoff generated on the land element with high runoff coefficient, e.g., impermeable road and built-up area, compacted soil.

Fig. 3 Orchard (hill top in left picture) and terrace farmlands (right picture) in Yangou watershed ©Yu Liu

- *Adjustment of industrial structure*. ISWC introduced supplemental and diverse livelihoods to ensure that the wellbeing of local communities was not adversely affected by the reduction of total area of arable land. The livelihood diversification includes, for example, new orchard crops such as Fuji apple and Pink Lady apple, fish-farming for both local sale and recreational fishing, and other commercial activities like labour services for the manufacturing sector, and shop running (Dang and Liu, 2009).
- *Demonstration of agricultural activities*. It comprises four aspects: i) crop and orchard planting; ii) management techniques; iii) techniques to promote efficient water use (Liu et al., 2005); and iv) technologies of livestock captivity (Xie, 2001).

Description of the results

- *Economy*

The annual income per person increased from 763 RMB in 1997 to 1,855 RMB in 2005 (130% increment). In addition, the sources of income of local communities significantly changed as a result of the project. From 2000 to 2005, the proportion of the planted cropland in the total arable area decreased from 78% to 57% (Dang and Liu, 2009). Also, the proportion of income from crop planting decreased from over 50% in 1997 to 36% in 2005 (Dang and Liu, 2009). Orchard increased rapidly. Apple planting became one of the key pillars of the local economy. In addition, non-agricultural incomes such as income from handcraft industry and wages also increased. Between 1998 and 2000, investment in local labour for infrastructure construction and revegetation for soil erosion control increased to one-third of the total investment (Ju et al., 2007). These changes in income sources imply an alleviation of the pressure on ecosystem through agricultural activities which are the most influential land use activities on the ecosystem.

- *Ecosystem function and services*

Land structure has changed in mainly two aspects. (1) Of the total Yangou basin of 47 km^2, the sloped cropland dropped from ~34% of the total basin area in 1997 to ~3% in 2003, and ~0.5% in 2009. (Xu et al., 2012). Now, dam farmlands and terrace cropland occupy 97.3% of the arable land. As compensation for the decline in cropland, the grain productivity increased by 63% (Wang et al., 2001). The crop yield in the terrace farmland increased to 8.25 t/ha, with an increment of approximately 3 t/ha (Wang et al., 2001). (2) From 1997 to 2003, vegetation restoration proceeded successfully. The coverage of vegetation in the watershed increased from ~27% to ~70%.

Soil erosion was successfully controlled. After the project, the average rate of soil loss decreased by 100-fold and now it is below the tolerant erosion rate of this region. The average concentration of sediment in the runoff dropped by 6-fold (Xu et al., 2012). The base flow steadily increased after the project, while the proportion of flood runoff showed a decreasing trend. It indicated a replenishment of the soil water (Xu et al., 2012).

The threats from water shortage were reduced. The volume of water lost through floods was minimized due to the dams, terraces and gathering infrastructures for rainfall runoff (Xu et al., 2012). Additionally, the efficiency[2] of water use in agriculture has increased by 59.1% (Wang et al., 2001).

- *Building local capacity*

Through the demonstration of technology in situ, local communities acquired knowledge of mitigating water loss, promoting the productivity of natural ecosystems and conserving ecosystems. After initial trainings, local community members had acquired sufficient capacity to develop alternative livelihoods such as fish farming. From 1997 to 2010, though the warm-dry climate affected land and crop, the local's income, crop yields and vegetation coverage increased.

[2] The water use efficiency (*WE*) is defined as the grain yield per unit water for one hectare cropland. To evaluate the water use efficient, the soil water storage in the beginning of planting (SW_0) and after the crop harvest (SW_h), rainfall depth in the growth season (P), and the grain yield (G) were measured. Then the water use efficiency is calculated based on a soil water budget approach: $WE = G / [(SW_0 + P) - SW_h]$.

GOOD PRACTICE ANALYSIS‡

Knowledge building

How has the project built upon or applied the findings of specific research projects? How has the project actively contributed to international understanding on Ecosystem-based Adaptation?

Before the project was launched, scientists had already started developing techniques in this region, which was pivotal in catalysing the mitigation actions. In the restoration of Yangou watershed, scientists conducted comprehensive research on the environmental and socioeconomic challenges faced by local communities. Furthermore, scientific research has identified and promoted a range of techniques as to promote community development. Following this research, local governments organized the demonstration of new techniques and training for local communities. Through this link, the results of scientific research were applied directly to environmental protection and development of livelihoods. For example, the rainfall-gathering infrastructure is a design that developed from one research project that was conducted by ISWC, CAS and MWR. In addition, fertilization techniques were derived from one research project of the National Key Technologies Research and Development Programme of China during the 9th Five- Year Plan.

Political ownership, collaboration and approval

How has the project secured support from political-level stakeholders and aligned its activities with wider development agendas to trigger further collaboration opportunities?

Yan'an government, together with CAS, initiated and executed the mitigation action in Yangou watershed. Also, the project was aligned with the policy of central government: Grain-to-Green policy.

The three key project stakeholders had different motivations in the project, namely:
i) government wanted to achieve its political goals of increasing the income of local residents and restoring local ecosystems; ii) scientists wanted to establish their evidence base through the project activities; and iii) local communities benefitted from the increased incomes and improved ecosystems.

Achieving co-benefits and balancing trade-offs

How were the costs and benefits external to the project taken into consideration, e.g. on employment, environment, health, poverty levels, food security etc? Explain how the project aimed to maximizing external co-benefits from project activities and avoid/minimizing external costs and damages.

There are multiple benefits of Yangou watershed interventions, besides the mitigation of soil erosion and water shortage. The benefits include: i) the expansion of non-agricultural vegetation; ii) the restoration of native vegetation over large areas; iii) biodiversity conservation; iv) increased food production; v) diversified livelihoods; and vi) increased local job opportunity

‡ This analysis is based on the "principles of good practice" developed by the EU/FP7-funded project AfriCAN Climate (2011-2014). These principles represent critical cross cutting issues shared by the majority of climate change projects, regardless of focus, scope and scale. They are intended to encourage critical reflection and help project developers and decision-makers draw out relevant lessons. Source: http://africanclimate.net/en/good-practice/8-principles-good-practice

from infrastructural construction and revegetation. The project provides a win-win situation where both ecosystem conservation and economic development are supported.

However, some trade-offs and long-term negative impacts have also been identified. For example, in order to compensate for the decline of croplands, the project included the activity to increase the crop productivity. In addition, some experts are worried about the problem of 'water trap' at the source of watersheds, such as Yangou, that the overuse of water in Yangou may reduce the water flow to the lower part of the river basin. Also, restoration of the vegetation, especially artificial reforestation in this semiarid environment, may increase the evapotranspiration of the ecosystem – a factor that directly contributes to the appearance of a dry soil layer (Wang et al., 2011). These possible problems need to be addressed.

Monitoring and Evaluation

How has the project demonstrated its impacts in terms of achieving objectives, outcomes, and outputs? Explain how M&E plans were developed, and how effectively they have been applied.

Monitoring and evaluation exercises were carried out by scientists from ISWC, CAS and MWR. The goals were to: i) improve the capacity of preventing soil erosion; ii) mitigate water shortage; iii) increase the grain productivity; and iv) increase the income of local communities. Corresponding to the goals, activities below were conducted.

(1) *Soil erosion and stream flow*. A sediment gauge infrastructure was established at the outlet of Yangou watershed to monitor the sediment-laden flow and stream flow. The monitoring results were made available in 1998, 2001, 2003, and 2010. (2) *Change of land use*. Three investigations of land use were taken separately in 1997, 2003 and 2009 (Xu et al., 2012).
(3) *Grain productivity*. Monitoring of the grain productivity was conducted before (1997) and after (2000) the application of productivity-promotion techniques. (4) *Change of income sources*. The industrial structure and their economy output during 2000-2005 were monitored.

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ECOSYSTEM-BASED ADAPTATION THROUGH SOUTH-SOUTH COOPERATION

GOOD PRACTICE CASE STUDY

Sustainable Development in Poor Rural Areas Project: Integrating Climate Change Adaptation into Poverty Reduction in China

Compiled by: EbA South Project Management Unit (Tatirose Vijitpan) Edited by: C4 EcoSolutions (Pierre Begat)

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The poorest people are often perceived as the hardest hit by climate change, especially those living in rural areas in developing countries. This case study presents a project in China that tackles both poverty alleviation and climate change adaptation in Henan Province, Shaanxi Province and Chongqing Municipality. In the project areas, climate change is expected to bring about extreme climate events, including prolonged drought periods, hailstorms, frost events, unpredictable precipitation patterns, and wildfires, which are likely to result in decreased agricultural productivity as well as reduced poor people's security in livelihood assets and increased their vulnerability. This project, therefore, piloted climate change adaptation measures along with provided support on basic infrastructure and livelihood activities through community- driven development approach. Sustainable land management, an ecosystem-based adaptation option, was the overall climate change adaptation technique applied in the project. With support from various stakeholders, in particular government at different levels, the project was very successful and has been replicated in other locations in China. Moreover, the project results substantially provided recommendations to the poverty reduction programme under the 13th Five- Year Plan (2016-2020) on economic and social development of China to enhance ecological construction along with infrastructure connectivity and basic public services.

This case could serve as a good example for other countries or sub-national levels with similar contexts to address both utmost challenges of poverty and climate change in an integrated manner.

Key lessons

- The innovative mechanisms of integrating climate change adaptation and ecological management with poverty reduction have not only increased the understanding of the project communities on the linkages between vulnerability, climate change and adaptation but also provided the Chinese government with effective approaches to tackle both climate change and poverty in the most-needy groups. Moreover, the innovative approach employed under this project also provided successful experiences for others to learn from. Some of the most successful interventions from the project were reproduced and scaled- up under country-wide strategic plans.

- The poverty-climate change vulnerability reduction linkages were shown in a multitude of benefits provided by the project. These included increased per capita income and improved food security from enhanced agricultural productivity; higher standards of living and greater well-being as a result of improved access to, *inter alia*, safe drinking water, electricity, markets, schools, healthcare systems; and environmental conservation through sustainable management of natural resources and land. All those benefits had contributed to not only increased social and economic circumstances of the poor households but also reduced vulnerability to climate change for the project beneficiaries simultaneously.

- Although the project activities were essentially implemented in remote and scattered rural areas, with the addition of a challenge of applying community-driven approach under the typical top-down approach, the project still received 'successful' achievement from the project's terminal evaluation. This attributed to remarkable efforts of the project management offices and support from governmental departments at all levels. The project had proved good collaboration of all the parties concerned in project implementation and problem-solving capacity to push the project forward as planned.

- Realisation of the project duration and flexibility in adjusting the timeline of the work plan are essential. At the beginning, implementation was slow due to several challenges. Owing to the project's large scale, it took time to, *inter alia*, mobilize-empower communities, set up the project implementation structure, build institutional and community capacity and open bank accounts for the beneficiary villages– especially with the large number of very poor population and in remote rural community setting. According to the project's terminal evaluation report, the implementation of the sustainable land management and adaptation component was particularly delayed because general understanding of the scope and implementation procedures of this rather complex component needed to be in place first.

- Capacity and readiness of local counterparts/partners are crucial for on-the-ground implementation. It was found that some project management offices (also at provincial level) were understaffed in the first couple of years. Therefore, consistent support was required from the supervision team.

GOOD PRACTICE DESCRIPTION

LOCATION: The project was implemented in Henan Province, Shaanxi Province and Chongqing Municipality of China.

IMPLEMENTATION PERIOD: 2010-2015

OPERATIONAL BUDGET: US$ 4.265 million was provided as grant from the Global Environment Facility (GEF) Trust Fund to support the 'Sustainable Land Management and Adaptation' component. US$ 100 million loan from the World Bank supported other poverty reduction components.

KEY STAKEHOLDERS: The project's Implementing Agency was the International Poverty Reduction Center in China (IPRCC). Since the project was designed and implemented through a decentralized approach and mechanism, the Central Project Coordination Office was established within the State Council Leading Group of Poverty Alleviation and Development to lead the project design, preparation, support and supervision to the Project Management Offices, established at provincial and county levels in the project provinces. The governments at all levels, especially local government authorities, played significant roles throughout project preparation, appraisal and implementation particularly on policy aspects and coordination among line departments. These local government agencies included the provincial Planning Commissions, Finance Bureaus, Poverty Alleviation and Development Offices, township governments. At village level, project community facilitators, supervised by respective county project management offices, were contracted to work with villagers on project implementation, especially on consultation, communication and training. As a community-driven approach was followed, the project communities/villages were fully involved in the whole process, including decision making. Consultants were also hired to provide technical assistance in different areas, including village resource assessments and mapping, design of pilot activities, training, environmental and vulnerability monitoring as well as national studies and consultations.

Background information and climate change vulnerabilities

The fight against poverty has been at the core of the development agenda for decades. Despite the continuously dedicated efforts from the international community, until now the work to end extreme poverty still has a long way to go[1]. Although at the global scale extreme poverty continues to fall rapidly, it is becoming harder to accomplish the remaining extreme poverty reduction. Economic shocks, food insecurity and climate change are critical threats that impede poverty alleviation. In particular, the extreme poor living in remote areas suffer the most from the above-mentioned phenomena.

Similar to the global context, although China's poverty rate has remarkably declined over the past decades, overcoming remaining poverty has become increasingly challenging. In China, about 80% of the poor live in the western and central parts of the country. Almost all of them are rural inhabitants, and a small number are poor rural migrants living in urban areas. The Chinese government has established ambitious plans with substantial poverty reduction funds to assist the villages officially classified as poor. Nonetheless, institutional constraints and a limited share of funding available at the village level have hindered the provision of basic rural infrastructure needs necessary for the poor and, consequently, the achievement of the national poverty reduction plans.

Furthermore, the majority of China's rural poor live in remote, ecologically fragile and inaccessible regions where agricultural conditions are typically poor with almost no alternative livelihood options in place. Their dependence on subsistence farming, with ineffective land and water resource management practices, places these rural poor to be highly vulnerable to climate change, especially in semi-humid to semi-arid transition regions. The climate change challenges–

[1] Ref: http://www.worldbank.org/en/topic/poverty/overview

including uneven and unpredictable precipitation patterns, prolonged drought periods, changing temperature regimes, impacts on water and evaporation regimes, hailstorms, frost events, and wildfires – may further intensify livelihood risks to this group of people, who merely possess inadequate understanding on sustainable resource management, risk assessments and farming techniques. Off-farm employment, although critical for increasing rural incomes, widely causes the concerns of growing social tensions in urban areas as well as unfavourable working and living conditions to the migrant workers and their accompanied family members, approximately totalled 230 million (17% of the total population) in 2006.

Recognising the two utmost and intertwining challenges of poverty and climate change, the project's two key objectives are to:
(1) Explore and pilot more effective and innovative ways of providing poverty reduction assistance to the poorest communities and households in Henan Province, Shaanxi Province, and Chongqing Municipality through Community Driven Development and participatory approaches; and
(2) Pilot sustainable land management and adaptation measures to address vulnerability to climate change in poor rural areas in the project provinces.

Intervention technologies

In the project areas, the major livelihood is subsistence agriculture. Thus, improvement of land and water management practices is crucial for strengthening the poor's adaptive capacity to climate change. The project's second objective therefore aims to pilot adaptation interventions that would complement the other objective on infrastructure and livelihood support activities. In addition, the project also assisted the government in integrating long-term sustainable land management, climate change risk management and adaptation into community-driven development approach and the national poverty reduction programmes. This concept of extending climate change scheme into remote areas with high level of rural poverty as well as the first large- scale trial of community-driven approaches in China was considered greatly innovative.

For the **poverty reduction components**, the interventions could be divided into 3 categories:

(1) Public service investment to tackle the lack of fundamental rural infrastructure and establish an enabling environment for the economic upliftment of the poor: The support provided included the construction and improvement of drinking water systems, basic housing repair, healthcare facilities, schools, village access roads and bridges, sanitation, agriculture production infrastructure. With full application of the community-driven development approach, which gave greater local autonomy and community participation throughout the process, these infrastructure needs were identified to truly address the improvement of the beneficiaries' well-being. For that reason, some other investment in the development plans was not supported (e.g. township roads, dam construction). Moreover, the communities were fully responsible for the project activity investments and implementation, with support from technical staff of line departments from the county and township governments to ensure the technical standards, completion, reporting etc.

(2) Provision of financial support to household-level production activities: Before the project arrived, there were no financial institutions in the project area. The support was in the form of small block grant to the community cooperatives that would provide loans to poor households. Those household-level income generation activities that were supported by the grant included cash crops, tree crops, grain crops, livestock raising, micro-agroprocessing. The participating villages took responsibilities of implementation and management of the funds.

(3) Capacity building to strengthen farmers' long-term development potential: The capacity building activities were also based on the identified demands, covering both on-farm and off-farm employment needs. These activities included vocational training for off-farm jobs, skill training for women, community management (for community leaders), infrastructure operation, access to market information, off-farm labour opportunities.

For the **sustainable land management and adaptation component**, a number of activities were implemented, as grouped below:

(1) Knowledge building: Different activities were conducted to enhance capacity of local governments and communities on analysing land degradation and climate change risks and vulnerability. Training was provided by technical assistance team on application of village assessment and planning tools, e.g. village resource mapping, climate change and land degradation vulnerability analysis, carbon stock index, environmental baseline assessment. Afterwards, participatory village assessment was carried out in each pilot village to identify and prioritise the preferred options for adaptation pilots.

(2) Pilot intervention implementation: The adaptation measures identified from the assessment were different in each of the project locations. These measures were mostly small infrastructures (on water resources, village waste management, land management) and agricultural improvements (on land management, forestry, animal husbandry). Specific interventions of the latter were, for instance, increasing diversity and drought resistance by introducing new farm and forage varieties; improving soil fertility; providing small equipment to manage climate hazards.

(3) Result dissemination and community-driven approach integration: Workshops to review lessons learned from the adaptation pilots were conducted to evaluate and include successful pilot activities into community-driven poverty reduction activities. Training and extension activities were then provided to all the project communities with an aim to strengthen capacity of the project provinces to integrate vulnerability to climate change and land degradation as well as adaptation to climate change risks into community-driven poverty reduction.

(4) National policy implications: Linkages between poverty, vulnerability to climate change, adaptation and relevant policy implications were analysed in a policy study. It also explored the potential of community-driven approaches in facilitating sustainable land management and climate change adaptation. In addition, exchanges between the agencies in charge of poverty reduction, land-water management, agriculture, forestry, climate change adaptation were organised in order to identify policy implications of poverty, vulnerability and climate change adaptation to support the national review process on poverty reduction agenda.

Description of the results

The total project beneficiaries were 715,300 absolute poor in 25 counties and districts in Henan, Chongqing and Shaanxi (88 villages in these counties were selected to pilot the sustainable land management and adaptation interventions). Women accounted for 46% of population in the project areas and there were ethnic minority groups (Tujia and Miao) in some parts of the project provinces. Women and ethnic minority groups had equal rights in the community driven approaches and decision making in the project.

According to the project's terminal evaluation report, indicator of the sustainable land management and adaptation component '*Disseminate the improved sustainable land management approach through innovative community pilots mainstreaming the Community Driven Development model while addressing the vulnerability of poor rural areas to climate change*' achieved '*Satisfactory'* level. The key results included:

- The beneficiaries in the project villages have increased understanding of environmental issues and awareness of potential climate change risks.
- Studies on policy related to poverty, climate change vulnerability and adaptation were conducted.
- Policy recommendations were proposed for consideration in the poverty reduction programme under the 13th Five-Year Plan (2016-2020) on economic and social development of China.
- Through natural resource conservation and sustainable land management, the project has generated benefits from stabilization and environmental rehabilitation.

Capacity and awareness in the 88 project pilot villages were enhanced on sustainable land management and adaptation. In all pilot villages, participatory resource mapping and village vulnerability assessment were successfully completed. The farmers now have better understanding of how their livelihoods and agricultural productions are impacted by climate change. Furthermore, based on the assessment results, the pilot villages identified the adaptation needs and implemented the adaptation actions accordingly. These include introduction of drought- tolerant crop varieties, land rehabilitation measures, water collection and irrigation schemes, flood-control and anti-hail facilities. All those actions aim to decrease the susceptibility of the project villages to climate-related risks. In addition, over the project implementation period, this component's pilot villages had yielded 369,000 tons of carbon sequestered, or 19.2% increased over the project implementation period.

In terms of the project's financial benefits, the sustainable land management and adaptation component integrates climate adaptation, sustainable land management, poverty reduction and rural income improvement in order to both enhance climate change adaptation and create economic benefits in the pilot villages. For land consolidation, adjusting the planting structure and drought control with rainwater, the rate of return is greater than 10%.

The adaptation pilot activities were so successful that similar activities were extended to the 'accurate poverty reduction' programme (under the 13th Five-Year Plan of the current government) of the 70 million remaining poor in China. This group of people lived in ecological fragile areas where sustainable land management and climate change adaptation were a challenge as well.

For the infrastructure and public service activities under the poverty reduction components, the satisfaction rate of the infrastructure improvement was 93.89%. Moreover, 96.04% of the beneficiaries considered the project addressed their needs, which has proved the effectiveness of community-driven development approach. 95% of the project villages have road access. 16% of the houses in the project villages have higher access to tap water and cistern water than the non-project villages. These values indicate very strong community participation, significant role the women in the villages play in the participatory process and the well constructed civil works that served the expressed needs of the communities. In addition, operation and maintenance systems for those infrastructures were established in the project communities.

For the financial provision activities, the project spent RMB 94.30 million (~USD 14.1 million) to establish 411 mutual-help groups (similar to local financial cooperatives) for 93,291 beneficiaries. Those funding activities particularly fulfilled financial necessity of poor households to enable them to perform income generating activities. As a result, the net income per capita in the project villages increased to RMB 7,367 (~USD 1,105) in 2014 from RMB 2,898 (~USD 435) in 2010, an annual increase of 20.5%. In comparison, in the non-project villages the annual increase was 9.7%, i.e. from RMB 3,005 (~USD 450) to RMB 4,774 (~USD 716).

A beneficiary survey conducted in 2015 comparing the project villages to the non-project villages showed that the project had contributed to the resilience of households to withstand risks and achieved a significant poverty reduction effect. Chronic poor (those in poor health or having insufficient resources/labour to tackle poverty) similarly occurred in both the project villages (18.0%) and the non-project villages (17.5%) at the beginning. However, in 2010-2014 the rural per capita income increased at an average annual rate of 20% in the project villages, or more than twice the rate of those in non-project villages. Correspondingly, during 2010-2014 the poverty rate declined by more than 50% in the project villages, or by more than twice the decline in non-project villages. Various factors could be attributed to the improved resilience against falling under poverty. These include improved infrastructure conditions (e.g. road access, drinking water supply, irrigation system), access to credit for emergencies (e.g. sickness, accidents), increased per capita income and improved food security from enhanced agricultural productivity. The increased resilience of those poor households would undoubtedly result in the increased adaptive capacity for climate change, although the survey did not cover this point.

GOOD PRACTICE ANALYSIS†

Community participation and inclusiveness

Has the project consulted with local communities in the formulation, implementation and decision making process? How were gender issues incorporated? Explain how the project mobilized local interest and ownership in order to ensure its activities responded to the needs of local beneficiaries.

The project was successful in reaching out to the most disadvantaged and poorest villages and households in the project provinces. A comprehensive social assessment was carried out during the project preparation process to identify the poorest communities and specific characteristics of poverty and needs of the poorest groups. The community-driven approaches had empowered the communities to be in charge of resources and management from the project planning to implementation stages. Farmers participated in selection of the project activities, implementation and supervision of construction. Community members were actively involved in the decision-making process, monitoring and implementation of actions that had direct impacts on their lives to greater living conditions and facilitated more income generation opportunities. In particular, women were provided with opportunities to influence decisions to select project activities based on their family needs and, thus, became more socially active and empowered by making decisions in their communities. National consultants supported the project management offices to provide training on various topics for the community members and closely involved them in poverty-vulnerability-adaptation assessments, pilot design- implementation, monitoring of results, etc. All these efforts highly enhanced the beneficiaries' ownership of all the project activities.
Consequently, compensation for any negative impact was arranged as collectively agreed and no involuntary resettlement issues arose. Ethnic minority households were specially ensured to equally benefit from the project investments based on their needs.

Building local capacities

How has the project ensured that local capacity was built during implementation phase? Explain how training programmes were integrated into core project activities and the measures taken to assure that built human capacity is maintained beyond the project's lifetime.

The project had built capacity of local stakeholders in a number of aspects. Since the communities were inexperienced in project management, different training sessions were provided at the beginning of the project. These included basic fund management, procurement, contract arrangements, IT technology application, complaint handling. In addition, training topics related to application of community-driven approach to sustainable land management and adaptation to risks, including climate change risks, were provided to community members and facilitators. As a result, the community could play a significant role in project implementation and, therefore, the sense of ownership brought about an incentive to manage the project properly until the end of the project. Their significantly improved capacity on project implementation, especially for the project management offices at county level, had become useful to other domestic projects later on. Furthermore, through capacity building activities and technical support from the

† This analysis is based on the "principles of good practice" developed by the EU/FP7-funded project AfriCAN Climate (2011-2014). These principles represent critical cross cutting issues shared by the majority of climate change projects, regardless of focus, scope and scale. They are intended to encourage critical reflection and help project developers and decision-makers draw out relevant lessons. Source: http://africanclimate.net/en/good-practice/8-principles-good-practice

consultants, the beneficiaries in the project villages gained a greater awareness of potential climate change risks, increased understanding of environmental issues and an appreciation of climate change mitigation measures. The pilot activities and experience in implementation have been documented and communication products were produced and disseminated in the project counties.

Transferability

How has the project ensured that its activities can be transferred beyond the specific contexts in which they were implemented? Explain how particular project measures, activities or concepts could be/have been applied in another contexts or regions and how successful these efforts have been.

Various factors, mainly ascribable to the project's well thought-out design and implementation arrangements, had contributed to transferability of the project. First of all, the overall project design remains highly relevant and could certainly be replicated in other areas of China under the government poverty reduction schemes. Its achievements through innovative ways for both poverty and climate change vulnerability reduction employing a full participatory approach were entirely aligned with the government's strategy and direction for poverty reduction; highly influential with regard to ongoing and upcoming poverty reduction programmes; long-lasting and life-changing on well-being of the poor villagers. After the project ended, Shaanxi province launched a new project on poor rural development and considered replicating some of the project activities into this new project. In addition, Chongqing University worked with the Chongqing provincial project management office on the final project report. After their survey on the project achievements, the university compiled 17 case studies on every project component and used them in their Master of Public Administration programme, which is popular for in- service government officers to upgrade their educational attainments. The use of lessons learned from the project would promise to substantially enhance the dissemination to increase the project impact well beyond the project areas. Apart from that, experience from the sustainable land management and adaptation pilot activities and their integration into overall poverty reduction challenges as well as policy studies analysing the linkages between poverty- vulnerability to climate change-adaptation had been disseminated through other workshops and events among relevant agencies at national scale. With regard to this point, the poverty alleviation agenda under the 13th Five-Year Plan of China – in which the policy recommendations of the project were proposed for consideration, has the key objectives to strengthen ecological construction, along with to promote infrastructure connectivity and to achieve equality of basic public services. All of these main objectives were all the key components under this project.

References

Information from this case study is mainly taken from related project documents, available at https://www.thegef.org/project/prc-gef-partnership-sustainable-development-poor-rural-areas.

ECOSYSTEM-BASED ADAPTATION THROUGH SOUTH-SOUTH COOPERATION

GOOD PRACTICE CASE STUDY

Tackling Climate Change in Irrigated Agriculture in the 3H (Huang-Huai-Hai) Basin of China

Compiled by: Tatirose Vijitpan (EbA South Project Management Unit) Edited by: Pierre Begat (C4 EcoSolutions)

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Globally, 70% of freshwater is used for agriculture[1]. According to the World Bank, in order to feed 9 billion people by 2050, agricultural production and water withdrawals will be increased by 60% and 15%, respectively. In many poor countries, agriculture is the most important economic sector. Unfortunately, it is also among the sectors most sensitive to climate change due to its high dependence, both directly and indirectly, on climate-induced conditions, such as droughts, floods, pests and epidemics. This case study presents an innovative way of tackling both agricultural production and climate change adaptation challenges through the two complementary projects at the time when China was just starting to prioritise climate change adaptation in the national policy agenda. One project sought to sustainably increase agricultural productivity, while the other one had the goal of enhancing adaptation to climate change in agricultural and irrigation management. The two projects were blended to be a combined operation. Both of them were implemented in China's most important breadbasket, where climate change is expected to bring about rise in temperatures and changes in precipitation patterns, among others, that will harshly hit an already water-scarce area. A range of interventions was introduced, such as productivity-enhancing and water-saving agricultural practices; better management of irrigation water through locally-based organisations; and promotion of high-value crops to boost rural incomes. Ecosystem-based adaptation (EbA) measures, for instance creating shelterbelts around the farmland to improve water retention, reduce soil erosion while also attract bird species, were a substantial part of the 'adaptation menu' developed for the field implementation. These adaptation measures have helped increase yields as well as provide greater protection from droughts and other events. Therefore, the farmers were enthusiastic to adopt those practices. Although this was the first comprehensive effort on agricultural climate change adaptation in China, it ultimately resulted in the successful mainstreaming of climate change adaptation in agriculture in China's 12th Five-Year Plan for Economic and Social Development (2011-2015).

The projects have provided extensive learning experiences for replication in other water and agricultural projects in China. This case study, therefore, could potentially inspire future development of climate change adaptation in agricultural sector in similar contexts worldwide.

[1] https://www.worldbank.org/en/topic/water/overview

Key lessons

- This case study has demonstrated that it is possible to retrofit an already on-going, large- scale agricultural irrigation project to integrate climate change adaptation focus. The positive results brought about from the combined projects have been realised by the key stakeholders, particularly the farmers and policy makers, on the improvements of agricultural productivity while saving water and the environment as well as responding to the climate change impacts. This is in fact a more cost-effective way to have a climate change adaptation project as an integral part of another project focusing on increasing agricultural water use efficiency, rather than implementing it as a stand-alone adaptation project.

- The objectives of both projects reflected that improved agricultural productivity was essential for better use of the country's water. In addition, they recognised that in order to be sustainable, land and water management was necessary to help protect the environment. In this regard, there were substantial investments in EbA measures to improve the agroecosystem. These measures typically benefitted both the productivity and ecological balance; shelterbelts could reduce soil erosion, integrated pest management decreased the use of pesticides, crop residue mulching conserved soil moisture, and application of organic fertiliser reduced the need of chemical fertiliser, among others.

- Since climate change adaptation was relatively new in China at that time, the adaptation interventions introduced to the farmers were easily assimilated as they brought benefits already under the current climate conditions, and would be resilient to further changes. Many of those 'no-regrets' adaptation measures, including EbA, were familiar to agriculture and irrigation extension staff. Some, such as the tree shelterbelts, were even already being practiced in the project areas, and were expanded during the implementation. Those measures evidently increased the farm yields as well as reduced the climate risks. Therefore, once the farmers understood the climate change concept and after they witnessed the demonstrations, they enthusiastically adopted those practices.

- The activities on knowledge generation, scientific assessment and capacity building on climate change adaptation were crucial to the success. The projects received technical support from experts both from domestic institutions (including the Chinese Academy of Agricultural Sciences and Chinese Academy of Sciences) and abroad throughout the whole process; from assessment of climate change impacts, design of the adaptation measures tailored to specific agro-ecological and climatic zones, to demonstration of those interventions that bring benefits for wider adoption. All were instrumental to achieving the adaptation objectives.

- Stakeholder engagement is of great importance. The projects highlighted the participatory implementation by working with the farmers and their associations, scientific community, provincial and county level command agriculture development programme offices, and the water and forestry bureaus to develop a commonly agreed list of climate change adaptation interventions. Substantial effort was put into dissemination of information to civil society, farmers, extension staff, government officials and political leaders on the concept of climate change and the adaptation required to respond to such changes. Altogether, these contributed towards obtaining immense support to implement such pioneering initiatives and eventually achieving the mainstreaming goal into one of the country's most significant development policies.

GOOD PRACTICE DESCRIPTION

LOCATION: Primarily in Hebei, Jiangsu, Anhui, Shandong and Henan with certain activities extended to Inner Mongolia, Jilin, Chongqing, Yunnan and Ningxia

IMPLEMENTATION PERIOD: Irrigated Agriculture Intensification III Project (IAIL3) in 2005-2010; Mainstreaming Climate Change Adaptation in Irrigated Agriculture Project (MCCA) in 2008-2012

OPERATIONAL BUDGET: Out of the IAIL3's total project cost of US$463 million, US$200 million loan was supported by the World Bank. The MCCA was financed by the Global Environment Facility (GEF) Special Climate Change Fund (SCCF) grant of US$5 million plus US$50.5 million as co-finance from the companion IAIL3 project.

KEY STAKEHOLDERS: Both projects were implemented by the State Office of Comprehensive Agricultural Development (SOCAD) under the Ministry of Finance. The Project Management Offices (PMOs) were also located in the Provincial Office of Comprehensive Agricultural Development (POCAD) and County Office of Comprehensive Agriculture Development (COCAD) in the project areas. The key stakeholders included national government agencies (e.g. Ministry of Finance, National Development and Reform Commission, Ministry of Water Resources, Ministry of Agriculture), local government agencies (e.g. Finance Bureaus, Planning Commissions, Water Resource Bureaus, Irrigation Districts, Agriculture Bureaus), national and sub-national research/academic institutions. The direct intended beneficiaries were farmers and local communities in the project sites.

Background information and climate change vulnerabilities

On a global scale, climate change and agriculture are intrinsically intertwined. According to the World Bank (2015), climate change impacts will affect agriculture the most. It is the key economic sector in the poorest countries and major source of income, food security, nutrition, jobs, livelihoods and export earnings. Even with adaptation actions such as adjusted agricultural practices and crops, studies show that by 2030 and 2080 climate change could still result in global crop yield losses as large as 5% and 30%, respectively. This could acutely lead to crucial increase of burden on the poor households, who spend approximately 60% of their income on food. The knock-on effects would include malnutrition, other social problems and countless challenges that altogether will threaten achievement of multiple Sustainable Development Goals. Certainly, climate change is only part of the equation besetting the world agricultural system; there are many other contributing factors that put the agricultural sector even more at risk. These factors are particularly related to market and regulations, including international trade policy.

China's accession to the World Trade Organisation (WTO) in 2001 had enhanced the country's economic position. At the same time, this also opened China to foreign competition. Within the WTO framework, China needed to participate and perform in internationally competitive agriculture, while food security was high on the country's development agenda. Although WTO membership provided opportunities for increasing farm incomes, it required the agricultural sector to undergo extensive structural change and modernisation by, *inter alia*, improving agricultural practices to produce safe, high quality and high value products; using water resources more efficiently; and cutting agricultural pollution. The Chinese government was well-aware of those issues and included them as central themes of the country's Five-Year Plans for National Economic and Social Development for 2001-2005 and for 2006-2010.

The 3H Basin, or the basin of the Huang-Huai-Hai rivers or the North China Plain, is China's most important agricultural area, producing 50% of the country's grain output and supported 425 million people. Water shortage was a critical issue in the 3H Basin, where the water demand was high and growing. Available water resources were already overexploited and groundwater levels were reducing up to 1 meter per year in some areas. Improving performance of the agricultural sector in the 3H Basin was essential to take advantages of the WTO membership opportunities. However, there were a number of significant challenges, including low quality and efficiency of agricultural production; low efficiency of irrigation facilities; and low market value of the agricultural products.

Moreover, reduction in water stream flows and groundwater recharge in the 3H Basin due to climate change is projected, in addition to increase of irrigation water demand and withdrawals caused by higher temperatures and higher evapotranspiration (ET). Several studies[2] conducted in the 3H Basin consistently indicate water stress as a major climate change impact in the area. This will post crucial challenges for water resources management and likely lead to intensifying agriculture, industry, urban settlements and ecosystem related problems. Furthermore, groundwater depletion has long been the top issue facing agriculture in the basin as agricultural production strongly relies on groundwater irrigation due to restriction of surface water for urban water supply (Hu et al., 2010). Along with abstractions through human activities, climate change also has strong implications on groundwater level in the region (Zhang et al., 2014). As the country's most important agricultural area, water management and groundwater irrigation problems in the 3H Basin, therefore, crucially threaten food security in China (Li et al., 2011; Yuan & Shen, 2013).

Intervention technologies

The IAIL3 project was designed to respond to the critical challenges of China's rural and water sectors on enhancing agricultural productivity while also conserving irrigation water and the environment. Climate change was not part of the project's original objective since it was not a priority of the government at the time. However, the interest in climate change adaptation escalated due to a series of poor harvests and the necessity to address the impacts of climate extremes: floods, droughts and high temperatures, and finally the government issued a National Plan for Coping with Climate Change in 2007. Therefore, during the IAIL3 project's mid-term review in 2008, it was decided to adjust the project by including a targeted climate change adaptation agenda through the addition of the MCCA project. A GEF SCCF grant was, thus, sought to complement the IAIL3 project as well as to assist the government in mainstreaming climate change adaptation into the National Comprehensive Agriculture Development Programme (CAD), which is China's largest national investment programme in irrigated agriculture. Adaptation measures would be carried out under the on-going companion IAIL3 project, and would be expanded to cover as much of the project area as possible.

The ***IAIL3 project*** had an overall objective below:

To increase water and agricultural productivity in low and medium yield farm land areas; raise farmers' income and strengthen their competitive capacity under post-WTO conditions; and demonstrate and promote sustainable participatory rural water resources management and agro-ecological environmental management in the 3H Basin.

It consisted of 4 components and the major activities are summarised as follows:

(1) Water-saving irrigation and drainage: (a) building and improvement of local irrigation and drainage systems in 500,000 ha of low and medium yield land; (b) application of engineering water-saving measures e.g. sprinkler irrigation and micro-irrigation, canal system, combined use of canals-wells-surface and groundwater to increase the irrigation efficiency; (c) application of agronomic water-saving measures e.g. land levelling, modification of agro- production structure according to local natural resources and economic conditions, soil moisture conservation by using crop residues, water-saving planting methods coupled with irrigation scheduling to reduce ET of crops and increase yield; (d) application of water-saving management measures, such as river basin-based unified surface and underground water

[2] for instance: Fu et al. (2009), Liu et al. (2013), Mo et al. (2013), Zhang et al. (2014)

management, promotion of self-managed irrigation areas, establishment of Water User Associations (WUAs: to improve participatory local water management and maintenance of irrigation facilities) in the five project provinces and other selected provinces; and (e) preparation and application of groundwater management plans.

(2) Agricultural modernisation and organisational development: (a) strengthening and modernisation of agricultural services; (b) high quality crop production, extension and demonstration; (c) strengthening farmers' organisations; and (d) enhancement of individual and institutional capacity of farmers, agricultural technicians and farmers' professional organisations.

(3) Agro-ecological environmental protection and management: (a) formation of shelterbelt forest networks around farmlands; (b) application of Integrated Pest Management measures; (c) environmental management and monitoring; (d) capacity building on soil, water and environmental conservation; and (e) demonstration and extension services on ecology and environment.

(4) Institutional strengthening and project management support: mainly for the CAD offices at state, provincial and county levels on (a) domestic and international training and study visits; (b) technical assistance from domestic and international expert teams; (c) scientific research and demonstrations; (d) support for an upgraded computerised project Management Information System (MIS); and (e) survey, design and supervision work for project implementation, including monitoring and evaluation (M&E).

The ***MCCA project*** had the overall objective below:

To enhance adaptation to climate change in agriculture and irrigation water management practices through awareness raising, institutional and capacity strengthening and demonstration activities in the 3H Basin. This would assist in mainstreaming climate change adaptation measures, techniques and activities into the CAD Programme.

It consisted of 3 components and the major activities are summarised as follows:

(1) Identification and prioritisation of adaptation options: (a) conducting climate change impact assessment in the 3H Basin and project area; (b) conducting gap analysis and identifying the adaptation measures to be integrated into the IAIL3 project and the CAD programme; and (c) prioritising and selecting the adaptation measures and demonstration sites, including consultations with farmers as well as provincial and county experts to help incorporate first-hand experiences into the implementation of those adaptation measures.

(2) Demonstration and implementation of adaptation measures: (a) implementation of the selected climate change adaptation measures, focusing mainly on agricultural production and irrigation water management, at the demonstration sites; and (b) integration of appropriate adaptation measures into the implementation of the IAIL3 project to help reduce vulnerability to climate change in the 3H Basin.

(3) Mainstreaming adaptation into national CAD programme and institutional strengthening: a series of technical assistance, knowledge sharing, capacity building, and public awareness raising activities on climate change adaptation, and preparation of a National Climate Change Adaptation Plan for CAD.

Description of the results

The IAIL3 project interventions covered improvements of both purely technical as well as management aspects. It was successful in improving the agricultural yield, water productivity, irrigation efficiency and crop value per kg. These resulted in a considerable increase of farmers' income with no significant increase in total water demand. The MCCA project smoothly integrated various climate change adaptation measures, including EbA, to enhance resilience to floods and droughts. According to the combined projects' terminal evaluation report, the overall outcome is rated 'Highly Satisfactory'. The projects' innovations ranged from water saving techniques to improved WUAs, to climate change adaptation. All of these are essential for long-term agricultural sustainability and for increasing production, enhancing food security, increasing rural incomes, saving water, and decreasing environmental impacts of agriculture.

The *MCCA project* covered 210,659 ha of demonstrated areas with 298,732 participatory stakeholders plus 172,868 ha of farmland under the *IAIL3 project*. The key results are summarised below.

Increased climate change adaptation awareness: Through a large number of capacity building and awareness raising activities, more than 56% of the stakeholders have become aware of the potential climate change impacts and the adaptation measures. Those activities were designed for each stakeholder groups. For the project implementation and management officials at all levels and research groups, 27 climate change adaptation related studies (e.g. on climate change impacts, specific adaptation options, implications for water management and farming interventions, contribution to CAD programme) were conducted by national and provincial experts (with technical assistance from international specialists) and with involvement of this group of project team members. By participating in such extensive studies, as a result their awareness and knowledge tremendously increased. For farmers, farmers' associations and WUA members, their direct participation in the adaptation interventions leads to a considerable increase of their awareness. For the broader group of stakeholders, the project totally disseminated 331 publications related to climate change adaptation knowledge and measures through newspapers, booklets, magazine, TV, radio, website and conferences. Importantly, thematic capacity building activities for various stakeholder groups (including farmers, technical staff, officials) were organised through workshops and study visits on scientific understanding of climate change and adaptation in water and agricultural sectors for totally 37,659 persons. A great number of additional consultation and coordination meetings were also organised with the government leaders and officials of relevant agencies to enhance their capacity and awareness of climate change adaptation and to promote climate adaptation measures for implementation at the demonstration sites. With all the aforementioned efforts, climate change adaptation concepts have become extensively welcomed by the government officials and farmers, as reflected in their strong support throughout the project implementation.

Climate change adaptation measures implemented in selected demonstration areas with stakeholder participation: Various types of agriculture and water adaptation measures were demonstrated under both projects. Those under the MCCA included promotion of 450,000 kg of seeds of adaptive crop varieties, introduction of 33 adaptation agricultural technologies, forestation of 710 ha, establishment of 314 sets of stormwater collection and storage facilities, and installation of groundwater monitoring (in Hebei) to enhance water resources management and adaptation capacity. Moreover, certain adaptation measures related to water-saving initiatives were scaled up in the IAIL3 project areas that resulted in an increase of water and agricultural productivity from 1.1 to 1.39 kg/m^3 and the improvement of the production per unit of ET from 55,000 to 114,000 kg. Those adaptation measures included introduction of 1.55 million kg of seeds of pest tolerant varieties, 19,000 ha of mulching, 691 sets of small water storage facilities,
1.8 million m^2 of anti-seepage channels, 13 million m^3 of channel excavation and dredging, 39,000 ha of land levelling, greenhouse facilities of 1.2 million m^2, and 1,825 ha of replication of pest control and prevention. As a result, per capita income of typical farm households from the adaptation measures applied was increased from 1,100 to 1,570 RMB.

Climate change adaptation policies and measures integrated into documents issued by state, provincial and county CADs: Totally, 173 governmental official documents (government reports, policy briefs, implementation/replication plans) on climate change impacts, adaptation policies and technical standards were issued. Based on the review of climate change impacts, available adaptation options and provincial contexts, POCADs actively introduced numerous policies, which significantly provided policy support to the implementation of the climate change interventions and capacity enhancement on adaptation in the provinces, especially the agricultural sector. In addition, “Circulations to Strengthen Climate Change Adaptation in CAD” were issued by SOCAD and all POCADs to guide all CAD counties on national and provincial CAD investment programme. Eventually, the policy recommendations to integrate climate change adaptation into CAD programme were formulated to mainstream climate change adaptation into the national and provincial CAD programme in China’s 12th Five-Year Plan for Economic and Social Development (2011-2015).

For the *IAIL3 project,* the key results could to some extent already contribute to climate resilience enhancement, even though climate change was not directly considered during the project formulation. First of all, average per capita net income (including non-agricultural income) of farmers in the project areas almost tripled, i.e. from 1,099 to 3,290 RMB, through increased high quality/value crop production. Additionally, unexpected sources of income, which was not quantified but estimated to be substantial, occurred from off-farm employment opportunities (e.g. fishery, animal husbandry, agro-product processing and transportation businesses) thanks to the reduced time and labour in agricultural operations from the mechanisation and effective irrigation initiatives introduced by the project. Secondly, the high-quality crop production (including high value, green, non-polluting and organic crops) was notably increased in order to strengthen farmer’s competitive capacity under post-WTO entry conditions. The grain production in the project areas increased from 3.2 to 4.2 million tons. 100,000 hectares (from zero as the baseline) were allocated to non-polluting, green and organic crops. This not only increased the farmers’ income but also improved food safety and agro-environmental management in the project areas. Thirdly, water productivity increased from 1.06 to 1.55 kg/m^3, and water usage dropped from 6,892 to 3,809 m^3/ha. The improvement could be essentially ascribed to the comprehensive water-saving actions to reduce the on-farm water consumption, improve irrigation efficiency, increase overall water availability, and improve participatory resource management through WUAs. Lastly, to promote sustainable participatory water resources management and enhance farmer participation, 1,022 WUAs (with membership of 490,000 and covering about 225,000 ha),
207 Farmers’ Associations (FAs, with 153,941 household members), and 20 pilot Farmers’ Cooperatives (FCs, with 5,783 household members) were established and operated. Establishment of these institutions significantly contributed to increase of crop yields and farmers’ income in the areas compared to farmers in the control group. FAs and FCs are specialised farmer organisations that support the members in providing information, techniques, marketing services, and importantly, acting as the “bridge” linking up farmers with markets. Their roles are crucial in agro-production process, upgrading farmers’ scientific knowledge, and assisting farmers to increase their incomes, e.g. from 2,321 to 4,031 RMB and from 2,637 to 4,160 RMB for the per capita income of households involved in the FAs and FCs, respectively.

GOOD PRACTICE ANALYSIS‡

Knowledge building

How has the project built upon or applied the findings of specific research projects? How has the project actively contributed to international understanding on Ecosystem-based Adaptation?

As the first comprehensive effort on agricultural climate change adaptation in China, a high level of expertise was required since the formulation. International and national experts, e.g. from the Chinese Academy of Agricultural Sciences, Chinese Academy of Sciences and provincial institutions, were brought in to support on climate change aspects throughout the planning and operations. The substantial integration of academics and expert consultants in the technical work was a notable feature that greatly contributed to the projects' performance. Tremendous efforts were particularly dedicated to building knowledge of the stakeholders, e.g. project teams at the provincial and county levels, farmer beneficiaries, government decision makers, senior and middle-level extension staff from various agencies, to understand and embrace the climate change agenda. Those activities included 37,000 person months of training for extension staff, 74,000 person months for farmers, 145 international and 3,600 domestic study tours, and 330 public outreach activities through media and other means. A variety of scientific analyses under the projects to support adaptation planning were significant in building capacity of Chinese scientists to rigorously address climate change issues and, therefore, laying a strong foundation for future work. In total, 27 studies were undertaken by applying integrated climate, hydrology, water allocation, and economic models. Numerous project-sponsored papers were published both in international and Chinese journals. Visits of technicians from neighbouring counties, presentations at conferences and other forms of international exchanges were also facilitated to disseminate the results and experiences at international level.

Political ownership, collaboration and approval

How has the project secured support from political-level stakeholders and aligned its activities with wider development agendas to trigger further collaboration opportunities?

Several factors were behind the success in political support of the projects. Government ownership and commitment were strong since the beginning; the key persons in SOCAD and other agencies were appointed and major implementing arrangements established in due time for the projects' fast start. Throughout the implementation, the government performed nearly ideal on its overall support. According to the Project Performance Assessment Report, the government's performance was ranked 'Highly Satisfactory' due to its full package to facilitate institutional arrangements, ready intervention to address inter-agency concerns, and demonstrate willingness to experiment. Particularly, the Project Management Offices (SOCAD, POCADs and COCADs)' performance was "outstanding" to cover such extensive project areas of 107 counties plus 16 countries of extended WUA programme. The provincial and county agencies under the Ministries of Water Resources, Agriculture, Environment and Forestry, among others, were also key implementers; while the academics and technical specialists played significant roles as well. Despite its seemingly cumbersome involvement of a large number of agencies, this extensive administrative structure turned out to be extremely effective, especially in facilitating the scale-up of climate change adaptation to a national programme via

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‡ This analysis is based on the "principles of good practice" developed by the EU/FP 7-funded project AfriCAN Climate (2011-2014). These principles represent critical cross cutting issues shared by the majority of climate change projects, regardless of focus, scope and scale. They are intended to encourage critical reflection and help project developers and decision-makers draw out relevant lessons. Source: http://africanclimate.net/en/good-practice/8-principles-good-practice

the existing government structure and agencies. In addition, the national decision makers, after witnessing the benefits of the adaptation measures, strongly supported further expansion of the initiatives. This could also be attributed to considerable information dissemination efforts plus the over 30 consultation meetings for the government officials and political leaders to obtain their support to implement such initiatives as well as to facilitate mainstreaming activity for the climate change adaptation agenda. Eventually, the inclusive value of IAIL3/MCCA is remarkable in terms of the impact on China's agricultural development at large. The IAIL3/MCCA had been taken as a model by the central government; the approach was integrated into the irrigated agricultural part of the National Comprehensive Agricultural Development Programme, which covers every province of China and in 2014 received a budget of 36 billion RMB (about USD 6 billion).

Building local capacities

How has the project ensured that local capacity was built during implementation phase? Explain how training programmes were integrated into core project activities and the measures taken to assure that built human capacity is maintained beyond the project's lifetime.

The project implementation mechanism was highly decentralised. In the project areas, the POCADs and COCADs coordinated the activities with the concerned provincial and county governmental bureaus, respectively, as well as other key implementers. Climate change adaptation awareness raising and capacity building activities were also the projects' fundamental elements, primarily conducted through training and demonstration for farmers as well as learning by doing for project field staff. Besides, the PMOs at different levels encouraged active participation from the farmer beneficiaries in the whole process of project preparation, implementation and maintenance, enabling them to become the owners of the project development. All those efforts greatly fostered the local level capacity in the projects. Nevertheless, a key highlight would be on the establishment and strengthening of the new grassroots organisations, who also implemented climate change adaptation measures under the projects and the members are mainly local farmers. These are the WUAs, FAs and FCs, which were created to derive the benefits for the farmer beneficiaries themselves, e.g. to better manage water, boost profitability, improve farming practice and commercialise agricultural products. Throughout the implementation, intensive technical assistance from the academics and specialists were provided to these farmer-led groups, such as on water-saving techniques, high-value crops, marketing, gender, climate change adaptation measures, together with such participatory principles as 'self-decision making' and 'self-management' approach, which underpin the successful operation of these farmer organisations.

Community participation and inclusiveness

Has the project consulted with local communities in the formulation, implementation and decision making process? How were gender issues incorporated? Explain how the project mobilized local interest and ownership in order to ensure its activities responded to the needs of local beneficiaries.

Due to the decentralised nature of the projects, local level stakeholder consultation was carried out even beyond a standard participatory practice, especially for those activities directly related to the farmer beneficiaries such as the preferences on proposed adaptation activities, suggestions on the measures' feasibility and practicability at the local level as well as the establishment and operation of the WUAs, FAs and FCs. Notably, engagement of the marginalised groups was well-considered. FAs and FCs have regulations to stimulate participation of poor households, who lived in about a third of the project counties. In the areas where ethnic minority groups were present, e.g. Mongol, Miao, Yao and Hui in Yunnan Province, Ningxia Hui Autonomous Region and Inner Mongolia Autonomous Region, Ethnic Minorities

Development Plans were prepared for the relevant project activities e.g. in the WUA development process. Participation of ethnic women was also a focus of the WUA formation. As a result, the ethnic minorities and women were adequately represented on the WUA executive committees. Moreover, specific training events were provided to women both in WUAs and provincial project staff, as part of the newly-integrated dimension to the SOCAD policies to promote participation of women in WUAs. This enhanced the perception of women, who play an important farming role i.e. 70-80% of agricultural labour force in some areas, in participation and democracy, and eventually led to upgrading women's status in the rural communities. Importantly, the introduced climate change adaptation measures had both provided greater protection from droughts and other climate events and helped increase yields. Thus, the farmers were enthusiastic to adopt the adaptation measures. Along with the substantial outreach to farmers and policymakers, farmers and government alike were committed to adapting agriculture to climate change and to take the programme forward. Through the institutional development of WUAs, FAs and FCs as well as continuous direct participation throughout the projects, the farmers were empowered and, therefore, ownership of the projects among farmers, WUAs, FAs and FCs became strong. According to the projects' assessment report, after the projects had ended several key activities, including the WUAs and FAs, become self-managed and self-financed and would expect to be sustained.

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ECOSYSTEM-BASED ADAPTATION THROUGH SOUTH-SOUTH COOPERATION

GOOD PRACTICE CASE STUDY

Greenhouse agriculture and water harvesting technologies for climate change adaptation in the Ningxia Hui Autonomous Region, China

Compiled by: Mulubrhan Balehegn for EbA South

Edited by: C4 EcoSolutions (Pierre Begat), EbA South Project Management Unit (Tatirose Vijitpan)

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This case study describes the use of diverse water harvesting and water saving technologies to mitigate the effects of recurrent drought, extreme weather and general decline in moisture availability in the arid and semi-arid Ningxia Hui Autonomous Region of China. The technologies introduced include the use of 'protected' agriculture (e.g. greenhouse farming), and the use of plastic and stone-gravel mulching of farmlands. While the sand/gravel mulching has been a traditional practice of local farmers throughout history, the plastic mulch and the greenhouse farming are newly applied in the region. These technologies have been introduced mainly through government subsidies and other forms of support programs. Coupled with government's diverse environmental policies for the region such as the National Forest Conservation Program (NFCP), the Grain for Green Program (GGP), land transfer policy, and the inter-basin water transfer programs, these have resulted in an increase in the overall income of local farmers, thereby leading to their widespread adoption since 1990s.

Project outcomes

- Through the increased productivity of farms, farmers have increased their income.
- The agricultural patterns have become better adapted to extreme weather variability and droughts.
- The implementation of greenhouse farming helped in sparing of large tract of formerly cultivated, degraded land, thereby providing improved opportunities for the National Forest Conservation Program.
- Greenhouses enable longer growing season for valuable vegetable crops, helping farmers to market high value cash crops.
- An integrated result of the above has led to an overall rehabilitation of degraded land.

Key lessons

- Successful implementation of adaptation technologies requires strong government policy support, including subsidies to create an enabling environment, until communities start to adopt them voluntarily.
- Protected agriculture (e.g. greenhouse farming) has improved productivity, thereby resulting in improved income.
- Protected agriculture assures higher productivity within limited area of land, sparing more degraded land for environmental rehabilitation programs.
- The implementation of water-saving technologies such as plastic and sand-gravel mulching have resulted in improved water use efficiency ultimately increasing farmers' income.
- Sustainable adaptation and adoption of these technologies, however, require continued knowledge sharing, training and financial assurance for farmers.

GOOD PRACTICE DESCRIPTION

LOCATION: Ningxia Hui Autonomous Region of China

This case study is not part of a particular project but describes the 2 technologies that have been continuously practiced as a response to climate change adaptation.

OPERATIONAL BUDGET: Government subsidy and individual farming families' sources e.g. contributing up to 16%-23% of household income

KEY STAKEHOLDERS: Government of Ningxia Hui Autonomous Region, Chinese Central Government, local farmers of Ningxia and various research/academic institutions

Background information and climate change vulnerabilities

This case study describes two innovations aimed at reducing the negative consequences of drought and extreme variability in the Ningxia Hui Autonomous Region in China. These innovations include (1) plastic and sand-gravel mulching for reducing moisture evaporation from sandy soils in the arid and semi-arid zones, and (2) use of greenhouse agriculture for climate change adaptation. Ningxia Hui Autonomous Region is located in northwest China. It is geographically located between $35^o14'$-$39^o23'$ N and $104^o17'$-$107^o39'$ E, lying in the upper reaches of the Yellow River bordered by Shaanxi on the east, Gansu on the south and Inner Mongolia in the north. Ningxia covers an area of about 66,400 km^2, and had a population of more than 6.6 million (in 2014), many of which are Hui Muslims (36%) (Yang et al., 2015). The area is composed of grassland (22,700 km^2 or 34%); cultivated land (11,000 km^2 or 17%); and potentially arable land (7,300 km^2 or 11%). In 2006, its GDP was 71.08 billion RMB, divided between primary industry (11%); secondary industry (49%); and tertiary industry (40%).

Ningxia has an arid and semi-arid agro-ecology with the annual average air temperature of 5-10^{o}C. The annual precipitation decreases from south to north; more than 400 mm in the southern part of Ningxia, 200-300 mm in the middle and less than 200 mm in the north. The precipitation is mainly obtained during summer and autumn (80%). Annual evapotranspiration is approximately 1,214-2,803 mm.

Ningxia is generally classified into three agricultural zones, based on topography and available water sources. These are (1) the Northern Yellow River irrigation region, (2) the central arid zone, and (3) the Southern mountain area (Zheng et al., 2006). The northern part is an irrigated agricultural area, where agriculture relies entirely on irrigation; the central part comprises interlacing agro-pastoral zones; and the southern part is a rainfed agricultural area. The irrigation area along the Yellow River in northern Ningxia is the fourth largest irrigated agricultural area in China and a major grain-producing area in Ningxia (Yang et al., 2015). Ningxia is affected by frequent weather and climate fluctuations. The major types of observed climate change and climatic challenges include an increasingly warmer weather conditions and the increase in frequencies of extreme weather events. Particularly for this province, water stress has recently become more serious and recurrent (Zou et al., 2005). Studies have shown that over the last 30 years, drought has affected 14.3% of the population, and 47.6% of the total land area, causing economic loss equivalent to US$ 26.7 million (Tan et al., 2014). The affected population, land and revenue losses caused by droughts have also increased by 279,000 persons, 32,000 hectares and US$ 13.4 per decade, respectively (Tan et al., 2014). Moreover, existing climate forecast indicates that future climate in Ningxia will see higher temperatures in the summer months (especially higher minimum temperatures), while rainfall will become highly variable and frequency and intensity of extreme events will increase (Wang and Chen, 2014), making rainfed crop cultivation less and less viable and increasing more pressure on already existing irrigation sources (Wang and Chen, 2014). In the last 50 years, Ningxia has shifted from a wet period (1960-1980) to a dry period (since 1995; Du et al., 2015). Furthermore, over the past decades, the observed average annual air temperature has significantly increased by 1.4-2 ^{o}C (Yuan et al., 2011).

Besides highly variable and extreme climate, Ningxia has also been historically affected by desertification. Desertification has affected 55.8% of Ningxia's total terrain (2.89 million hectares), with additional 1.21 million hectares of grassland and 132,000 hectares of farmlands also currently threatened by desertification (PRC and UNDP 2010). Most farmers in the province are highly vulnerable to the effects of climate change, because their livelihood depends on agricultural practices that are highly sensitive to climatic conditions. For instance, the drought in 2004-2006 had a significant impact on the agricultural productivity of mixed farming, grazing and irrigated areas (Li et al., 2013). Official statistics from Ningxia's Meteorological Bureau on agricultural disasters shows that during the period 1949 to 2000, on average 23% of the province's arable land (equivalent to 480,000 ha) experienced yield losses of 10%−30 % and 17% of the area yield losses greater than 30 % (Li et al., 2013). Direct economic losses in the agricultural sector showed a steep jump in 2001 from RMB 910 million to RMB 1.27 billion per year (Li et al., 2013). The main negative consequence of changing climate is the reduced amount of water for irrigation from the Yellow River (Liu and Xia, 2004, Yang et al., 2015). The negative impacts of these challenges are also exacerbated by other challenges, including (1) limited capacity and reliability of seasonal weather forecasting services, that hindered farmers' ability to reliably predict weather and take adaptation measures; (2) flooding, which has become a new challenge by itself, to which farmers are not traditionally adapted; (3) limited or low compensation to farmers who participate in adaptation practices, which discourages voluntary adoption of technologies; and (4) inadequate cooperation between local government departments.

In light of the challenges caused by extreme weather change and recurrent drought, the construction of efficient water-saving infrastructure has become the core of drought adaptation strategy of the Ningxia government, with socio-economic sustainable development being the ultimate goal (Yang et al., 2015). Ningxia has, therefore, become the face of the Chinese government's attempt to adapt to climate change and variability in China's arid region starting in early 2000s (Yang et al., 2015). The implementation of these technologies required an integration of policies, institutional leadership, engineering, technological and social initiatives and measures. These specific coping and adaptation strategies were made to be aligned with the national macro adaptation strategies (Yang et al., 2015).

Among the many measures implemented in this perspective, two technologies are further described in this case study: the use of plastic and stone mulching as well as greenhouse farming.

Intervention technologies

a) Greenhouse agriculture: Greenhouse construction, as an example of protected agriculture, has been promoted as a poverty reduction measure in Yellow River irrigated areas. Greenhouses enable longer growing season for valuable vegetable crops, and reduce water loss from evapotranspiration. Because of its benefit on increased productivity and farmer's income, the number and coverage of protected agriculture, particularly greenhouse agriculture, has been increasing over time. In 2006 about 30% of the cultivated land was covered by greenhouses, and the proportion has been continuously increasing. In 2011, the area under protected horticulture was 40,000 km^2 (Guo et al., 2012), and increased afterwards owing to the increased productivity of the system. This technology, where agricultural practices are mainly horticulture, crop production under greenhouse conditions has attracted the attention of farmers and policy makers due to its potential for improving productivity. A tailor-made greenhouse that fits the local environment was also designed - a groove type of greenhouse with 80m (length)*10m (width) *3.5m (height) (Guo and Li, 2013). This design contains about 1.5-2 m underground with two wind shields at each side of the greenhouse at 1m. Transparent film is used at the top of the greenhouse to let the sunshine in and the insulating layer is used to preserve the heat. A rain-collecting cellar is also constructed nearby the greenhouse to collect rain for irrigation in winter. Figure 1 below is an example of such type of greenhouse farm.

Figure 1. Farmers in Ningxia working in a greenhouse (©Tan Haishi)

b) Water conservation techniques: The most important challenge brought about by climate change is a steady decline in the amount of moisture in the soil. Therefore, conservation of water is an essential technology to assure that the available water will not be lost before it is used for important purposes. In this case study, two types of water conservation technologies are described. These include (1) the use of plastic mulch, and (2) the use of sand-gravel mulch.

(1) The *use of plastic mulch* in areas facing water shortage: Farmers in Ningxia have been using various water harvesting technologies including the use of plastic film on the land in autumn to collect rain and reduce evaporation. Thin plastics are bought in rolls and used to cover the length and width of a farmland, thereby protecting rainwater from evaporating quickly. Plants are allowed to grow through small holes made on the plastic. Any rainwater falling onto the plastic is collected and allowed to flow directly to the soil through the same holes. Plastic mulches, though very effective at increasing water use efficiency in dryland areas, however, have been blamed for their catastrophic environmental consequences, as tons of undegradable plastic is left every year on farmlands and outdoors after their use (Changrong et al., 2006). Realising this problem, biodegradable plastic mulches with similar effect on water conservation, and even better effect on soil microbial content, have been devised and are already in use by farmers (Moreno and Moreno, 2008).

(2) The *use of stone and gravel mulch* to reduce evaporation from sandy soils: When irrigation water is limited, farmers take action to reduce the amount of moisture lost

by evaporation through various measures, including the traditional use of sand- gravel mulching to protect from moisture evaporation. Typically, farmers used stones and gravel mulch to reduce evaporation of moisture from the soil, to enable them to produce watermelon (Figure 2). This technology is a prerequisite for viable production of watermelons, as growing watermelons required relatively large amount of water compared to other crops, and technologies for conserving and harvesting available moisture were a must. This technology, also called ‘shatian’ or ’sandy fields’ in Chinese, actually emerged in the 1930s in Ningxia. This has been an indigenous practice of Chinese farmers in the Arid North-West China (Li, 2003). In 2009, the total planting area of gravel-mulched watermelon is 687 km^2 in Zhongwei City, where watermelon growing is a major industry. The "traditional wisdom" of gravel-mulched watermelon production technique was developed at a larger scale three decades ago, prior to the availability of water-saving trickle fertigation and bio-degradable plastic mulch materials.

Figure 2. Farmers harvesting watermelons growing on gravel-covered land in Zhongwei City of Ningxia ©Xinhua

Description of the results

Greenhouse agriculture

Greenhouses enable longer growing season for valuable vegetable crops and reduce evapotranspiration water losses. The use of greenhouse agriculture in the 2000s greatly increased the vegetable production, productivity and revenue produced from it. In 2005, vegetable planting area under protected agriculture was 10,733.33 ha, and that in sunlight greenhouses was 7,600 ha (Jianping et al., 2008). As a result of the greenhouse agriculture, the number of vegetable varieties exceeded 50, compared with only 10 varieties in the 1960s and 30 in the 1980s, and the annual yield reached 3.579 million tons, with per-capita share of vegetables in Ningxia exceeding 600 kilograms (Jianping et al., 2008).

The yield from greenhouse farms ranged from 4.5 – 6 kg/m^2, a value that is higher than the yield from conventional agriculture (Guo and Li, 2013). Another important impact of the greenhouse agriculture is that, due to its implementation, many less productive farmlands have been abandoned and converted into forest land, resulting in an increase in forest cover in the province (Restrepo et al., 2017).

Water harvesting and conserving technologies

a) *Plastic mulching*: Plastic mulches are widely used in arid and semi-arid areas of China for various purposes. For instance, 87% of farmers in Minqin County of Gansu Province use plastic film to conserve rainwater and that has improved crop productivity by 53% (Ingman et al., 2015). The use of plastic mulching has been increasing from time to time in different districts of the Ningxia region. The advantages of using plastic mulches are various - including increasing water use efficiency, plant growth rate and productivity, increasing mineral or fertilizer availability, controlling runoff, and reducing weeds in farmlands (Li et al., 2004, Yan et al., 2010). Plastic mulching (Figure 3) can be of ordinary mulching, which is the use of mulching plastic film on the surface layer of soil at regular intervals, and full-film mulching, which covers the entire soil surface with a plastic film. It is also sometimes combined with sand-gravel mulching.

Figure 3. A villager lays plastic mulches on bare ground (Right) and then stamps down the plastic mulch (left)

in Jiatang Township of Haiyuan County, Ningxia. (©Xinhua)

b) *Gravel and stone mulching of sandy soils*: This technology was introduced in Ningxia in 1930s. Farmers put stones on sandy land to protect water and regulate temperature and reduce evaporation of limited moisture from the sandy soil. Carboniferous limestone gangue sand/gravel containing selenium minerals is typically used for mulching purpose, especially in watermelon farming. Rainwater leaches the minerals deposited in the sand/gravel. Then, watermelons absorb the selenium. The selenium-rich watermelons grown in this fashion are therefore called selenium sand melons. The sand/gravel serves three purposes (Yang et al., 2015): (1) to reduce surface runoff and make full use of limited precipitation, (2) to conserve moisture in the soil and decrease evaporation, and (3) to increase mineral components of the soil. Sand-gravel mulching irrigation is a combination of sand-gravel mulching and supplementary irrigation unique to the Ningxia region. In sand- gravel mulching, a layer of sand and gravel is placed on the soil, and then a mulch plastic film is layered over the sand and gravel at intervals of about 80 cm (Figure 4). A study by Li (2002) proved that mulching sandy soils with gravel and stone resulted in 32% more dew deposition than unmulched soil. Since dew deposition reduces evaporative moisture loss, the mulching improves the availability of moisture for crop production (Monteith, 1957). Dew can help horticultural crops such as cucumber, watermelon and pumpkin from drying as a result of extreme temperature and drought (Stone, 1957), which in turn also improves their growth rate and productivity under moisture stressed condition. Gravel-mulching was effective in conserving moisture and increasing yield and water use efficiency at about 1.9 times more than conventional flat soil cultivation in semi-arid regions of China (Li, 2002). Similarly, in an experiment undertaken at the semi-arid Loess Plateau, China, gravel-sand mulching produced results in the production of higher biomass yield of maize than plastic- mulching or straw-mulching (Wang et al., 2009). A combination of plastic mulching with sand-gravel mulching (Figure 5), in an experiment in dry semi-arid China, also resulted in an average runoff efficiency (runoff/rainfall) of 87% and a twofold increase in crop yield and 1.8-fold increase in water use efficiency (Li et al., 2000). The only drawback of sand-gravel mulching is its high labour intensity and associated labour costs. Since sand gravel/stone mulching is very labour intensive (around 6,000 RMB/ha), it only applied to high-value crops such as watermelon (Li et al., 2013).

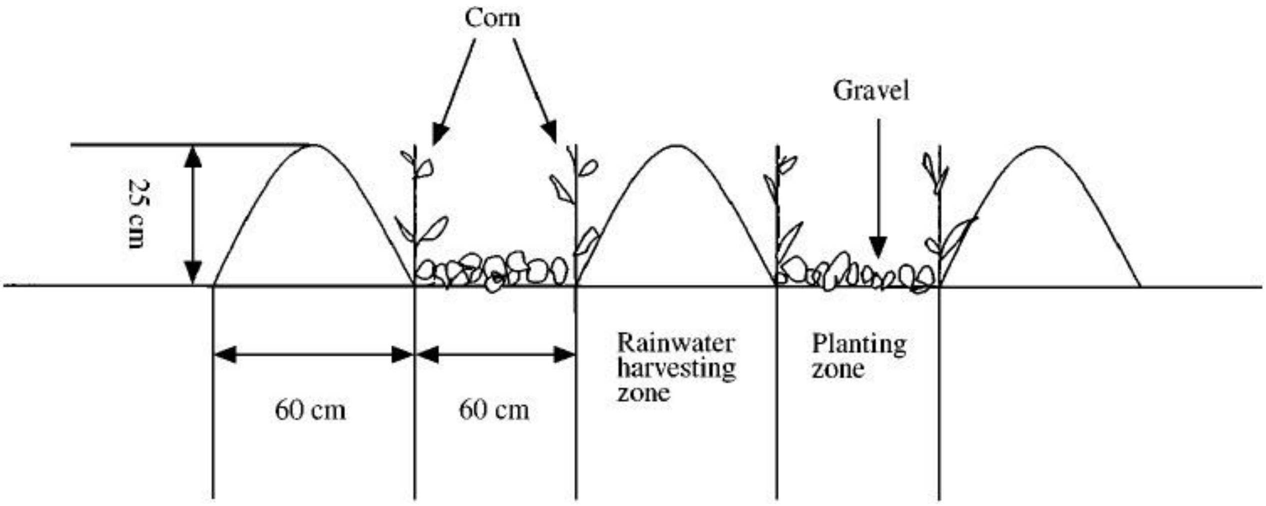

Figure 4. Schematic diagram of in-situ rainwater harvesting combined with gravel mulch system (© Li et al., 2000)

Figure 5. Combination of gravel and plastic mulching in Ningxia (© Yang et al., 2015)

GOOD PRACTICE ANALYSIS*

Knowledge building

How has the project built upon or applied the findings of specific research projects? How has the project actively contributed to international understanding on Ecosystem-based Adaptation?

The technologies described in this case study are specific examples and practices within the overall land rehabilitation and poverty reduction policy of the government of the People's Republic of China. At the beginning, though some of the technologies were indigenous (e.g. sand-gravel mulching), many of the technologies were initially derived from the experience of other countries where these technologies performed well (Bennett, 2008).

Through the 1,000 villages poverty alleviation program, the government helped in not only construction and provision of the different technologies such as the provision of greenhouse farming equipment, but also included labour skills training to foster adoption of new farming technologies and train farmers to seek employment in urban areas.

Hundreds of studies have also been undertaken on the issues of climate change adaptation, including the technologies described in this case study. Nonetheless, so far there is no formal channel for transferring the knowledge generated from these studies to the farmers who use the knowledge. Educated farmers, however, are still using the internet and other sources to obtain information for their newly adopted technologies. Moreover, because of the economic returns, there is very active farmer-to-farmer information sharing and dynamic feedback environment.

Transfer of knowledge within farming communities was also supported and orchestrated by the Ningxia government, an effort which required coordination of various social sectors and economic systems, improvement of the social security system and involvement of different stakeholder and a scientific decision-making.

Community participation and inclusiveness

Has the project consulted with local communities in the formulation, implementation and decision-making process? How were gender issues incorporated? Explain how the project mobilized local interest and ownership in order to ensure its activities responded to the needs of local beneficiaries.

Not only experiences from foreign countries have been obtained, local experience and indigenous knowledge on the different practices were also taken into consideration. The technologies described in this case study were part of national and provincial policies of environmental rehabilitation and poverty reduction in Ningxia. Some of the policies, including the restriction of grazing, inter-basin water sharing, land rights transfer, grain for green policies, resettlement programs, have all been implemented with direct involvement of the local people.
Participation in many of these programs (e.g. resettlement) was also on a voluntary basis. Also, the implementation of these technologies was undertaken through local dialogue and engagement.

* This analysis is based on the "principles of good practice" developed by the EU/FP7-funded project AfriCAN Climate (2011-2014). These principles represent critical cross cutting issues shared by the majority of climate change projects, regardless of focus, scope and scale. They are intended to encourage critical reflection and help project developers and decision-makers draw out relevant lessons. Source: http://africanclimate.net/en/good-practice/8-principles-good-practice

Apart from these approaches, the Ningxia government strengthens the development of farmers' associations in different districts to enhance market access, technology extension and risk mitigation. Village Mutual Financial Cooperative, as a new type of financial initiative, has also enhanced the adoption of the different technologies.

The government also provides credit services for enabling the poorest part of the communities to participate in the activities. So far, Ningxia has established a rural credit and lending system with Agriculture Development Bank, Agricultural Bank, Rural Credit Cooperatives, and Postal Savings Bank as its main channels. The rural small-amount credit loans have become the primary source of credit funds for farmers to boost production. In 2008, Ningxia Rural Credit Cooperatives issued 430,000 "green loan notes", accounting for 46% of the total number issued to farmers in Ningxia. Farmers can use the note to draw money for emergencies, and deal with matters of great urgency in their daily life. The "green loan notes" are used by the method of "examination for once, control of balance, granting the loan on demand, set a record for each loan, no limitation on the number of issuances, and revolving use", to meet farmers' demand for loans.
With the loan note, farmers can apply for loans once in need, and the highest amount of the loans can be as high as 5,000 RMB (Min et al., 2008).

Political ownership, collaboration and approval

How has the project secured support from political-level stakeholders and aligned its activities with wider development agendas to trigger further collaboration opportunities?

In response to increased drought and other negative consequences of climate change, the Chinese government has implemented a number of adaptation planning and mitigation actions and policies since the 1980s. These policies described below, assured the direct participation of local people, the government and other external partners. The most important policies included the following:
1. Grazing restriction: Appreciating the effect of sheep grazing in causing grassland degradation and thereby exacerbating the effect of climate change, in 2003 a grassland grazing prohibition was implemented throughout Ningxia region (Yang et al., 2015). All sheep were kept in captivity through governmental subsides. Artificial alfalfa grasslands were also developed to support pastoralists who were prohibited from grazing.
2. Grain for Green Program (GGP): The government also put the policy of grain for green in order to return farmlands (that were originally grasslands) back into grasslands (Yang et al., 2015). This policy was meant to increase pasture availability for the sheep that were restricted from grazing. The grain for green scheme resulted in reduced amount of land for farming, thereby encouraging farmers to adopt the greenhouse crop production (Sjögersten et al., 2013).
3. The National Forest Conservation Program (NFCP): The government also supported the efforts to introduce climate change adaptation technologies though forestation, artificial fencing and grassland self-rehabilitation. The program aimed to afforest 31 million hectares by 2010 (Sjögersten et al., 2013).
4. The Land Transfer Policy: The Ningxia government has implemented the land transfer policy issued by the central government in 2004. Land transfer refers to the transfer of land-use rights, such that farmers can voluntarily transfer the use right of the arable lands they operate to other farmers or economic organizations. This policy was implemented in order to create suitable conditions for the implementation of the described technologies. Under the traditional system, land ownership of households is very small (approximately 0.17 hectare). Moreover, the land belongings to families were found to be scattered at different places, because the land was allocated to cover different levels of fertility, productivity etc., for every household. This, however, created a problem in the implementation of water saving and other technologies, as the lands were too fragmented to implement any working technology. For this reason, the land transfer policy was issued, implemented and supported the adoption of the different water saving and conserving technologies.

5. Inter-Basin Water Transfer: The government also implemented an inter-basin water transfer from the Yangtze River in anticipation that the project will greatly increase the region's adaptive capacity and resolve the water shortage problem (Yang et al., 2015). This has enabled the acquisition of enough water for implementing the technologies such as the greenhouse farming that require a considerable amount of water.
6. Financial subsidies: All levels of government strongly promote various dry-farming and water-saving agricultural technologies through financial subsidies in Middle and South Ningxia. The financial subsidies enabled poor households, who would otherwise be unable to adopt the technologies.

Financial sustainability

How has the project secured financing for sustaining and/or expanding its impacts beyond the initial project lifetime? Explain how the project secured national (e.g. government) and international (e.g. international donors) support for sustaining its impacts.

While practicing these adaptation measures, farmers also participate in non-farm economic activities in order to support their income. 50% respondents studied by Li et al. (2013) indicated that they practice off-farm income generating activities. Off-farm employment has been an important risk aversion strategy, lest the different adopted technologies fail to work. Moreover, the Ningxia government provides subsidies for plastic mulches, gravel mulches, greenhouse agriculture and others. Such subsidies and off-farm employment opportunities provided basis for sustaining the adopted technologies.

The overall increased income of farmers following these technologies, assures the future sustainability of these. For instance according to a study by Sjögersten et al. (2013), farmers said they were 'much better off than 10 years ago'. Income levels averaged around 3,000 RMB per head of population. Even with such increased income and availability of government subsidies, farmers' adoption of these technologies will depend on funding and expertise available to support change in practice (Sjögersten et al., 2013).

Building local capacities

How has the project ensured that local capacity was built during implementation phase? Explain how training programmes were integrated into core project activities and the measures taken to assure that built human capacity is maintained beyond the project's lifetime.

In order to improve the awareness of climate change and its negative impacts among government officials at all levels, and decision makers in enterprises and public institutions, and gradually foster a contingent of cadres who have better understanding of global climate change, different awareness-raising programs were undertaken by the government (Min et al., 2008).

Prior to the introduction and implementation of the different technologies, the Ningxia government undertook training of local technicians, farmers, farmers' agents, processing enterprises of agricultural products, members of rural specialized cooperatives, and village cadres. This personnel was trained in the technical and management skills to apply the selected techniques at demonstration sites, in the ultimate objective of disseminating these technologies to larger scale increasing the income of farmers and processing enterprises of agricultural products (Min et al., 2008).

Monitoring and Evaluation

How has the project demonstrated its impacts in terms of achieving objectives, outcomes, and outputs? Explain how M&E plans were developed, and how effectively they have been applied.

The Ningxia government actively encourages the participation of researchers from different local research institutes to continuously undertake studies that evaluate the impact of the different technologies, with the goal of identifying potentials for scaling up and limitations for corrections. The research institutes include: Ningxia University, Academy of Agriculture and Forestry Sciences, Academy of Social Sciences, Meteorological Research Institute, etc. The findings from the different evaluative studies undertaken by researchers help as formal tools for evaluating the impact of technologies.

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ECOSYSTEM-BASED ADAPTATION THROUGH SOUTH-SOUTH COOPERATION

GOOD PRACTICE CASE STUDY

Farmers' Seed System Enhancement and Traditional Knowledge Revitalization for Climate Change Adaptation of Mountainous Farming Communities in Southwest China

Compiled by: Li Guanqi, Tian Milin, Liang Haimei, Song Xin, Zhang Yanyan, Farmers' Seed Network (China) and Yiching Song, Centre for Chinese Agricultural Policy, Chinese Academy of Sciences

Edited by: C4 EcoSolutions (Pierre Bégat), EbA South Project Management Unit (Tatirose Vijitpan)

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The Stone Village © Song Yiching

The sustainability of agriculture in the Stone Village depends heavily on its irrigation system and diversified landraces, which play important roles in the livelihoods and spirituality of the villagers. In recent years, traditional farming in the Stone Village has been facing many challenges due to the rapid economic development process and the negative impacts of climate change. In particular, the native crops and traditional seeds planted and saved by local farmers were losing and traditional farming knowledge is also diminishing at an alarming speed.

To respond to the challenges of rapid economic development and climate change, and to raise local farmers' awareness on environmental and climate vulnerability, this project targeted two thematic areas:

- in-situ conservation, management and sustainable utilization of landraces
- collaborative and participatory platform for farmers and external agencies

Project outcomes

- establishment of in-situ conservation mechanism for enhancing local seed system, including participatory plant breeding (PPB) trials and establishment of community seed bank (CSB) led by farmers
- formation of participatory learning groups, including farmers, supported by researchers from the Centre for Chinese Agricultural Policy (CCAP) and Guangxi Maize Research Institute (GMRI) and facilitators from Farmers' Seed Network (FSN)

This case study highlights the traditional agricultural heritage, as practiced at the Stone Village that could help to protect and revitalize traditional food crops, seeds and resilient farming and food systems. All of these would contribute to enhancing the global understanding on Ecosystem-based Adaptation (EbA) that emphasises local wisdom and knowledge systems.

Key lessons

- The farming system in Stone Village shows how indigenous people manage and make use of natural resources in a sustainable way and their knowledge system reflected in their livelihoods and spirituality.
- A holistic approach, including plant breeding, community development and indigenous culture conservation, can enhance natural resources management and traditional culture enhancement for climate change adaptation.
- Traditional knowledge management practices can be strengthened by joint efforts from public and private external parties that support and facilitate the community-led preservation of local management systems.
- In order to promote a community-based agrobiodiversity management and sustainable use which utilise both traditional knowledge and modern science, a supportive seed policy is needed to provide incentives and recognition for both farmers and scientists at local and national levels in order to protect smallholder farmers' interests on in-field conservation of seeds and promote agro-ecological farming practices and related diversified food systems.

GOOD PRACTICE DESCRIPTION

LOCATION: Stone Village in Lijiang City, Yunnan Province, China

IMPLEMENTATION PERIOD: January 2015 - December 2016

OPERATIONAL BUDGET: US$ 20,000

KEY STAKEHOLDERS: community leaders, women groups, public plant breeders, researchers, and NGOs

Background information and climate change vulnerabilities

The Stone Village, located in the Jinsha River Valley, has an agro-mountain culture of rich biological, cultural, and linguistic diversity. It has over 1,300 years of mountain farming history and the Naxi people manage the landscape using a traditional system of crop diversification and water management practices that are adapted to the surrounding natural conditions. The sustainability of agriculture in Stone Village depends heavily on its irrigation system and diversified landraces, which play vital roles in the community members' livelihoods and spirituality.

In recent years, traditional farming in the Stone Village has been facing challenges from climate change, resulting in negative impacts on livelihoods and traditional culture of community members. An increased incidence of droughts, delayed rainy season, and pests has been observed by farmers. Compared to 20 years ago, the rainy season is now delayed from April to June and ends in October instead of September – an overall reduction of a month. Nowadays, the peak rainy season months are June, July and August. In the last 10 years, drought had occurred almost every year and lasted for 1 to 2 months, usually in May and June. The unstable rainfall pattern and drought resulted in putting off sowing seeds. Moreover, these extreme climate events brought about multiple effects of high temperature and pest outbreak, causing farmers to suffer loss from crop failure.

Climate change is imposing further burden on farming communities and having a growing impact on daily lives of villagers, who must now deal with unstable water resources and harsher growing conditions, as well as out-migration and shrinking agricultural labour. One of the most important changes is the decline in rainfall. Drought shrivels maize crops, leaving farmers to wait for the July rainfall. Sometimes, farmers experience irregular floods in the same season. In September 2014, continuous rainfall damaged a large area of nearly-matured maize, devastating the harvest.

In addition, traditional crop varieties were losing, and traditional farming knowledge was declining. Based on the baseline survey results, the main causes for the disappearance of traditional crop varieties and indigenous knowledge were the promotion of hybrid seeds, transition to chemical agriculture and the unpredictable micro-climate along Jinsha River, all these factors obviously reduced resilience for community when facing the challenge of climate change.

To combat the challenges of rapid economic development and climate change, and to raise local farmers' awareness on environmental and climate variability, this project aimed to achieve the following objectives in a multi-stakeholder participatory approach:

- Conservation and sustainable use of diversified crop landraces
- Farmers' participatory learning and collective capacity building

Intervention technologies

- Participatory Plant Breeding (PPB): PPB is a set of tools to strengthen agrobiodiversity as well as enhance collaboration between scientists and farmers. PPB was applied in the Stone Village to involve farmers to conduct trials on maize, legume, peanut and vegetables, on the basis of yield, taste, use and key agronomic indicators, to identify and select crop varieties adaptive to local circumstances and culture. Later on, the samples of tested varieties were brought to store in the community seed bank. Moreover, traditional knowledge was recognized and integrated in the process of PPB.
- Walking Workshops: Walking Workshop is a peer-to-peer action learning tool for farmers. As an alternative approach to the prevailing top-down learning method, it encourages participants to observe and dissect a wild range of topics in the field, where more complex and concrete situations exist. This learning-by-doing approach promotes in-field investigation, to increase the likelihood that farmers will improve their understanding and practices. With the walking workshop methodology, farmers in the Stone Village discussed possible tools and solutions for seeds management, traditional knowledge and practices. Traditional ritual was also restored and documented during a workshop.
- Farmers School: The Stone Village has developed routine training and learning system within the community, to invite experts to share different topics including video documentation, integrated pest management and post-harvest management.
- Market Linkage: The ecological agricultural products such as ham, liquor and geranium aroma were carefully designed and packaged by external contractors, to build market linkage with the urban consumers. Farmers in the Stone Village were encouraged to get involved in conservation of the landraces and agroecology.

Figure 1: Community seed bank in the Stone Village © Tian Milin

Description of the results

Through the project implementation, a community-based workgroup, consisting of farmers and researchers, has been formed. Main achievements have been made in community seed system enhancement and traditional knowledge documentary. Specific outputs are as below:

- A community seed bank was established in the Stone Village, with 113 local varieties collected. A women group is in charge of renewing and making use of these seeds. As part of the PPB, the farmers' group in the Stone Village conducted different in-field trials on seeds improvement and Zhang Xiuyun, Li Ruizhen and other women farmers made use of maize germplasm from Peru [1]and GMRI to improve and develop new hybrid varieties. Mu Yichang, He shanhao and He Xiuqin set up seeds fields to grow and select plenty of crops and seeds. The landraces improved, and *in-situ* conserved through PPB and CSB can assist the farmers to be well adaptive to the extreme climate events such as drought. Moreover, farmers are in favour of the water-saving crop varieties as well.
- The participatory documentation on irrigation system was conducted, and the main findings were displayed to villagers in the Workshop and Farmers School to raise their awareness on how to collectively preserve and use the irrigation system continuously.

Figure 2: Woman farmer breeder, Ms. Zhang Xiuyun, in the Stone Village © He Baopu

[1] Potato Park in Peru is partner community of Stone Village. Facilitated by the International Network of Mountain Indigenous People (INMIP), farmers from the Stone Village were supported to exchange seeds and traditional knowledge with members of the Potato Park.

GOOD PRACTICE ANALYSIS†

Knowledge building

How has the project built upon or applied the findings of specific research projects? How has the project actively contributed to international understanding on Ecosystem-based Adaptation?

The Stone Village is a living laboratory for exploring and exchanging knowledge and experiences. The project provided platform for local farmers from the Stone Village and researchers from GMRI and other institutes to work together in applying both knowledge and technologies in modern plant breeding science in combination with the experiences and knowledge of community members. Walking workshop and farmers school approaches were used during the project to promote interactive learning and exchange of knowledge between mountainous areas in China and Peru. As a result, key members' awareness on conservation and sustainable use of traditional seeds had been raised. Therefore, they continued to keep and exchange seeds within community through seed bank in which the number of varieties increased from 108 to 113. In order to keep the seed bank's seeds active, the women management group has established "seed fields" in a few identified households to grow the seeds from the bank.
Seeds, therefore, have been moving between the bank and the field and exchanged among farmers and communities. The PPB trials also extended from staple food to herbs and vegetables. All activities mentioned above are still well in operation even after the project closed, because they effectively help the farmers to reduce operating costs by using community resources and social capital. In May 2017, indigenous people from the Potato Park in Peru were invited to attend a workshop and go on a field visit to analyse the similarity and differences between the two communities, and how traditional farming heritage can help to protect and revitalize traditional food, agriculture, seeds and water systems to enhance the global understanding on Ecosystem-based Adaptation.

Community participation and inclusiveness

Has the project consulted with local communities in the formulation, implementation and decision-making process? How were gender issues incorporated? Explain how the project mobilized local interest and ownership in order to ensure its activities responded to the needs of local beneficiaries.

In terms of inclusiveness, the project involved multiple stakeholders – from both public and private sectors, e.g. researchers and social enterprise – during its implementation. Farmers in the Stone Village joined the project activities through farmers school, walking workshops, and various meetings. Researchers contributed their knowledge and techniques in the process of developing PPB and CSB, while social enterprise supported farmers by supplying their agricultural products to urban consumers as a new approach to preserve and make use of local crop varieties.

In addition, women in the Stone Village play an important role in guarding and utilizing seeds within community. Female farmers actively engaged in the PPB trials and seed bank management. They exchanged seeds and related knowledge and experiences with each other through women groups, farmers school activities or social media. They are also good at creating

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† This analysis is based on the "principles of good practice" developed by the EU/FP7-funded project AfriCAN Climate (2011-2014). These principles represent critical cross cutting issues shared by the majority of climate change projects, regardless of focus, scope and scale. They are intended to encourage critical reflection and help project developers and decision-makers draw out relevant lessons. Source: http://africanclimate.net/en/good-practice/8-principles-good-practice

innovative healthy and nutritious recipes using local crops and traditional food culture. Gender inclusion is critical to the preservation of traditional knowledge systems, in particular those related to local food system and crop varieties.

Building local capacities

How has the project ensured that local capacity was built during implementation phase? Explain how training programmes were integrated into core project activities and the measures taken to assure that built human capacity is maintained beyond the project's lifetime.

The project provided walking workshop and farmers school training activities for local farmers on plant breeding, seed saving, and participatory documentation of irrigation system in the Stone Village. To ensure that capacity building activities would be in accordance with the needs of farmers, facilitators and experts from CCAP and GMRI designed those training courses based on a baseline survey and field visits, aiming at planning and monitoring projects on climate change adaptation by focusing on agroecology promotion, seed saving and pest management. These community-based practices and intervention technologies can be applicable to other mountainous areas with similar bio-cultural landscapes in developing countries.

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ECOSYSTEM-BASED ADAPTATION THROUGH SOUTH-SOUTH COOPERATION

GOOD PRACTICE CASE STUDY

Paddy Land-to-Dry Land programme in the Miyun Reservoir Watershed of China's capital region

Compiled by: Chao Fu for EbA South

Edited by: C4 EcoSolutions (Pierre Bégat), EbA South Project Management Unit (Tatirose Vijitpan, Diwen Tan)

25 December 2017

Since 2006, Paddy Land-to-Dry Land (PLDL) programme has been implemented in the Miyun Reservoir Watershed to relieve Beijing's water crisis as inflows into the reservoir have decreased significantly due to both agricultural development and reduced precipitation. In the programme, local governments and communities in the upstream of Miyun Reservoir made efforts to convert the flood-irrigated rice paddies to dryland cultivation, with financial compensations by the Beijing government. So far, all 6,867 ha of rice paddies have been converted to dryland cultivation in the programme. It generated benefits of improved water quantity and quality that exceeded the costs of reduced agricultural output plus transaction cost, while both downstream beneficiaries and upstream providers gained from the programme. The PLDL programme has been successful in achieving environmental goals, as well as enhancing household livelihoods in the long run, thus contributing to improve the resilience of local communities in a changing climate.

Project outcomes

- All 6,867 ha of rice paddies converted to dryland cultivation in the upstream of Miyun Reservoir;
- Decreased irrigation water by 51.5-66.4 million m^3 per year;
- Reduced total nitrogen and total phosphorus export by 10.36 and 4.34 tons per year, respectively;
- Participants' total income increased relative to nonparticipants, although the agricultural income decreased;
- Participants' labour required for agricultural production and fuelwood use decreased, while spending on education and material assets increased relative to nonparticipants.

Key lessons

- The PLDL programme has been implemented within the strategic framework of regional collaboration to achieve shared and sustainable goals between the upstream and downstream stakeholders.
- The programme is built on the Payments for Ecosystem Services (PES) principle. The payments made by the Beijing government annually are critical to provide incentives for upstream communities to provide ecosystem services valuable to the downstream, abate competition between the upstream and downstream for water resources, and lead to long- term shifts in livelihood activities that depend less on fragile ecosystems.
- Implementing PES programmes requires sensitive considerations, taking into account household livelihood dynamics and behavioural responses to incentives provided to ensure a fair compensation.

GOOD PRACTICE DESCRIPTION

LOCATION: Chengde and Zhangjiakou, two municipalities in China's Hebei Province with land area in the upstream watershed of Miyun Reservoir

IMPLEMENTATION PERIOD: 2006-2020

OPERATIONAL BUDGET: CNY 6,750 per ha per year during 2006-2007; CNY 8,250 per ha per year during 2008-2015; and CNY 10,500 per ha per year during 2016-2020, plus the transaction and programmatic costs about CNY 1,053 per ha per year

KEY STAKEHOLDERS: The governments of Beijing Municipality and Chengde and Zhangjiakou municipalities of Hebei Province

Background information and climate change vulnerabilities

The Miyun Reservoir is located in the northeast of Beijing, China. It is one of the major surface water sources of domestic water in the nation's capital city, covering a surface area of 188 km^2 with a storage capacity of 4,317 million m^3. The reservoir controls an upstream watershed with a drainage area of 15,800 km^2, of which only one quarter is located in Beijing and the remaining three-quarter in the neighbouring Hebei Province. The watershed has a semiarid, continental monsoon climate with annual mean temperature of 9–10 °C and annual mean precipitation of 489 mm, while summer precipitation from June to September accounts for more than 80% of the annual precipitation. The elevation ranges from 150 to 2,400 m and the topography is characterized by mountains with steep slopes and deep valleys. About 880 thousand people live in the watershed, of which more than 90% are engaged in agricultural work.

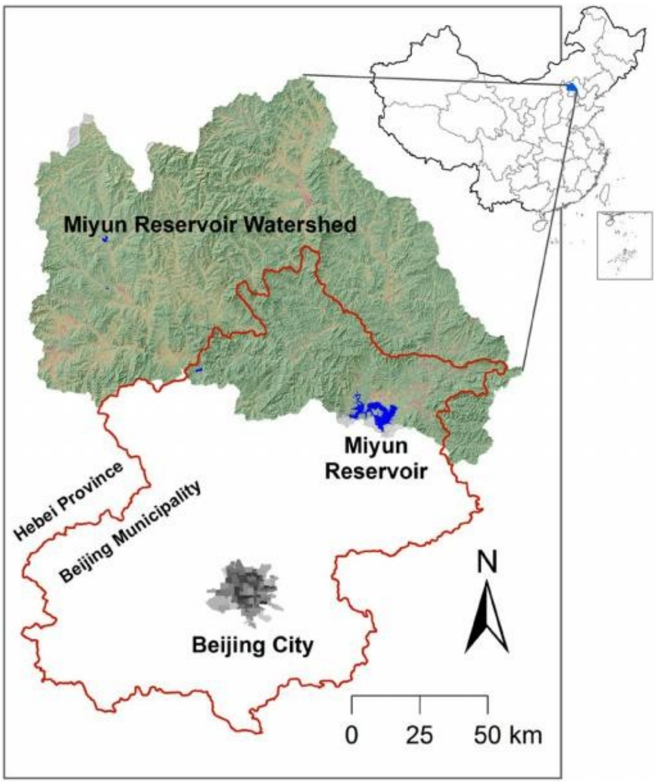

Figure 1: Miyun Reservoir Watershed (© Zheng et al., 2013)

From 1960s to 2000s, inflows into the reservoir have decreased by about 70% (~160 million m^3 per decade) due to upstream water withdrawals for agriculture and reduced precipitation due to a warmer and drier climate. At the same time, total nutrient concentration has increased by 3-4 times in the reservoir due to agricultural non-point-source pollutants. It is always a great concern for the government of Beijing Municipality to prevent the Miyun Reservoir from the decline in water quantity and quality, in order to meet Beijing's demand for water of a growing population.

Intervention technologies

In 2006, Beijing and Hebei Provinces jointly initiated the Paddy Land-to-Dry Land (PLDL) programme that aimed to increase water yield and reduce nutrient loads in the Miyun Reservoir. According to the agreements signed between Beijing Water Authority and Chengde and Zhangjiakou Municipalities, local governments and communities in the upstream of Miyun Reservoir made efforts to convert the flood-irrigated paddies for rice cultivation to dryland cultivation. Instead of growing rice, farmers were encouraged to grow dryland crops especially corn. Considering the loss in household income from converting productive rice paddies to less lucrative cornfields, the Beijing government paid an average of CNY 450 per mu[1] (CNY 6,750 per ha) per year for the converted land. The payments were increased to CNY 550 per mu (CNY 8,250 per ha) per year in 2008 and to CNY 700 per mu (CNY 10,500 per ha) in 2016.

Figure 2: Flooded rice paddies on steep slopes often contribute to decreased water quality and quantity. (© Brian Robinson / McGill University)

[1] 1 ha = 15 mu

Description of the results

Since the spring of 2007, all 103,000 mu (~6,867 ha) of rice paddies have been converted to dryland cultivation in the upstream of Miyun Reservoir. The vast majority switched to growing corn, while others turned to growing wheat, millet or potato. In total, 155 villages within 25 rural townships of Zhangjiakou and Chengde participated in the PLDL programme. It was estimated that the programme decreased irrigation water by 51.5 - 66.4 million m^3 per year. From a water balance perspective, the programme increased water yield by 18.2 million m^3 per year, which was calculated as the difference in evapotranspiration between paddy fields and cornfields. The programme reduced total nitrogen (TN) and total phosphorus (TP) export by 10.36 and 4.34 tons per year, respectively, which was calculated by using the average ratios of TN and TP loss with runoff and household data in 2011 on the amount of fertilizer use for each crop. The value of increased water yield and improved water quality was estimated to be about 1.5 times of the opportunity costs (i.e. costs of reduced agricultural output) of the upstream farmers plus transaction costs. Generally, the programme is regarded as successful in improving water quantity and quality in the Miyun Reservoir.

GOOD PRACTICE ANALYSIS†

Political ownership, collaboration and approval

How has the project secured support from political-level stakeholders and aligned its activities with wider development agendas to trigger further collaboration opportunities?

Since 2001, Beijing Municipality and Hebei Province have jointly initiated a series of regional collaborative activities. Through those activities, the Beijing government provides fiscal transfer payments, policy and technical support for socioeconomic development in underdeveloped areas of Hebei. The PLDL programme shows the political resolve of both sides to achieve shared and sustainable goals, that is, to protect critical water sources while sustain local livelihoods. It has been included as part of regional collaboration agreements between Beijing and Hebei to integrate conservation into their collaborative efforts for regional development. In 2006, Beijing and Hebei signed a memorandum of understanding to enhance their collaboration in economic and social development, clearly putting forward that Beijing would provide financial support for the PLDL programme and afforestation for water source conservation in the Miyun Reservoir Watershed. The commitments were reaffirmed in the subsequent intergovernmental conservations, especially under the framework agreement on Beijing-Hebei collaboration signed in 2010 and then renewed for the period of 2013-2015. It’s worth noting that, at the end of 2015, the Chinese government released a national plan for the coordinated development in the Beijing- Tianjin-Hebei region. Oriented by this development plan, the PLDL programme has been highlighted as one of the key programmes during 2016-2020 for ecological conservation and restoration in Chengde and Zhangjiakou municipalities.

Financial sustainability

How has the project secured financing for sustaining and/or expanding its impacts beyond the initial project lifetime? Explain how the project secured national (e.g. government) and international (e.g. international donors) support for sustaining its impacts.

The PLDL programme has been built on payments for ecosystem services (PES). The PES approach establishes a financial relationship between the providers of ecosystem services in the upstream and their beneficiaries in the downstream. It offers incentives for upstream communities to provide ecosystem services valuable to the downstream and abates competition between the upstream and downstream for water resources. More importantly, it is potential to increase household’s cash income and lead to long-term shifts in livelihood activities that depend less on fragile ecosystems. As mentioned above, payments have been made by the Beijing government annually during 2006-2015 within the strategic framework of Beijing-Hebei collaboration. Since 2016, payments by Beijing have been increased not only to support the PLDL programme, but also to launch programmes for the development of green and ecological corridors and clean-type small watersheds in the upstream of Miyun Reservoir. These programmes are complementary to each other in terms of sustaining their impacts on conservation and development in the watershed.

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† This analysis is based on the “principles of good practice” developed by the EU/FP7-funded project AfriCAN Climate (2011-2014). These principles represent critical cross cutting issues shared by the majority of climate change projects, regardless of focus, scope and scale. They are intended to encourage critical reflection and help project developers and decision-makers draw out relevant lessons. Source: http://africanclimate.net/en/good-practice/8-principles-good-practice

Achieving co-benefits and balancing trade-offs

How were the costs and benefits external to the project taken into consideration, e.g. on employment, environment, health, poverty levels, food security etc? Explain how the project aimed to maximizing external co-benefits from project activities and avoid/minimizing external costs and damages.

The PLDL programme has achieved beyond environmental goals. It has created significant impact on livelihoods, through changes in livelihood portfolios and changes in household production and consumption activities. Household survey data from 2011 shows that, between 2006 and 2010, the PLDL participants' agricultural income decreased relative to nonparticipants, but remittance income increased. Those participants also decreased their labour for agricultural production and fuelwood use while increased spending on education, coal, liquefied petroleum gas, and material assets like televisions, motorcycles and cars relative to nonparticipants. These changes in the structure of household income and labour can help improve overall household living conditions. Interestingly, the survey data indicated that participants did increase rates of fertilizer application significantly, especially phosphorus, compared with nonparticipants. It may offset some of the desired effects of the PLDL programme. However, reductions in nutrient export to surface water prevail; therefore, the programme still has a positive net impact on water quality. In recent years, the local governments of Zhangjiakou and Chengde have initiated a combination of policy measures and demonstration projects for the promotion of green organic farming and high efficient water use in agriculture, which may improve the livelihoods aspect of PLDL programme in the long run.

Monitoring and Evaluation

How has the project demonstrated its impacts in terms of achieving objectives, outcomes, and outputs? Explain how M&E plans were developed, and how effectively they have been applied.

The PLDL programme is led by the local governments to distribute payments to participating households based on bottom-up reporting on the converted land area. Since its inception, water resource managers and the public are interested to understand the full impacts of the programme. In 2010, the Beijing government issued a benefit evaluation report of PLDL programme to review the implementation of the programme and evaluate its economic benefits. In recent years, several studies have been conducted to evaluate the programme's environmental benefits and costs, impacts on household livelihoods, as well as farmers' willingness to support and participate in the programme. Recommendations have been made in these studies for fair compensation and enhanced regional cooperation.

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Strengthening Community and Ecosystem Resilience against Climate Change Impacts: Developing a Framework for Ecosystem-based Adaptation in Lao PDR and Viet Nam

The rich natural capital endowment and ecosystem services in the Greater Mekong Sub-region (GMS) have continued to play a crucial role in supporting economic growth. Recognition of the role of ecosystem services and sustainable management of the natural resources play a key role in addressing emerging development and climate change adaptation challenges. Therefore, Eb A has great potential to be an important part of the adaptation strategy for the GMS. However, capacity and knowledge on how to select and implement EbA measures remain poorly developed; especially in terms of guidance on how EbA fits with regional, national and sub-national climate change and development strategies.

To respond to this gap, the World Bank, in partnership with the World Wildlife Fund (WWF), and in the context of the broader World Bank Netherland Partnership Program (BNPP), supported the development of a genericoperational framework for considering and assessing EbA responses. This framework was piloted in two countries (Lao PDR and Vietnam), and produced several valuable pieces of work that are aimed at supporting the development of EbA responses and mainstreaming of EbA in policy and planning.

The development of the generic framework and associated products comes at an opportune time when international policy negotiators and national decision makers are taking steps to integrate and mainstream EbA in their policy and on-the-ground work. Interest in EbA is rapidly increasing and the approach is now considered an important aspect of "climate-smart" development.

Key Lessons

- Population growth and unsustainable land-use for development activities have served to degrade the ecosystems. For example, the construction of sluice dams to prevent salinity intrusion has interfered with ecological flow affecting estuaries and related livelihoods.
- EbA or any adaptation measures should be coupled with strategies to address "adaptation deficits" by tackling current non-climate related problems that exacerbate vulnerability.
- EbA measures can play a significant role in ensuring sustainability of coastal habitats.
- The EbA operational framework should be integrated into climate change action plans.
- The EbA framework needs to be institutionalized as an official guideline.

Related Document:

Strengthening Community and Ecosystem Resilience against Climate Change Impacts: Developing a Framework for Ecosystem- based Adaptation in Lao PDR and Vietnam

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Green Coast: community-based coastal restoration in Indonesia, Sri Lanka, Thailand, India and Malaysia

Coastal areas around the world are vulnerable to climate change impacts. Green Coast is a community-based coastal ecosystem restoration programme implemented in Indonesia, Sri Lanka, Thailand, India and Malaysia. It was developed in response to the December 2004 Indian Ocean tsunami. Since the first phase of the programme (2005-2007), the Green Coast model has been regarded as a well-tested approach in relation to climate change adaptation.

Main activities included:

1. Coastal ecosystem rehabilitation;
2. Building sustainable livelihoods;
3. Develop village regulations to support environmental conservation efforts;
4. Environmental education compaigns.

In Indonesia, the programme continued with a second phase (2007-2008). In the areas of Aceh and Nias it successfully rehabilitated 893 ha of coastal land through the planting of mangroves (1.6 million seedlings) and beach plants (250,000 seedlings) along with the conservation of coral reefs.

Green Coast, funded by Oxfam Novib (Netherlands), has been developed by Wetlands International, in partnership with WWF, IUCN, and Both ENDS.

Key lessons

- Restoring coastal ecosystems helps to protect communities and livelihoods from the impacts of climate change, including storms, flooding, erosion and associated problems.
- Mangroves dissipate the energy and reduce the s ize of wave heights 5 - 7.5 times more than unvegetated beach surfaces (Quartel et al., 2007) and therefore can be used to increase the resilience of coastal areas.
- If local inhabitants are directly involved in plantation and nursing activities, they can actively participate in the restoration of their environment and alternative livelihoods can be built.

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Authors:

Hina Aslam hina.aslam@ unep- iemp.org

Contact
info@unep-iemp.org
UN Environment-International Ecosystem Management Partnership (UNEP-IEMP)
C/o Institute of Geographic Sciences and Natural Resources Research (IGSNRR),
Chinese Academy of Sciences (CAS)
No.11 A Datun Road, Chaoyang District, Beijing 100101, China

UN environment programme International Ecosystem Management Partnership 国际生态系统管理伙伴计划