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Green Infrastructure for a Climate Resilient Society

Nature-Based Solutions for Erosion Control in Vietnam

PROJECT FULL NAME	COUNTRY & REGION	IMPLEMENTING AGENCY	EXECUTING AGENCIES
Climate Resilient Rural Infrastructure in Northern Mountain Province of Vietnam	Vietnam, East Asia 	Asian Development Bank, United Nations Development Programme	Agriculture Projects Management Board (APMB), Ministry of Agriculture and Rural Development (MARD)

GEF PROJECT ID: **3103**

PROJECT TYPE: **FSP**

GEF PERIOD: **GEF-4**
SPECIAL CLIMATE CHANGE FUND

FOCAL AREA

- Climate Change Adaptation

IMPACT AREAS

- Climate Change Adaptation
- Climate Change Mitigation
- Biodiversity
- Food Security
- Poverty Reduction
- Strengthen Resilience

04/23/2012
CEO Endorsement

05/31/2017
Project Closure

06/30/2009
Project Approval

05/05/2015
Mid-Term Review

GEF Project Grant	Co-financing Total
$3,400,000	**$96,150,000**

Summary

This project aimed to demonstrate and promote the application of bioengineering[1] measures in road and riverbank slope protection and stabilization to build the resilience of local communities to the impacts of climate change and extreme weather events. The project also sought to familiarize local experts with bioengineering techniques and to initiate mainstreaming of climate resilient green infrastructure development in Vietnam through pilot projects and targeted capacity building. Pilot demonstration sites were used to test a range of bioengineering techniques and formed the physical basis of knowledge transfer to relevant line ministry staff through training and site visits. The project illustrated that nature-based solutions can be applied to prevent serious erosion and can increase the resilience of local communities. It also demonstrated successful bioengineering solutions at four riverbanks and roadside slope sites, and prepared landslide and flash flood risk maps for Son La and Bac Kan provinces. To promote sustainability and replication across the region, the project built the capacity of technical personnel to employ bioengineering techniques and developed knowledge products, risk assessments, and guidance documents. With funding from the Special Climate Change Fund of the Global Environment Facility (GEF), the project was implemented jointly by the Asian Development Bank (ADB) and the United Nations Development Programme (UNDP), and executed by the Agriculture Projects Management Board, Ministry of Agriculture and Rural Development, Vietnam, with technical backing of the International Centre for Environmental Management (ICEM).

1 Bioengineering is the use of vegetation to serve an engineering function, forming a practical subset of green infrastructure. In many parts of the world, the use of plants to control slope erosion is a well-developed, low-cost technique. Plants have been used to stabilise slopes for centuries, but the expansion of civil engineering in the 20th century involved a reliance on man-made materials with precisely predictable properties, and the use of vegetation was neglected. The modern practice of bioengineering has emerged over the last 40 years in response to the high costs and sometimes low performance of the conventional approaches used by civil engineers for slope stabilization and erosion control.

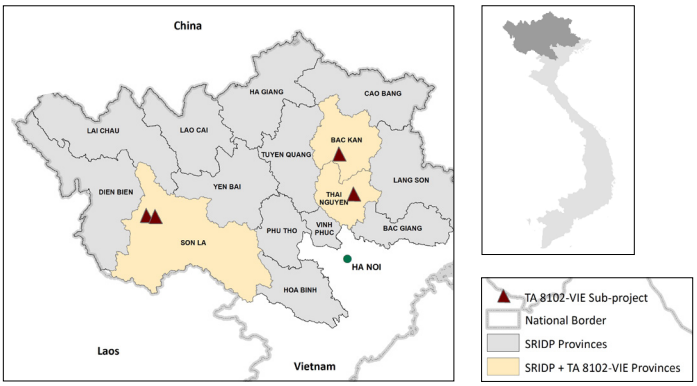
Results, Global Environmental Benefits and Adaptation Benefits

The project has achieved the following global environmental benefits as well as direct adaptation benefits for local communities:

- Resilience of local landscapes and communities was strengthened, and socioeconomic benefits were provided to local people through bioengineering methodologies.
- Four riverbank and roadside bioengineering demonstration sites were completed. After several years, the pilot sites proved that the slope and embankment protection has increased the resilience of local communities to natural events such as extreme flooding.
- Overall construction cost of riverbank and roadside protection were reduced due to the cost effectiveness of bioengineering techniques, which were 10-23% of conventional techniques.
- Bioengineering methodologies created local employment and provided other local benefits such as fodder, building materials, and medicinal plants.
- Aquatic and terrestrial habitats were established for plants and animals. Such habitats had been lost in nearby areas treated by conventional engineering.
- The capacity and technical skills of 179 Vietnamese government personnel, drawn from the national, provincial, district, and commune levels, were improved along with university staff and students and local communities, as well as visiting delegations from Lao PDR and Timor Leste.
- Technical guidelines were developed, providing detailed technical designs and construction methods for selected bioengineering and associated engineering options.
- More than 20 knowledge products were completed and put into use by local and national governments and universities, including videos and a website covering: (i) climate change vulnerability assessment; (ii) design, construction, and monitoring of the demonstrations and their effectiveness; (iii) workshops and training materials; and (iv) technical recommendations on design and use of bioengineering for rural infrastructure in Northern Vietnam.

Environmental Challenge

Vietnam is one of the most hazard-prone countries in the East Asia and Pacific region. The country's 3,260-km coastline is regularly exposed to typhoons, floods, drought, coastal erosion, and landslides, which pose significant threat to roads, embankments, and water supply infrastructure. Vietnam has extremely high exposure to flooding, ranked 1st with Bangladesh, including, riverine, flash, and coastal flooding. Vietnam also has high exposure to tropical cyclones and their associated hazards.[2] Floods represent the largest risk by economic impact in Vietnam, accounting for an estimated 97% of average annual economic losses from natural hazards.[2] All 15 Northern provinces in Vietnam experience



Project location map (ADB 2017: 6)

a large number of climate-related challenges. They have limited and poor quality infrastructure compared to the rest of Vietnam. Infrastructure loss and damage result in high maintenance and rehabilitation costs, and loss of benefits to local communities when structures remain un-repaired and nonfunctional. With poor and unstable infrastructure, local communities are also exposed to risk of land and property damage and loss. Therefore, increasing the resilience of infrastructure is important to improving the overall resilience of communities.

Integrated Approach and Key Features

Innovative approach with integrated benefits

Bioengineering measures are low-cost options to supplement conventional infrastructure engineering designs and to strengthen the resilience of infrastructure through erosion control, water conservation, enhanced slope stability, and sustainability of water-crossing structures, and reduced maintenance and rehabilitation costs. In many cases, hard or mixed measures are necessary to stabilize and protect a slope or embankment. In these cases, a combination of low-cost conventional measures (gabions) and bioengineering was applied, with nearby sites treated with conventional hard engineering measures (reinforced concrete and hard revetments), allowing for comparative assessment. Two years after project completion, there were no signs of erosion at any of the demonstration sites despite several serious floods and intense rainfall events. The bioengineering measures have kept the slopes stable and safeguarded the riverbanks, road slopes and adjacent land from erosion. Sites subject to serious erosion prior to the project have been improved by the bioengineering work.

Aside from serving primary engineering purposes, bioengineering has also provided social, economic and ecosystem benefits. For example, the bioengineering measures used local cost-effective labor and materials. The approach engaged and empowered local communities for repairs and maintenance, utilized locally applicable techniques, and created ownership and local employment. Also, the demonstrations established aquatic and terrestrial habitats for plants and

2 https://climateknowledgeportal.worldbank.org/country/vietnam/vulnerability

animals. As the project sites were small in scale[3], the amount of greenhouse gas mitigation and other benefits from this project were limited. But application of the same methodologies on a larger scale, such as riverbank protection at watershed level, can have more significant impacts on climate change mitigation and adaptation, biodiversity conservation and food security, for example. The demonstrations at the pilot sites have shown that using plants can also provide productive benefits, such as cardamom, fodder, firewood and others. In addition, the bioengineering approach used in this project was particularly inclusive, with a high proportion of women and a wide range of ethnic minorities included in the labor forces.

Producing knowledge products and capacity building

Bioengineering requires new design standards, skills and techniques, including plant and geotechnical knowledge, and effective engagement with local communities. The project supported knowledge and learning opportunities to share lessons learned from this project broadly with other provinces in Vietnam and other countries in the region and to facilitate scale up and replication. These knowledge and learning opportunities included workshops, technical guidelines, training materials, and a project website, as well as videos in English and Vietnamese. Local, national and regional government officials and other stakeholders are able to use these knowledge products. Consequently, with these learning materials and associated training, the project has helped raise awareness and build skills among government officials in bioengineering approaches to infrastructure resilience.

Knowledge sharing and mainstreaming bioengineering in infrastructure

The project involved relevant national, provincial, and district government officials in training, local consultations, field visits, and workshops. The project also conducted activities to scale up systematic application of bioengineering methods to national and regional level, including: (i) national level workshops and proposed policy and regulatory innovations, (ii) participation in the riverbank (2015) and roadside bioengineering (2016) workshops by delegates from the Lao PDR, (iii) a visit to the two riverbank demonstration by delegates from Timor Leste in September 2015, and (iv) a visit to the riverbank protection demonstration site in Bac Kan Province by UNDP delegates in November 2015. In September 2016, a group of engineering faculty and students from the University of Transport and Communications in Hanoi visited the roadside demonstration site in Thai Nguyen Province.

Local community planting new Vetiver grass in Son La Province (June 2015) @ICEM

Based on the project experiences, ADB has extended its application of bioengineering in infrastructure to other countries in the region, such as Lao PDR and Timor Leste. ADB organized a regional workshop to share the experience of sustainable infrastructure in the Asian region on May 2017 in Hanoi, and introduced lessons learned from this project. To share the lessons learned of this project in the region and beyond, ADB is developing a publication titled "Awareness Raising Material on Bioengineering for Green Infrastructure."

Lessons Learned

Nature-based solutions strengthen resilience of local landscapes and communities

The project demonstrated that nature-based solutions worked well to strengthen the resilience of local landscapes and infrastructure. Lessons learned included: (i) bioengineering should be considered at the earliest stage of project planning; (ii) high-risk locations need to be identified as early as possible using proven vulnerability assessment and slope condition criteria; (iii) specific slope problems need to be identified and assessed using low-cost geotechnical investigation procedures[4]; and (iv) integration of hard and soft measures needs to be considered to solve problems where bioengineering alone is insufficient.

It is also vital to achieve the active engagement of local contractors and communities to provide training in bioengineering methods, in designing the intervention, identifying suitable plant species, sources, replication methods and planting seasons, and to monitor the project for maintenance. Plant selection for the bioengineering project was based on the project's objectives, site analysis, project design, plant species' characteristics, planting material availability, and cost. In order to ensure maintenance during early stages, especially for watering trees and plants, management arrangements with local governments and local communities need to be formally established. Considering social aspects of bioengineering design was also critical for the project's success. The social aspects of the bioengineering design included: (i) identifying communities willing to host the demonstrations; (ii) identifying pilot demonstration sites with tangible community benefits – for example, at SP4 Bac Kan Province, protection of the community access track on the riverbank, agricultural land, and other assets; (iii) reviewing plant options for their engineering properties, potential economic uses and local availability; and (iv) continuing local consultation and capacity building as well as knowledge sharing.

Communities understood and appreciated the benefits of the bioengineering approach because they were closely involved in construction and maintenance. Subsequently, based on their experience in the project, some families have applied bioengineering methods to protect their own land.

3 For example, Sub-Project (SP) 4 was along 106 m of riverbank and approximately 800 m^2 of a slope area located in Thanh Mai Commune, Cho Moi District, Bac Kan Province. SP31 was approximately 102 m of the roadside cut slope and a slope area of around 1,700 m^2 located in Phong Lap Commune, Thuan Chau District, Son La Province. SP32 was along 111 m of riverbank and a slope area of around 1300 m^2 passing through Thom Mon and Chieng Ly Communes Thuan Chau District, Son La Province. SP35 was along 94 m of roadside cut slope and 87 m of fill slope and had a slope area of approximately 3763 m^2 located in Lien Minh Commune, Vo Nhai District, Thai Nguyen Province.

4 Low-cost geotechnical investigation procedures include the Dynamic Cone Penetrometer, which is used to determine the strength of subgrade and base layers. It is used to conduct pavement research and other studies in the US because it is easy to transport and inexpensive to operate.

With bioengineering, local communities do not need to wait for government to fix infrastructure or protect their property. They can take preventative measures and maintain green infrastructure on their own initiative using local materials and labor, although follow-up training and awareness raising with local governments, contractors and communities are necessary. Communities also need to be involved in sharing experiences and management approaches with neighboring communities and with government at district, provincial and national levels.

Need for on-going investment in scaling up and mainstreaming bioengineering in infrastructure

Bioengineering has been well received by the provinces, districts, and communes in Vietnam, particularly with respect to the low-cost and effectiveness of the measures which use local plants and community participation for roadside and embankment stabilization. The project's training and communications materials have had an influence on the tide of opinion within national government, with project products continuing to be used by government in training activities. Strong local government commitment and engagement also helped promote outcomes and advocate uptake with national government. However, bioengineering techniques are yet to be formally included in national design standards and specifications in Vietnam. This will require a sustained and longer commitment to mainstreaming and capacity building than can be covered in a single project.

In Vietnam, there are institutional barriers to the use of low-cost bioengineering solutions, not only in engineering codes but also in the contracting processes that currently provide little incentive for cost savings. Thus, a more extensive network of pilot demonstrations needs to be established, accompanied by development of technical standards and cost norms for bioengineering methods. Equally important in the medium term is modifying the curriculum for training of engineers, so they have the skills and commitment to integrating nature-based solutions into all aspects of their work. The University of Transport and Communications in Hanoi has already made use of the project's outputs in engineering instruction and has expressed interest in further bioengineering research.

Key role of development partners in promoting nature-based solutions

ADB followed a blended approach and bundled the GEF grant for this project with a large infrastructure loan to Vietnam, which enabled the Vietnamese government to try an innovative approach like bioengineering in infrastructure in Northern Vietnam. Thus, when the GEF Partner Agencies can work with government to combine pioneering GEF investments with large conventional loans, opportunities can emerge for effective demonstration of innovative solutions for scaling up and replication. This project provided good examples at the pilot demonstration sites and communicated the benefits from field experiences of the bioengineering approach at local, national and regional levels, paving the road for scaling up. Ideally, in a scaled-up demonstration, pilot sites should be in areas where they are easily accessible for decision makers, planners, and researchers. Also, locating demonstrations close to conventional engineering projects addressing the same issues would enable comparative monitoring of performance in years to come.

Overview of bioengineered riverbank protection in Bac Kan Province (September 2015) @ICEM

References and Multimedia

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