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Developing Ecosystem based Adaptation Strategies for Enhancing Resilience of Rice Terrace Farming Systems against Climate Change

1. Description of activities and collaborating partner institution

Hani rice terraces in China and Ifugao rice terraces in the Philippines are world-renowned sustainable rice terraces that have served local communities for thousands of years. However, climate change is affecting the sustainability of those ecological management systems as it brings in new dimension of continuous changes to local water cycle that would be beyond the regulating capacity of current rice terrace systems.

This project was conducted with the aim to provide scientific base in developing ecosystem based adaptation measures and providing a generic method to strengthen resilience of traditional rice terrace farming systems in the Monsoon Asia region, reducing risk of flood and drought. It is a three-year collaborative project of the United Nations University Institute for the Advanced Study of Sustainability, Ifugao State University, Yunnan Normal University, and the University of the Philippines, supported by the Asia Pacific Network for Global Change Research (APN).

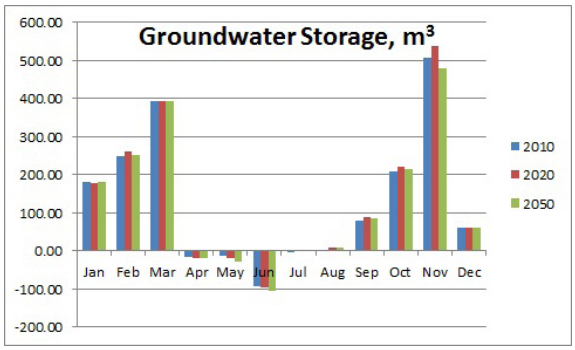
2. Key results

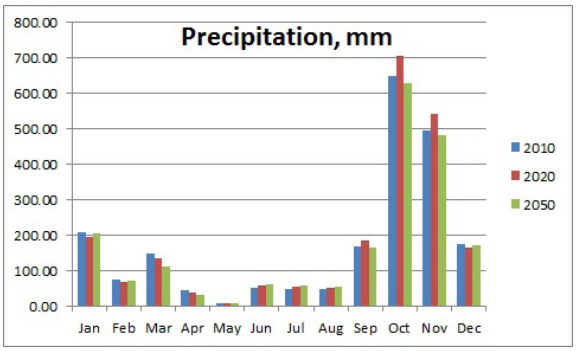
2.1. Ifugao Rice Terraces

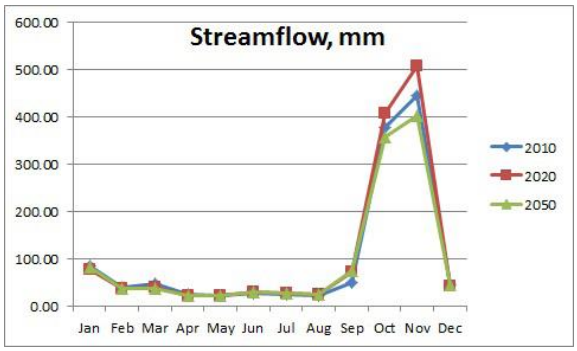
The Ifugaos adopt a strict land use pattern for long-term sustainability of rice terraces. Rice terraces are cultivated below the forests called *muyong* and form an integrated landuse pattern. The *muyong* forest are private woodlots but are sustainably managed with assisted natural regeneration to ensure watershed service to the rice terraces below. Shifting cultivation is practiced to produce other crops above the *muyong* forests.

Climate variability brings about changes in hydrologic patterns, which then translate to changes in the farming system to adapt and survive. The research project simulated scenarios incorporating the effects of climatic and land use variation on the groundwater and surface water flow in the cascade of rice paddies using the United States Geological Survey (USGS) model called Coupled Ground-Water and Surface-Water Flow Model (GSFLOW).

The simulations show results of future higher precipitation during rainy season, higher streamflow and largest groundwater storage, which poses risk of slope instability. However, there is opportunity to store excess water for use during the dry months.







Other simulations were done to show the effects of the changes in the forest cover. It showed that the contribution of the forest to intercepting precipitation is significant.

Based on the research results, the project suggested following measures:

a) Construction of small farm reservoir[1] (SFR)

The small farm reservoir may be constructed in the area to help augment the water supply towards the crop water requirements. However, if an SFR is to be constructed, further investigation must be done as to its effect to the overall hydrology of the area.

b) Promotion of traditional forests 'muyong' management

The traditional 'muyong' management is investigated as an integrated approach that can improve the livelihoods of community, support water regulation functions under future climatic extremes and provide a mechanism for reducing landslide risks.

c) **Carbon stock payment schemes (forest management policy)**

A study in the Ifugao *muyong* shows that *muyong* forests have the highest carbon stocks among different carbon pools of the local forests (Herath, et. al., 2015). Carbon credit payment schemes under the UN-REDD+ (Reducing Emissions from Deforestation and Forest Degradation) programme where *muyong* owners and growers can receive payment from the government can be devised to discourage the owners from converting forest land to alternative uses. Whether the level of payment is land-based or tree-based, carbon payment schemes provide incentives to alter the behaviour of the owners towards maintaining their

[1] a small earth dam structure which should collect rainfall and runoff and release this water to supplement water supply

forests. The forest management scheme should also consider water storage for extreme events triggered landslide increase that was identified in the landslide risk modelling of the system.

d) Sustainable eco-tourism (livelihood sector)

Parties to the Convention on Biodiversity (CDB) adopted guidelines involving indigenous peoples and local communities in tourism development and many governments have embraces the potential of tourism through actively promoting ecotourism development. The local NGO, Save the Ifugao Terraces Movement (SITMo) has successfully implemented culture-sensitive tourism through community involvement.

e) Environmental services payments (benefit sharing)

IRTs function as watershed, supplying water to and serving several dams such as Ambuklao Dam, Binga Dam, Magat Dam, and San Roque dam for neighbouring regions and even parts of the Metro Manila through maintenance of the highland forests like the *muyong*. Collectively, the province supports about 945 MW in these hydroelectric dams, which is about 60% of the waters that are electrifying Luzon. During the public forums and policy dialogues many local participants expressed that there should be some benefit sharing mechanism where the headwater people as custodians of watersheds to receive some of the benefits derived from this water. It may be worthwhile to investigate the feasibility of taxing water based revenues and transfer of some to upstream region for infrastructure development and other subsidies.

2.2. Hani Rice Terraces

The landscape of Hani Rice Terraces is composed of the forests on the mountain top, the villages below the forests, rice terraces below the villages and the water systems linking the forest, the villages and the rice terraces together. Instances of water scarcity and period of concentrated availability have been noted under historical and future rainfall scenarios (under changing climate).

Water Scarcity Index was used as a tool to identify and understand threats to water security, which turns out to be an appropriate way of looking at overall changes in demand and supply. This index shows the balance between potential water availability and the current water demand as an indicator of water security. It is defined as:

$$\mathrm{Rws} = (\mathrm{W} - \mathrm{S})/\mathrm{Q}$$

Where W = Annual total water withdrawal; S = desalinated water; and Q = annual available water resources. The interpretation of water scarcity index is given in the below table.

Table 1. Water scarcity and its interpretation

Range of values	**Interpretation**
Rws < 0.1	No stress
0.1 < Rws < 0.2	Low stress

0.2 < Rws < 0.4	Moderate stress
Rws > 0.4	High stress

The water scarcity index can also be used to identify periods in which action is required and show if interventions can really help solve the problem in an acceptable manner. Projection for future scenario under climate change showed that water scarcity index values between wet and dry periods are set to become more pronounced, both in upstream and downstream of Hani rice terraces.

Based on the result, the project suggested following measures:

1. Doubling the water retention ponds

By doing so, the water scarcity indiex is predicted to be shifted, which implies increasing water security under future climate change scenarios.

2. Development of a basin level strategy that accommodate re-introduction of the traditional water management system of the Hani rice terraces

The traditional water management system in Hani Rice terrace, which involved ditch leaders for water allocation and the use of carved wood locks for distributing water, were no longer in practice. Loss of the traditional system is considered to have contributed to the imbalance of the system. The Basin level strategy is suggested that would ideally guide the decision making process on the maintenance of the system as well as sustaining the cultural heritage of the site, i.e. the water system. Possible re-introduction of the traditional system may be considered and need to be looked into.

3. Lessons learned and good practices

Some lessons learned from the research project:

a) *Modern approach and technology should be made suitable to the existing traditional/local practices*

   Traditional and indigenous practices on natural resource management have existed but in danger of being lost. It is necessary that modern technology be made suitable to the local practices. This project also recommends that technology and sustainable practices, i.e. optimization of weather forecasting and modelling though inter-agency cooperation should be made compatible to traditional practices of the local communities. In addition, scientific understanding of the farmers should be enhanced through capacity building programs.

b) *Sustainability of an environmental system should be addressed in a holistic approach.*

In this project, the rice terrace system should be considered as a complete living system of people, environment and customary practices, consisting both of tangible and intangible elements. Therefore, it is important to consider strategy that allows for benefit sharing between environment and the people.

4. Key Challenges and Future Potential Work

Identifying some potential entry points for each strategy is crucial in ensuring that policies are relevant and effective in addressing the impacts of changing climate to the rice terraces. For this end, it is proposed that:

(a) academics are nominated to the policy making bodies of climate change and indigenous affairs; and
(b) start up some incubator projects incorporating all stake holders that can develop into large scale development practices.

The UNU-IAS frame work INATE (International Network for Advancing Transdisciplinary Education) is a framework that can be used to implement such projects.

Climate change profiling and building up common indicators for planning implementation and monitoring purposes both in local and national level should be established. Information management system and data sharing making data accessible will enable better forecasting and strategy design by participating agencies for climate change adaptation.

Through policies, payment for environmental services such as water user's fee based on equal sharing with upstream and downstream communities can be implemented. Attractive incentives to the indigenous people, i.e. Ifugao people, who maintain the rice terrace systems can be offered through economic interventions such as alternative livelihood programs.

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