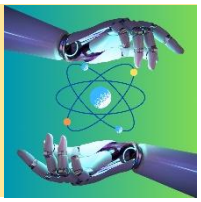
International Journal of Community Service
ISSN: 3083-9696
Journal homepage: https://e-journal.scholar-publishing.org/index.php/ijcs



Cross-National Academic Synergy for Environmental Preservation of Pucok Krueng Mosque: Sustainable Approach

Bahagia[1], Meta Keumala[2], Erdiwansyah[3,4], Zuraihan[5], Richard Mareno[5], Mohd Sabrizaa Abd Rashid[6], Kelly Ann Reed[7]

[1]Department of Environmental Engineering, Universitas Serambi Mekkah, Banda Aceh 23245, Indonesia
[2]Department of Educational Sciences, Universitas Serambi Mekkah, Banda Aceh 23245, Indonesia
[3]Department of Natural Resources and Environmental Management, Universitas Serambi Mekkah, Banda Aceh 23245, Indonesia
[4]Centre for Automotive Engineering Centre, Universiti Malaysia Pahang Al-Sultan Abdullah, Pekan 26600, Malaysia
[5]Faculty of Engineering, Universitas Almuslim, Aceh, Indonesia
[6]Universiti Teknologi MARA, Malaysia
[7]Oxford Brookes University, UK

Corresponding Author: bahagia@serambimekkah.ac.id

Abstract
Environmental degradation from soil erosion poses a serious threat to religious infrastructure along riverbanks. This International Community Service (ICS) initiative aims to implement a "Green Barrier" solution through planting productive fruit trees around Pucok Krueng Mosque in Pidie Jaya. The program involves collaborative synergy among academics from Universitas Serambi Mekkah (Indonesia), Universiti Teknologi MARA (Malaysia), and Oxford Brookes University (UK). The methods employed include field observations, technical outreach to local communities, and participatory planting activities. The results indicate increased public awareness of the importance of green belts in stabilising soil structure and reducing the impacts of surface runoff. Beyond ecological benefits, selecting fruit trees adds value by providing potential economic benefits for the mosque's future prosperity. This synergy demonstrates that sustainable environmental approaches can strengthen the resilience of socio-religious infrastructure in rural areas.

Article Info
Received: 18 Februari 2026
Revised: 15 March 2026
Accepted: 26 March 2026
Available online: 30 March 2026

Keywords
Community Services
Environmental Conservation
International Synergy
Green Barrier
Soil Erosion

1. Introduction

Pucok Krueng Mosque, located in Gampong Teupin Peuraho, Meureudu District, Pidie Jaya Regency, is not merely a physical structure but the central hub of religious and social life for the surrounding community. Geographically, however, the mosque is located in a critical zone directly adjacent to a channel and on sloped terrain. Such conditions increase susceptibility to land degradation, especially in regions with high rainfall intensity, where the kinetic energy of raindrops and surface runoff accelerates

soil detachment and transport [1], [2]. This vulnerability is further intensified by the tropical climatic characteristics of Pidie Jaya, which receives substantial annual rainfall and experiences seasonal peaks capable of triggering severe erosion events [3], [4].

If left unmanaged, progressive erosion along the riverbank threatens the structural integrity of the mosque's foundation, potentially endangering worshippers and risking the loss of a vital socio-religious asset. Conventional engineering solutions, such as reinforced concrete retaining walls, are often costly and environmentally intrusive [5]. Consequently, sustainable alternatives are required. One such approach is implementing a Green Barrier system by planting productive fruit trees. This bio-engineering method stabilises soil by reinforcing it with dense root systems while simultaneously forming a vegetative buffer that reduces runoff velocity and soil particle detachment [6], [7].

Geographical data for Pidie Jaya indicate significant rainfall variability over recent years, which has directly contributed to increased erosion susceptibility in the Teupin Peuraho area. Tropical regions commonly record annual precipitation between 1,500–2,500 mm, with peak monthly rainfall exceeding 300 mm during monsoon periods [8], [9]. Such variability, particularly prolonged heavy rainfall, can increase river discharge and accelerate bank erosion processes [10]. Without adequate protective systems, the structural stability of nearby infrastructure becomes highly vulnerable.

Addressing erosion challenges requires solutions that are both technically effective and environmentally sustainable. Through international collaboration, academic teams have introduced the Green Barrier concept as an innovative nature-based solution grounded in bioengineering principles. Vegetative systems reduce rainfall impact energy, enhance soil shear strength through root reinforcement, and improve slope stability [11], [12]. In humid tropical climates, raindrop impact can break soil aggregates and lower ground elevation near foundations, whereas root networks function as natural soil anchors that enhance mechanical resistance and long-term stability [13], [14].

Selecting fruit trees as the primary Green Barrier component reflects a community-based sustainability strategy. Unlike static concrete structures, vegetative barriers provide dynamic ecosystem services, including groundwater absorption, microclimate regulation, and biodiversity support [15], [16]. Productive species such as mango, rambutan, and durian also offer economic value, encouraging community participation in long-term maintenance. This integration fosters a sense of ownership among residents, linking environmental stewardship with potential harvest benefits that can support mosque welfare and local livelihoods [17],[18].

Figure 1: International Community Service (ICS) Team (Universitas Serambi Mekkah, UiTM, Oxford Brookes) with community leaders in front of Pucok Krueng Mosque.

Implementation of this program represents a paradigm shift from conventional disaster management toward Nature-based Solutions (NbS) for risk mitigation. Collaboration between Universitas Serambi Mekkah and international partners Universiti Teknologi MARA (Malaysia) and Oxford Brookes University (UK) introduces global expertise to address local environmental challenges. Such partnerships ensure that planting techniques, species selection, and water management practices follow international conservation standards while remaining aligned with local ecological knowledge [20].

Through this approach, Pucok Krueng Mosque evolves beyond its role as a place of worship to become a living laboratory for sustainable environmental education in Aceh Province.
Community empowerment forms a central component of the project, particularly through strengthening the roles of youth and mosque administrators in safeguarding environmental assets. Technical training programs equip residents with knowledge of organic mulching techniques to protect soil surfaces from splash erosion and maintain moisture balance [21],[22]. Over time, this capacity-building initiative promotes environmental self-reliance, reducing dependence on external infrastructure interventions that often require lengthy implementation processes [23],[24].

Figure 2: Situation Analysis and Observation of Erosion-Prone Points by the Expert Team Along the Riverbank Surrounding the Mosque.

Skill Development and Training Programs

a) This program focuses on enhancing the capacity of the local community, particularly mosque youth groups and mosque administrators, to understand nature-based disaster mitigation.
b) Bio-Engineering Workshop: Participants receive education on soil erosion mechanisms along riverbanks and how vegetation root systems function as natural stabilisers.
c) Planting and Maintenance Techniques: Specialised training on planting productive fruit trees, strategic planting-hole preparation on sloped terrain, and the use of organic mulch to protect soil surfaces from splash erosion.
d) International Knowledge Transfer: Through collaboration with academics from Universiti Teknologi MARA (Malaysia) and Oxford Brookes University (UK), the community gains insights into global environmental conservation standards adapted to local wisdom in Pidie Jaya.

Infrastructure and Equipment Support

a) Although focused on vegetative solutions, the program provides supporting facilities to ensure the success of green infrastructure at Pucok Krueng Mosque.
b) Provision of Superior Seedlings: Assistance in supplying various productive fruit tree seedlings (mango, rambutan, citrus) with strong taproot characteristics acting as natural "earth anchors" to reinforce soil stability near the mosque foundation.
c) Conservation Equipment: Distribution of planting tools and organic materials (mulch) to maintain soil moisture while preventing surface compaction caused by high rainfall in Meureudu.
d) Mosque Landscape Arrangement: Establishment of green barriers at critical erosion-prone points surrounding the mosque as a protective buffer against riverbank abrasion.

Financial and Environmental Sustainability Programs

a) Program sustainability is ensured by integrating environmental benefits with economic potential to support mosque prosperity.
b) Productive Economy (Self-Sustaining Mosque): Fruit trees are selected not merely as shade plants but as future income sources; harvest yields can support mosque funds or benefit worshippers directly, fostering local food self-sufficiency.

c) Ecosystem Resilience (Climate Mitigation): The initiative functions as a carbon sink and a hydrological regulator, helping maintain groundwater availability in Gampong Teupin Peuraho, supporting SDG 13 (Climate Action) and SDG 15 (Life on Land).
d) Sense of Ownership: Direct community involvement from the planting stage cultivates a strong sense of responsibility. Residents protect the trees as both economic assets and disaster-prevention measures, ensuring the mosque's long-term environmental sustainability through participatory stewardship rather than reliance on external assistance.

2. Methodology

This study employed a qualitative case study approach to evaluate the impact of a community service program on environmental conservation. The implementation of the International Community Service (ICS) program adopted a participatory model involving cross-national academics and local community members. Systematically, the program was conducted in three main phases:

Pre-Implementation Phase (Situation Analysis and Observation)

a) The initial phase began with a situation analysis through field observations to map the physical environmental conditions surrounding Pucok Krueng Mosque.
b) Site Identification: The team conducted field surveys to identify critical points vulnerable to soil erosion and land degradation, particularly areas directly adjacent to the riverbank.
c) Data Collection: Data were gathered through landscape observations and in-depth interviews with mosque administrators and local community leaders to understand the historical pattern of erosion in the area.
d) Technical Assessment: Evaluation of slope gradients and soil conditions was conducted to determine the most effective vegetation types for serving as a green barrier.

Core Phase (Technical Training and Socialisation)

a) After field data were collected, technical training (capacity-building) sessions were conducted to transfer knowledge to the community, especially to mosque youth groups and administrators.
b) Educational Workshops: Participants gained an understanding of erosion mechanisms (such as splash erosion and surface runoff) and the strategic role of vegetation in stabilising soil structure.
c) Technical Materials: Training included proper planting techniques, application of organic mulch to protect soil surfaces, and maintenance methods for productive trees to ensure optimal growth in tropical ecosystems.
d) Academic Synergy: This phase also involved panel discussions with international experts to provide global perspectives on sustainable development standards for religious infrastructure environments.

Implementation Phase (Field Action and Evaluation)

a) The final phase consisted of field implementation, representing the direct application of the Green Barrier concept.
b) Participatory Planting: Tree-planting activities were carried out collectively and symbolically by the ICS team together with community members. Selected species were productive, well-rooted trees (such as mango and local fruit species).
c) Soil Stabilisation: Trees were strategically positioned at erosion-prone points to bind soil particles and reduce the kinetic energy of rainfall.
d) Monitoring and Evaluation: Follow-up assessments were conducted to evaluate planting outcomes and develop sustainability reports, ensuring that the community can independently maintain the tree garden over the long term.

Figure 3: Implementation of the workshop and technical training on Green Barrier planting for mosque administrators and youth members.

Figure 4: Planting of productive fruit tree seedlings on sloped areas as an effort to stabilise the soil.

3. Result & Discussion

The International Community Service (ICS) program not only produced physical changes in the mosque's landscape but also generated significant impacts across three main pillars: ecology, socio-economics, and academic synergy.

Ecological Effectiveness: Vegetation-Based Erosion Mitigation

a) Technical analysis indicates that planting fruit trees on the sloped areas around Pucok Krueng Mosque functions as critical green infrastructure. Mechanically, tree roots increase soil cohesion, while the canopy reduces the kinetic energy of rainfall striking the ground surface.
b) Surface Runoff Reduction: The presence of a tree garden slows surface water flow, preventing soil particles from being easily transported into the river.

c) Increased Infiltration: Vegetation promotes water infiltration into soil pores, which in the long term helps maintain the stability of the mosque's foundation and reduces the risk of subsidence or minor landslides.

Socio-Economic Transformation: Trees as Productive Assets

a) The program results demonstrate a shift in local community perspectives regarding environmental sustainability. The selection of fruit trees (such as mango, rambutan, and citrus) has been central to the success of this empowerment initiative.
b) Utility Value: Community members no longer view trees merely as ornamental plants but as productive assets, fostering intrinsic motivation among worshippers to maintain them in anticipation of future harvests.
c) Mosque Prosperity: The yield from these trees can later be used for congregational consumption or sold to support mosque funds, creating a circular economic cycle that contributes to the financial self-sufficiency of the religious institution.

Figure 5: Participatory discussion on the use of organic mulch to protect soil surfaces from splash erosion.

International Synergy and Knowledge Transfer

a) The involvement of academics from Universitas Serambi Mekkah, Universiti Teknologi MARA (Malaysia), and Oxford Brookes University (UK) provided scientific credibility to local environmental practices.
b) Global Standards, Local Application: Field discussions generated technical recommendations integrating international conservation standards with endemic Acehnese plant species. This reflects the principle of "Think Globally, Act Locally."
c) Empowerment of Mosque Youth: Local youth gained direct exposure to simple bioengineering methods, such as organic mulch, and practical technical knowledge that is rarely accessible through formal rural education systems.

Figure 6: Symbolic handover of productive plant seedlings as part of the mosque economic empowerment program.

Figure 7: Tree planting activities around the mosque.

4. Conclusion

The international community service program "Safeguarding Pucok Krueng" concludes that integrating vegetation-based science (bioengineering) and active community participation is the key to preserving the environment of religious infrastructure. By implementing a Green Barrier with productive fruit trees, this project has effectively addressed land degradation challenges around the Pucok Krueng Mosque. Several key findings can be drawn from this initiative:

1) Technical Success: Strategically planting fruit trees on sloped areas has proven to be a sustainable method for stabilising soil structure and reducing surface runoff, thereby protecting mosque infrastructure from riverbank erosion.
2) Community Empowerment: The use of productive plants shifts community perspectives from simple environmental maintenance to the management of "economic assets." This ensures long-term tree care through the direct benefits to mosque prosperity and congregational welfare.

3) Significance of Collaboration: Cross-national academic synergy among Universitas Serambi Mekkah, Universiti Teknologi MARA (Malaysia), and Oxford Brookes University demonstrates that international collaboration can generate locally adaptive solutions grounded in global scientific standards.

As a follow-up step, periodic monitoring of tree growth rates and groundwater infiltration levels at the site is recommended. This environmental management model, which combines disaster mitigation and economic self-reliance, has strong potential to be replicated in other mosques and public facilities across Pidie Jaya Regency and throughout Aceh Province.

Acknowledgement

The authors express their sincere appreciation to Universitas Serambi Mekkah for its financial and facility support, as well as to the cross-national academic team from Universiti Teknologi MARA (Malaysia) and Oxford Brookes University (UK) for their expert collaboration in this program. Gratitude is also extended to the Pidie Jaya Regency Government, Universitas Almuslim, and all village officials, mosque administrators, and the youth community of Pucok Krueng Mosque for their active participation and outstanding cooperation, which enabled this international community service initiative to be successfully implemented and to deliver sustainable benefits for both the environment and the local community.

References

[1] W. H. Wischmeier and D. D. Smith, Predicting Rainfall Erosion Losses, Washington, DC, USA: USDA, 1978.
[2] R. P. C. Morgan, Soil Erosion and Conservation, 3rd ed. Oxford, U.K.: Blackwell, 2005.
[3] R. Lal, “Soil degradation by erosion,” Land Degradation & Development, vol. 12, no. 6, pp. 519–539, 2001.
[4] D. Pimentel et al., “Environmental and economic costs of soil erosion,” Science, vol. 267, pp. 1117–1123, 1995.
[5] FAO, Status of the World’s Soil Resources, Rome, Italy, 2015.
[6] D. H. Gray and A. T. Leiser, Biotechnical Slope Protection and Erosion Control. New York, NY, USA: Van Nostrand Reinhold, 1982.
[7] A. Stokes et al., Ecological Mitigation of Hillslope Instability. Boca Raton, FL, USA: CRC Press, 2014.
[8] J. Nieuwolt, Tropical Climatology. London, U.K.: Wiley, 1977.
[9] IPCC, Climate Change 2021: The Physical Science Basis. Cambridge, U.K.: Cambridge Univ. Press, 2021.
[10] R. P. C. Morgan and M. A. Nearing, Handbook of Erosion Modelling. Oxford, U.K.: Wiley-Blackwell, 2016.
[11] D. H. Gray and R. B. Sotir, Biotechnical and Soil Bioengineering Slope Stabilization. New York, NY, USA: Wiley, 1996.
[12] M. G. Anderson and K. S. Richards, Slope Stability. Chichester, U.K.: Wiley, 1987.
[13] J. Sidle and H. Ochiai, Landslides: Processes, Prediction, and Land Use. Washington, DC, USA: AGU, 2006.
[14] J. Gyssels, J. Poesen, E. Bochet, and Y. Li, “Impact of plant roots on the resistance of soils to erosion,” Catena, vol. 57, pp. 27–44, 2005.
[15] J. De Baets et al., “Root characteristics of representative Mediterranean plant species and their erosion-reducing potential,” Earth Surface Processes and Landforms, vol. 32, pp. 173–189, 2007.

[16] H. L. Penman and I. Calder, Forests and Water. London, U.K.: Academic Press, 2007.
[17] FAO, Guidelines for Soil Conservation and Management, Rome, Italy, 2017.
[18] M. Faisal and I. Fahmi, "Community Service Through Socialization of Simple Incinerators as Alternative Waste Management Solutions in Islamic Boarding Schools," vol. 1, pp. 232–246, 2026.
[19] M. Keumala, T. K. Razi, and J. Harahap, "Community Service in Banda Aceh: Case Studies of Hazardous and Toxic Materials at PT DIPO," vol. 2, pp. 110–117, 2025.
[20] UNEP, Nature-based Solutions for Climate Adaptation, Nairobi, Kenya, 2022.
[21] R. P. Hudson, Soil Conservation, 3rd ed. Ames, IA, USA: Iowa State Univ. Press, 1995.
[22] A. Gani, "Community Service on Solar PV Integration for Smart Farming Irrigation Systems in Islamic Boarding Schools," vol. 2, pp. 118–127, 2025
[23] T. J. Toy, G. R. Foster, and K. G. Renard, Soil Erosion: Processes, Prediction, Measurement, and Control. New York, NY, USA: Wiley, 2002.
[24] A. Yulianur and H. Maksum, "Community Capacity Building Through Renewable Energy Operator Training: A Case Study on the Installation and Operation of Off-Grid Micro-Hydro Power Plants," vol. 2, pp. 139–151, 2025