

Coastal squeeze or prospects for alternative approaches?

Viola van Onselen, Postdoctoral researcher NTNU

Wan Jou Lin (宛柔林), PhD candidate NTNU

Taiwan's natural coastline faces significant challenges, such as coastal erosion, land subsidence, rising sea levels, and the adverse effects of human activities. Particularly vulnerable is the low-lying west coast, where rapid socio-economic development has profoundly impacted the environment. Ecosystems are quickly deteriorating or vanishing entirely, resulting in a loss of biodiversity and critical natural resources. Traditional responses to coastal erosion and wave impact often rely on the construction of hard structures along the coastline. However, in recent decades, there has been a growing advocacy for more sustainable alternatives. This piece highlights the emergence of such solutions and emphasizes the pivotal role of women in addressing these challenges.

Engineered structures like revetments and tetrapods are frequently constructed to mitigate wave energy and protect coastal communities. Though, these interventions can inadvertently contribute to a phenomenon known as "[coastal squeeze](#)" [1]. Coastal squeeze refers to the narrowing or loss of coastal habitats, as the sea rises, the space available for coastal habitats like wetlands and mangroves gets squeezed between the rising water and the fixed structures. These fixed structures are a result of coastal development or infrastructure projects consisting of hard (grey) engineered structures, such as seawalls, jetties, or harbour installations along the shoreline. While some of these structures may protect coastal properties in the short term, they can ultimately contribute to habitat loss and coastal erosion in the long term.

In a recent study conducted by [Lansu et al. \(2024\)](#) [2], it was found that globally the built environment is, on average, situated approximately 392 meters from sandy shorelines. Alarmingly, the research revealed that 33% of sandy shores possess less than 100 meters of space free from infrastructure. Moreover, projections indicate that between 23% to 30% of this vital space may be lost by the year 2100 due to the escalating threat of rising sea levels. [Data on the Taiwanese coastline](#) [3] show that more than 50% has been constructed (armoured by grey engineering), which has contributed to increased erosion and in some cases, irreparable damage throughout the coastline.

These findings underscore the critical and pressing need for proactive measures aimed at restoring natural habitats, enhance natural resources, and safeguarding the biodiversity crucial for the resilience and sustenance of coastal communities.

Nature-based solutions to revive natural coastlines

Instead of relying solely on traditional engineered structures like seawalls and breakwaters, nature-based solutions work with nature to provide sustainable and effective coastal protection. [Nature-based solutions](#) (NbS) is an umbrella term for measures that protect the coastline and restore natural ecosystems, reverse biodiversity loss and tackle the negative effects of climate

change on infrastructure and society [4]. Providing adequate space for nature-based solutions is essential for maximizing their effectiveness in mitigating and adapting to environmental challenges such as climate change. This space allows natural ecosystems to thrive, provide critical ecosystem services, and support biodiversity and resilience in the face of changing environmental conditions.

The body of literature on NbS and associated benefits is rapidly growing, and there is growing interest among policymakers and government entities in funding studies exploring the role of NbS in diverse contexts. In Taiwan, a similar trend is observed, with a surge in funding allocations towards NbS initiatives. Ongoing studies are dedicated to identifying optimal strategies, pinpointing vulnerable areas along the coastline and management plans that facilitate the effective adaptation NbS. Concurrently several and projects and experiments are set up to focus on restoring or establishing mangroves, coastal dunes, and wetlands.

Several mangrove projects in Taiwan serve as examples highlighting the importance of conducting experimental setups and thoroughly studying the local context beforehand. For instance, the rapid expansion of mangroves at the outlet of Zhuoshui Creek in [Fangyuan Township](#) or at the [Guandu reserve](#) in Taipei has disrupted the habitat of local Taiwanese endemic species and obstructed waterways [5]. Despite these negative impacts, valuable lessons can be gathered from these experiences for future nature-based approaches aimed at reducing coastal erosion or mitigating flood events. Coastal dune restoration projects in [Beimen](#) and [Caota](#) dunes have booked more successful results, as dunes form an effective barrier for storms, wave impacts and sea level rise [6].

Another critical consideration regarding nature-based approaches is the limited space along the coastline in Taiwan, which can pose challenges for implementing NbS. In such scenarios, hybrid solutions that blend hard engineering structures with green elements can offer a more feasible approach to enhancing nature. Or managed retreat strategies can be considered, which involves moving existing infrastructure further inland to allow natural habitats to expand seaward and reduce the impacts of coastal squeeze.

Holistic approaches: women as agents for change

[Numerous studies underscore](#) the need for a more integrated and holistic approach to coastal management and environmental restoration [7]. Consequently, it is valuable to explore diverse concepts that stimulate holistic thinking, recognizing the interdependence among all living beings and not see human and nature as separate.

NbS strategies should support natural and social benefits and also involve local communities, stakeholders, and Indigenous groups in coastal management efforts. For sustainable, long-term support, it is imperative that NbS are embraced not only by decision-makers but also by communities at the grassroots level, include diverse perspectives and multiple stakeholders. [Ongoing research](#) in Taiwan is dedicated to addressing these inquiries, aiming to create a more sustainable coastline and enhance adaptability in response to climate change [8]. It is acknowledged that there is a wider need to include more Indigenous and feminine perspectives

in nature restoration and climate change adaptation. Indigenous communities in Taiwan, most renowned for their hunting traditions among the Tayal, Truku, and Bunun people, have maintained enduring connections with their environments, possessing profound insights into the ecological systems that sustain them [9]. Taiwan Indigenous wisdom embodies the dynamic interplay between the people, their ecosystem, and the myriad living beings and spirits inhabiting their lands. Despite this rich heritage, the historical narrative of Taiwan's Indigenous peoples is one marked by displacement and marginalization, as Japan Colony and dominant governments have frequently uprooted them from their ancestral territories. These communities resided in pristine, resource-rich regions, where their land claims aim not to expand territorial boundaries, but rather to safeguard traditional lands and cultural practices integral to holistic environmental stewardship [10]. Indigenous knowledge offers unique perspectives that can enhance projects, leading to greater effectiveness in achieving ecological goals. Additionally, integrating this knowledge helps in the preservation of cultural heritage and promotes social equity [11].

Moreover, globally more often [women are at the forefront of environmental movements](#) [12]. For example, Indigenous women in Taiwan also fight when defending the natural environment and different Taiwanese women spearhead in ecological movements and are leading the fight against pollution, excessive consumption and climate change. Lai Xiaofen, executive supervisor of the Environmental Protection Foundation of the Housewives Alliance, pointed out that changing food and production and consumption patterns is crucial to curbing the current climate crisis. This helped raise awareness about environmentally sustainable agriculture. Or Li Yi Cheng, the director of the tree planting department of Tse-Xin Organic Agriculture Foundation, actively engages in greening the coastline of Taiwan. She leads reforestation projects of coastal forests and engages many volunteers in tree planting actions, while also increasing environmental awareness. Another example is that of Tzu Chi, a part of the Homemakers United Foundation (HUF) environmental protection agency which is lead by female activists. They have been leading activities that concern recycling practices, waste reduction and beach clean ups. In 2006, they have tried to push for a national law that makes recycling mandatory for materials such as aluminium, paper, and plastic bottles. After their project succeeded, recycling became adopted nationwide [13].

The roles these and many other women are playing in environmental activism and the promotion of nature-based solutions in Taiwan are significant. They contribute not only to national policies and practices but also to local and community-based initiatives, ensuring that environmental action is inclusive and effective. This leads back to the study of [ecofeminism](#), which includes an appreciation of the historical connections between women and nature as well as a commitment to environmental protection [14]. The primary tenets of ecofeminism show that there is a direct correlation between the exploitation of women and the exploitation of the natural world, and that it is essential to comprehend the aspects that unite these two types of oppression in order to properly understand both. Taiwan's indigenous women may relate to the wide range of positive aspects of the environmental movement while standing on the foundation of ecofeminism. Understanding and integrating feminist perspectives can enrich the implementation of NbS by ensuring they are not only effective in terms of biodiversity and climate benefits but also in promoting gender equality and social justice [15]. Therefore we

argue to include more feminine perspectives in the implementation of nature-based solutions, to pave a way for a more inclusive and effective approach to addressing ecological challenges.

Concluding remarks

In the context of NbS, feminine and Indigenous knowledge can offer valuable insights and approaches. The inclusion of Indigenous knowledge in NbS is also recognized in international frameworks and debates, such as the Sendai framework for Disaster Risk Reduction, the International Union for Conservation of Nature (IUCN) Global Standard for Nature-based solutions, and the United Nations Framework Convention on Climate Change (UNFCCC). These frameworks emphasize the importance of respecting and integrating traditional knowledge and practices in environmental management and policy-making.

Given the critical role women play in the family and community dynamics, their active participation and leadership in NbS could enhance the overall effectiveness and resilience of their communities. Therefore, empowering women in this field is not just about addressing gender imbalance but also about making disaster risk management and climate adaptation as effective and inclusive as possible.

The above-mentioned principles encourage reimagining human-nature relationships and promoting more sustainable and harmonious ways of interacting with the environment. The next step is finding best-fit strategies for different coastal contexts, determine where to implement them and how to manage (revived) coastal ecosystems. To realize a truly comprehensive restoration of nature, solutions must transcend disciplinary boundaries and operate across various levels and policies.

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Wan Jou Lin is a PhD candidate at the department of Taiwan Culture, Languages and Literature, National Taiwan Normal University. She studies Indigenous ecofeminism.

Viola van Onselen is a Postdoctoral researcher at the department of Geography, National Taiwan Normal University. She studies Nature-based Solutions in coastal settings.