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Traditional Khmer Water Practices: A Case Study of Phnom K'to, Vietnam

Vu Thi Phuong Linh, Bruno De Meulder and Kelly Shannon
OSA Research Group, KU Leuven

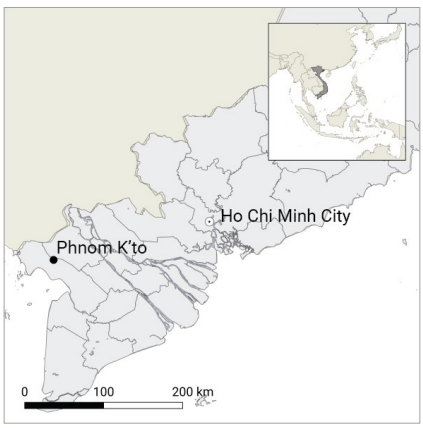
Phnom K'to (Cô Tô Mountain) is the easternmost peak of a small chain of granite outcrops of Vietnam's Mekong Delta. It reveals a long and rich tradition of water management that is often overlooked in present-day development. Although the region is under Vietnamese control, it had centuries of Khmer rule and inhabitation. Today, the marginalized Khmer settlements around Phnom K'to are spread across varied terrain, from rugged mountains to muddy floodplains, with monsoon-fed and flood-cycle cultivation. The Khmer's traditional water practices were carefully adapted to topography and water variations, forming interconnected habitats and productive mosaics specific to Khmer society. However, their vernacular landscape has been dramatically transformed and recast by modern canals (since the nineteenth century), dike building and granite mining (since 1975), and roads and reservoirs (since the 2010s). Whereas the entire region suffers from the consequences of global warming (particularly floods and droughts) and ecological destruction, there is an opportunity to revisit traditional Khmer water practices to provide insights for reconfiguring the water system. Fieldwork-based drawings, annotated with Khmer terminology, highlight morpho-topological readings of the relationship between water management practices and settlement. The research seeks to uncover opportunities to revisit and revalue such practices to renew stewardship of the territory.

Keywords: *traditional Khmer water practices, landscape mosaics, stewardship, adaptive (re)cultivation, traditional ecological knowledge*

KEY THEMES

CLIMATE

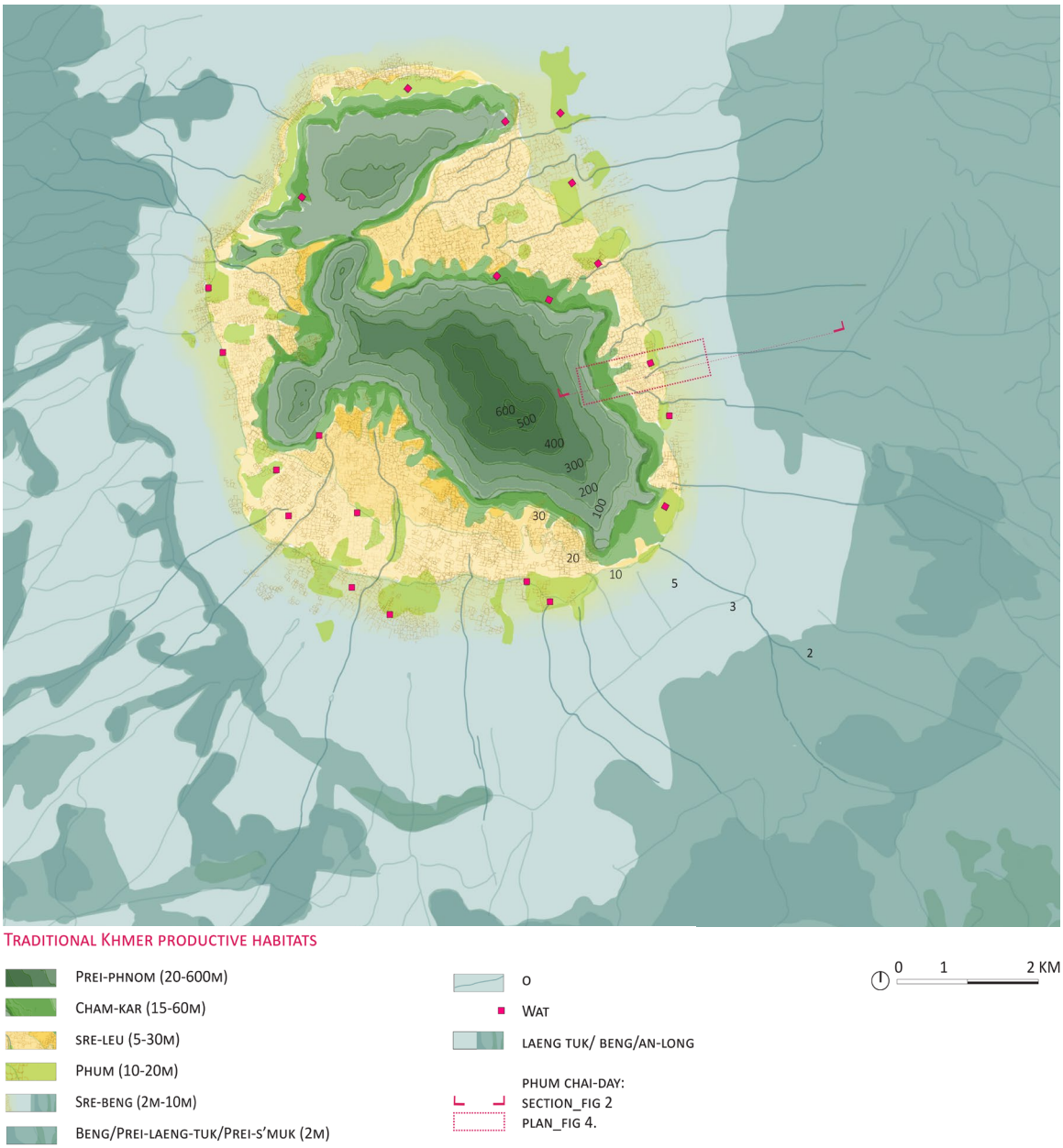
Aw : Tropical Savanna Climate



< Fig. 1 *Chamkar* (foothill garden/orchard forest) to *sre-leu* (terrace rice field) in Phnom K'to (Source: Linh Vu, 2022).

Traditional Khmer Water Systems and Habitats in the Mekong Delta

The Long Xuyên-Hà Tiên Quadrangle in Vietnam, along with the Plain of Reeds and Cambodia's Tonlé Sap Lake, form the primary seasonal freshwater reservoirs in the Mekong Delta. The Long Xuyên-Hà Tiên Quadrangle shares traditional Khmer water practices that also exist in present-day Cambodia. The transboundary flood regimes and interactions with mountainous topography have led to the development of



^ Fig. 2 Phnom K'to traditional water system (Source: Linh Vu, 2024).

a particular traditional Khmer water management system. Phnom K'to in Vietnam serves as a case study within this landscape. Phnom K'to (Cô Tô Mountain) is in the region known in Vietnam as the Seven Mountains (Thất Sơn). It is part of the Cardamom Mountains, mostly in Cambodia.

In folk tales, Phnom K'to is described as the most poetic and spiritual among the mountains in the Mekong Delta, where water is key. Its sacred mountain forest feeds several *o* (streams linking the foothills and the fields) that nurture productive habitats in the plain before merging with the flood regimes of the delta (Son 1959). Khmer cosmology is interwoven with the delta-mountain geography. Six major productive habitats are embedded in the water-topographical system, forming the Phnom K'to landscape. They are 1) *prei-phnom* (mountain forests); 2) *chamkar* (foothill gardens/orchard forests); 3) *sre-leu* (upper field/rainfed terraced rice field); 4) *phum* (inhabited garden/village) in the alluvial apron; 5) *sre-beng* (lower field/flooded rice field) and 6) *beng/prei-laeng-tuk/prei-s'muk* (marshland/swamp/flooded melaleuca forest) in the floodplain (fig. 2).

Traditional Khmer Water Management Practices and Cultural Landscapes

The Khmer Indigenous landscape has been maintained for centuries by a sequence of typo-morphologies across the topography and through habitats, from the mountain to the floodplain, reflecting the Khmer culture of respecting trees, water and soil (fig. 3). Beginning in the higher elevation, *prei-phnom* is the primary water source. It stores monsoon water, recharges aquifers and maintains biodiversity. In Khmer tradition, the *prei* (forest) is a sacred entity with limited access (Son 1959). The *mac-tuk* (mountain stream) is naturally retained at the *la-an* (ravine) foothills before being directed to fields. On the slopes, the *chamkar* is formed through selective clearing and planting, with a water management system centered on the *la-an*, *trapaeng* (natural pond/wetland) and *an-tuk* (constructed pond/water tank).

Different irrigation techniques are employed in the *sre-leu* and the *sre-beng*. Water from the foothills flows through the *o* to the *sre-leur* and cascades from one terrace to another through openings in the *pleu* (terrace wall). Various *an-don* (excavated ponds) and *o* (natural ponds) retain water, while the *andon-tuk-dei* (well) is used in the dry season. Meanwhile, in the *sre-beng*, traditional Khmer cultivation follows the Mekong flood regime, particularly through the practice of growing *srau-peang-tuk* (floating rice). Here, natural *beng* and *prei s'muk* host water and aquatic species. In the *phum*, water for production comes from common sources such as *o*, *andon-tuk-dei* or *sras* (pond of the wat). Each family typically has its own *andon*, *an-tuk* or a drilled well.

Role of the Wat: Water Management and the Social Construction of Space

Wats are Theravada Buddhist temple complexes that are the heart of Khmer society and important features in the landscape. Located in the foothills and in the alluvial apron near main streams, wats literally and figuratively sustain Khmer society and play an important role in the water management of the productive landscape (Taylor 2014, 162–90). Every *phum* has a wat; it provides a focal point for individual, religious and institutional milestones. Monks guide the community's cosmological and agricultural rituals (Le 1969). In Phnom K'to, a few extended families formed a *phum* with a wat, which ex-

Traditional Khmer productive habitats	Water terms/typologies
Prei-phnom (mountain forest)	*An-long* (all-year submerged area on floodplain)
Chamkar (foothill garden/orchard forest)	*Andon* (dug pond/shallow well)
Sre-leu (upper field/rainfed terraced rice field)	*Andon-tuk-dei* (well)
Phum (inhabited garden/village)	*An-tuk* (pond/water tank)
Sre-beng (lower field/flooded rice field)	*Beng* (marshland/swamp)
Beng/prei-laeng-tuk/prei-s'muk (marshland/ swamp/melaleuca forest)	*Hoc* (small ditch)
Features and plants	*La-an* (ravine/all-year mountain stream)
Chai-day (stupa/ash-tower in wats/phum's name)	*Le-ron* (ridge and furrow)
Daem koki (Hopea odorata, growth as wat's forest)	*Mac-tuk* (mountain stream)
Krang (garden/forest island on the field)	*O* (stream from the foothill to the field)
Ktom neak ta (spirit house)	*O* (natural pond near the phum or stream)
Neak ta (more-than-human-beings in Khmer animism)	*O-tuk* (running water/ditch)
Prei (forest)	*Pleu* (rice-terrace walls)
S'muk (flooded melaleuca)	*Prek* (channel/canal/river)
Srau-laeng-tuk (floating rice)	*Sras* (brick/stone pond in the wat)
Sre (rice field)	*Trapaeng* (natural pond/wetland)
Sre-co-beng (overlap system of sre-leu and sre-beng)	*Tuk* (water)
Daem svay (mango tree)	*Tuk-choh* (flood reversal)
Daem thnaot (palm tree)	*Tuk-haur* (water descends from the mountain)
Wat (Buddhist temple complex)	*Tuk-kraom-dei* (ground water)
	Tuk-laeng (flood-rising/flooding season)
	Tuk-reak (water drying up/dry season)

* The terms were collected during fieldwork and in discussion with a local senior social worker. They are also mentioned in the published works of Taylor (2014), Nam (1959) and Vuong (1993). Khmer terminology reveals an intimate link of language, place names and everyday practices to landforms and ecological processes. The water-related terms also embody sacred meanings and social-ecological interconnectedness in landscape construction through generations of families and the larger community. It is critical to learn from the case since local Khmer practices and terms are being replaced by Vietnamese systems and names that do not necessarily carry the same embedded meanings. This in turn, results in both a disregard and loss of traditional water management practices and spaces and a loss in water management knowledge.

^ Table 1. Khmer words in the drawings and writing* (Source: Linh Vu, 2024).

panded and has been rebuilt over time. Wats institutionalize the inhabited landscape through labor and material offerings. However, despite the wat's domination, ancient animist traditions continue to be respected alongside Buddhism. This means that the wat does not dominate nature (mountain, forest, water regimes) but instead integrates with it (Phan 2014).

Water activities in the *phum* are spatially and symbolically linked to the wat, which helps maintain and protect water sources for the community. The *sras*, built by the community using stone, is important for storing water (Le and Nguyen 2021), especially in the dry season. Since water is central to Khmer cosmology, as a component of the wat, the *sras* is sacred and its water is used carefully. Lotus is often grown in the *sras*, which minimizes evaporation and purifies the water while serving as a religious symbol.

The wat is also the center of seasonal festivals and water ceremonies, which are essential to social and agricultural life. Events such as Choul-Chnam-Thmey (New Year Festival) and Ok-Om-Bok (Moon Festival) include rituals like welcoming and praying for rain, celebrating the recession of floodwaters and offering prayers to the moon for the monsoon season. Floating altars and lights are used in ceremonies to bless the community with good crops.

Historically, wats were closely connected to a natural water source and local animist practices and beliefs, particularly those involving *neak-ta* (more-than-human beings). For example, near the *la-an* in the *phum* Chai-day, local people planted a *daem svay* (mango tree) to mark the most critical communal and perennial water source. Traditionally, shrines or sacred rocks have been placed near *la-an* in gratitude to the mountain forest *neak-ta* for abundant water; these can still be found near historical wats and ruins close to the foot of the mountain. Throughout the Khmer's tumultuous history in the region, wats have been closely linked with the building and rebuilding of Khmer communities (Taylor 2014).

Mosaics and Flows as Integrated Systems: Kinship in Landscape Operation

The cascading productive mosaics and flows in Phnom K'to have been shaped and transformed over centuries through interrelated water management processes. These processes involve micro-topographical manipulation and the maintenance of shared ecological resources, often managed through kin networks. Traditional Khmer social structures – including household members and relatives, neighbors and friends within a hamlet or nearby hamlets – mobilize groups to engage in wet rice cultivation. This labor-intensive practice relies on simple techniques and rudimentary tools that minimize soil and water disruption (Son 1959). Despite modernization and the imposition of more generalized systems, these cooperative social structures, rooted in kinship and communal labor, persist to varying degrees (Biggs 2012; Linh 2016).

Slope reclamation in Phnom K'to has created productive landscapes with minimal earthworks. Effective water management for planting requires careful manipulation of micro-topography, while seasonal water, temperature and vegetation cycles make the earthworks dynamic. Precise quantities of water are essential for plant growth, which can be difficult to achieve in extreme wet or dry periods. A common technique, the *le-ron* (ridge and furrow), helps conserve water during droughts and drain excess during wet-season overflows. Flat areas are cleared to make the *sre-leu* (upper field/rain-

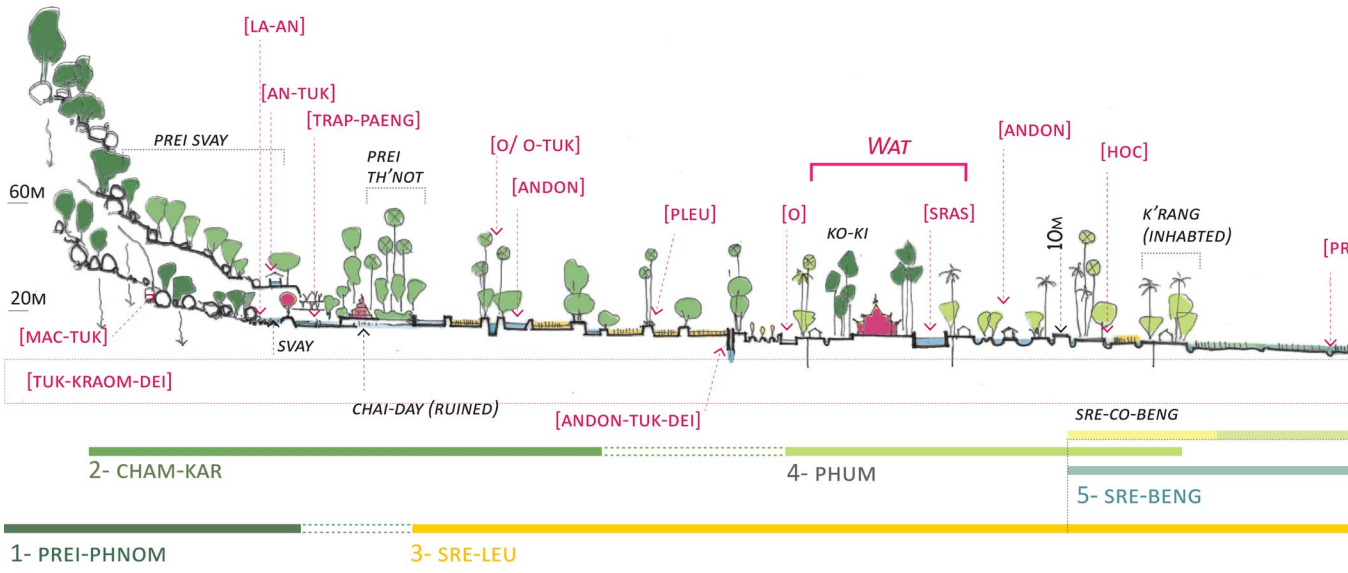
fed terraced rice field) and *pleu* (terrace walls) retain water. The topography defines an organic *sre-leu* morphology, with uneven *pleu* ranging from a few centimeters downhill to a meter uphill. These fields, typically small – often less than 0.3 ha – are crafted using simple, traditional methods that make them manageable for local farmers.

The cascading arrangement of productive mosaics and the careful maintenance of water flows create ecological connections across diverse terrains and habitats. The rough surfaces of foothills and wetter areas along streams are prioritized for *chamkar* and water retention, forming "wet-green flows" that are thick in the foothills and sparser in the floodplain. Natural streams and watersheds are reconfigured to integrate productive plots and water channels that divert the mountain water to various fields or discharge surplus water. This system incorporates a network of various ponds and wetlands, which act as micro-watersheds. Protected from evaporation by tree canopies and aquatic vegetation, these water bodies help minimize evaporation, ensuring sustained water availability for the ecosystem.

Finally, *bau-waq* (shared/aid-labor) is a Khmer tradition in which kin groups help one another in the fields, especially when planting rice, transplanting seedlings and harvesting crops. The rationale behind the collective practice is not only that it makes possible the required labor intensity but also offers a way of dealing with subtle differences in wetness and, consequently, in time-intensive work in the *sre-leu*. Many Khmer water terms, such as *la-an*, *trapaeng*, *pleu* and *o*, denote common use and care, as well as degrees of sacredness.

Seasonal Daily Stewardship: The Cultivation of Culture

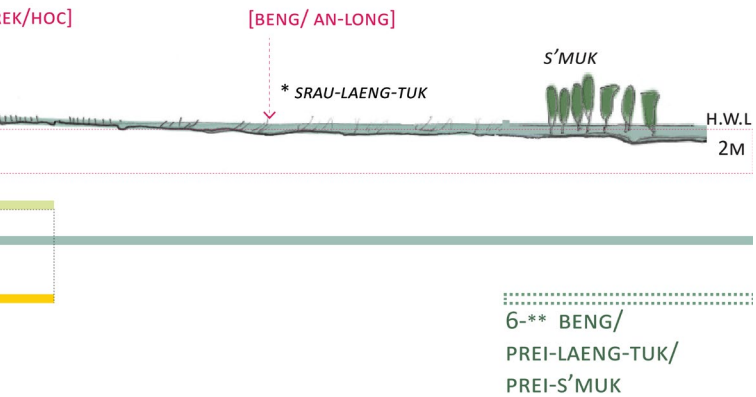
For centuries, Khmer everyday practices were re-



^ Fig. 3 Khmer morpho-typologies (and terms) pertaining to water practices are related to habitats and topography across Phum Chai-Day, Phnom K'to (Source: Linh Vu, 2022).

^ Fig. 4 The reconstructed *sras* (pond) in 1995 in Wat Chi-mung, built in 1712 in Phnom K'to. These construction dates were written on the gravestone inscription near the entry of the wat (Source: Linh Vu, 2022).

* *Srau-laeng-tuk* was replaced by the modern wet-rice.
** 6 - *Prei-laeng-tuk/prei-s'muk* is remained few kilometers away from the *phum*.
There are some initiatives to re-introduce *srau-laeng-tuk* & rewild *prei-laeng-tuk* in tri ton.



lated to cosmology, where destruction precedes rebirth (Taylor 2014, 252–71). Even today, everyday practices intertwine with water stewardship, forming natural–cultural interactions (Bourdeaux 2023). In Phnom K'to, farming takes place year-round, and everyday water practices are synchronized with the seasons. The Khmer seasons are named in relation to water regimes and their accompanying practices and rituals. In the upper fields, *tuk-haur* (run-down water) denotes the rainy season *w*hen monsoon water descends from the mountain, whereas *tuk-reak* (water dry-up) indicates the dry season. In the lower fields, the seasons are known as *tuk-laeng* (flood-rising) and *tuk-choh* (flood reversal). The beginning of the planting season is a time to pray to *neak-ta* for rain and favorable weather to start preparing the *sre* (rice field). Meanwhile, the cultivation season culminates with

harvesting and the Ok-Om-Bok festival to thank the moon being for good crops. In traditional Khmer homesteads, cultivation of the annual rice crop is adjusted to natural water conditions and does not require large-scale hydraulic interventions. Farmers grow wet rice and gather fish in the rainy season; they grow drought-resistant plants and raise herd animals that graze on fields in the dry season. They make use of the *chamkar* throughout the year.

Conclusion: Learning from Traditional Khmer Water Management to Adapt to Global Warming

Traditional Khmer water management in Phnom K'to shows how local ecological knowledge frames the morphological identity and social meaning in collective processes of domesticating landscapes. All water elements and the cascading productive mosaics embody elements of Khmer cosmology and integrate daily water stewardship with cultural traditions. The cascading productive mosaics and water elements are not only functional but also symbolically tied to the Khmer worldview.

The Khmer vernacular landscape has been continually transformed by external influences, beginning with Vietnamese colonization during the Nguyễn Dynasty and continuing through the introduction of new technologies during the colonial period and centralized state interventions (Biggs 2012; Linh 2016). Key changes include deltaic canalization in the early nineteenth century, the construction of high dike systems since 1975, the expansion of rock mining in Phnom K'to since 1985, and, since 2020, extensive road widening and paving. Additionally, large-scale water reservoirs have been built since the 2010s to support intensive agricultural production. These interventions have resulted in severe environmental destruction, intensified water scarcity and the disruption of Khmer cultural identity. The language of the landscape has been altered, as traditional terminology has

^ Fig. 5 Landscape mosaics and flows with micro-topographical manipulation and plantation are labor-intensive and involve traditional kinship patterns. Phum Chai-day (Source: Linh Vu, 2024).

been replaced by engineering jargon, erasing the cultural significance embedded in the landscape.

Given these challenges, there is an urgent need for a radical shift in approach. Traditional water practices, which have been acknowledged as relevant in global warming discourse, can aid the development of innovative approaches, including those that involve integrating technology and social organization (Krupnik et al. 2018). Traditional knowledge that is deeply rooted in the Khmer landscape and everyday practices suggests the value of cooperative strategies and community stewardship that works in harmony with natural processes rather than by imposing conventional civil engineering solutions.

Policy Recommendations

- The design of water projects, programs and policies should be informed by a combination of current scientific knowledge – such as hydrological models that address the impact of global warming – and lessons from Khmer traditional water practices and knowledge. These traditional practices, which work with the forces of nature, offer an intelligent and culturally resonant alternative to conventional civil engineering approaches. In the case of the Khmer, the traditional water terminology and management are reflected in landscape morphologies and daily practices, promoting cooperation and sustainable water management through community stewardship.

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Vu Thi Phuong Linh is pursuing a PhD at KU Leuven. Her research concerns water urbanism and Indigenous practices in the Mekong Delta. She has lectured at Yersin University (Đà Lạt, Vietnam) and has worked on urban resilience and sustainable development projects of the European Union, UNDP and the World Bank in Vietnam. She has also been involved in the Vietnamese government's Mekong Delta plans.

Contact: linh.vu@kuleuven.be

Bruno De Meulder teaches urbanism at KU Leuven, and is the current program coordinator of MaHS and MaULP and the vice-chair of the Department of Architecture. With Kelly Shannon and Viviana d'Auria, he formed the OSA Research Group on Architecture and Urbanism. He studied engineering architecture at KU Leuven, where he also obtained his PhD. He was a guest professor at TU Delft and AHO (Oslo) and held the Chair of Urban Design at Eindhoven University of Technology from 2001 to 2012. He was a partner of WIT Architecten (1994–2005). His doctoral research dealt with the history of Belgian colonial urbanism in Congo (1880–1960) and laid the basis for a widening interest in colonial and postcolonial urbanism. His urban design experience intertwines urban analysis and projection and engages with the social and ecological challenges that characterize our times.

Contact: bruno.demeulder@kuleuven.be

Kelly Shannon teaches urbanism at KU Leuven, is the program director of the Master of Human Settlements (MaHS) degree and the Master of Urbanism, Landscape and Planning (MaULP) degree and a member of the KU Leuven's Social and Societal Ethics Committee (SMEC). She received her architecture degree at Carnegie Mellon University (Pittsburgh), a post-graduate degree at the Berlage Institute (Amsterdam), and a PhD at the University of Leuven, where she focused on landscape to guide urbanization in Vietnam. She has also taught at the University of Colorado (Denver), Harvard's Graduate School of Design, the University of Southern California, Peking University and The Oslo School of Architecture and Design, among others. Before entering academia, Shannon worked with Hunt Thompson (London), Mitchell Giurgola Architects (New York), Renzo Piano Building Workshop (Genoa) and Gigantes Zenghelis (Athens). Most of her work focuses on the evolving relation of landscape, infrastructure and urbanization.

Contact: kelly.shannon@kuleuven.be