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Chapter 24

Wetland Creation in Hong Kong

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In nature, wetlands are formed only by natural forces over a relatively long period of time. Can humans mimic nature to recreate wetlands? Is wetland creation/restoration a way ahead for wetland conservation?

Abstract. Creation and restoration of wetlands have in recent years gained momentum over many parts of the globe. The trend has come to Hong Kong. Wetlands in Hong Kong are mostly created or restored simply as a result of development activity (e.g. residential developments, road and railway construction). In essence, a wetland is gained for each wetland lost. Many advocate that wetland mitigation is a promising approach in resolving the long-standing conflict between conservation and development parties, whilst some criticise it as oversimplification of complex natural wetland ecosystems. Of critical importance is whether both the functions and structure of a natural wetland can be replicated and recreated. To take Hong Kong as a case study, this chapter aims to critically discuss: (i) the need and state of wetland creation/restoration; (ii) the approach to, and characteristics of wetland mitigation; and (iii) the specific challenges of wetland recreation and restoration.

24.1. The Need to Create/Restore Wetlands

Wetlands were once regarded as wastelands, and even public health hazards for being a source of mosquitoes, flies, snakes, unpleasant odours, and disease. In the past, many thought that wetlands were places to avoid, or to drain and fill. Following an important proclamation of the Ramsar site of Mai Po and Inner Deep Bay in 1995 which signified an official recognition of wetlands by the Hong Kong SAR Government, the importance of wetlands is gaining increased recognition. People now acknowledge that wetlands are vanishing too rapidly, that they are important and that those remaining should be preserved, and those that have been destroyed or damaged should be restored and recreated. Wetlands in Hong Kong are mostly threatened by development, pollution and overuse

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(Lau, 2002). By far the greatest threat is environmentally irresponsible development.

Wetland creation and restoration is intended to help resolve contentious situations where development pressures conflict with wetland conservation efforts. This concept is gradually gaining acceptance and support, which is indicated by the growing number of wetland projects in Hong Kong. The decision to recreate or restore wetlands would bring with it a wide range of benefits, including provision of habitat for rare species and for rich biodiversity, flood abatement, soil conservation and pollutant removal from water, and an array of recreational values. Creation of wetland habitats is increasingly being used as an essential tool by conservationists in many parts of the world who wish to reverse the trend of habitat loss. However, it is of increasing concern that wetland creation in Hong Kong will be used as a tool by developers to push land development further into remote countryside, mostly in the New Territories.

24.2. Some of the Last Remaining Wetland Paradise in Hong Kong

Ironically, wetlands are often located where someone wants to build (e.g. housing development of Fairview Park, Royal Palms and Palm Springs). The New Territories can claim to be amongst the last remaining sources of wetlands in Hong Kong (Fig. 1). In the northwest, they are at Tin Shui Wai, Nam Sang Wai, Lut Chau, Tam Kon Chau, Mai Po, Pak Hok Chau, Lin Barn Tsuen, Wing Kei Tusen, Fung Lok Wai, Lok Ma Chau, Ma Tso Lung, San Tin and Long Valley. In the northeast, they are at Luk Keng, Nam Chung, Kuk Po, Sam A Chung, Sam A Tsuen and Sha Lo Tung. Some other wetlands can be found in the outlying islands, such as Pui O and Penny's Bay in Lantau Island.

24.3. Some Current Wetland Mitigation Projects in Hong Kong

In the past few years, there is a growing trend for wetlands to be built alongside developments in Hong Kong (e.g. Hong Kong Wetland Park; West Rail Wetland Creation; Kam Tin Bypass; Lok Ma Chau Rail Station). On-site or off-site wetlands have been enhanced so that the total wetland value is increased. Figure 2 shows the locations of current wetland projects in Hong Kong. Table 1 shows some of the key ongoing wetland mitigation projects in Hong Kong.

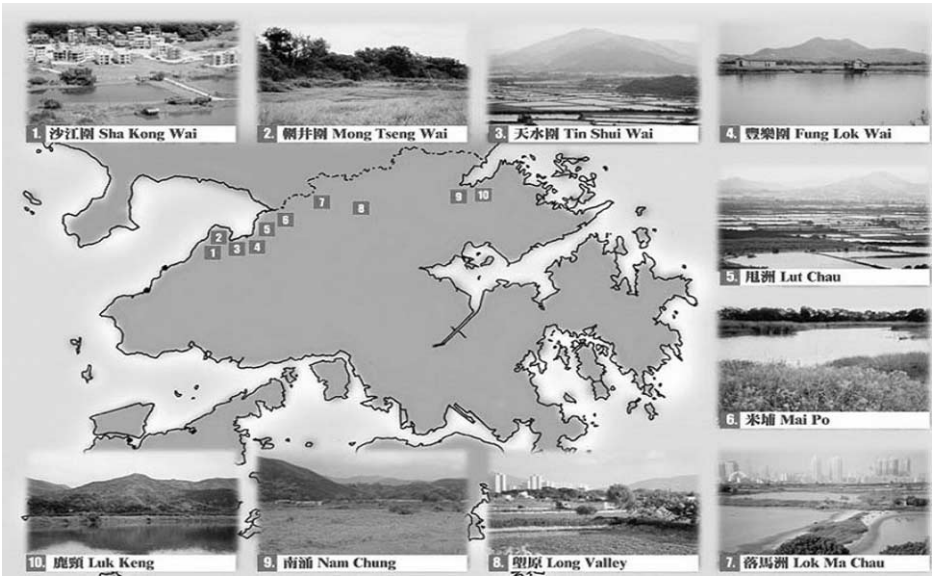

Figure 1: Some wetlands in the New Territories, Hong Kong.

24.4. Wetland Mitigation Approach

Wetland mitigation aims to offset the loss of wetland and wetland functions. More specifically, wetland mitigation aims to rectify the adverse impacts on the affected

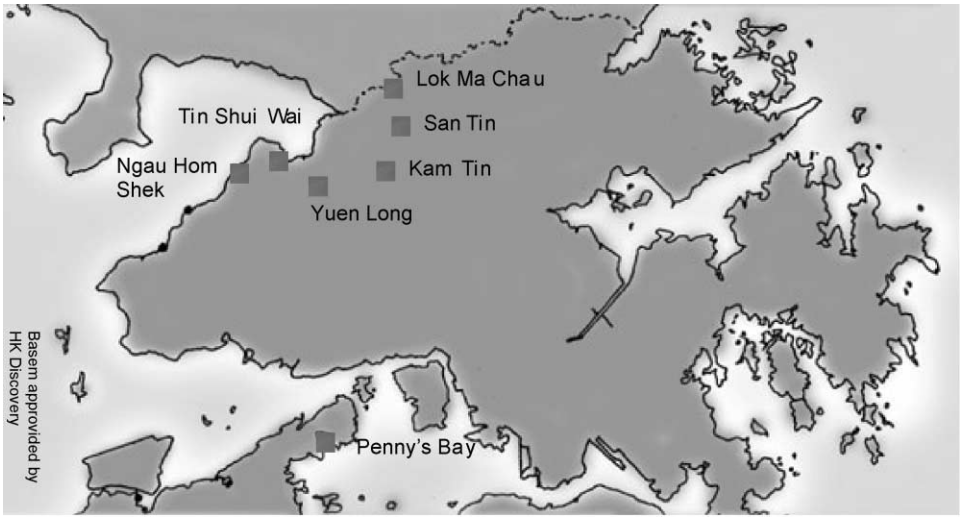

Figure 2: Location of current wetland projects in Hong Kong.

Table 1: Wetland projects in Hong Kong.

Location of the wetland	Project	Method	Development purpose	Main use of the wetland
Tin Shui Wai	Hong Kong Wetland Park	Creation and restoration	Urban development	Education, sightseeing and conservation
Lok Ma Chau	Lok Ma Chau Station Wetland Creation	Creation and enhancement	Transport	Conservation and water quality polishing
Lok Ma Chau	Sheung Shui to Lok Ma Chau Spur Line	Creation and enhancement	Transport	Conservation and fishery
Kam Tin	West Rail Wetland Creation	Creation and restoration	Transport	Conservation
Kam Tin	Kam Tin Bypass	Creation and restoration	Transport	Conservation
San Tin	San Tin Created Wetland	Creation and enhancement	Flood protection	Flood control and conservation
Tai Tam	Rare/Protected Species Transplantation, Hong Kong Disneyland	Creation	Theme park	Conservation
Yuen Long	Yuen Long Floodway Wetland Creation	Creation	Drainage	Water quality polishing, flood control

wetland environment by *restoration, enhancement or creation* (Kusler & Kentula, 1990). It is widely recognised that wetlands have important environmental, social, cultural and economic benefits, and some of the benefits are irreplaceable. Wherever possible, development should be avoided if it is to have significant impact on wetlands in Hong Kong. Where development is permitted due to overriding social or other benefits, impact should be minimised; where the impact is more extensive, wetland mitigation is required. Targeted mitigation works, with clear objectives carried out by experienced ecologists and contractors, can help to offset wetland loss thus providing an interface between expanding economy and development, whilst maintaining wetland values and functions. It is hoped that dramatic and controversial issues, such as Long Valley and Sha Lo Tung, can be avoided in the future.

In many countries (e.g. the US and the UK), wetlands have been created, restored or enhanced to encourage habitat replacement for years (Merritt, 1994). For each wetland that is impacted by a development project, the proponent of the project (be it a private company or the government) must restore the affected wetland after the project has been completed. If the wetland has been destroyed, then they are required to enhance the value of another existing wetland or create a new one (Garbisch, 1986). The goal in wetland mitigation is to attain a no net loss of wetland functions and values.

24.5. Suggested Mitigation Sequence

In all wetland projects, a three-step mitigation process, i.e. Avoidance → Minimisation → Compensation, should be used (Kusler & Kentula, 1990).

1. *Avoidance* — preservation of existing high quality habitat should take precedence over restoration or creation. Avoidance of impact is the first priority in any development project and alternative site or design for the project should be sought to prevent any wetland loss. It must be stressed that trading existing critical habitat for wetland restoration or creation should always be avoided unless the benefits of the trade-off outweigh the benefits of maintaining the critical existing habitat.
2. *Minimisation* — when there is no alternative to a development, adverse effects on wetland should be minimised.
3. *Compensation* — compensatory mitigation is required, as a last resort, for any unresolved impacts which remain after all appropriate and practical minimisation has been implemented. The emphasis is "no net loss" (National Research Council, 2001). Compensation should focus upon replacing specific wetland functions that have been lost as a result of the development. Both wetland functions and area are important.

Through mitigation measures, critical wetland habitats can be preserved. It is easier to restore a natural wetland than to create a brand new one. The success of mitigation banking is dependent on numerous variables (Hruby & Brower, 1994). It can take 10 years for a wetland to become established, however, it may take only several (e.g. three–five) growing seasons for a wetland to become established in subtropical Hong Kong as it has adequate rainfall and a long growing season. The fact that a mitigation bank can be created before the impact occurs allows time for the new or enhanced area to become effective, thereby eliminating any time without a wetland.

When a mitigation wetland site is chosen and planned, its location should be close to the impacted area (Kusler & Kentula, 1990). If an off-site location must be selected away from the impacted area, it should be located within the same hydrographic region. The reason for getting closer to the impacted site is that certain species, which are local or regional, is likely to be lost if the mitigated site is outside that particular area or region and thus outside their ecological range and tolerance. If a species has particular requirements with reference to geographical variation, the species would be susceptible to elimination. For example, if a species has a diet of very specific plants that can grow only at certain altitudes; the species would have limited or no areas to go to and could eventually die off, causing a loss in species richness and subsequently biodiversity for that area/region (Kusler & Kentula, 1990).

As a rule, wetland mitigation should not be carried out at the expense of high quality upland habitats which may have high wildlife or other values, but lack protection (Erwin, 1990).

"Type for type" approach in wetland habitat replacement should always be considered (Erwin, 1990; USACE, 1998). This approach tends towards restoration of a specific wetland habitat including soils, plants and wildlife. However, to advocate complete restoration of any type of wetland system in minute detail, is both impossible and unrealistic. This approach will not be appropriate when such replacement is not technically feasible, or when another type of wetland has greater value or more regional significance.

24.6. Wetland Replication

It is worth mentioning that wetland mitigation is NOT wetland replication as many may argue (Kusler & Kentula, 1990). No two wetlands are exactly the same. Unlike the cloned sheep Dolly, we cannot "clone" a wetland. In fact, wetland mitigation is all about conversion of a wetland from a disturbed or altered condition to a previously existing or similar condition.

The experiences from many wetland restoration projects in the US and the UK show that it is impossible to restore wetland ecosystems exactly as they were in terms of their complexity and variation in physical appearance, species composition and ecological processes (Keddy, 2000). This can never be achieved 100%, partly because wetlands are dynamic ecosystems, and partly due to lack of pre-impact baseline data. Most importantly, for economic, political, technical or practical reasons, compromises in the design/implementation of many wetland projects have to be made.

24.7. Challenges in Wetland Mitigation in Hong Kong

The experience of wetland creation and restoration to date in Hong Kong indicates that there are some challenges ahead, including:

24.7.1. Lack of Relevant Policy

Whilst there is a will to mitigate the effects of developments on wetlands, the capability is not always present. In Hong Kong, there is no standardised, consistent approach to wetland mitigation.

24.7.2. Lack of Clear Mitigation Goals and Objectives

There are many functions and values of wetlands, and these have to be clearly recognised before they can be restored or re-created under a mitigation scheme. Without clearly stated goals and objectives, projects lack direction (Erwin, 1990). Many mitigation projects lack clear goals and objectives so that crucial factors in their design could be missed, and the success of the mitigation may never be assessed. If the goal of a wetland project is quality enhancement of wildlife habitat, then the main objective is to improve habitat value for wetland birds. The failure to identify goals may suggest that the majority of the wetland projects were not designed by competent landscape architects. Most landscape architects have very little training in wetland ecology especially in specifying what type of wetland systems would be suitable for any particular form of wildlife, such as waterfowl. In reality, a range of experts in hydrological and civil engineering, soil science and landscape architecture, as well as constructed wetland specialists and wetland plant ecologists should be brought together for any wetland project. Of critical importance is the need to specify both immediate (e.g. temporary buffer area) and ultimate (e.g. wildlife habitat, education, research) goals.

24.7.3. Lack of Comprehensive Monitoring Methods and Requirements

In wetland creation/restoration projects, whether a project is a success or not is always the centre of argument between developers and conservationists. With clearly defined goals and objectives, associated performance standards should also be clearly stated (Erwin, 1990). An example can be the number of breeding pairs of several key wetland bird species (e.g. Great Egrets, Little Egret) that are to use the site after the completion of creation/restoration works. Quite often there is insufficient or complete absence of monitoring requirement for wetland projects. In most cases, monitoring methodology, which should be used for assessing the performance standards, is poorly defined. For some wetland projects, the monitoring methodology is inappropriate and unsatisfactory.

24.7.4. Lack of Reference Wetlands

For wetland creation/restoration projects, reference wetlands are used as a standard for measuring wetland ecosystem functions, such as enhancing value of wildlife habitat (see Brown, 1991). Wildlife populations are sampled and compared with those of reference wetlands. It is very difficult to locate a reference wetland which has suffered relatively little human disturbance in Hong Kong. Most of our wetlands have been impaired in one way or another by human influence, mostly in the form of direct impact from habitat development by either filling or related activity due to development pressure, or by altering the hydrology by traditional wet-farming activities over the past few decades, thus preventing them from acting as quality reference wetlands.

24.7.5. Lack of Appropriate Success Criteria

Success criteria, if any, may be predetermined and chosen inappropriately by engineers and/or landscape architects. A natural wetland ecosystem functions in a dynamic way, including a combination of biological, chemical and physical variables. Simple criteria may be chosen to signify success of a wetland project. If a wetland is created for the purpose of holding water and supporting wetland birds, the evaluation of success is simple and straightforward, and it is more likely to be a successful project. If we aim to recreate all the functions of a natural wetland then the project will almost certainly fail. Success criteria must be realistic, achievable, and defined carefully and appropriately with the involvement of qualified wetland specialists.

24.7.6. Lack of Basic Ecological Knowledge Regarding Natural Wetlands in Hong Kong

Hong Kong has very few, if any wetlands that have not been impacted by man. We know relatively little about aquatic plant communities native to the region, or how they are sustained. More ecological information is required about wetlands in Hong Kong or south China to establish the requirements of wetland plant and animal species so that these can be considered when designing new wetlands.

24.7.7. Lack of Local Qualified Expertise

The greatest obstacle to wetland mitigation and conservation in Hong Kong is the severe shortage of qualified local wetland specialists. There is no "Cook Book" approach for wetland restoration or creation (Kentula, 2003). Building wetland is not rocket science, but successful wetland mitigation depends greatly upon expertise in planning, project design and careful on-site expert supervision. Inappropriate design criteria are often associated with the failure of wetland projects. It is worrying that the majority of environmental consultants who play the role of "Constructed Wetland Specialist" for wetland projects in Hong Kong have very little training and experience in wetland ecology, creation and restoration. It is of increasing concern that some wetlands which are being created or restored (e.g. Wetland Creation Project in Kam Tin, Ming Pao, 2002) may not fully compensate for the loss of those which they are supposed to replace.

24.7.8. Inappropriate Scale and Location

Individual small creation or restoration projects targeting a single piece of wetland can be ecologically valuable. However, in some cases individual wetland patches are too small and they are isolated from one another, leading to drastic reduction of the potential ecological value being created (Kusler & Kentula, 1990). To avoid missing out connectivity, a rule of thumb is that whenever possible the minimum acceptable scale for wetland creation/restoration planning should be in a watershed context. Created or restored wetlands are more likely to be successful if their functions are considered in terms of their role in the overall surrounding watershed. Wetlands which are located at a hydrologically and ecologically appropriate place may favour the establishment and maintenance of wetland functions and values. In addition, wetland projects should incorporate upland habitats to form an inter-connected ecosystem.

24.7.9. Lack of Long-Term Commitment for Created/Restored Wetlands

A matter of great concern is the apparent lack of a follow-up plan in connection with the created/restored wetland. Where successful wetland creation is recognised, it is questionable as to whether long-term continuous management, which is costly would be considered, undertaken and strictly enforced. Water quality and level have to be monitored and regulated. Vegetation management is also a must to avoid the dominance of a few species and to control the invasion of unwanted exotic, aggressive species, such as *Phragmites* spp., *Echinochloa* spp. and *Brachiaria* spp.

24.7.10. Rigid Specification of Civil Engineering Projects

Most wetland creation projects in Hong Kong are considered as parts of the landscape section of civil engineering projects, not ecological. Strict contractual agreements have to be adhered to. In wetland mitigation, on-site flexibility in habitat construction is crucial, with habitat designers on site constantly being aware of opportunities for enhancements in ground profiling, surface treatments and planting layouts which go beyond the base plans. A wetland creation project cannot be carried out using traditional construction methods and contracts. However, the great skills amongst our construction industry workers can be harnessed and applied to the task with good effect if they are properly instructed by experienced wetland creation staff and ecologists, and with a new type of contractual arrangement. Bull-dozer operators, for example, often need guidance with regard to critical elevation requirements and micro-profiling of the ground surface. Labourers need guidance with regard to plant handling and planting requirements.

24.8. Conclusion

Despite the fact that a number of wetland projects are underway, in technical terms, wetland creation and restoration is still in its infancy in Hong Kong. Wetland mitigation remains a challenge to conservationists and wetland specialists involved in creating, restoring or enhancing dynamic, complex wetland ecosystems, which would otherwise be formed by natural forces. There is plenty of room for improvement of the wetland mitigation approach and technique. Extra scientific and technical efforts should be put into improving wetland mitigation, covering all phases of project planning, design, construction, and operation and maintenance.

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References

Brown, M. T. (1991). *Evaluating constructed wetlands through comparisons with natural wetlands: Corvallis, Oreg*, U.S. Environmental Protection Agency, Environmental Research Laboratory, EPA/600/3-EPA91/058, p. 37.

Erwin, K. L. (1990). Freshwater marsh creation and restoration in the southeast. In: J. A. Kusler, & M. E. Kentula (Eds), *Wetland creation and restoration: the status of science* (pp. 233–248). Island Press, Washington.

Garbisch, E. W. Jr. (1986). *Highways and wetlands-compensating wetland losses: McLean, Va*, Federal Highway Administration, Office of Implementation, Contract Report DOT-FH-11-9442, p. 60.

Hruby, T., & Brower, C. (1994). *Guidelines for developing freshwater wetlands mitigation plans and proposals, ecology publication #94-29*. Washington State Department of Ecology, Washington.

Keddy, P. A. (2000). *Wetland ecology: principles and conservation*. Cambridge University Press, Cambridge, p. 614.

Kentula, M. E. (2003). *Restoration, creation, and recovery of wetlands*, United States Geological Survey Water Supply Paper 2425.

Kusler, J. A., & Kentula, M. E. (1990). *Wetland creation and restoration: the status of science*. Island Press, Washington, p. 591.

Lau, S. S. S. (2002). Threats to our wetlands and wetland birds. *Hong Kong Discovery*, **11**, 22–26.

Merritt, A. (1994). *Wetlands, industry & wildlife: a manual of principles and practices*. The Wildfowl & Wetlands Trust, Gloucester, p. 182.

National Research Council (2001). *Compensating for wetland losses under the Clean Water Act*. Committee on Mitigating Wetland Losses, Board on Environmental Studies and Toxicology, Water Science and Technology Board, p. 348.
USACE. (1998). *Guidelines on the establishment and operation of wetland mitigation banks in Georgia*. U.S. Army Corps of Engineers, Savannah, p. 19.

Glossary[1]

Wetland restoration	to return a wetland from a disturbed condition to a previously existing or similar condition.
Wetland enhancement	to increase some functions of an existing wetland.
Wetland creation	to build new wetlands by converting non-wetlands into wetlands.
Wetland functions	the driving forces which maintain wetland ecosystems, e.g. hydrology, physical processes (e.g. sediment movement), biological processes (e.g. competition, predation), and biogeochemical processes (e.g. nutrient cycling).
Wetland values	such as use value (e.g. recreation), social value (e.g. water quality improvement, flood protection), wildlife value (e.g. breeding, rearing and feeding ground).
A hydrographic region	is defined as a geographic area drained by a major stream, or an area composed of a drainage system made up of streams and lakes.
Goals	are defined as general statements about desired project outcomes.
Objectives	are defined as specific statements about desired project outcomes.
Performance standards	are observable or measurable attributes that can be used to determine if a project meets its intended objectives.

[1] See Kusler & Kentula (1990) and Merritt (1994).