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Data Paper 資料論文

**Dataset of the vascular plants survey of the cemetery
in Miaoli County, Taiwan**

苗栗公墓維管束植物調查資料集

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Abstract

To investigate the distribution of threatened plants in Miaoli cemeteries, we conducted a survey of vascular plants and their phenological data from May 2017 to December 2020, and a total of 3,025 occurrence data were recorded, including, 114 families and 594 species of plants. Among them, there are 9 species classified as Nationally Critically Endangered (NCR), 19 as Nationally Endangered (NEN), 13 as Nationally Vulnerable (NVU), 9 as Nationally Near Threatened (NNT), and 9 with Data Deficient (DD). In addition to rare plants, many alien species have also been discovered, with high occurrence frequency and occupying large areas. Some have already caused harm, such as *Bidens pilosa* var. *radiata*, *Mikania micrantha*, *Ageratum houstonianum*, *Praxelis clematidea*, and *Megathyrsus maximus*.

Key words: Sampling event, Research, Vascular plant, Cemetery, Phenology

摘要

為調查受脅植物於苗栗公墓之分布，自 2017 年 5 月起至 2020 年 12 月，調查苗栗縣內公墓的維管束植物分布位置及物候資料，共記錄 3,025 筆資料，114 科 594 種的植物，其中國家極危（NCR, Nationally Critically Endangered）9 種，國家瀕危（NEN, Nationally Endangered）19 種，國家易危（NVU, Nationally Vulnerable）13 種，國家接近受脅（NNT, Nationally Near Threatened）9 種，資料缺乏（DD, Data Deficient）9 種，除珍稀植物外，亦發現許多外來種植物，出現頻度高且占大面積，有些已造成危害，如大花咸豐草 (*Bidens pilosa* var. *radiata*)、小花蔓澤蘭 (*Mikania micrantha*)、紫花藿香薊 (*Ageratum houstonianum*)、貓腥草 (*Praxelis clematidea*)、大黍 (*Megathyrsus maximus*) 等。

關鍵詞：調查活動、調查、維管束植物、公墓、物候

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Introduction

Miaoli County features a diverse topography, including coastal areas, hills, plateaus, and mountainous regions, with hills being the most prominent feature. The western hills extend from the southern boundary of the Taoyuan and Hsinchu plateaus, with the terrain gradually sloping from east to west. The county's major rivers originate in the eastern mountains and eventually flow westward into the Taiwan Strait. These rivers, arranged from north to south, include Zhonggang Creek, Houlong Creek, Xihu Creek, and Daan Creek. They traverse various terrains, creating a complex landscape and diverse ecosystems that provide suitable habitats for flora and fauna (Zeng *et al.* 1998). This study focuses on the cemeteries in Miaoli

County, which are primarily located in plains and hilly areas, with altitudes ranging from 3 to 643 meters above sea level. The region has a subtropical monsoon climate, with an average annual temperature of 20 to 22°C and an annual rainfall of approximately 1,600 millimeters. These climatic conditions are conducive to the growth and reproduction of plant communities. Due to cultural practices, cemetery areas are generally less disturbed by human activities, making them potential refuges for many native threatened plants. Previous surveys of botanical ecological resources in Miaoli County lacked accurate temporal and spatial distribution information, especially concerning the distribution and conservation of threatened plant species, necessitating

a comprehensive investigation. In order to understand the ecological vegetation status of these areas, a survey of plants in cemeteries was conducted from May 20, 2017, to December 26, 2020. Threatened plants were the main survey targets, and the cross-line survey method was adopted. Since the cemetery was very small, we then walked by following the trail area for all investigations. We took photos and uploaded them to the Taiwan Vascular Plant Survey and Phenology Observation (<https://plant.tbn.org.tw/>). This platform records the time, location, plant list, and phenology, followed by reviewing it every season to collect the growth and phenology status of plants in different seasons. As this was an opportunistic observational survey, common species and plants without flowers or fruits were not documented, resulting in a total of 3,025 records with 594 species from 114 families (Chenet *al.* 2017) (Table 1). Poales is the order with the highest accumulated number

of occurrences (556), followed by the Fabales (537), Asterales (346), Rosales (187), and Malpighiales (184) (Table 1). Among them, the dataset also included 9 Nationally Critically Endangered (NCR) species, 19 Nationally Endangered (NEN) species, 13 Nationally vulnerable (NVU) species, 9 Nationally near threatened (NNT) species, and 9 data deficient (DD) species (Editorial Committee of the Red List of Taiwan Plants 2017). Besides rare plants, many alien species were also identified, with high frequency and extensive coverage, such as *Bidens pilosa* var. *radiata*, *Mikania micrantha*, *Ageratum houstonianum*, *Praxelis clematidea*, and *Megathyrsus maximus* (Miaoli County Natural Ecology Society 2016).

Table 1 List of orders, families and numbers of species and plants in the dataset

表 1 資料集內涵蓋的植物目別、科別、物種數及觀察數量

Order	Family	No. of Species	No. of occurrences
Alismatales	Araceae	2	6
Apiales	Apiaceae	3	13
	Araliaceae	6	11
	Pittosporaceae	1	1
Aquifoliales	Aquifoliaceae	1	4
Arecales	Areaceae	2	10
Asparagales	Amaryllidaceae	2	16
	Asparagaceae	2	13
	Hypoxidaceae	2	9
	Iridaceae	1	5
	Orchidaceae	2	4
Asterales	Asteraceae	57	336
	Campanulaceae	2	10
Austrobaileyales	Schisandraceae	2	6
Boraginales	Boraginaceae	1	14
	Cordiaceae	1	4
	Ehretiaceae	2	18
Brassicales	Brassicaceae	5	14
	Cleomaceae	2	3
Caryophyllales	Aizoaceae	1	2
	Amaranthaceae	10	27
	Basellaceae	2	5
	Cactaceae	2	2
	Caryophyllaceae	5	11
	Droseraceae	1	3
	Molluginaceae	2	2
	Phytolaccaceae	1	1
	Polygonaceae	9	30
	Portulacaceae	2	9
Talinaceae	1	1	

Celastrales	Celastraceae	1	1
Commelinales	Commelinaceae	2	10
Cornales	Cornaceae	1	1
Cucurbitales	Cucurbitaceae	5	29
Dioscoreales	Dioscoreaceae	3	12
Dipsacales	Adoxaceae	2	3
	Caprifoliaceae	1	10
Equisetales	Equisetaceae	1	4
Ericales	Actinidiaceae	1	3
	Ebenaceae	1	1
	Pentaphragaceae	1	1
	Primulaceae	5	26
	Styracaceae	1	2
	Symplocaceae	1	23
Fabales	Fabaceae	69	528
	Polygalaceae	2	9
Gentianales	Apocynaceae	6	24
	Loganiaceae	1	2
	Rubiaceae	16	61
Geraniales	Geraniaceae	1	3
Gleicheniales	Gleicheniaceae	1	2
Lamiales	Acanthaceae	2	8
	Lamiaceae	11	70
	Linderniaceae	2	4
	Oleaceae	1	1
	Orobanchaceae	3	26
	Paulowniaceae	1	1
	Plantaginaceae	2	6
	Scrophulariaceae	2	3
	Verbenaceae	2	21
Laurales	Lauraceae	6	30
Liliales	Liliaceae	1	17
	Smilacaceae	1	19

Malpighiales	Euphorbiaceae	15	84
	Hypericaceae	1	1
	Malpighiaceae	1	1
	Passifloraceae	1	7
	Phyllanthaceae	19	83
	Salicaceae	2	4
Myrtales	Lythraceae	1	25
	Melastomataceae	1	12
	Myrtaceae	2	2
	Onagraceae	4	17
Oxalidales	Elaeocarpaceae	1	1
	Oxalidaceae	2	14
Pandanales	Pandanaceae	1	2
Piperales	Aristolochiaceae	1	4
Poales	Cyperaceae	30	131
	Poaceae	99	423
	Typhaceae	1	2
Polypodiales	Blechnaceae	2	2
	Dennstaedtiaceae	3	11
	Lindsaeaceae	1	2
	Pteridaceae	5	8
	Thelypteridaceae	3	3
Ranunculales	Menispermaceae	3	37
	Papaveraceae	1	1
	Ranunculaceae	3	27
Rosales	Cannabaceae	5	31
	Elaeagnaceae	1	9
	Moraceae	7	46
	Rhamnaceae	2	6
	Rosaceae	17	79
	Ulmaceae	2	7
	Urticaceae	5	9
Santalales	Santalaceae	1	7

Sapindales	Anacardiaceae	5	30
	Meliaceae	1	14
	Rutaceae	3	12
	Sapindaceae	1	11
	Simaroubaceae	1	1
Saxifragales	Altingiaceae	1	4
	Crassulaceae	1	1
Schizaeales	Lygodiaceae	1	14
Solanales	Convolvulaceae	13	54
	Solanaceae	4	11
sparagales	Asphodelaceae	1	5
Vitales	Vitaceae	9	78
Zingiberales	Cannaceae	1	1
	Zingiberaceae	1	16
Zygophyllales	Zygophyllaceae	1	3
total		594	3,025

Project description

Title: Survey Data of Vascular Plant of Cemetery in Miaoli County

Study area description:

A total of 65 cemeteries in Miaoli County were surveyed (Fig. 1).

Taxonomic coverage

General taxonomic coverage description: Vascular plants

Taxonomic ranks:

Phylum: Tracheophyta

Common names: Vascular plants

Spatial coverage

General spatial coverage: Area of Miaoli County, Taiwan.

Coordinates: 24°15'14.4"N and 24°37'55.2"N Latitude; 120°34'26.4"E and 121°19'22.8"E Longitude

Temporal Coverage

May 20, 2017 – December 26, 2020

Methods**Method step description:**

1. Several survey routes were set up along the existing paths in each survey

cemetery. During the survey, mobile phones and the OruxMaps navigation program (<https://oruxmaps.com>) were used to record GPS track data.

2. A camera was used to capture occurrences of vascular plants.

3. After the investigation, the photos were added with GPS coordinates.

4. All records were uploaded to the Taiwan Vascular Plant Survey and Phenological Observation platform (<https://plant.tbn.org.tw/>).

5. Identification of each record's plant species was conducted by experts. After the record was identified, all data were made public to the "Taiwan Biodiversity Network database (<https://www.tbn.org.tw/>)".

Study extent description:

From May 2017 to the end of December 2020, a flora survey was conducted in 65 cemeteries in the county through multiple visits (Table 2).

Sampling description:

Description of the survey method:

Table 2 Profile of survey sites

表 2 調查公墓點說明

Site	Latitude	Longitude	Habitat description
SY_3	24.35379	120.74938	In addition to grasslands, there are some sandbars and secondary forests near streams, and the ground cover is mostly naturalized plants.
DU_1	24.44004	120.87648	Surrounded by broad-leaved mixed forests and bamboo forests, with more grasslands and fewer shrubs.
DU_9	24.37039	120.81833	The area has a smaller slope, mostly shrubs and grasslands, surrounded by broad-leaved mixed forests.
DU_8	24.36804	120.84292	There are many grasses and shrubs in the area surrounded by broad-leaved natural forests.
DU_12	24.36137	120.80359	The area is slightly sloping, with many grass lands and few shrubs in this area.
DU_10	24.34468	120.82877	There are fewer shrubs and more grass lands in this area, with Liyutan Reservoir to the south.
KG_9	24.47078	120.83394	There are many grass lands and fewer shrubs in the area. The south side is an orchard field, and the north side is bamboo forests and broad-leaved forests.
KG_11	24.51168	120.83970	There are fewer shrubs and more grasses in the area.
CN_2	24.68433	120.86073	There are a few small trees in the area, and half are shrubs and grasslands.
HH_1	24.49728	120.75736	It is located at the high point of the northern end of the Houyan Mountains. There are many shrubs and grassland slopes in the area.

XU_2	24.53326	120.75483	The terrain is flat, and half of the area is shrubs and grasslands.
JO_1	24.31888	120.83503	The area is divided equally into shrubs and grasslands.
JO_2	24.30143	120.83785	Most of the area has been abandoned, the ecology tends to develop towards large vines, and the environment has been degraded.
JO_3	24.33199	120.81092	The steep slopes facing south of the cemetery have been sprayed with herbicides on a large scale, and the naturalized species are dominant.
NC_2	24.62755	121.00178	Large herbs and shrubs have been grown in this area.
NC_3	24.63052	120.97917	More shrubs than grasslands have been observed in this area.
HL_n1	24.65776	120.80725	It is located in a small cemetery on an independent hill along the coast. The area is mostly grassland.
HL_21	24.58060	120.74217	There are more grasslands than shrubs in this area.
HL_22	24.60213	120.74653	It is located near the left bank of the Xihu River outlet. There are more grasslands than shrubs in this area.
HL_23	24.60227	120.73446	The terrain is open and flat, and there are more grasslands than shrubs in this area. The northeast wind is strong in this area.
HL_8	24.65914	120.78194	There are many coastal shrubs, vines, and herbaceous plants in this area, and wind-resistant and salt-tolerant shrubs and trees have been planted to prevent wind and sand fixation.
HL_11	24.62850	120.75983	It is a wide and open area located on a plain near the sea. There are more

			grasslands than shrubs in the area.
HL_n2	24.63838	120.76331	It is a wide and open area located on a plain near the sea. There are more grasslands than shrubs in the area.
HL_5	24.64501	120.81040	It is located on a small hill in the coastal plain. There are more shrubs than grasslands in the area.
HL_6	24.65869	120.81959	It is located on the front edge of the hills. There are more shrubs than grasslands in the area.
HL_n3	24.65320	120.80203	It is located on the southern edge of the hills. There are more grasslands than shrubs in the area.
YN_1	24.43134	120.65102	It is located on a hill. The area is divided into grasslands and shrubs.
YN_7	24.42505	120.68828	It is facing south with gradually descending hills. The area is divided into grasslands and shrubs.
YN_2	24.43118	120.65465	It is located on the northwest side of the hill. The area is divided into grasslands and shrubs.
YN_8	24.41524	120.68795	It is on the hills, and the area is divided into grasslands and shrubs.
YN_12	24.44756	120.63587	It is close to the seaside. There is a sand-fixing net with many windproof and sand-fixing plants planted there. There are many seaside plants and lawns in the area.
YN_10	24.39971	120.70151	It is located on the edge of a hill. The hinterland is not large, and half of the area is grasslands and shrubs.
YN_3	24.44424	120.66248	The cemetery area is manually weeded and burned, and the area is divided into grasslands and shrubs.
YN_5	24.44227	120.66550	The area is divided equally between

			grasslands and shrubs.
YN_6	24.43437	120.67209	The west side of the tomb area is close to Yuanli Creek and rice fields, and there are many shrub plants in the area.
MO_1	24.57657	120.80997	It is located on a steep hillside. There is a road running through the center of the cemetery from north to south. The area is divided into grasslands and shrubs.
MO_2	24.53644	120.80354	It is located on a hilly platform. The area has a variety of plant species, with half grasslands and half shrubs.
MO_3	24.52950	120.79093	It is on the hilly platform. There are scattered small tea gardens, ravines, grasslands, and half-grassland and shrub-covered areas in the area.
MO_5	24.58710	120.80130	It is surrounded by dense broad-leaved woods, a few bamboo forests, and mostly covered with shrubs.
SW_1	24.67339	120.95371	It is located on the hilly slopes on the left bank of Zhonggang Creek. The area is mostly covered with shrubs.
TF_n1	24.68670	120.95013	It is sloping down gently to the south on a hilly slope. The area is mostly filled with shrubs.
TA_1	24.34752	120.92778	The area has naturalized plants and a few shrubby plants.
TA_2	24.35952	120.94555	There are more grasslands than shrubs in the area.
TG_9	24.56602	120.71623	It is gently rising up the hillside on the right, with half grasslands and shrubs covering the area.
TG_29	24.50348	120.68594	There are some broad-leaved trees and bamboo forests in the area, and little grassland is covered.
TG_24	24.54503	120.70552	It is on the windward side of the

			hillside near the coast, and most of the area is covered by shrubs.
TG_8	24.49787	120.72051	It is gently descending to the hill slopes to the south, with a variety of plant species, including grasslands and shrubs.
TG_11	24.46179	120.71202	The center of the tomb area is high and slowly descends to the surrounding areas. Half grasslands and half shrubs have been covered in the area.
TG_19	24.52326	120.71997	There are half grassland and half shrubby plants observed in the area.
TG_18	24.50595	120.72325	It is located on a small platform on the hills of the left bank over the Tongxiao and shrubs in the area.
TG_14	24.44754	120.69779	It is a hilly valley with the upper reaches of the Aikouliiao River as its slope. The area is divided into half grasslands and half shrubs, with rich plant species.
TG_3	24.48797	120.69981	It is on a hillside, and the center of the cemetery is divided into north and south areas by a road and fields. The area is divided into grasslands and shrubs.
TG_5	24.46710	120.71833	It is on the hilly slope on the right bank of the Nanshi River. The area is divided into half grasslands and half shrubs, with many species.
TG_6	24.46633	120.67075	The hilly platform is crisscrossed by Jingzaipi Creek, and half of the area is covered by grasslands and shrubs.
TG_7	24.50081	120.70958	There are many grass lands in the area, and there are rice fields and fruit tree farming nearby.

TO_7	24.64214	120.83527	The hilly slopes have gullies and small pools. The terrain is complex. There are scattered broad-leaved trees, many shrubs, and grasslands in the area.
TO_5	24.64573	120.86486	It is a small valley. There is a small area of abandoned farmland, shrubs, grassland, and two small pools. There are many shrubs and vines in the area.
ST_4	24.53809	120.92214	It is located on a gently rising hillside on the right bank of the Dadongshi River. There are many naturalized plant grasslands in the area.
TG_9	24.42487	120.80662	It is located on river terraces. The terrain is gentle, with many grasslands and dominant naturalized plants.
TG_1	24.49810	120.78882	It is a gently rising hillside, with few shrubs and many naturalized grasslands.
TG_5	24.48096	120.77312	It is on the gently rising hillside. Herbicides are suspected to have been used in the area, resulting in habitat degradation and rapid growth of naturalized plants.
TG_6	24.46970	120.80394	It is on the left bank of the river terrace. The soil in the area is mostly small gravel grassland, with mostly naturalized plants and simple species.
TF_2	24.66079	120.88676	The gently descending slopes are hilly. There are many dominant naturalized plants in the area, covered by half shrubs and half grassland plants.
TW_11	24.58801	120.89934	It is on the left bank of Mingde Reservoir, and the hilly slopes gently descend to the north. There are many shrubs and grasslands in the area.

Character encoding: UTF-8

Format name: Darwin Core Archive format

Format version: 1.5.

Distribution: https://ipt.taibif.tw/archive.do?r=miaoli_cemetery_plants
<https://www.gbif.org/dataset/af97275b-4603-4b87-9054-c83c71c45143>

Preferred identifier: <https://doi.org/10.15468/6gayzd>

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Acmella repens (Asteraceae), a newly naturalized plant in Taiwan

臺灣新歸化植物—伏生金鈕扣

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Abstract

A newly naturalized species from the Northern part of Taiwan, *Acmella repens* (Walter) Rich., native to tropical and subtropical regions of the Americas, is reported herein. This species is distinguished from other *Acmella* species in Taiwan by its conspicuous ray flowers, with limb lengths of 3–6 mm, and its predominantly decumbent or prostrate stems.

Key words: Flora, Formosa, Naturalized species, Taxonomy

摘要

本文報導新歸化於臺灣北部的菊科植物—伏生金鈕扣 (*Acmella repens* (Walter) Rich.)。該種原生於熱帶與亞熱帶美洲，其形態與其他臺灣已記錄的金鈕扣屬物種相比，伏生金鈕扣的舌狀花相當顯眼，花瓣長度達 3–6 mm，而莖通常伏生或匍匐生長。

關鍵詞：植物誌、臺灣、新歸化種、分類學

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Introduction

The genus *Acmella* comprises approximately 35 species distributed across tropical and subtropical regions worldwide (POWO 2024). In Taiwan, the genus includes one native species, *A. paniculata* (Wall. ex DC.) R. K. Jansen, one widely cultivated species that occasionally escapes, *A. oleracea* (L.) R. K. Jansen, and three naturalized species—*A. brachyglossa* Cass., *A. ciliata* (Kunth) Cass., and *A. uliginosa* (Sw.) Cass. (Chung *et al.* 2007; Chung

et al. 2008). In this study, we report that *A. repens* (Walter) Rich. is a newly naturalized species in Taiwan. A detailed morphological description, photographic illustrations, and a revised key to the *Acmella* species in Taiwan are also provided.

Key to the *Acmella* species in Taiwan:

- 1a Capitula discoid, without ray florets2
- 1b Capitula radiate, with 4–10 ray florets 3

- 2a Capitula cylindric, > 1 cm wide; phyllaries 15–18, triseriate; achenes without evident cork-like margins
..... *A. oleracea*
- 2b Capitula conical, < 1 cm wide; phyllaries 9–12, biseriate; achenes with evident cork-like margins
..... *A. paniculata*
- 3a Leaves broadly obtuse, truncate or shallowly cordate at base; achenes with evident cork-like margins *A. ciliata*
- 3b Leaves attenuate or cuneate at base; achenes without evident cork-like margins4
- 4a Stems usually decumbent to prostrate; ray limbs conspicuous, 3–6 mm long.....
..... *A. repens*
- 4b Stems usually ascending to erect; ray limbs relatively inconspicuous, 0.5–2 mm long.....5
- 5a Disc florets 4- or 5-merous, corollas light yellow or greenish; phyllaries 7–11, biseriate; disc achenes 1.5–3 mm long ...
..... *A. brachyglossa*
- 5b Disc florets 4-merous, corollas yellow

to orange; phyllaries 5–6, uniseriate; disc achenes 1.2–1.8 mm long..... *A. uliginosa*

Taxonomic treatment

Acmella repens (Walter) Rich. in Persoon, Syn. Pl. 2: 473. 1807. Fig. 1.

Basionym: *Anthemis repens* Walter, Fl. Carol. 211–212. 1788.

Type: Not stated in the protologue (Walter 1788).

Neotype: USA. Texas: Chambers County, “0.5 mi W of Exit 812 (jct Texas 61 on rte to Hankamer) along I-10E”, 10 June 1979, *Jansen & Harriman 665* (OS, barcode: 0000006 image!, isoneotypes: F, MO, NY, OSH, TEX, US), designated by Jansen (1985: 34).

Synonyms: See Hind (2011) for the whole synonymy.

Morphology: Perennial herbs, ca. 10–20 cm tall. Stems decumbent or prostrate, rooting at nodes, green to purple, pilose. Petioles 0.3–2.5 cm long, pilose, narrowly winged. Leaf-blades 1–4 × 0.4–3 cm, ovate-lanceolate

to ovate, base attenuate to truncate, apex acute, pilose on both surfaces, margin denticulate to coarsely dentate, sparsely ciliate. Peduncles 3.6–16 cm long, sparsely or pilose. Capitula radiate, 5.8–14 mm high, 4.5–13.5 mm in diam. Receptacle 3.2–10 mm high, 0.5–3 mm in diameter, apex acute to acuminate. Phyllaries 6–16, biseriate, herbaceous to membranous, pilose, margin ciliate, 2.5–6.8 × 0.6–3.5 mm. Paleae 2.5–4.5 × 0.3–1 mm, apex rounded to acuminate, stramineous. Ray florets 5–8, slightly to greatly exceeding the phyllaries; corollas 4–7 mm long, yellow to orange-yellow; tube ca. 1 mm long, pilose; limb 3–6 × 1.5–3.5 mm. Disc florets ca. 70–150; corollas 1.5–2.5 mm long, yellow to orange-yellow, 5-merous; tube 0.4–0.8 mm long; throat ca. 1 mm long; lobes 0.2–0.5 mm long and wide; stamens 0.8–1.2 mm long, anthers dark brown to black; style 1.2–2 mm long, the lobes 0.3–0.5 mm long. Achenes blackish, 1.5–2 mm × 0.6–0.8 mm, ciliate, lacking

a cork-like margin and shoulders; pappus of 1–2 subequal or unequal bristles, 0.2–0.5 mm long.

Distribution and ecology:

Acmella repens is native to tropical and subtropical regions of the Americas, ranging from the central and southeastern United States to Venezuela, Paraguay, and Cuba (Robinson 2006; POWO 2024). In Taiwan, two wild populations have been recorded, both located in New Taipei City. These populations were observed in open grassy areas, including a park and a trail. The phenology of *A. repens* in Taiwan remains insufficiently documented; however, it is presumed to flower year-round, similar to its behavior in its native range (Jansen 1985).

Additional specimens examined:

TAIWAN. New Taipei City: Ruifang District, Chinkuashih, 550 m elev., 9 May 2024, *Hsu 15523* (TAIF); Shulin District, Shanchia, 20 m elev., 11 May 2024, *Hsu 15531* (TAIF).

Etymology: The specific epithet

is likely derived from the species' repent growth form. We propose to use “伏生金鈕扣” as its Mandarin name.

Taxonomic remarks: The morphological characteristics and measurements described above are based solely on materials collected in Taiwan and exhibit a narrower range of variation compared to native populations (Jansen 1985). This species was originally identified as *Acmella oppositifolia* (Lam.) R.K. Jansen in Jansen's monograph on the genus *Acmella* (Jansen 1985). However, Robinson (2006) clarified that the original materials of *A. oppositifolia* (basionym: *Anthemis oppositifolia* Lam.) correspond to *Heliopsis buphthalmoides* (Jacq.) Dunal. Consequently, the next available name, *A. repens*, was then adopted (Hind 2011). Among the *Acmella* species in Taiwan, *A. repens* can be readily distinguished by its conspicuous ray flowers with 3–6 mm long limbs and its predominantly decumbent or prostrate stems.

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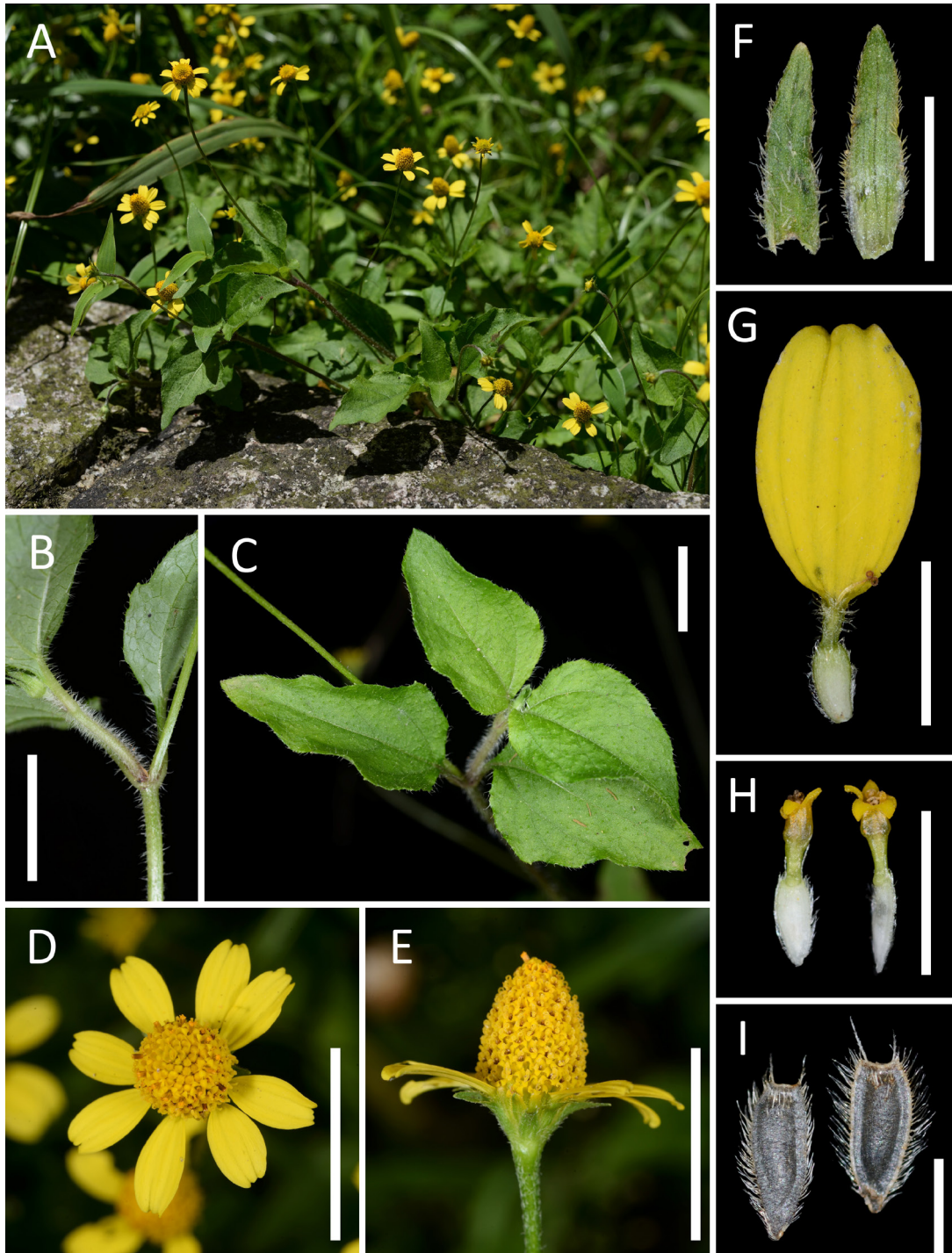


Fig. 1 Morphology of *Acmella repens* (from Hsu 15523). A. Habits. B. Stem. C. Leaves. D–E. Capitula. F. Phyllaries. G. Ray floret. H. Disc florets. I. Achenes. Scale bars: B–E = 1 cm; F–H = 3 mm; I = 1 mm.
圖 1 伏生金鈕扣的形態 (標本 Hsu 15523)。A. 植株全貌。B. 莖。C. 葉。D–E 頭花。F. 總苞片。G. 舌狀花。H. 管狀花。I. 瘦果。比例尺：B–E = 1 cm；F–H = 3 mm；I = 1 mm。

布朗薑（莎草科）於臺灣的再發現

Rediscovery of *Carex brownii* (Cyperaceae) in Taiwan

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摘要

近期野外調查發現一莎草科蘆屬植物，經標本及文獻比對後，為臺灣 90 年未曾再次被採集過的布朗蘆（*Carex brownii* Tuck.），本種於宜蘭縣大同鄉思源啞口再次發現。文中提供布朗蘆形態特徵、彩色圖片、臺灣之分布圖及建議。

關鍵詞：蘆屬、莎草科、重新確認、思源啞口、臺灣

Abstract

A recent field survey led to the rediscovery of *Carex brownii* Tuck., a sedge species unrecorded in Taiwan for over 90 years, located at Siyuan Yakou in Datong Township, Yilan County. The report includes details on its morphology, photographs, distribution in Taiwan, and related recommendations were also provided.

Key words: *Carex*, Cyperaceae, Rediscovery, Siyuan Yakou, Taiwan

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前言

莎草科（Cyperaceae）蘆屬（*Carex* L.）為臺灣維管束植物種類第一大屬（Hsieh 2002），第二版臺灣植物誌記錄有 60 種（Koyama *et al.* 2000），其中不乏多種紀錄稀少或是 1940 年後再無採集紀錄的種類。過

去蘆屬植物因形態相似、外形不醒目及鑑定所需之細微特徵不易觀察等因素，為人所忽略亦或造成鑑定上的困難，故鮮少有報導。近年，研究人員的努力及公民科學的興起，臺灣陸續有蘆屬相關的野外報導或研究成果發表，相繼新記錄或重新確認許多過往

資訊缺乏及狀態不明的蘆屬類群（許及鐘 2017；許 2020；許 2022；劉及陳 2022；Yang and Chen 2005；Liao *et al.* 2016）。在本文發表之前，臺灣的蘆屬中仍有布朗蘆（*C. brownii* Tuck.）、寬穗蘆（*C. metallica* H. Lév.）及鹼蘆（*C. scabrifolia* Steud.）已至少有 80 年未曾有相關報導（許 2020）。

根據《2017 臺灣維管束植物紅皮書名錄》最新的原生物種受威脅程度等級的類別，寬穗蘆及鹼蘆的被評估為區域滅絕（Regionally Extinct, RE），顯示在臺灣可能已無野外族群，而布朗蘆為資料缺乏（Data Deficient, DD）仍處於野外族群不明的狀態（臺灣植物紅皮書編輯委員會 2017）。布朗蘆在臺灣首次報導於第一版臺灣植物誌（Koyama 1978），內文引用日本植物學者大井次三郎（Jisaburo Ohwi）2768 採集號的標本，採集紀錄地點為 Pianan ambu，即現今宜蘭思源埡口，並補述該筆為臺灣唯一紀錄，至第二版臺灣植物誌（Koyama *et al.* 2000）仍僅此一筆紀錄。由於

臺灣植物誌引用標本未記載存放處，作者群未見此份 Ohwi 2768 標本，查閱 TAI、TAIF、HAST、TAIE 標本館之電子資源後，無其他布朗蘆分布於臺灣的確切紀錄，因此無從確認布朗蘆在臺灣之狀態，僅見 TAIF 收藏一份日本東京採集的標本（Makino *s. n.* 1898）。此外，廖（2014）在其論文中引證兩份採自臺灣之布朗蘆標本，但皆為錯誤鑑定，其中 Huang & Hsieh 4848（TAI!）為川上氏蘆（*C. alopecuroides* D. Don），Chen *et al.* 7276（TAIF!）則是柔果蘆（*C. mollicula* Boott）。

2024 年 4 月第一及第二作者於宜蘭縣思源埡口地區進行野外調查時，意外尋獲一蘆屬植物，經檢閱植物標本館收藏的標本，並且比對國外文獻後確認為布朗蘆，本文將提供形態特徵簡述及圖片（圖 1、圖 2）、分布（圖 3）、生態環境及物候資料。

分類處理

Carex brownii Tuck., Enum. Meth. Caric. 21. 1843.

Replaced synonym: *Carex striata* R. Br., Prodr. 243. 1810. *nom. illeg.*, non *Carex brownii* Michx., Fl. Bor.-Amer. 2: 174. 1803.

Type: AUSTRALIA. New South Wales, 1802–1805, *R. Brown s.n.* (syntypes: BM000991217 image!, E00393540 image!, K000961134 image!, MEL727781 image!); *R. Brown 6086* (syntypes: E00393539 image!, K000961133 image!).

Heterotypic synonym: *Carex nipposinica* Ohwi, Acta Phytotax. Geobot. 11: 255. 1942. Type: JAPAN. Honshu, Hyōgo, Mt. Rokko, *S. Okamoto s.n.* (not traced).

形態描述: 根莖短橫走。稈近簇生，直立，具三稜，高 30–80 cm，基部具鞘。葉基生，線形，短於稈，長 30–60 cm，寬 3–5 mm，葉背淡綠至灰綠色，基部具棕色鞘。總苞葉狀，長於穗，基部具鞘。穗總狀排列，3–5 枚，頂端 2–3 枚近生，其餘疏生；頂生穗雄性，線狀圓筒形，長 1–3 cm；側生穗雌性或先端具少數雄花，圓柱

狀，長 1.5–3 cm，寬 5–6 mm，草綠色，下部穗具長柄，上部穗柄較短。雄花鱗片披針形，長 2–6 mm，寬 1–1.5 mm，先端漸尖，具芒。雌花鱗片卵形，長 1–2 mm，具芒。柱頭 3 裂。果囊橢圓形、倒卵形或近球形，斜出，成熟時近橫展，綠色，長 3.5–4.5 mm，表面光滑無毛，具多條脈紋，略短或等長於鱗片，先端具短喙，平截或具 2 齒。瘦果寬卵形至橢圓形，橫斷面三稜形，長約 2 mm，寬約 1 mm，先端具彎曲短喙。

地理分布: 中國、韓國、日本、新幾內亞、澳洲及紐西蘭 (*Koyama et al.* 2000)。Haq *et al.* (2011) 報導本種新記錄於印度，但該文附圖看起來並不符合本種的描述，因此該分布紀錄仍有待進一步確認。臺灣目前僅知分布於宜蘭思源埡口地區 (圖 3)。

生態環境及物候資料: 生長於溪流附近地被低矮的開闊草地。花期 3–5 月、果期 4–7 月。

備註: 布朗臺的重要鑑別特徵包含雌雄穗 (圖 1B、1C、圖 2) 長 1–3 cm，雌花鱗片具芒，柱頭 3 裂，

果囊（圖 1F、圖 2）表面具脈紋，先端具短喙，瘦果（圖 1G）的橫斷面三稜形；臺灣目前已知的薑屬植物中，腫喙薑（*C. tumida* Boott.）及太魯閣薑（*C. purpureotincta* Ohwi）與本種形態特徵相似，腫喙薑雌雄穗較長，3–14 cm，果囊光滑，脈紋不明顯；太魯閣薑雌雄穗長 6–18 cm，果囊在穗軸上排列稀疏鬆散，鱗片較長，約 5 mm，可與本種區分。為確認臺灣現生分布的布朗薑族群，作者群於沿線及附近環境相似的生育地進行踏查，但未見其他野地族群。經調查發現已知族群約 20 株成熟個體，生育地鄰近步道旁容易受到人為干擾，且伴生種多為外來歸化種（Chang-Yang *et al.* 2022），例如：多花黑麥草（*Lolium multiflorum* Lam.）、車前草（*Plantago asiatica* L.）、白花三葉草（*Trifolium repens* L.）、天藍苜蓿（*Medicago lupulina* L.）及大扁雀麥（*Bromus catharticus* Vahl），另外伴生的原生植物尚有燈心草（*Juncus effusus* L. var. *decipiens* Buchenau）。依據臺灣植物紅皮書編輯委員會（2017）之準則

對目前的族群數量及分布範圍現況，初步評估受威脅程度等級應屬於極危（Critically Endangered, CR）。

引證標本：臺灣（TAIWAN）。宜蘭縣（Yilan County），大同鄉（Datong Township），思源埡口（Siyuan Yakou），海拔 1900 m，19 Apr. 2024，劉冠廷（*G. T. Liu*）534、535（TAIF）。Same locality，4 May. 2024，吳紘瑞（*H.R. Wu*）421（TAIF）。Same locality，17 May. 2024，劉冠廷（*G. T. Liu*）540（TAIF）。

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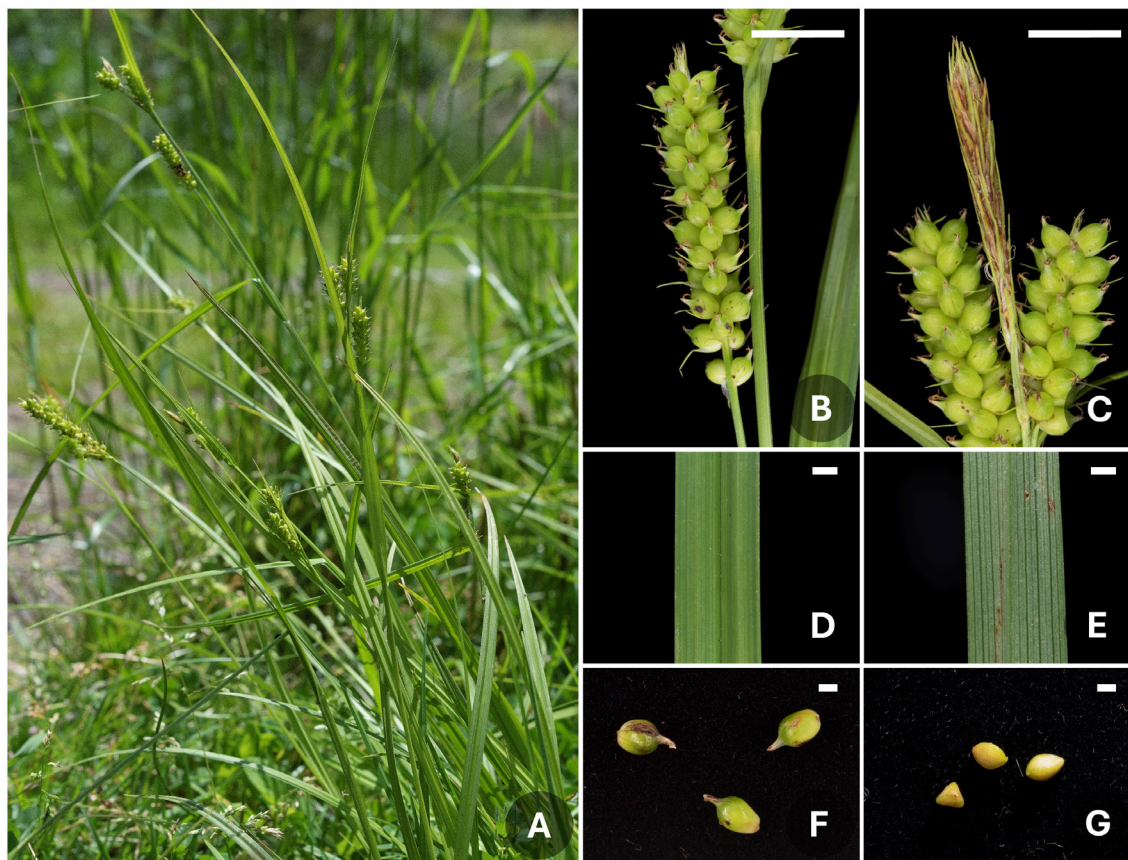


圖 1 布朗薹的形態特徵圖。A. 植株；B. 側生雌穗，果囊等長或略短於鱗片，柱頭 3 枚；C. 頂生雄穗，鱗片披針形；D. 葉近軸面；E. 葉遠軸面；F. 果囊；G. 瘦果。比例尺：B-C=1 cm；D-G=1 mm。

Fig. 1 Morphology of *Carex brownii*. A. Habit. B. Lateral pistillate spike, perigynia as long as or slightly shorter than the scales, with 3 stigmas. C. Terminal staminate spike, scales lanceolate. D. Adaxial leaf surface. E. Abaxial leaf surface. F. Perigynia. G. Achenes. Scale bar: B-C = 1 cm; D-G = 1 mm.



圖 2 布朗蘆的果穗特徵圖，箭頭處為芒。比例尺 =1 cm。

Fig. 2 Morphology of *Carex brownii*, the arrowhead pointing to the awn. Scale bar: 1 cm.

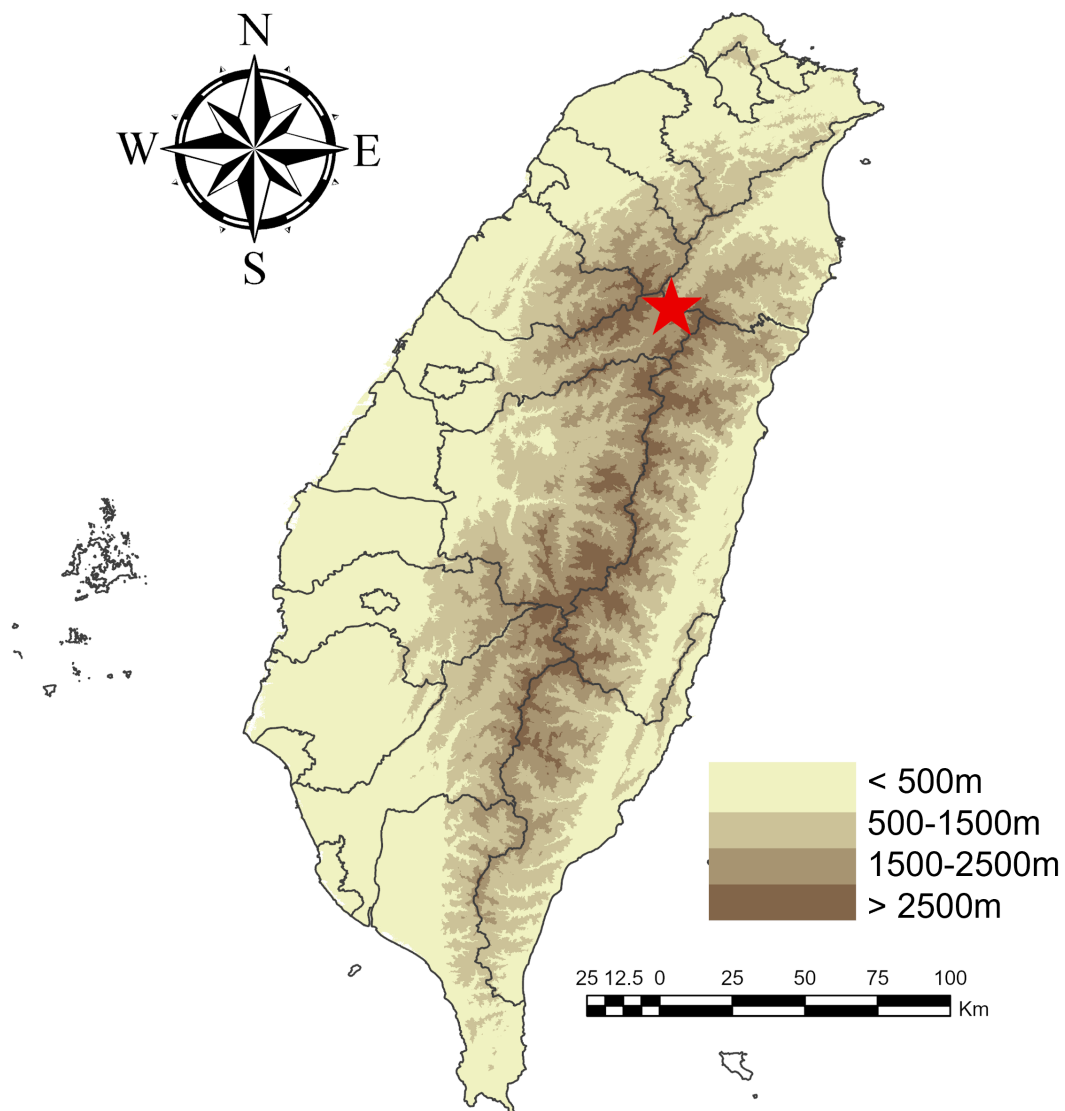


圖 3 布朗蘆於臺灣的分布圖。紅色星符號為布朗蘆的分布位置，海拔約 1900 m。

Fig. 3 Distribution map of *Carex brownii* in Taiwan. The red star symbol in the map indicates the distribution of *C. brownii*.

以涵容曲線評估鰲鼓濕地環堤水域水文調 控之可行性

Assessing the feasibility of hydrologic alteration for peripheral waters of Aogu Wetland using storage capacity curves

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摘要

臺灣位處東亞澳遷徙線上，鰲鼓濕地每年除黑面琵鷺 (*Platalea minor*) 度冬外，尚有鸕鶿類、雁鴨類、鷺科等水鳥族群度冬，各類群水鳥對水深偏好不一，若能依據地形與水文特性調控水位，可改善水鳥棲地品質。鰲鼓濕地環堤水域包含千島湖草澤、南方水池、西南草澤、西側草澤、西北側開放水域等處，本研究使用虛擬基站即時動態測量以步行及操筏對鰲鼓濕地環堤水域地形測量，建立各水域之水域面積、水深分布、蓄水容積等涵容曲線。並於各分區水域設置水位監測站，2017–2018 度冬季環堤水域各區水位變動趨勢一致，由 10 月開始最高，一路下降至隔年 2 月春雨後開始回升，平均水位 -0.6 m (Elevation, EL.)。以水深概略區分鸕鶿類與鷺鳥可用棲地，比較環堤水域水位監測紀錄與涵容曲線可發現，兩功能群可用棲地面積隨水位變化，於 12 月達最大值，但水位谷值與可用面積峰值發生時間不同，鸕鶿類可用棲地多寡依序為西側裸灘、西南草澤、西側草澤，鷺鳥則為西南草澤、西側裸灘，其餘水域可用棲地不多，鸕鶿類可用面積僅約鷺鳥 1/4 不到。由於濕潤裸灘為鸕鶿類主要覓食棲地，水位週期變動頻度可保持裸灘濕潤，有助於增加覓食棲地可用度。經分析探討可看出，鰲鼓濕地環堤水域排水條件較差，颱風帶來水量需藉助動力排除，但就引水改善各區水鳥棲地品質則具有相當潛力，但其水文調控需有因地適應的水文設計方案。本研究將水庫運轉規線觀念應用至鰲鼓環堤水域的涵容曲線建立，在經營管理實務上可透過涵容曲線，將園區長期監測的水位歷線轉換成水域面積歷線、各類群可用棲地面積歷線。透過現地管理人員的經驗累積，或是鳥類群集監測資料與水位監測資料的進一步比較分析，可建立最適化水位操作規則，改善水鳥棲地品質。

關鍵詞：人為濕地、環堤水域、涵容曲線、水文調控

Abstract

Taiwan is located at the midway point of the East Asian-Australasian Flyway. The waterbird wintering or stopover in the Aogu Wetland include shorebirds, waterfowls, herons, as well as the Black-faced Spoonbills (*Platalea minor*). Due to various preferences for waterbirds for water depths, altering water levels based on topography and hydrological characteristics is needed to create more habitats for each group of waterbirds. The peripheral waters of Aogu Wetlands consist of several connected ponds, such as Thousand Islands Lake, southern water pond, southwestern marsh, western marsh, and northwestern open waters. In this study, the water area, water depth distribution, and storage capacity curve of each pond were established through the virtual-based station real-time kinematic (VBS-RTK) topographic surveying by walk and boat. Water level monitoring was conducted three times a month at each water pond station. Results indicate that the water level peaked in October 2017, followed by consistently drawing down in the peripheral waters until February 2018, but after spring rains, the water level began to rise again thereafter. The mean water level of the period of time was -0.6 m (EL.). The usable habitats were categorized based on the preference of two major water bird groups - shorebirds and herons, and it was observed that the usable habitat areas for these two groups varied with the water level changes by comparing the records of water level monitoring with the capacity curve. The maximum usable area was reached in December, but the timing of the lowest water level and the peak usable areas were different. For shorebirds, the maximum usable habitat areas were mainly located on the mudflat of the western side, followed by southwestern marshes, and then western marshes. For herons, the maximum usable habitat areas were only on the southwestern marshes and the mudflats on the western side, and there were not much available habitats in other waters for herons. The usable areas for shorebirds were only

about a quarter of those for herons. Since moist mudflat was the main feeding habitat for shorebirds, the periodic variation in water levels could keep the mudflats moist, thus helping to increase the availability of feeding habitats. Results indicate that the drainage conditions were relatively poor. The water brought by typhoons required dynamic drainage. However, improving water diversion has shown a significant potential for enhancing the quality of water bird habitats in peripheral waters. Nevertheless, hydrologic alteration must be adapted to local conditions with a well-designed hydrologic management plan. This study applies the concept of reservoir's rule curves to establish the capacity curves for the Aogu peripheral waters. In management, the capacity curves allow the conversion of long-term stage monitoring into water surface area and available habitat area for various species. By accumulating the experience of on-site managers or conducting further comparative analysis of bird assemblage and water stage monitoring, an optimal water stage operation rule could be developed to improve the quality of water bird habitats.

Key words: Artificial wetlands, Peripheral waters, Storage capacity curves, Hydrologic alteration

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緒言

東亞澳水鳥遷徙線 (East Asian - Australasian Flyway, EAAF) 為全球八條主要鳥類遷徙線之一，臺灣西南沿海的濕地位於 EAAF 線上，冬季經常會吸引大量水鳥過境 (stopover) 與度冬 (wintering)，為臺灣重要的生態資源 (Lee *et al.* 2024)。水鳥度冬期間屬乾季，濕地水源補充不穩定可能影響濕地水質與鹽度，枯水的棲地可能影響水鳥覓食與棲息。濕地若地盤過低造成積水過深，一方面涉禽無法利用，一方面營養鹽長期累積使棲地劣化 (國立嘉義大學 2022)，因此濕地的水文環境與水鳥棲息利用息息相關。

Crivelli *et al.* (1995) 探討水位變動對北希臘濕地之繁殖水鳥的影響，結果發現水位上升會使淺水區域 (如沼澤區) 的棲息鳥種數下降，深水區域的棲息鳥種數增加，在岸邊繁殖的鳥種數也會減少，但食魚性 (piscivorous) 鳥種的數量則會增加。Taft *et al.* (2002) 在美國加州中央谷地濕地進行研究，發現環境中缺乏淺

水灘地時，以實驗操控降低濕地水位能顯著增加該地水鳥的棲息密度；但在環境中淺水灘地區域比例較大時，相同的操作並不會增加實驗濕地的水鳥棲息數量。水位高低變化也會影響水鳥的棲息種類及分布狀況 (Colwell and Taft 2000; Faragó and Hangya 2012; Kreakie *et al.* 2012; Sebastián-González and Green 2014)，不同類群水鳥的棲息經常受到水深的影響 (Ma *et al.* 2010; Samantha *et al.* 2010)。

水循環牽動了水體交換，並為生物提供食物來源，穩定生態系統，而水位控制則是濕地經營管理與水鳥保育的重要議題。鰲鼓環堤水域各區深淺不一，若要進行相關分區水位控制，則須先行掌握各區水域底床高程分布，方能估算各區水域在不同水位條件下之水域面積、水深分布、蓄水容積等特性。近年無人機功能演進以及數值地形高程測繪軟體的發展，規劃空拍機航線、視角差搭配控制點布設已可得到公分級精度之地面數值地形高程。惟，濕地水域水下底床高程無法透過此法測繪，因此水域底床地

形高程之測繪難度仍高。

Zuhaidah *et al.* (2009) 提出 VRS-RTK 擴大有效作業範圍，提高定位精度及可靠度，可提供全面性的定位成果品質監控。在平面上可達 4 cm 及高程上可達 6 cm 的精度。內政部國土測繪中心於 2006 年度完成建置 e-GPS 即時動態定位系統，並於 2009 年正式營運，開放即時性衛星動態定位服務、衛星觀測資料電子檔供應服務及衛星觀測資料後處理動態定位服務等 3 項服務。2014 年更名為 e-GNSS 即時動態定位系統，提供國內登記有案之法人團體高精度之雙星系（GPS、GLONASS）定位服務，2019 年 10 月 1 日進而提供全星系定位服務。

由於行動數據通訊傳輸技術快速發展，RTK 已成為國際測繪與定位技術主流。內政部國土測繪中心所建置之 e-GPS 即時動態定位系統於 2009 年正式營運（內政部國土測繪中心 2023a）。透過即時傳輸建置於全國各地之衛星定位基準站全年無休接收每秒 1 筆之連續性衛星觀測資料，經由

控制及計算中心對於各基準站衛星觀測資料之整合計算處理後，目前在臺灣只要在可以同時接收 5 顆 GPS 衛星訊號的地方，均可以無線連網方式，在極短時間內獲得公分級精度之定位坐標。

本研究透過 e-GNSS 系統提供之 VBS-RTK 服務，依水深區分是否可涉水穿越，可涉水區域以手持 GNSS 接收器徒步沿穿越線直接量測底床高程，無法涉水區域以操筏測得水深，再以 GNSS 接收器量測水面高程（水位）以換算底床高程，建立鰲鼓濕地環堤水域各區之涵容曲線。接著透過涵容曲線與歷史潮位紀錄之比較分析，評估水文調控之可行性，可作為人為濕地（artificial wetlands）（Tundisi and Matsumura-Tundisi 2004; Rajpar *et al.* 2022）分區經營管理策略擬定之參考。

材料與方法

2.1 研究區域－鰲鼓濕地環堤水域

鰲鼓濕地園區位於嘉義縣西北部，緊鄰外傘頂洲，為臺灣西南沿海

主要濕地之一，嘉義縣鰲鼓野生動物重要棲息環境亦位於此。區內擁有多樣的棲地環境，如農地、廢耕地、防風林、溝渠與沼澤濕地，其中環堤水域具有廣闊的泥灘、草澤、水池等，是國家級重要濕地也是野鳥重要棲地（Important Bird Area, IBA），每年冬季除有大量的雁鴨類、鷺科、鷗科、鸕鶿類與鸕鶿等水鳥棲息。許富雄等人（2017）彙整 1986 至 2016 年在鰲

鼓濕地進行的鳥類調查文獻，以鳥種遷留型態、棲息環境分成水域泥岸游涉禽、泥灘涉禽等 6 類生態同功群，探討鰲鼓濕地近 30 年的鳥類組成變化。結果發現 30 年間共記錄有 265 種 534,292 隻次，各時期之冬候鳥的相對數量逐漸降低，而留鳥的相對數量則有逐漸增高的趨勢。本研究以鰲鼓濕地作為涵容曲線建立與水收支分析之研究區域，如圖 1。



圖 1 研究區域 - 鰲鼓濕地位置圖。(包含西北側開放水域與草澤、西側草澤、西南側草澤、南方水池、千島湖等)

Fig. 1 Study site – location of the Aogu Wetland. (including northwestern pond and mudflat, western marsh, southwestern marsh, southern pond, and Thousand Islands Lake)

2.2 VBS-RTK 及 e-GNSS 系統定位原理

衛星導航系統（Global Navigation Satellite System, GNSS）即時動態定位（Real Time Kinematic, RTK）技術，是利用 2 台以上 GPS 接收儀同時接收衛星信號，其中一台置於已有精確三維座標點上作為基站，另一台則作為移動站用來測定未知點坐標，基站根據精確座標利用 OTF（on the fly）解算法求得週波未定值，只需使用幾筆觀測量就可即時求得週波未定值，利用高精度的載波觀測量進行定位並將其值傳送給移動站以求得移動站的座標值。惟，此法受限於測繪區域附近須有水準控制點或引測點來架設已知座標值之參考基站，移動站與基站間須（無線電或藍芽）通訊順暢，且須 2 部接收儀，購置成本高且現地外業須有兩組人員。

為了克服傳統 RTK 技術的瓶頸，近年發展了虛擬基準站（Virtual Base Station, VBS）之 RTK 定位技術，VBS-RTK 採用多基站的方式，經由網路彼此連結，將觀測資料匯集到控制

中心，進行資料檢核和儲存。當移動站將其近似座標傳回控制中心時，控制中心會計算出一組新的基準站觀測量出來並回傳給移動站，而這組新的觀測量點位，就如同一個新的基準站落在移動站附近稱為虛擬基準站。（施等 2020）

2.3 涵容曲線建立方法

對任意開放水域，底床係指未蓄水時之地盤高（ground level, GL），為平面座標之函數以 $GL(x,y)$ 表示。水面高程（water surface elevation, WSE）即水位（water stage），受降雨、地表逕流、地下水位、入出口潮汐水位影響，WSE 為時間之函數，亦可以 $WSE(t)$ 表示。水深（depth, D）則為水位與地盤高之高程差，因此 D 為時間及平面座標之函數，可以 $D(x,y,t)$ 表示。地盤高、水位及水深三者相對關係示如圖 2，並可表示如下式：

$$WSE = GL + D \text{ 或 } GL = WSE - D$$

將此開放水域以格點、測線或散布點施測，測得各點之 GL 之後，可

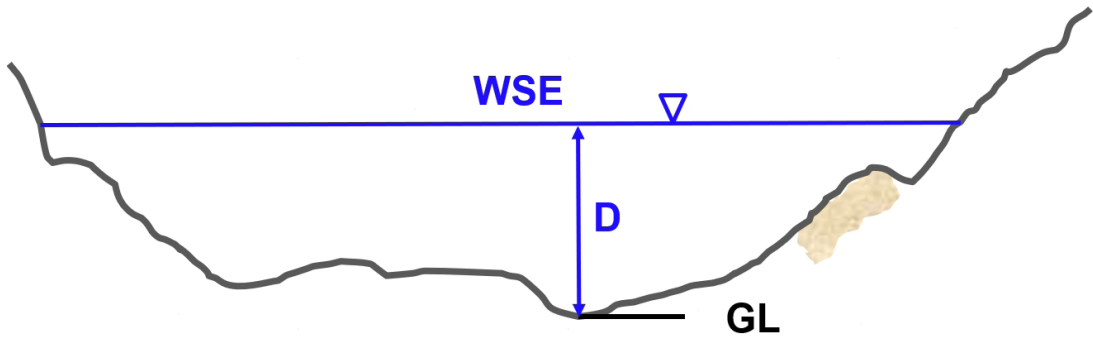


圖 2 地盤高 – 水位 – 水深關係圖。

Fig. 2 Relationship between ground, water stage, and water depth.

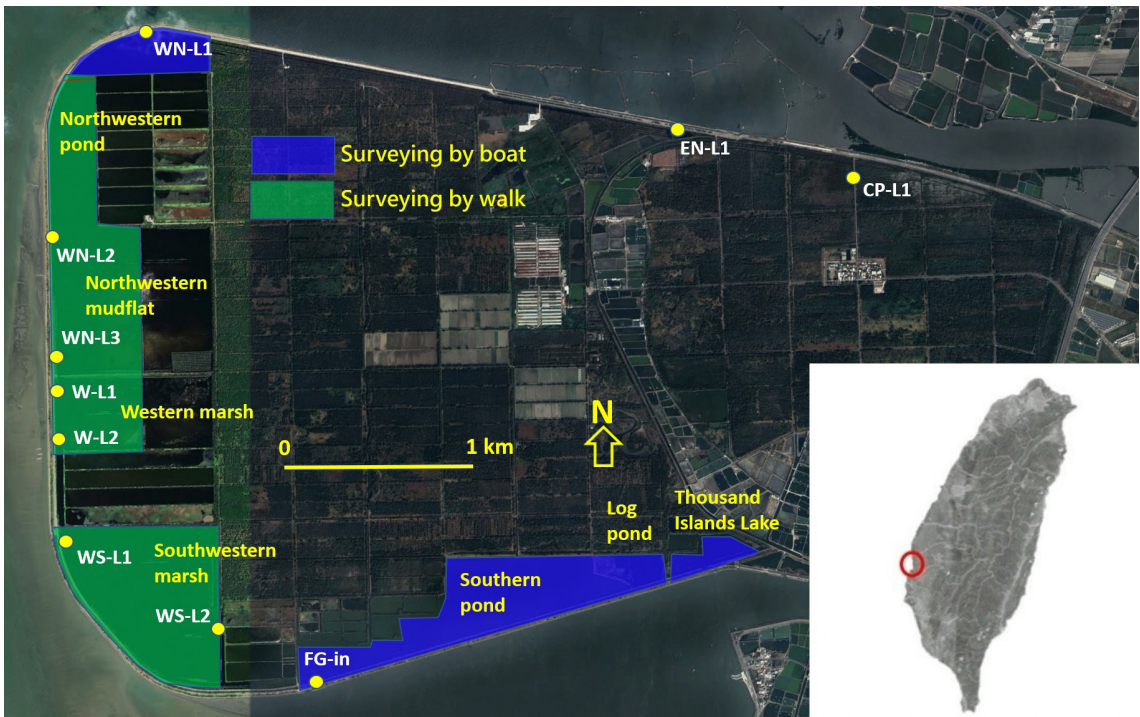


圖 3 鰲鼓濕地開放水域水位觀測站及底床高程施測方式分區圖。

Fig. 3 Locations of the water level observation stations and zoning for terrain surveying of the open water areas in Aogu Wetland.

利用科學試算軟體或 GIS 軟體之地形分析工具，將該區水域依所測點地盤高 GL 繪製等高線圖，計算各等高線圖面積而得到該水域地盤高程－面積關係，接著可以錐形體積公式推估各等高線平面間所為區域之容積，得到該水域地盤高程－容積關係。經踏勘後發現各區底質狀況不一，底質較硬、可步行涉水如西側水域、西南草澤等，則設置穿越線進行斷面剖線測量；底質為爛泥厚度大、步行困難，規劃以管筏施測，如西北草澤、南方水池、千島湖等，則以操筏測量底床高程，不同測量分區詳圖 3。

穿越線斷面剖線測量係由研究人員手持 VBS-RTK 衛星定位儀（Sokkia GRX2）徒步測量地盤高，VBS-RTK 利用國土測繪中心於全臺各地設置之衛星定位參考站網作為參考站，透過 e-GNSS 系統即時解算衛星定位之資料，其測量精度水平為 1.5 cm，垂直為 3 cm。操筏測量則以橡皮艇或管筏搭載研究人員進入水域，以繫有鉛塊下沉之皮尺測量水深，每天之測量工作分為上、下午兩時段分次進行，

每個時段之水深測量開始前及結束後均以 VBS-RTK 測量該水域之水位，因此底床地形測量在垂直方向仍保有 VBS-RTK 相同等級之精度。由於管筏受人員操筏動作、水面波動、風吹等因素，高精度之 VBS-RTK 系統在管筏上無法收斂，因此水平座標改以快速收斂之簡易式 GPS 定位（Garmin eTrex 30），精度約 3 m。測量現地作業情形詳圖 4。

本研究 VBS-TRTK 測量作業水平座標採用 TWD97 二度分帶座標，水準高程系統係內政部訂定之 TWVD2001（Taiwan Vertical Datum 2001）系統（內政部國土測繪中心，2023b）之正高系統，高程基準係指在 1990 年 1 月 1 日之標準大氣環境情況下，基隆潮位站 1957 年至 1991 年之潮汐觀測資料所計算之平均潮位而得。

2.4 環堤水域水位監測

本研究為監測鰲鼓濕地環堤水域之水位變化，依據區面積、連通狀態、設置水位竿可及性、避免觀測對水鳥棲息造成干擾等因素規劃設置監測



圖 4 手持 VBS-RTK 徒步測量及操筏測量水深情形。

Fig. 4 The portable VBS-RTK snapshots of the terrain surveying by walk and boat.

站，包含東北側草澤（EN-L1）、環堤西北側至南側之廣闊開放水域西北側開放水域（WN-L1、WN-L2、WN-L3）、西側草澤（W-L1、W-L2）與西南側草澤（WS-L1、WS-L2）及南方水池出口水門（FG-in）等處水位監測站，詳圖 3。水位站水準測量與前節一致採 e-GNSS 系統提供之 VBS-RTK 服務，高程系統亦為 TWVD 2001。在 2018 年 10 月至 2019 年 4 月之候鳥度冬期的每月上、中、下旬進行 3 次水位高度記錄，其它月份則於每月中旬進行一次水位高度記錄。

2.5 東石潮位紀錄

東石潮位站位於嘉義縣東石鄉東石漁港內，為本研究樣區南側鄰近之

潮位站，由交通部中央氣象署設置，觀測期間為 1993 年迄今，潮位站水準點編號 TG10X，本研究透過交通部中央氣象署氣候資料服務系統（CODiS）取得東石潮位站歷史潮位資料。

結果

3.1 鰲鼓濕地環堤水域涵容曲線

鰲鼓濕地環堤水域之地形測量，俟候鳥陸續北返後開始依前述規劃方式進行現地作業，經 2019 年 4 月至 7 月於現地密集施測。所得三維地形資料下載至電腦後以 QGIS 進行地形分析，測點分布詳如圖 5，圖中座標格點間距為 500 m，現地測點以圓點表

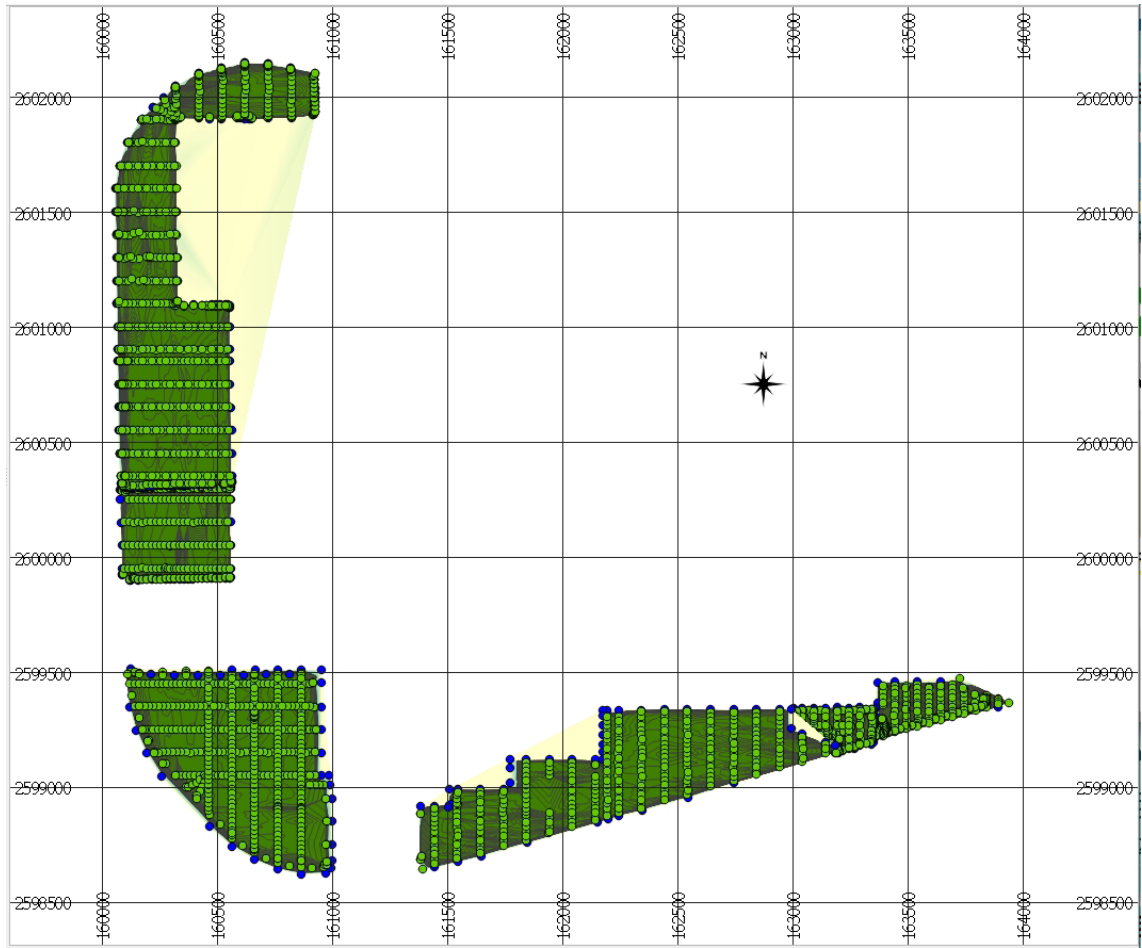


圖 5 鰲鼓濕地環堤水域地形測量現地作業成果測點分布圖。

Fig. 5 The spatial distribution of terrain surveying points in peripheral waters of the Aogu Wetland.

示。

將環堤水域內各水域現地測量所得高程內插至 1 m 格點上，再依 1 m 格點高程繪製 0.1 m 間距之等高線，各分區水域等高線分布詳圖 6，圖中座標格線間距為 100 m。

以鰲鼓濕地西北開放水域北區之

地形等高線分布圖為例，水域最低點為 EL. -3.3 m，水域最高點為 EL. 0 m，將各高程及相對應之等高線面積依序由水域最低點至水域最高點之連線即為該水域之高程－面積曲線，各分區水域如西北開放水域南區、西側草澤、西南草澤、南方水池、貯木池及千島

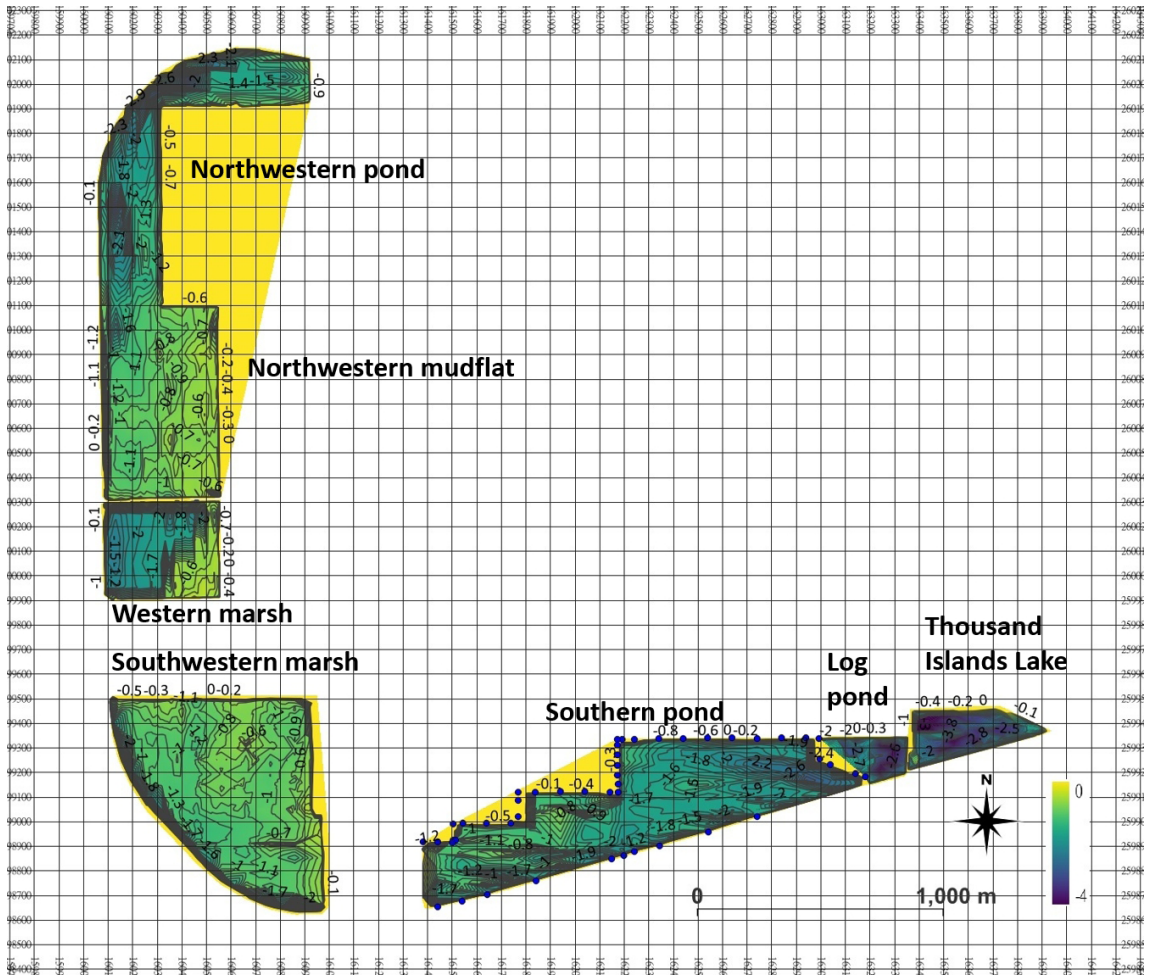


圖 6 鰲鼓濕地環堤水域地形等高線分布圖。

Fig. 6 The terrain contour map of the peripheral waters of the Aogu Wetland.

註：網眼間隔為 100 m

Note: The mesh spacing is 100 m

湖等之高程 – 面積及高程 – 體積曲線圖，各高程 – 面積比較如圖 7。

3.2 鰲鼓濕地環堤水域水位變動趨勢

一般來說可透過水收支狀況來瞭解水體或集水區之貯水量變動，水收支方程式可概略表示如下：

$$dV_w / dt = I - O$$

$$I = P + S_i + G_i + T_i$$

$$O = ET + S_o + G_o + T_o$$

其中， V_w 為濕地貯水量， t 為時

間， I 為入流量， O 為出流量， P 為降雨量， S_i 為地表逕流入流量， S_o 為地表逕流出流量， G_i 為地下水入流量， G_o 為地下水出流量， T_i 為潮汐入流量， T_o 為潮汐出流量， ET 為蒸發散量。

鰲鼓濕地係圍堤造陸之海埔地，獨立於內陸排水系統外，無區外逕流匯入；且突出海岸線之海埔地，地下水水力梯度甚小，可忽略地下水入出流量。南方水池七孔水門為環堤水域

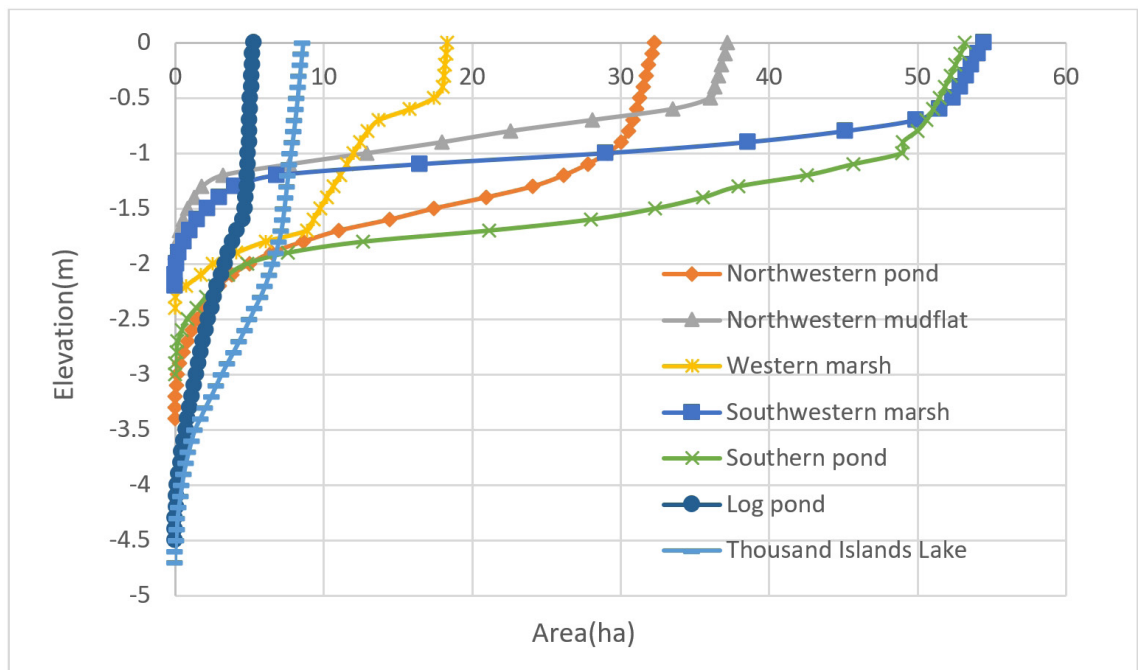


圖 7 鰲鼓濕地環堤水域各分區涵容曲線比較圖。

Fig. 7 The storage capacity curve for each zone in peripheral waters of the Aogu Wetland.

註：縱座標：高程（m）（相對於臺灣本島水準原點）、橫座標：面積（ha）

Note: The vertical axis represents elevation (m) (Relative to the Taiwan level origin- above the Taiwan Vertical Datum 2001). The horizontal axis represents area (ha)

唯一排水通道，若南方水池之水門處於關閉狀態，則出流量可簡化為蒸發散量。自 2017 年 10 月起開始建立每旬 1 次之水位監測，2018–2019 度冬季水位觀測紀錄，詳圖 8。本次度冬季環堤水域 8 處水位監測站（含 FG-in、WN-L1、WN-L2、WN-L3、

W-L1、W-L2、WS-L1、WS-L2）的平均水位高為 -64.53 ± 3.57 cm，尤其是在 11 月中旬後的平均水位高大都在 -60 cm 以下。

鰲鼓濕地獨立未連通水域包含東北草澤（EN-L1）、造林地（CP-L1）、廢棄魚塢（DF-L1 至 DF-L3）、千島

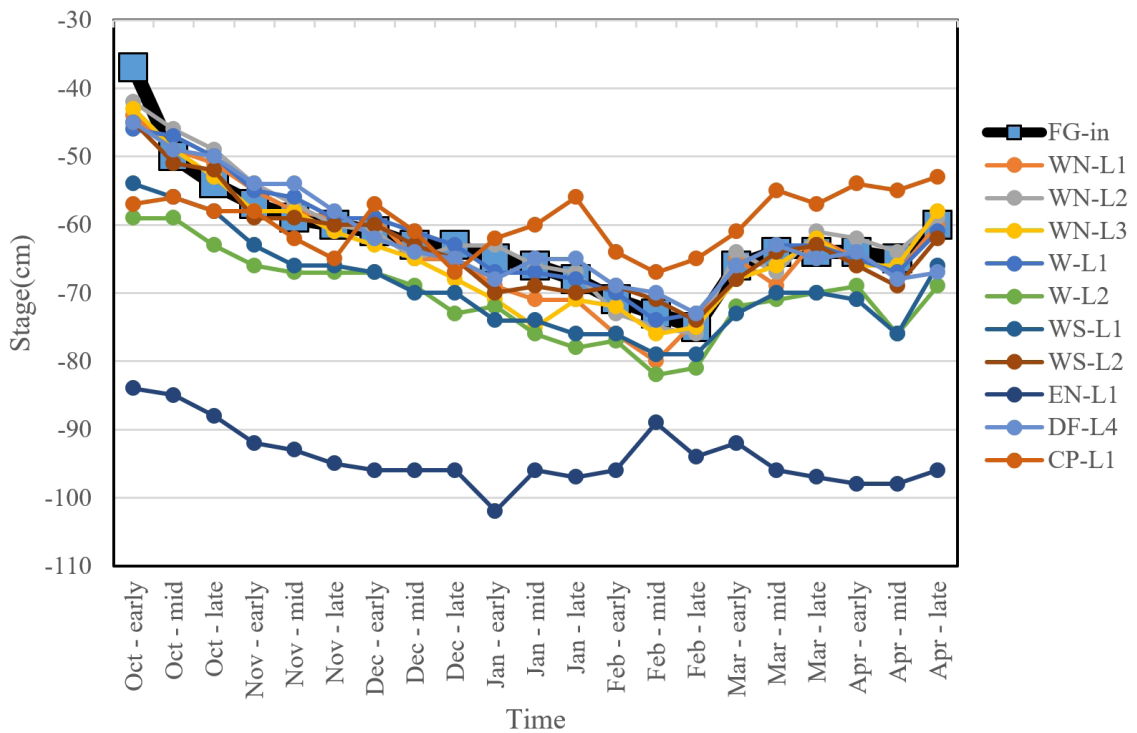


圖 8 鰲鼓濕地環堤水域各站 2017/10 至 2018/04 各旬水位觀測紀錄。

Fig.8 Water surface elevation hydrograph of peripheral waters of the Aogu Wetland from October 2017 to April 2018.

註：虛線係表示南方水池內水非汛期常年平均水位 -60 cm

Note: The dotted line indicates that the average all-year-round stage in the southern pool was about -60 cm during the non-flood season.

湖 (TI-L1)、貯木池 (TI-L2) 等，而環堤水域西南草澤與西側草澤、南方水池以道路旁水道連通，形成連通水域。由圖 8 可發現水位變化趨勢，連通水域各測點均低於 -60 cm，平均水位高大致介於 -61 至 -93 cm 之間。各水域的水位在這段期間大致呈現逐漸降低的狀態，這應與這段期間是園區乾季較少降雨，園區水位隨排水與蒸發散而逐漸降低有關。2017–2018 度冬季環堤水域各區因水體連通，水位變動趨勢一致，由 10 月開始最高，一路下降至隔年 2 月春雨後開始回升，平均水位 -0.6 m (E.L.)，如圖 8。

3.3 鰲鼓濕地環堤水域各功能群可使用棲地面積

若將各區水位歷線 (hydrograph) 以水位涵容曲線代入，則可轉換為各區之水域面積歷線。由於體型較小的鸕鶿類岸鳥 (shorebird) 偏好於泥灘地覓食，而體型較大且腳長的鷺鳥 (heron) 則可於水深小於 30 cm 的水域涉水覓食 (Ntiamoa-Baidu *et al.* 1998; Ma *et al.* 2010)，因此可概略區分鸕鶿類與鷺鳥可用棲地為水深 5 cm

以下及 5–30 cm。以鸕鶿類岸鳥水深 0–5 cm 範圍為例，其任一時間之可使用棲地面積為水面面積扣除 5 cm 等水深線面積，鷺鳥亦同。若透過涵容曲線代入水位歷線，則可得到岸鳥及鷺鳥的可使用棲地面積歷線，如圖 9。

水鳥兩功能群可用棲地面積隨水位變化，於 12 月達最大值，但水位谷值與可用面積峰值發生時間不同，鸕鶿類可用棲地多寡依序為西側裸灘 (西北南區)、西南草澤、西側草澤，鷺鳥則為西南草澤、西側裸灘 (西北南區)，其餘水域可用棲地不多，由圖 9(a) 可看出 11 月至 3 月間鸕鶿類岸鳥可用面積約在 5 ha 至 15 ha 間波動，鷺鳥可用面積約則在 40 至 50 ha 間波動，鸕鶿類可用面積僅約鷺鳥可用面積的 1/4 不到。由於濕潤裸灘為鸕鶿類主棲地，水位週期變動頻度可保持裸灘濕潤，有助於增加覓食棲地可用度。

3.4 東石潮位站潮位紀錄特性

本計畫於交通部中央氣象署氣候資料服務系統 (CODiS) 取得鄰近東石潮位站 1996 年至 2014 年之潮位資

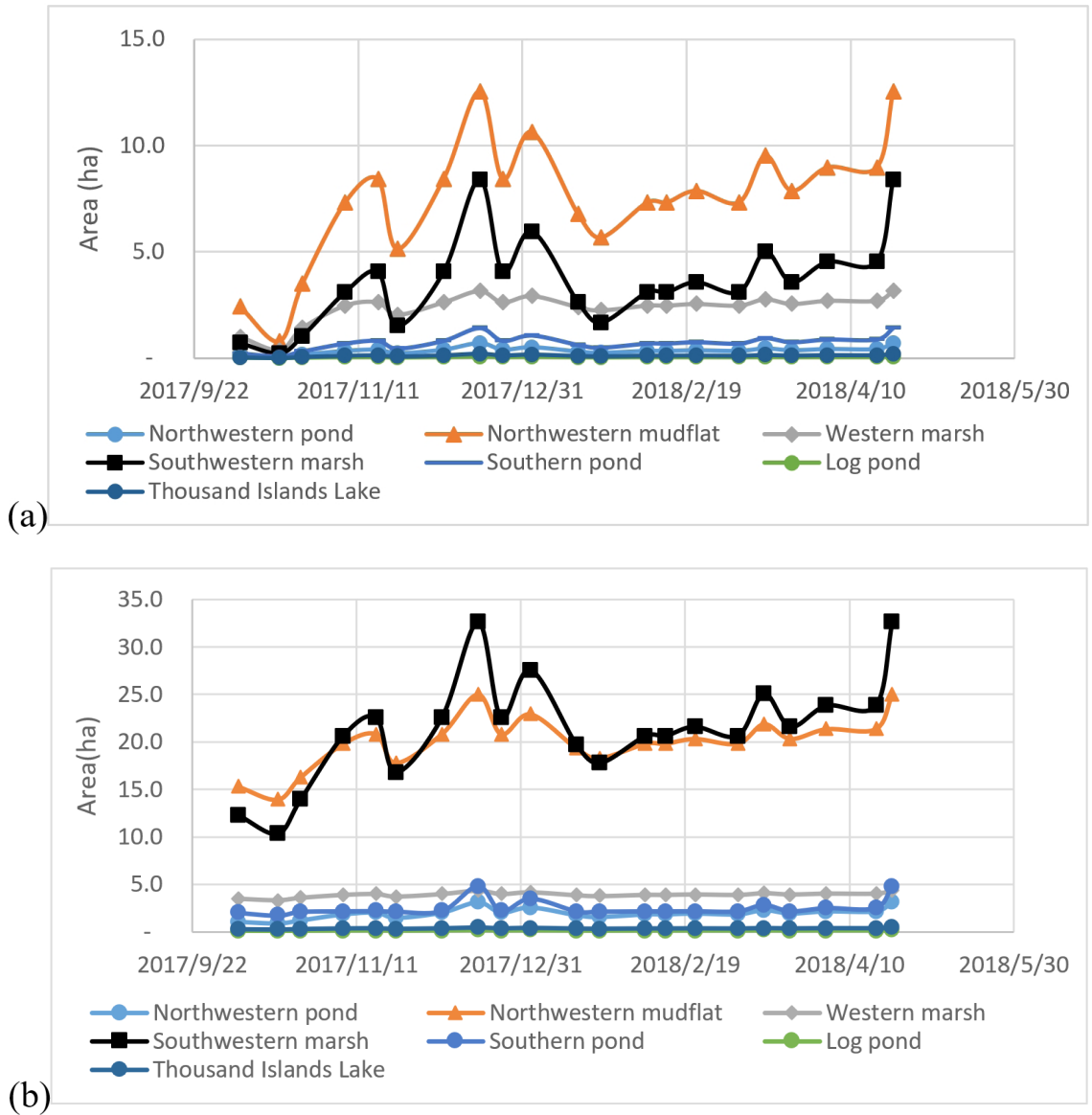


圖 9 鰲鼓濕地環堤水域各區水鳥可用面積：(a) 岸鳥、(b) 鷺鳥。

Fig. 9 Usable area for the water bird groups in peripheral waters of the Aogu Wetland: (a) shorebirds, (b) herons.

料，並分析其平均高潮位（MHL）、平均潮位（ML）、平均低潮位（MLL）逐月四分位數統計，其中 MHL 及 MLL 盒鬚圖如圖 10。圖中可看出天文潮因地球公轉軌道面與自轉軸夾角，MHL 在 5 月前後潮位較高且幅度較大，而 12 月前後則潮位較低且幅度也較小。夏季潮位較高這樣的特性使得颱風來襲時排水更加困難，而度冬期間 ML 高於環堤水域水位，仍具引水潛力。

討論

4.1 涵容曲線於濕地水文調控之意涵與水文調控之可行性

涵容曲線過去多用於描述水庫水位 - 面積 - 容量之關係，通常以水位為縱座標，面積及容量為橫座標，可藉由水庫水位相對應出面積及蓄水量。水庫涵容曲線經現地測量建立後，水庫便可依其集水區逕流特性、供水特性等建立其運轉規線，也就是該水庫實際運轉的規範。本研究將此一觀念應用至鰲鼓環堤水域的涵容曲線建立，在經營管理實務上可透過涵容曲

線，將園區長期監測的水位歷線轉換成水域面積歷線、各類群可用棲地面積歷線。透過現地管理人員的經驗累積，或是鳥類群集監測資料與水位監測資料的進一步比較分析，可建立最適化（optimal）水位操作規線，改善水鳥棲地品質。

概略區分鵲鴿類與鷺鳥可用棲地為水深 5 cm 以下及 5-30 cm，由圖 7 涵容曲線可看出接近水平段即意味面積隨水位上升而急遽增加，因此營造水鳥可用棲地應把握接近水平段水位範圍。西側裸灘（西北南區）可營造岸鳥棲地之水位範圍介於 EL. -1.2 m 至 EL. -0.5 m 之間，可營造鷺鳥棲地之水位範圍則介於 EL. -1.0 m 至 EL. -0.3 m 之間；而西南草澤可營造岸鳥棲地之水位範圍介於 EL. -1.2 m 至 EL. -0.7 m 之間，可營造鷺鳥棲地之水位範圍則介於 EL. -1.0 m 至 EL. -0.5 m 之間。而西北水域、南方水池雖然水域面積廣闊、然多為深水區域，其餘水域則屬小面積之錐狀底床。

圖 10 顯示 1996 年至 2014 年之潮位資料，東石沿海的各月份 ML 介

於 +10 cm 到 +40 cm 之間、MLL 介於 -50 cm 到 -80 cm 之間；圖 8 水位監測資料顯示環堤各區水域介於 -40 cm 到 -70 cm 間，各月份之大潮平均低潮位也僅有 1 月份與 2 月份低於 -66 cm，且其大潮平均低潮位可達 -80 與 -74 cm。

比較兩者可發現：(1) 比較環堤水域水位監測紀錄與涵容曲線可發現，ML 在冬候鳥度冬期介於 EL. +0.3 m 至 EL. +0.1 m 之間，仍高於環堤水域水位（介於 EL. -0.8 m 至 EL. -0.4 m 之間），水頭差仍有 0.5 m 至 0.8 m 間，其中又以西側裸灘與西南草澤兩處是較有潛力以水文調控改善水鳥棲地品

質的水域；(2) 僅有 12 月至 2 月有重力排水之條件。然而，園區東石農場內環堤區域的廣大水體，在冬季要藉由七孔水門將水排出外海的效能並不高，尤其是七孔水門外側沙洲近年似有淤積升高的狀態，使七孔水門的排水效能更為降低。經由前述比較發現，鰲鼓濕地環堤水域基本上是有引水潛力但難以排水。

4.2 地層下陷與海平面上升

根據內政部國土測繪中心（2021）調查顯示，位於西南海岸之潮位站於 2012 年至 2020 年 8 年間持續下降之箔子寮、塹港、東石、永安等潮位站之水準高程均呈持續下降，

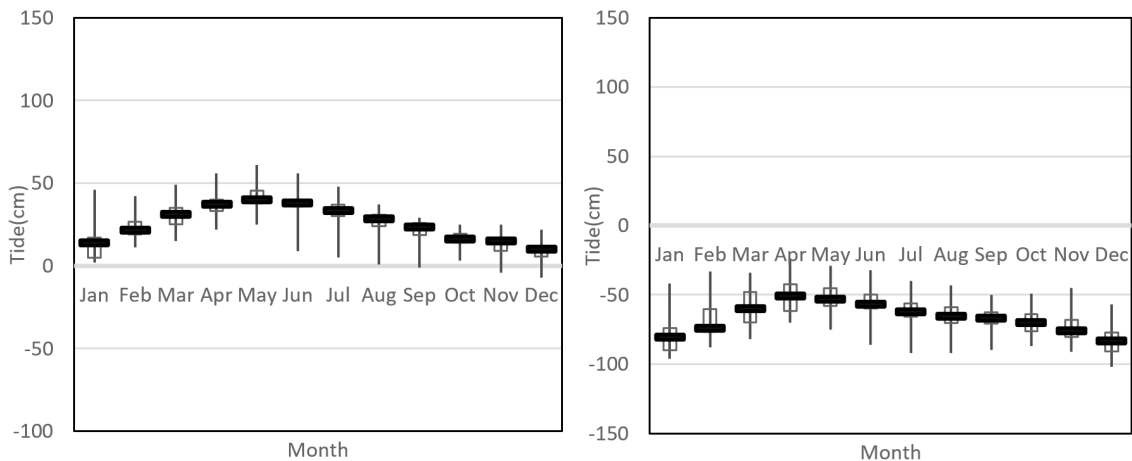


圖 10 東石潮位站 1996–2015 年平均潮位及平均低潮位月變動趨勢圖：（左）ML、（右）MLL。
Fig. 10 Box plots of the mean level (ML) and mean low level (MLL) of the Dongshi tide gauge from 1996 to 2015.

其中箔子寮、塭港、東石等 3 站均鄰近鰲鼓濕地，箔子寮潮位站下降速率為 8.2 mm/year，塭港潮位站下降速率為 3.8 mm/year，東石潮位站下降速率為 7.5 mm/year，三潮位站平均年下降速率為 6.5 mm。經濟部水利署（2023）對嘉義地區的地層下陷監測分析，嘉義地層下陷以布袋、義竹較為嚴重，年下降速率超過 5 mm，鰲鼓地區較輕微，年下降速率小於 2.5 mm。但從交通部運輸研究所（2009）的觀測分析指出布袋港年下降速率約為 40 mm，較前兩者分析嚴重數倍，究其原因可能為港區多為海埔新生地，回填土層仍持續壓密中。惟，鰲鼓濕地亦屬海埔新生地，因此地層下陷因子須持續關注。

此外，近一世紀因地球暖化，冰川持續融化而造成海平面上升，謝等（2022）指出近 20 年海平面上升速率麥寮約為 4.2 mm/year，塭港約為 9.8 mm/year，東石則有 13.2 mm/year，將軍約為 6.2 mm/year，顯示海平面上升速率不小，平均約為 8.2 mm/year。惟，綜合比較謝等（2022）研究與水利署

（2023）、運輸研究所（2009）觀測，謝等（2022）研究所得海平面上升速率可能歸因於潮位站水準點下陷；綜合水利署（2023）與謝等（2022）間差異約為 1.7 mm/year。地層下陷與海平面上升速率短期可能會影響環堤水域排水條件，長期則可能影響水域生態，確切原因仍須進一步研究確認。

結論與建議

從前述分析討論可看出，鰲鼓濕地環堤水域排水條件較差，颱風帶來水量需藉助動力排除，但就引水改善各區水鳥棲地品質則具有相當潛力，但其水文調控需有因地適應的水文設計方案，所需考慮面向茲討論如後：

(1) 分區調控：從 3.3 節及 4.1 節分析討論可看出，鰲鼓濕地各區水域適合水文引水調控以改善水鳥棲地品質主要為西北裸灘和西南草澤兩區；但各區水體目前是連通、水位連動的條件下，引水效率差，且無法個別水體條件營造改善適合的水鳥功能群棲地，可在各區連通處設置水閘門。(2) 引水水源：南方水池的水門是環堤水域水

體唯一出口，水門出口是六腳排水匯入臺灣海峽之河口淺灘，受外傘頂洲內縮與泥沙淤積影響，僅在高潮位時海水才能到達水門口，需改善水門外淤積情形或尋找替代水源。(3) 改善水循環：也因南方水門是唯一出口，南方水池因底泥淤積與營養鹽累積，海水進出均需經過水質相對差的南方水池混合，可能會影響其他區水質；建議可於北方北港溪出海口，以簡易虹吸管利用潮位與堤內之水位差重力引水。

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