Mapping of Taiwan's wetland distribution using the 2020–2021 land use investigation data

以 2020–2021 國土利用現況調查成果資料繪製臺灣濕地分布圖

Tien-Shui Chen[1,*], Hsing-Juh Lin[2], An-Zhu Huang[2], Wei-Chung Chen[2], and Li-Ling Li[3]

陳添水 [1,*] 林幸助 [2] 黃安珠 [2] 陳渭中 [2] 李莉鈴 [3]

[1]Taiwan Biodiversity Research Institute, Nantou, Taiwan

[2]Department of Life Sciences, Plant Ecophysiology, National Chung Hsing University, Taichung, Taiwan

[3]Green Energy and Environment Research Laboratories, Industrial Technology Research Institute, Taipei, Taiwan

[1] 農業部生物多樣性研究所 552005 南投縣集集鎮民生東路 1 號

[2] 國立中興大學生命科學系 402202 臺中市南區興大路 145 號

[3] 財團法人工業技術研究院綠能與環境研究所 310104 新竹縣竹東鎮中興路四段 195 號

*Corresponding author: tschen@tbri.gov.tw

* 通訊作者：tschen@tbri.gov.tw

Abstract

In order to promote the conservation of wetlands in Taiwan, the Wetland Conservation Act came into effect on February 2, 2015. However, basic information, such as the types, areas, and distribution of wetlands in Taiwan, were still incomplete. In this study, the data from the Land Use Investigation maintained by the National Land Surveying and Mapping Center, Ministry of the Interior for the years 2020 to 2021 were used, along with relevant remote sensing imagery and integrated image platforms. The Land Use Investigation data, consisting of 93 categories, were matched with the 42 wetland classification types defined by the Ramsar Convention, and those wetland types were extracted by using Geographic Information System (GIS) software for mapping and analysis to understand the spatial distribution of wetlands in Taiwan. The study identified 24 Ramsar wetland categories, including 9 marine/coastal wetland categories, 5 inland wetland categories, and 9 artificial wetland categories, with a total area of 462,000 hectares. This information could serve as a foundational dataset for wetland-related research and provide wetland management authorities with references and applications in decision-making, planning, and operational management.

Key words: wetland, Ramsar Convention, Geographic Information System (GIS)

摘要

臺灣為推動濕地生態之保育，濕地保育法業於 2015 年 2 月 2 日開始施行，惟有關臺灣濕地之類型、面積及分布等基礎資訊仍不完整。本研究以內政部 2020–2021 年更新維護之國土利用現況調查成果資料為材料，配合相關遙測影像資料與介接影像平台，將國土利用調查資料 93 類與拉姆薩公約之濕地分類類型 42 類按其定義進行配對，並以地理資訊系統軟體萃取濕地類型，完成製圖與分析，以瞭

解臺灣濕地之空間分布。研究篩選出拉姆薩濕地類型計有 24 類，包括海洋／海岸濕地 9 類、內陸濕地 5 類及人為濕地 9 類，面積合計 46.2 萬 ha，此資訊可提供濕地相關研究基礎資料，以及濕地管理單位在決策、規劃及經營管理之參考與應用。

關鍵詞：濕地、拉姆薩公約、地理資訊系統

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Introduction

Wetlands are one of the Earth's most productive ecosystems, providing unique and abundant habitats that nurture rich biodiversity and biomass. They were also recognized as crucial repositories of plant genetic materials (Ramsar Convention Secretariat 2006). Wetlands offer diverse ecological functions and services, such as water supply, water quality improvement, recreation, and habitat support. On average, the annual value of wetlands was estimated to exceed $2,800 per hectare (Brander *et al.* 2006). According to the Millennium Ecosystem Assessment, global wetlands disappeared more rapidly than other ecosystems (Agardy and Alder 2005). Therefore, it was important to record that information on the distribution and status of wetlands. With significant advancements in the spatial resolution and availability of Earth observation data, these technologies can be widely applied to wetland monitoring and mapping (Fitoka and Keramitsoglou 2008). The global coverage of inland and coastal wetlands exceeds 12.1 million square

kilometers, nearly the size of Greenland. Of this total, 54% were permanently submerged, and 46% experienced seasonal flooding (Gardner *et al.* 2018). The largest areas of wetlands were in Asia which covers 32% of the global area, followed by North America (27%), Latin America and the Caribbean region (16%) (Davidson *et al.* 2018). However, natural wetlands gradually disappeared, and wetland-dependent species, such as fish, water birds**,** and turtles, seriously declined. Approximately one-fourth of these species face the threat of extinction, particularly in tropical regions (Gardner *et al.* 2018).

Due to the lack of clear boundaries between wetlands and aquatic or terrestrial areas, various academic fields focus on different aspects of wetland research, and the recognition of wetlands varies among different countries or regions. According to the first article of the Ramsar Convention, which defines wetlands, “wetlands are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres” (Ramsar Convention Secretariat 1971). This definition was the broadest and most widely accepted internationally. Taiwan, in its Wetland Conservation Act announced on July 3, 2013, largely adopted the definition of wetlands from the Ramsar Convention. The Convention categorizes wetlands into three major types: Marine/Coastal Wetlands, Inland Wetlands, and Human-Made Wetlands. Each of these major types was further subdivided into 12, 20, and 10 categories, respectively, totaling 42 wetland types (Ramsar Convention Secretariat 2013).

To promote the conservation of wetland ecosystems, the Ministry of the Interior in Taiwan designated 75 national important wetlands in 2007. In 2010, the Executive Yuan approved the "National

Important Wetland Conservation Plan (Years 100–105)" as a blueprint for promoting wetland conservation and restoration. Furthermore, on July 3, 2013, the Wetland Conservation Act was announced, and on February 2, 2015, it was implemented on World Wetlands Day. In total, 83 national important wetlands were identified, including 2 international-level important wetlands, 40 national-level important wetlands, and 41 temporarily designated local-level important wetlands, covering a total area of approximately 47,600 hectares. Among the 41 locally designated important wetlands, a reassessment had been conducted, with 23 locations completed and ongoing assessments (Urban and Rural Development Branch, Construction and Planning Agency, Ministry of the Interior, 2019). However, existing research projects tended to focus on aspects, such as wetland survey and maintenance, ecological restoration, environmental education, and related measures under the Wetland Conservation Act. Essential and important issues, such as wetland types, their respective areas, and distribution in Taiwan have not been thoroughly addressed. This study primarily adopts the method used by Chen (2017) for producing wetland distribution maps based on the Ramsar Convention wetland classification. The Land Use Investigation maintained by the National Land Surveying and Mapping Center, Ministry of the Interior for the years 2020–2021 was used, along with relevant remote sensing imagery, followed by employing the Geographic Information System (GIS) tools to extract wetland types. The study aimed to create wetland maps and conduct spatial analysis to understand the spatial distribution of wetlands in Taiwan, which could address the aforementioned issues and provide wetland management agencies with references and applications for decision-making, planning, and operational

management.

Materials and methods

1. **Study area**

The definition of wetlands in Article 4 of the Wetland Conservation Act in Taiwan was as follows: "refers to natural or artificial areas, permanent or temporary, stationary or flowing, with fresh, salt, or brackish water, including marshes, lagoons, peatlands, intertidal zones, and water areas, including areas of marine water the depth of which at low tide does not exceed six meters". This definition was nearly consistent with the definition in the Ramsar Convention. The wetlands obtained in this study were based on the wetland types defined by the Ramsar Convention. Due to the lack of complete depth data for the surrounding sea areas of outlying islands, the research scope was limited to Taiwan's main island and its surrounding sea areas within 6 meters.

2. **Materials**

The primary data used in this study was the Land Use Investigation layer. This numerical layer was indirectly obtained through the Council of Agriculture from the maintenance data updated by the National Land Surveying and Mapping Center of the Ministry of the Interior in the years 2020 to 2021. The land use classification system was divided into three levels: the first level includes 9 major classes, the second level was further subdivided into 48 subclasses, and the third level was then further detailed into 93 categories, as detailed in Appendix 1 (National Land Surveying and Mapping Center, Ministry of the Interior 2010). The depth data for the surrounding sea areas were provided by the Department of Land Administration of Ministry of the Interior. These included the completed basic sea area maps and depth survey data for 5m and 10m water depth lines, from which the 6m water depth line was interpolated using an interpolation

method. Upon consulting with the National Land Surveying and Mapping Center of the Ministry of the Interior regarding the most recently completed basic sea area maps and depth survey data, it was confirmed that this data was managed and supplied by the Department of Land Administration of Ministry of the Interior. The 6m water depth lines were edited and produced using ArcGIS Pro.

3. **Wetland extraction**

The Ramsar Convention categorizes wetland types into three main groups: Marine/Coastal Wetlands, Inland Wetlands, and Artificial Wetlands. Each of these groups was further subdivided into 12, 20, and 10 types, respectively, resulting in a total of 42 wetland types, as detailed in Appendix 2 (Ramsar Convention Secretariat 2013). We matched the wetland classification types of Land Use Investigation with the Ramsar Convention accorded to their definitions of wetland types. This matching process involved incorporating relevant reference layers and imagery, including obtaining the coastal area boundary layer from the National Land Management Agency, accessing the National Land Surveying and Mapping Center's Land Surveying Map Network Map Service System, utilizing nationwide aerial photography and Formosat-2 satellite through the Aerial Survey and Remote Sensing Branch's Taiwan Aerial Photography and Formosat-2 Image Supply Platform, and using data from Google Maps and Google Earth Pro. These sources were used to filter and identify land use categories that meet the definition of wetlands.

4. **Image processing**

The land use categories containing wetlands, identified through the matching and filtering process, were merged and mapped using GIS software, specifically ESRI ArcGIS Pro.

Results and discussion

We matched and extracted the wetland types based on the definitions of the 93 land use categories in the Land Use Investigation with the 42 wetland classification types of the Ramsar Convention. The goal was to identify and extract wetland types. The results show that out of the 93 land use categories, 24 matched the wetland types defined by the Ramsar Convention. The extracted data encompassed a total of 1,147,875 records with a cumulative area of 2,300,004 hectares. The matching and extraction results were detailed in Table 1. Among the identified wetland types, 13 land use categories, including paddy fields, aquaculture, rivers, dredging rivers, canals, drainage ditches, reservoirs, lakes, other reservoirs, canal sandbar beach place, sea, wetlands and beaches, conformed to the wetland classification types defined by the Ramsar Convention. Additionally, 11 land use categories, such as broadleaf forests, government agencies, elementary schools, middle schools, colleges and universities, other cultural facilities, park green square, the salt industry and related facilities, grassland, reef rock, and the place of partial areas have not been used, including some sections qualified as wetlands.

Due to differences in the classification types between the Land Use Investigation and Ramsar Convention wetland classification, the corresponding relationship was not a simple one-to-one mapping. Instead, it was often involved with one-to-many or many-to-one relationships. In one-to-many relationships, for example, some aquacultures were corresponded to Ramsar wetland types 1 (aquaculture ponds) and J (coastal saline lagoons) because they were located in lagoons. Rivers were subdivided to correspondence to Ramsar wetland types F (estuarine waters), mangroves (I), streams (M, N), and irrigation or

drainage channels (3, 9). In many-to-one relationships, for instance, paddy fields, some government agencies, and elementary schools collectively correspond to Ramsar wetland type 3 (paddy fields). Dredging rivers, canals, drainage ditch, middle schools, and the park green square jointly correspond to Ramsar wetland type 9 (canals, drainage channels, and ditches).

Some land use categories posed challenges in classification, such as the rivers category needing differentiation into estuaries, permanent, or seasonal rivers. The drainage ditches category could not be distinguished from irrigation channels or drainage channels in some cases. The spring wetlands category may have small or elongated channels that may be difficult to mark, especially when located under forests. Some mangrove categories were often classified as either natural or artificial broad-leaved pure forests. Other categories, such as those belonging to schools, parks, military lands, etc., require further extraction to identify pools. The handling of these issues has been discussed by Chen (2017), and other related problems were outlined below.

The land use classification of Land Use Investigation classifies rice crops as "rice fields" category in the third-level classification for the years 2006–2015. Other paddy crops, including water bamboo shoots, calla taro, water weeds, lotus, water lily, water lotus, water chestnut, Dajia rush, triangular rush (saline grass), and cattail plants, were classified as "dry farm." In the classification for the years 2016–2019, paddy fields were further divided into rice fields and other paddy fields categories. However, in the classification of Land Use Investigation for the years 2020–2021, rice fields with other paddy fields were merged into a general category of “paddy fields". Upon verification, it was found that some of the other wet fields were planted

aquatic crops in rotation with rice. Approximately half of the entries in the land classification in the year 2008 were erroneously categorized as either "rice field " or " dry farm".

The data on reservoir categories comply with the Ramsar Convention's wetland classification types for reservoir storage areas (with an area exceeding 8 hectares), consisting of 43 polygons. There are also 43 polygons with areas below 8 hectares. However, some polygons in this category, when referenced against images, were found to be segmented by roads or bridges, resulting in blocks smaller than 8 hectares. Upon closer inspection by enlarging the images, it was discovered that if these segments were connected to existing reservoirs, they were considered part of the same polygon and were still classified as Type 6 (permanent freshwater lakes). Additionally, during image comparison, it was observed that reservoirs may appear segmented due to different wet and dry seasons. Therefore, a detailed examination through image enlargement was necessary to confirm whether these segments represent areas of the same reservoir.

The lake category includes some parts of water named lakes that were not naturally formed. If their proximity to agriculture and roads suggests artificial origins, they were classified as artificial lakes. The classification principles for cases where these lakes are intersected by roads or bridges are as follows:

If the segmentation exceeds 8 hectares, they were categorized as Type 6 (water storage area).

If the segmentation was less than 8 hectares, they were categorized as Type 2 (pond).

For natural lakes that were intersected by roads or bridges:

If the segmentation exceeds 8 hectares, they were categorized as Type O (permanent freshwater lake).

If the segmentation is less than 8

hectares, they were categorized as (Tp, Ts) (permanent freshwater marsh and pond, seasonal freshwater swamp and pond).

The wetland category layer primarily consists of nationally important wetlands, such as the Chenglong Important Wetland, and wetland parks like the Jhongdu Wetland Park. Some areas designated as wetland parks had undergone land use transformation, becoming aquaculture ponds or salt pans. Depending on their water body size, they were classified as Convention wetland type 6 (water storage areas) or 2 (ponds). Alternatively, based on their environmental characteristics, they may be categorized as H (intertidal marshes) or I (intertidal forested wetlands), such as intertidal marshes or intertidal mangrove swamps.

Regarding the beach category, certain blocks appear to be intertidal mudflats when viewed on the layer, located near the coastline and adjacent to mountains. However, a 3D inspection revealed them to be exposed mountain slopes with steep gradients. They remain unaffected during high tide, and rainwater or seawater does not easily accumulate in these areas. As a result, they were classified as non-wetlands. In cases where intertidal mudflats had mangrove distribution, they were extracted as Convention wetland type I (intertidal forested wetlands).

For the broadleaf forest category, the focus was on extracting habitats where mangroves have been grown. These habitats were often located along the coast and around aquaculture ponds near the sea. Some tree species, such as *Casuarina equisetifolia* used in windbreak forests, may grow in mixed stands with mangroves. Certain windbreak tree species, like the *Hibiscus tiliaceus*, could resemble mangroves when they were farther away. It was crucial to identify their growth environment, leaf width, leaf shape, and

root location to confirm the accuracy of tree species identification.

In the reservoir category, some constructed wetlands were originally paddy fields or ponds. After conversion into constructed wetlands, they primarily served as sewage treatment areas. When these areas were inspected, their functionality as constructed wetlands was considered, and they are classified as Convention wetland type 8 (Wastewater treatment areas).

In the reef crag category, it was observed during layer inspection that some areas classified as rocky shore were actually exposed land in inland mountainous regions. These areas were then classified as non-wetlands.

For the grassland category, some layers showed the presence of mangroves along ditches and drainage channels near the estuary. In such cases, the extraction process identifies them as Convention wetland type I (intertidal forested wetlands).

The areas and proportions of various wetland types extracted according to wetland classification are summarized in Table 2, and the distribution of wetlands in Taiwan is illustrated in Figure 1. The total area of 24 wetland types was 462,079.00 hectares. Among the three major wetland categories as following:

Marine/Coastal Wetlands had a total area of 112,419.64 hectares, constituting 24.33% of the total wetland area. This category includes nine types**,** such as shallow marine waters, coral reefs, rocky marine shores, sand bars or sand dune, estuarine waters, intertidal mud or sand, intertidal marshes, intertidal forested wetlands, and coastal saline lagoons. Shallow marine waters, with an area of 74,717.24 hectares (16.17%), are the largest subtype.

Inland Wetlands covered a total area of 99,457.70 hectares, accounting for 21.52% of the total wetland area. This category includes aquaculture ponds, ponds (usually less than 8 hectares), rice

fields, irrigation channels or drainage ditches, salt fields, reservoir areas, excavation areas, wastewater treatment areas (artificial wetlands), canals, drainage channels, and ditches. Rivers in inland areas, totaling 97,513.34 hectares (21.10%), were the largest subtype.

Human-made Wetlands, the largest in terms of area among the three categories, had a total area of 250,201.66 hectares, representing 54.15% of the total wetland area. This category includes aquaculture ponds, ponds, paddy fields, irrigation channels or drainage channels, salt pans, water storage areas, excavations, wastewater treatment areas and canals. Among them, paddy fields, covering 168,433.51 hectares (36.45%), were widely distributed in the plains of Taiwan and represent the largest subtype among wetland categories.

Conclusion

In this study, we utilized the Land Use Investigation data that have been maintained by the National Land Surveying and Mapping Center, Ministry of the Interior in Taiwan for the years 2020–2021. The wetland types were matched with the classifications defined by the Ramsar Convention. The ground spatial resolution of aerial imagery for wetland inspection was less than 50 cm, an improvement over the previous use of color-fused satellite imagery with a resolution of 2 meters, enhancing wetland identification capabilities. However, distinguishing between permanent and seasonal streams, especially for many narrow and elongated streams exhibiting intermittent patterns during the dry season, still remains challenging due to the often subterranean flow.

Additionally, the lack of differentiation between irrigation and drainage channels in the data results in shared channels for industrial and agricultural purposes. Therefore, distinguishing between irrigation channels and drainage channels in

human-made wetlands using imagery remains challenging.

GIS software was employed to extract wetland types and produce a wetland distribution layer. We identified 24 Ramsar wetland types, including 9 marine/coastal wetland types, 5 inland wetland types, and 9 artificial wetland types. The total area was 462,079 hectares. This information serves as fundamental data for wetland-related research, providing wetland management units with reference data for decision-making, planning, and operational management. It could also be used for subsequent research applications, such as wetland assessment, net-zero loss policies, biomass, carbon emission inventories, ecological service calculations, and studies on various wetland types.

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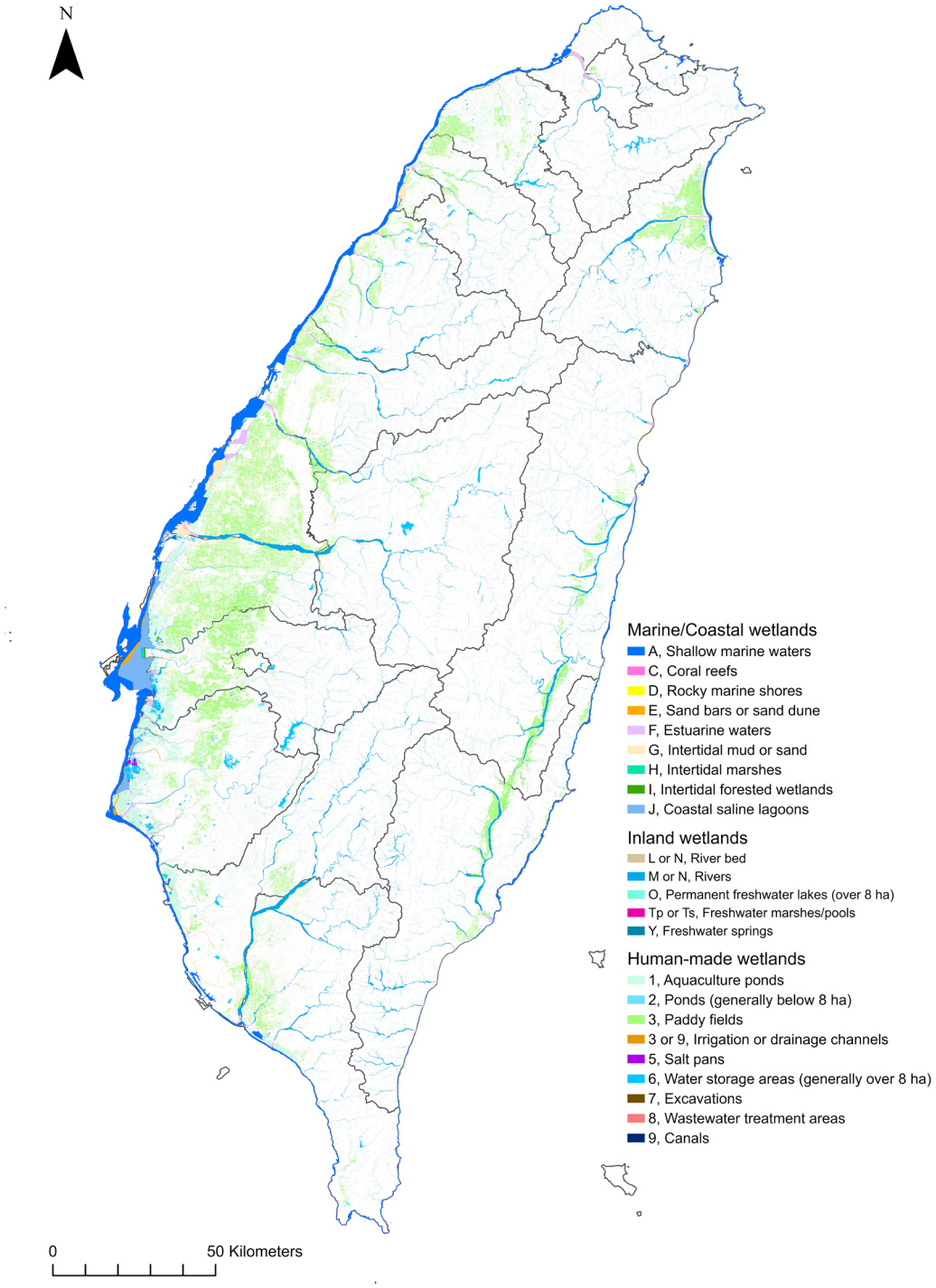

圖 1 臺灣濕地分布圖。

Fig. 1 Map showing wetland distribution in Taiwan. (English codes or numbers correspond to the code of the Ramsar wetland classification system)

Table 1 Land Use Investigation Data matched with the wetland types specified in the Ramsar Convention
表 1 國土利用現況調查成果資料與拉姆薩公約之濕地類型配對表

L_C3*	Lcode_C3**	Ramsar_code***
Paddy field	010101	3
Aquaculture	010200	1,J
River	040101	F, I, (M, N), (3, 9)
Dredging River	040102	9, not wetland
Canal	040103	9
Drainage ditch	040104	(3, 9), 9, F, I, J, Y, (M, N)
Reservoir	040201	6, not wetland
Lake	040202	O, (Tp, Ts), 2, 6, Y, not wetland
Other reservoirs	040203	A, O, (Tp, Ts), Y, 2, 6, 7, 8
Canal sandbar beach place	040300	G, I, (L, N)
Sea	040600	A, J
Wetland	090100	E, F, G, H, I, (L, N), 1, 2, 6, 8, (3, 9), not wetland
Beach	090301	D, E, F, G, I, (L, N), (M, N), not wetland
Broadleaf forest	020200	part of H, I
Governmental agency	060100	part of F, J, (M, N), 1, 2, 3, (3, 9)
Elementary school	060202	part of 2, 3, (3, 9)
Middle school	060203	part of 2, 9, (3, 9)
Universities, colleges and institutes	060204	part of 1, 2, 6, (3, 9)
Other cultural facilities	070103	part of 2, Y
Park green square	070200	part of 2, 3, 6, 8, 9, (3, 9), A, D, I, (M, N), O, Y
Salt industry and related facility	080300	part of 1, 2, 5, 6, (3, 9), H, I
Grassland	090200	part of I, (M, N), 2
Reef crag	090303	part of C, D, E, G, (L, N)
the place has not been used	090501	part of 2, (3, 9), F, I

*L_C3: Landuse_Class3; **Lcode_C3: Landuse code_Class3; ***Ramsar_code: Ramsar Convention's wetland classification codes

*第三級土地類別：國土利用現況調查成果資料第三級土地利用類別；**第三級土地利用類別代碼；***拉姆薩公約濕地分類代碼

Table 2 Wetland types and areas in Taiwan
表 2 臺灣濕地類型與面積

Ramsar code	Wetland types	Area (hectare)	Area (%)
Marine/Coastal wetlands		112,419.64	24.33
A	Shallow marine waters (海岸淺水域)	74,717.24	16.17
C	Coral reefs (珊瑚礁)	348.97	0.08
D	Rocky marine shores (岩礁)	547.75	0.12
E	Sand bars or sand dune (沙洲或沙丘)	2,981.50	0.65
F	Estuarine waters (河口)	10,459.40	2.26
G	Intertidal mud or sand (潮間帶泥灘或沙灘)	8,527.32	1.85
H	Intertidal marshes (潮間帶草澤)	432.87	0.09
I	Intertidal forested wetlands (潮間帶林澤)	1,131.25	0.24
J	Coastal saline lagoons (海岸鹹水潟湖)	13,273.33	2.87
Inland wetlands		99,457.70	21.52
L, N	River bed (河床)	1,551.13	0.34
M, N	Rivers (溪流)	97,513.34	21.10
O	Permanent freshwater lakes (over 8 ha) (永久性淡水湖泊)	254.53	0.06
Tp, Ts	Freshwater marshes/pools (淡水沼澤與池塘)	122.35	0.03
Y	Freshwater springs (淡水湧泉)	16.35	0.00
Human-made wetlands		250,201.66	54.15
1	Aquaculture ponds (養殖池)	38,894.11	8.42
2	Ponds (generally below 8 ha) (池塘)	10,550.84	2.28
3	Paddy fields (水田)	168,433.51	36.45
3, 9	Irrigation or drainage channels (灌溉渠道或排水道)	18,188.43	3.94
5	Salt pans (鹽田)	463.63	0.10
6	Water storage areas (generally over 8 ha) (蓄水區)	13,418.38	2.90
7	Excavations (開鑿區)	0.07	0.00
8	Wastewater treatment areas (廢水處理區)	204.85	0.04
9	Canals (運河)	47.84	0.01
Total		462,079.00	100.00

Appendix 1 The classification system used in the Land Use Investigation Data of Taiwan for the years 2020-2021

附表 1 臺灣 2020-2021 年國土利用現況調查成果土地使用分類系統

Code 1	Class 1	Code 2	Class 2	Code 3	Class 3
01	Agriculture	0101	Farm crops	010101	Paddy field
				010102	Dry farm
				010103	Fruit tree
		0102	Aquaculture	010200	Aquaculture
		0103	Poultry	010301	Livestock
				010302	Pasture
		0104	Agriculture related facilities	010401	Agricultural production facilities
				010402	Agricultural production, marketing and processing facilities
02	Forestry	0201	Conifer forest	020100	Conifer forest
		0202	Broadleaf forest	020200	Broadleaf forest
		0203	Bamboo grove	020000	Bamboo grove
		0204	Confusion forest	020401	Conifer and broad-leaf confusion forest
				020402	Bamboo and broad-leaf confusion forest
				020403	Bamboo and Conifer confusion forest
				020404	Bamboo, conifer and broad-leaf confusion forest
		0205	Shrubland	020500	Shrubland
		0206	Young woodland	020600	Young woodland
		0207	Other forest-use land	020700	Other forest-use land
03	Transportation	0301	Airport	030100	Airport
		0302	Railroad and related facility	030201	Common railroad
				030202	Railroad related facility
		0303	High-speed railroad and related facility	030301	Common railroad
				030302	High-speed railroad-related facility
		0304	Mass rapid transit and related facility	030401	Mass rapid transit
				030402	Mass rapid transit-related facility
		0305	Path and related facility	030501	National highway
				030502	Provincial road
				030503	Expressway
				030504	Common path
				030505	Path related facility
		0306	Harbor	030601	Commercial harbor

				030602	Fishing port
				030603	Special-purpose port
				030604	Other port related facility
04	Water Conservancy	0401	River course	040101	River
				040102	Dredging River
				040103	Canal
				040104	Drainage ditch
		0402	Reservoir	040201	Reservoir
				040202	Lake
				040203	Other reservoirs
		0403	Canal sandbar beach place	040300	Canal sandbar beach place
		0404	Water conservation structure	040401	Embankment
				040402	Water Gate
				040403	Pumping station
				040404	Reservoir barrage
				040405	Underground takes the water well
				040406	Other water conservancy facility
		0405	Flood prevention path	040500	Flood prevention path
		0406	Sea level	040600	Sea
05	Built-up Land	0501	Trade	050101	Retail sales wholesale
				050102	Service industry
		0502	Pure housing	050200	Pure housing
		0503	Mixed-use housing	050301	The concurrently industry uses the housing
				050302	The concurrently trade uses the housing
				050303	Concurrently others use housing
		0504	Manufacturing industry	050400	Manufacturing industry
		0505	Stores in a storehouse	050500	Stores in a storehouse
		0506	Religion	050600	Religion
		0507	Funeral and burial facility	050700	Funeral and burial facility
		0508	Other built-up Land	050801	Constructs
				050802	Other
06	Public Land	0601	Governmental agency	060100	Governmental agency

		0602	School	060201	Preschool
				060202	Elementary school
				060203	Middle school
				060204	Universities, colleges and institutes
				060205	Special school
		0603	Medical health care	060300	Medical health care
		0604	Social welfare facility	060400	Social welfare facility
		0605	Public utility	060501	Meteorology
				060502	Electric power
				060503	Gas
				060504	Running water
				060505	Gas station
		0606	Environmental protection facility	060600	Environmental protection facility
07	Recreation and Leisure	0701	Cultural facilities	070101	Decretory cultural facilities
				070102	General cultural facilities
				070103	Other cultural facilities
		0702	Park green square	070200	Park green square
		0703	Leisure facility	070301	Amusement place
				070302	Sports place
08	Minerals	0801	Mining industry and related facility	080100	Mining industry and related facility
		0802	Earthstone and related facility	080200	Earthstone and related facility
		0803	Salt industry and related facility	080300	Salt industry and related facility
09	Miscellaneous Land	0901	Wetland	090100	Wetland
		0902	Grassland	090200	Grassland
		0903	Bare land	090301	Beach
				090302	Landslide
				090303	Reef crag
		0904	Builds the surplus cubic meter of earth and stone	090400	Builds the surplus cubic meter of earth and stone
		0905	Exposed open area	090501	Has not used the place
				090502	In artificial change land

Data sorted out and modified from the Land Use Investigation of Taiwan National Land Surveying and Mapping Center, M.O.I. (https://www.nlsc.gov.tw/cl.aspx?n=13705)

Appendix 2 Ramsar wetland classification system
附表 2 拉姆薩公約濕地類型分類系統

Wetland Code/Description
Marine/Coastal Wetlands A -- Permanent shallow marine waters in most cases less than six metres deep at low tide; includes sea bays and straits. B -- Marine subtidal aquatic beds; includes kelp beds, sea-grass beds and tropical marine meadows. C -- Coral reefs. D -- Rocky marine shores; includes rocky offshore islands and sea cliffs. E -- Sand, shingle or pebble shores; includes sand bars, spits and sandy islets; includes dune systems and humid dune slacks. F -- Estuarine waters; permanent water of estuaries and estuarine systems of deltas. G -- Intertidal mud, sand or salt flats. H -- Intertidal marshes; includes salt marshes, salt meadows, salting and raised salt marshes; includes tidal brackish and freshwater marshes. I -- Intertidal forested wetlands; includes mangrove swamps, nipah swamps and tidal freshwater swamp forests. J -- Coastal brackish/saline lagoons; brackish to saline lagoons with at least one relatively narrow connection to the sea. K -- Coastal freshwater lagoons; includes freshwater delta lagoons. Zk(a) – Karst and other subterranean hydrological systems, marine/coastal.
Inland Wetlands L -- Permanent inland deltas. M -- Permanent rivers/streams/creeks; includes waterfalls. N -- Seasonal/intermittent/irregular rivers/streams/creeks. O -- Permanent freshwater lakes (over 8 ha); includes large oxbow lakes. P -- Seasonal/intermittent freshwater lakes (over 8 ha); includes floodplain lakes. Q -- Permanent saline/brackish/alkaline lakes. R -- Seasonal/intermittent saline/brackish/alkaline lakes and flats. Sp -- Permanent saline/brackish/alkaline marshes/pools. Ss -- Seasonal/intermittent saline/brackish/alkaline marshes/pools. Tp -- Permanent freshwater marshes/pools; ponds (below 8 ha), marshes and swamps on inorganic soils; with emergent vegetation water-logged for at least most of the growing season. Ts -- Seasonal/intermittent freshwater marshes/pools on inorganic soils; includes sloughs, potholes, seasonally flooded meadows and sedge marshes. U -- Non-forested peatlands; includes shrub or open bogs, swamps and fens.

Va -- Alpine wetlands; includes alpine meadows and temporary waters from snowmelt.
Vt -- Tundra wetlands; includes tundra pools and temporary waters from snowmelt.
W -- Shrub-dominated wetlands; shrub swamps, shrub-dominated freshwater marshes, shrub carr, alder thicket on inorganic soils.
Xf -- Freshwater, tree-dominated wetlands; includes freshwater swamp forests, seasonally flooded forests and wooded swamps on inorganic soils.
Xp -- Forested peatlands; peat-swamp forests.
Y -- Freshwater springs; oases.
Zg -- Geothermal wetlands.
Zk(b) – Karst and other subterranean hydrological systems, inland

Human-made wetlands

1 -- Aquaculture (e.g., fish/shrimp) ponds.
2 -- Ponds; includes farm ponds, stock ponds, small tanks; (generally below 8 ha).
3 -- Irrigated land; includes irrigation channels and rice fields.
4 -- Seasonally flooded agricultural land (including intensively managed or grazed wet meadow or pasture).
5 -- Salt exploitation sites; salt pans, saline etc.
6 -- Water storage areas; reservoirs/barrages/dams/impoundments (generally over 8 ha).
7 -- Excavations; gravel/brick/clay pits; borrow pits, mining pools.
8 -- Wastewater treatment areas; sewage farms, settling ponds, oxidation basins, etc.
9 -- Canals and drainage channels, ditches.
Zk(c) – Karst and other subterranean hydrological systems, human-made.

Data Source: https://www.ramsar.org/