

Establish Taiwan aquifer storage and recovery site selection



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Date:10/05

Outline

1.  Introduction

2.  Methods

3.  Results and discussion

4.  Conclusions and Future work

1. Introduction

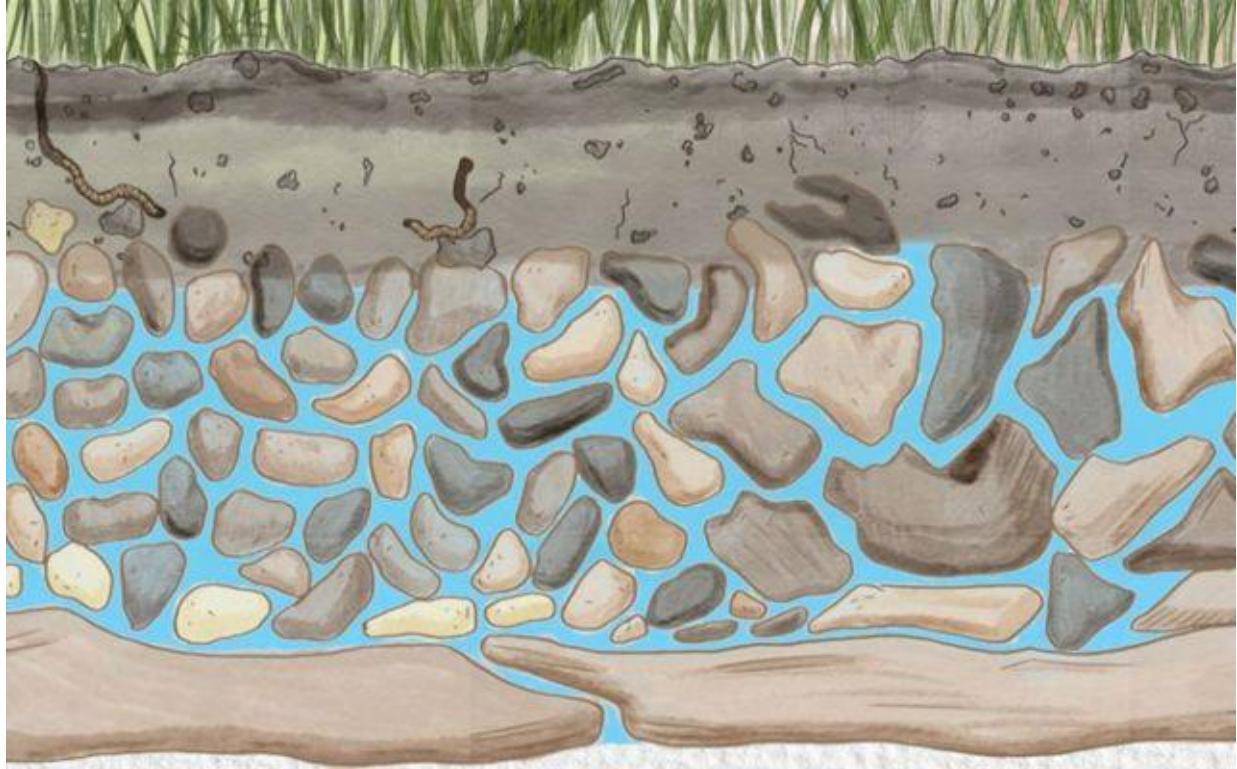
Due to Taiwan's rapid economic development and high population density, agriculture, industry and people's livelihood .**Water resources has become a very important issue.**



Picture source: Shutterstock

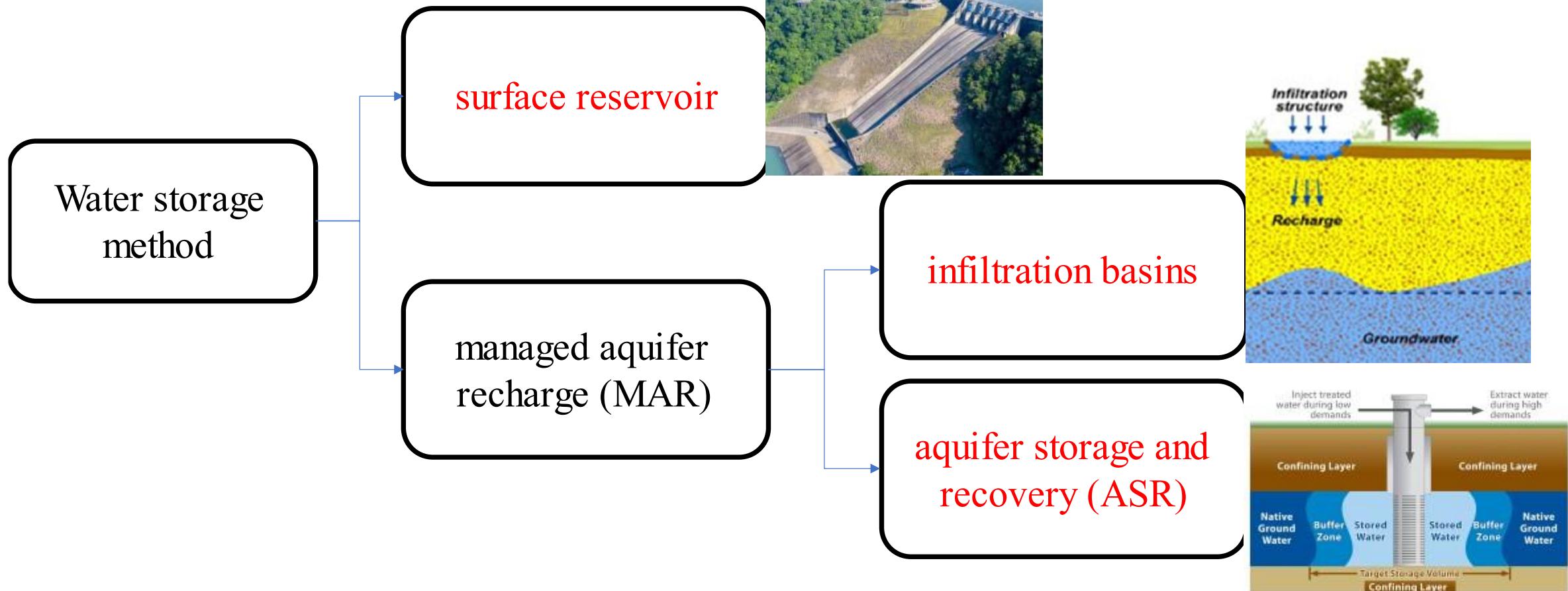
Groundwater's advantage

- 1.considerable storage space
- 2.decentralized storage
- 3.not easily affected by surface human activities, pollution and seasonal
- 4.low construction and maintenance costs
- 5.easy access, etc.



Picture source:The Nature Conservancy

Water storage method



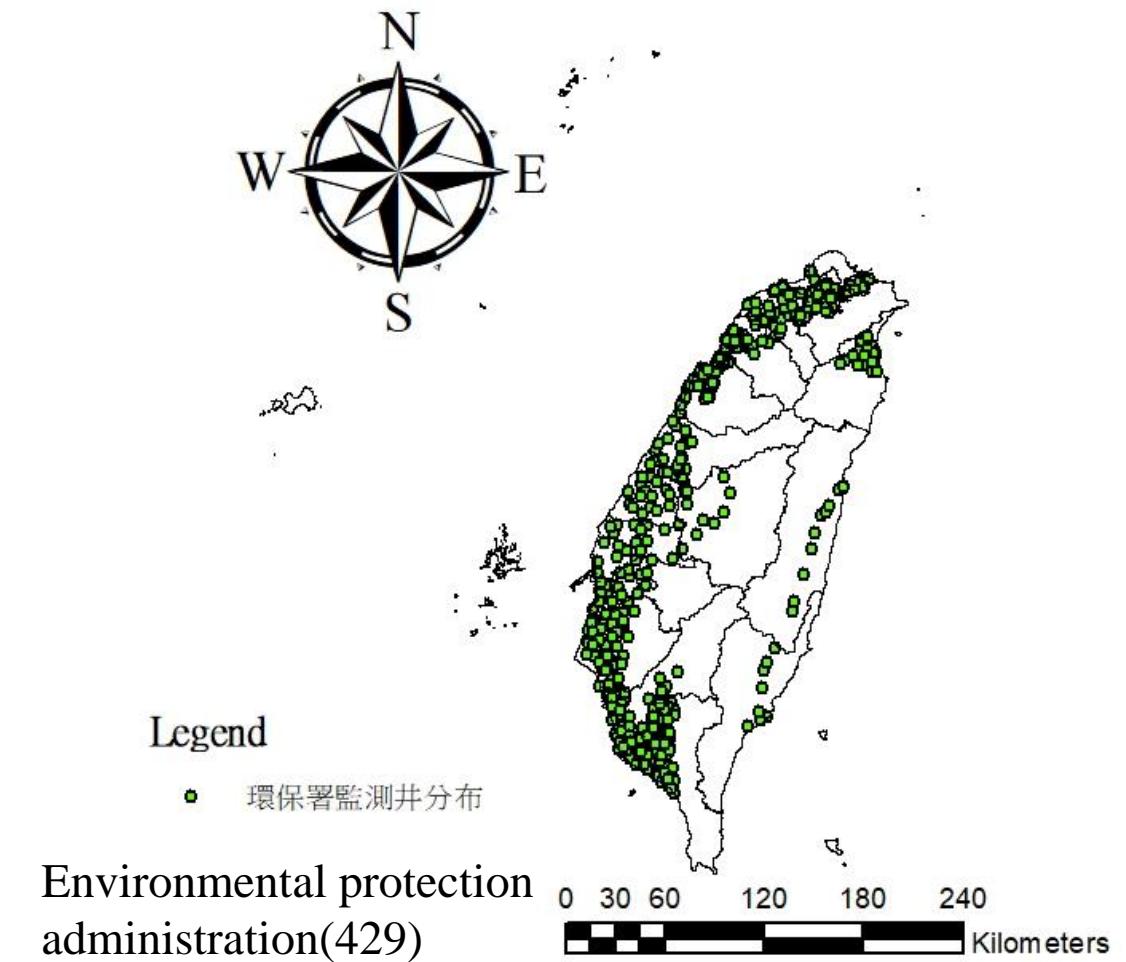
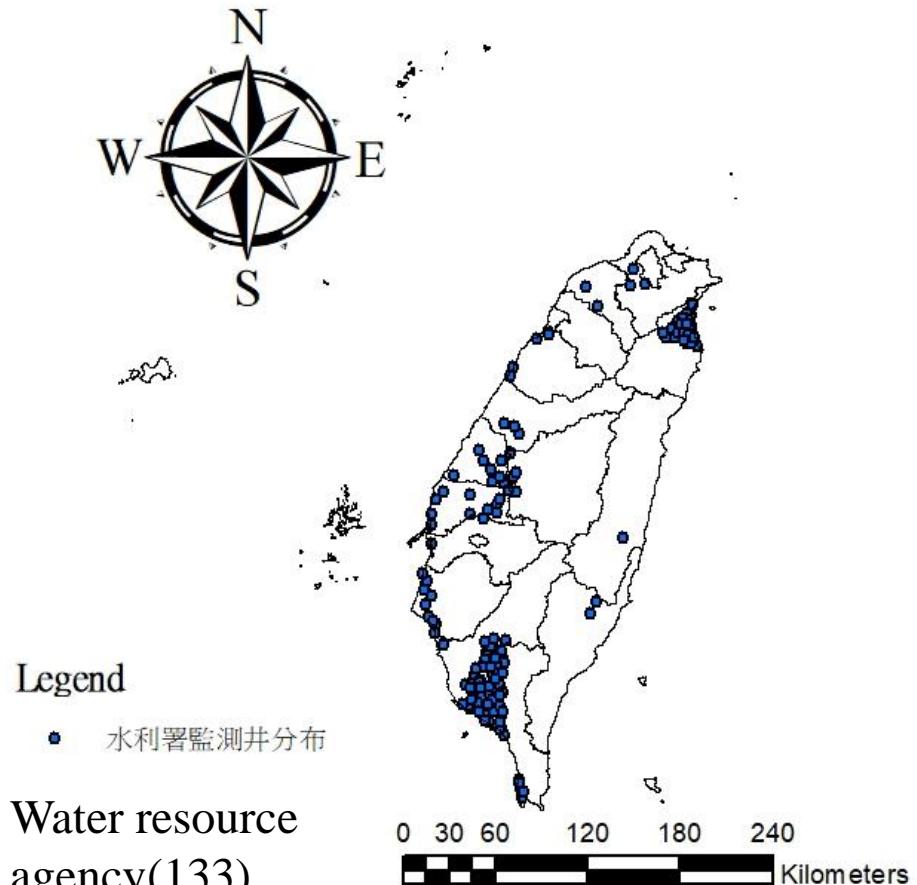
Objective

Using **excel** and **Arcgis** to collect and process the data to get the dataset.

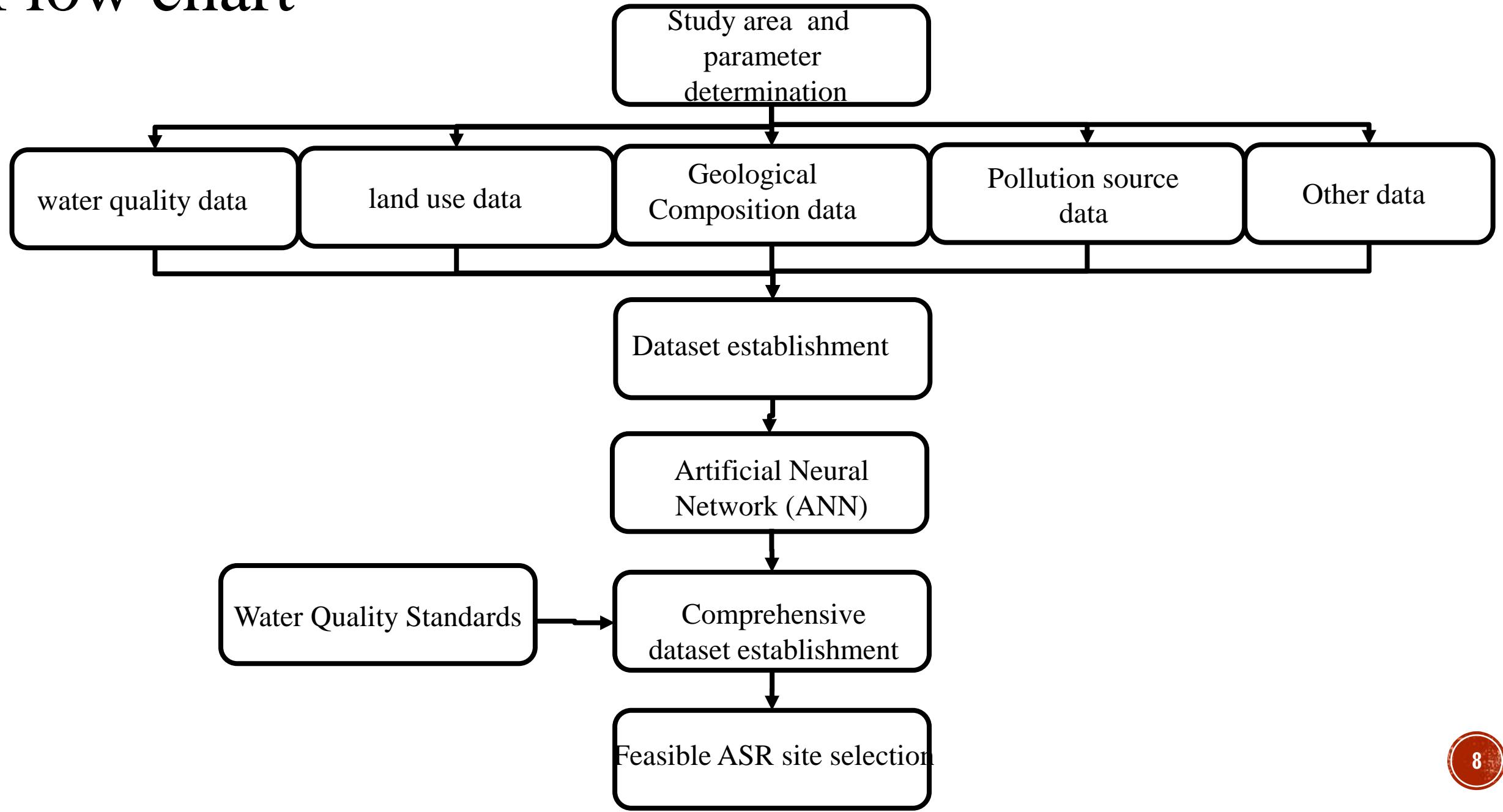
Due to lot of vacant among the dataset,I am going to use **artificial neural network** to make dataset more comprehensive.

Compare with Water Quality Standards to **select the feasible site for aquifer storage and recovery in Taiwan** .

2.Method and materials

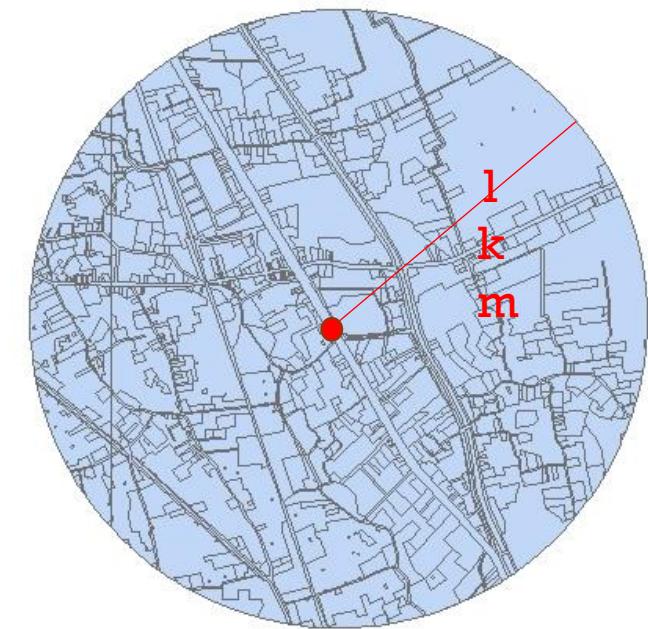


Flow chart



Water quality		land use		geological composition		Pollution source		Other	
classify	parameter	Parameters (continued)	Parameters (continued)	Parameters (continued)	Parameters (continued)	Parameters (continued)	Parameters (continued)	description	Source
Water quality parameters	Water surface to wellhead depth (m)	Oxidation-reduction potential (mV)	Nitrate Nitrogen (mg/L) Sulfate (mg/L) Total Organic Carbon (mg/L)	Chromium (mg/L)	Manganese (mg/L) Mercury (mg/L) Nickel (mg/L) Total phenols (mg/L)	Sodium (mg/L) Potassium (mg/L) Calcium (mg/L) Magnesium (mg/L) Total Alkalinity (mg/L)	2018 Groundwater Quality Information Announced by the Environmental Protection Agency	Environmental protection administration	
	Water temperature (°C)	Total hardness (mg/L) Total dissolved solids (mg/L)	Arsenic (mg/L) Cadmium (mg/L)	Copper (mg/L) Lead (mg/L) Zinc (mg/L)	Fluoride salts (mg/L)	Iron (mg/L)			
Water quality parameters	Conductivity ($\mu\text{mho}/\text{cm}25^\circ\text{C}$)	Chloride salts (mg/L)						Water resource agency	
	pH value	Ammonia nitrogen (mg/L)							
Water quality parameters	Dissolved oxygen (electrode method) (mg/L)							Water resource agency	
	Dissolved oxygen (electrode method) (mg/L)	Unit discharge volume Q/s (cmh/m)	Chloride (mg/L) Ammonia nitrogen (mg/L)	Total Organic Carbon (mg/L) Arsenic (mg/L) Cadmium (mg/L) Chromium (mg/L) Copper (mg/L)	Lead (mg/L) Zinc (mg/L) Iron (mg/L) Manganese (mg/L) Mercury (mg/L)	Nickel(mg/L) Sodium (mg/L) Potassium (mg/L) Calcium (mg/L) Magnesium (mg/L)	2018 Groundwater Quality Information Announced by the Water resource agency		
Water quality parameters	Redox potential (mV)	Water permeability coefficient K (m/min)	Nitrate nitrogen (mg/L) Sulfate (mg/L)					Water resource agency	
	Total Hardness (mg/L)	Water conductivity T (m ² /min)							

classify	parameter	Parameters (continued)	description	Source
land use information	Agricultural land (%) Forest use land (%) Land used for transportation (%) Land for water use (%)	Land used for construction (%) Public use land (%) Recreational land (%) Mineral salt utilization land (%) Other land use (%)	According to the land use data published by the Ministry of the Interior in 2006, and according to the location of the water quality well, with the well as the center and a radius of one kilometer as a circle, the percentage of the circle area occupied by each land use was investigated.	Ministry of the Interior



classify	parameter	description	Source
geological composition data	Gravel composition (%) Sand composition (%) Soil composition (%) Clay composition (%)	Classified by particle size, gravel above 2.00mm, sandy soil 0.25~2.00mm, soil 0.063~0.25mm, clay <0.063, and check the engineering drilling around the water quality well, and calculate the components from the surface to the groundwater level Geological composition percentage	Central geological survey,M OEA

工程名稱：-

地點：內湖區大湖街131巷

鑽孔編號：BH-03

深 度：15.03 M

鑽孔標高：32.20 M

坐標系統：TWD97

地下水位：7.10 M

坐 標 N：2775958.45

**sand****Gravel**

Water quality

land use

geological composition

Pollution source

Other

classify	parameter	description	Source
Pollution source information	County and city population (person) County area (square kilometers) County and city population density (person/square kilometer) Number of pigs slaughtered by county and city (head) Number of cattle slaughtered by county and city (head) Number of sheep slaughtered by county and city (head) County and city pig breeding area (hectares) County and city cattle breeding area (hectares) County and city sheep breeding area (ha)	Human and animal activities may be one of the sources of pollution, so the number, area and density of humans and livestock in the county and city where the water quality wells are located	Dept. of household registration Council of agriculture, executive yuan

Water quality

land use

geological composition

Pollution source

Other

classify	parameter	description	Source
Other information	aqi so2 co o3 pm10 pm2.5 No2 The location of the landfill from the well (km) Landfill disposal volume (metric tons)	The correlation of air pollution indicators may be low, and it can be discussed whether to use them after collecting them first. For landfills, it depends on whether there is a water quality well within a radius of one kilometer, and if it exists, what is the buried amount	Environmental protection administration

Artificial neural network

supervised learning technique(Often use in prediction)

	Parameter(A)	Parameter(B)	Parameter(C)	Parameter(D)
Well(1)	10	6	3	7
Well(2)	20	1	3	5.5
Well(3)	30	2	5	11.5
Well(4)	50	5	4	not recorded

Artificial neural network

supervised learning technique(Often use in prediction)

train

	Parameter(A)	Parameter(B)	Parameter(C)	Parameter(D)
Well(1)	10	6	3	7
Well(2)	20	1	3	5.5
Well(3)	30	2	5	11.5
Well(4)	50	5	4	?

$$D=0.1A+0.5B+C$$

Artificial neural network

supervised learning technique(Often use in prediction)

test

	Parameter(A)	Parameter(B)	Parameter(C)	Parameter(D)
Well(1)	10	6	3	7
Well(2)	20	1	3	5.5
Well(3)	30	2	5	11.5
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$$D=0.1A+0.5B+C$$

Artificial neural network

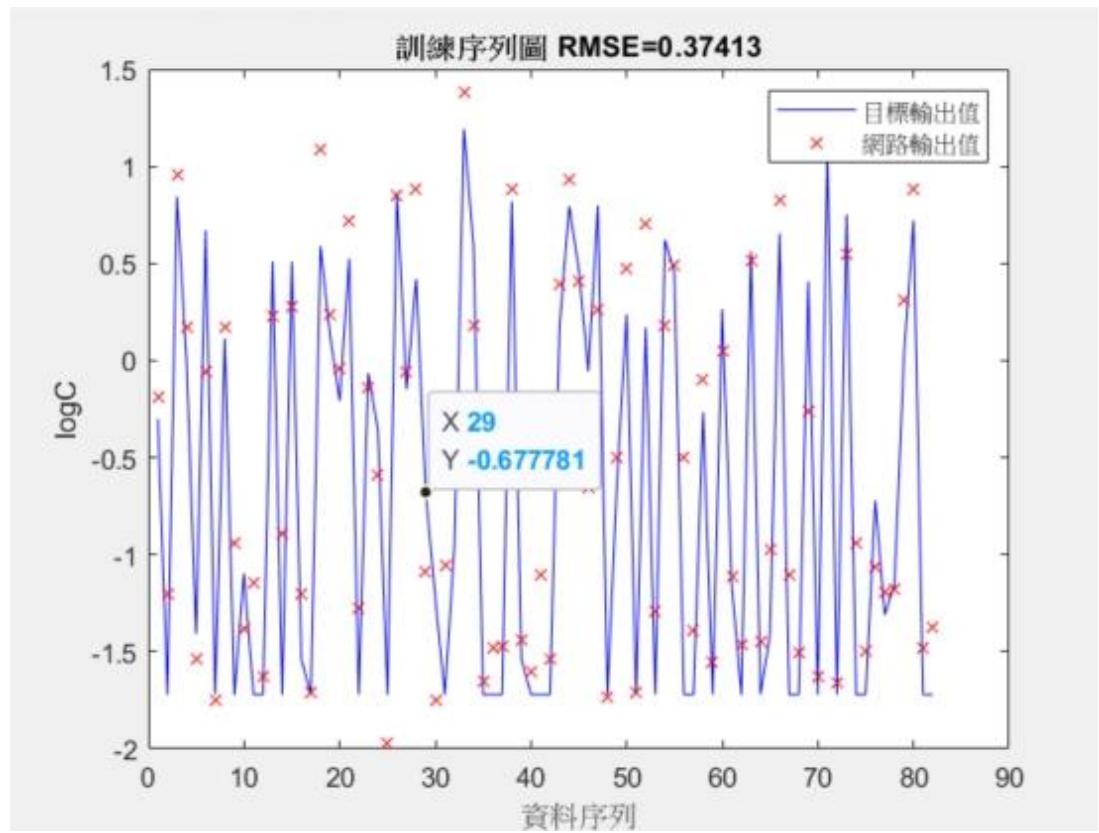
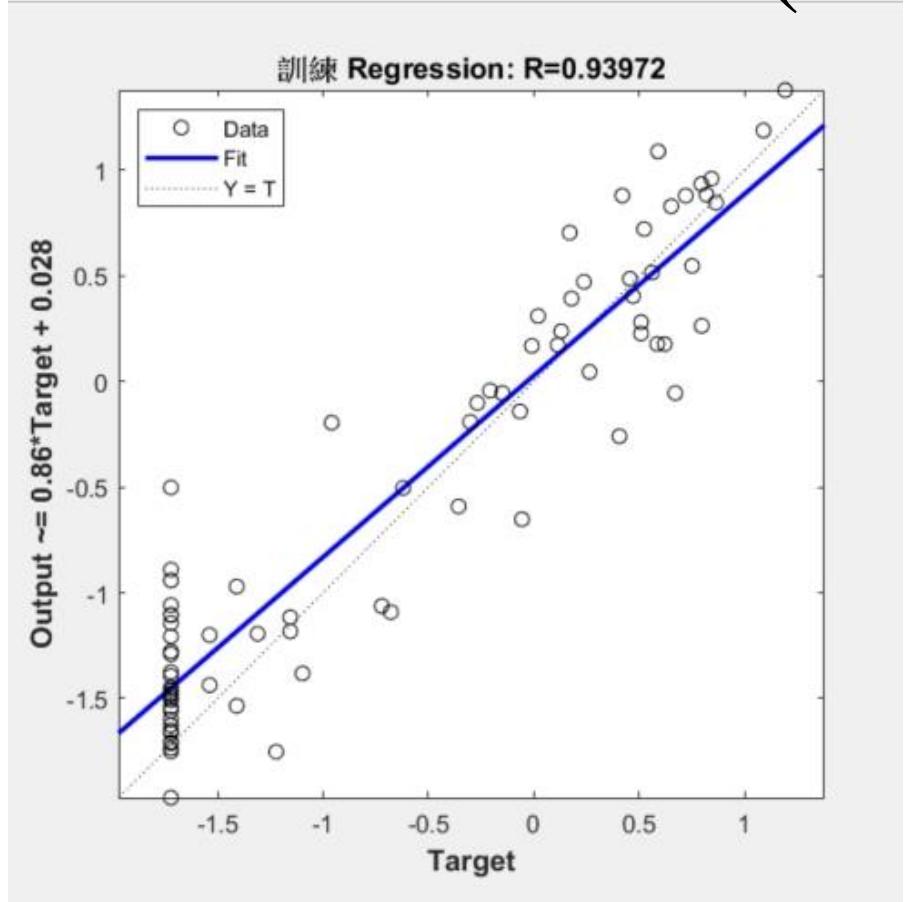
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Well(1)	10	6	3	7
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Well(3)	30	2	5	11.5
Well(4)	50	5	4	not recorded

$$D=0.1A+0.5B+C \text{ (black box)}$$

not recorded  11.5

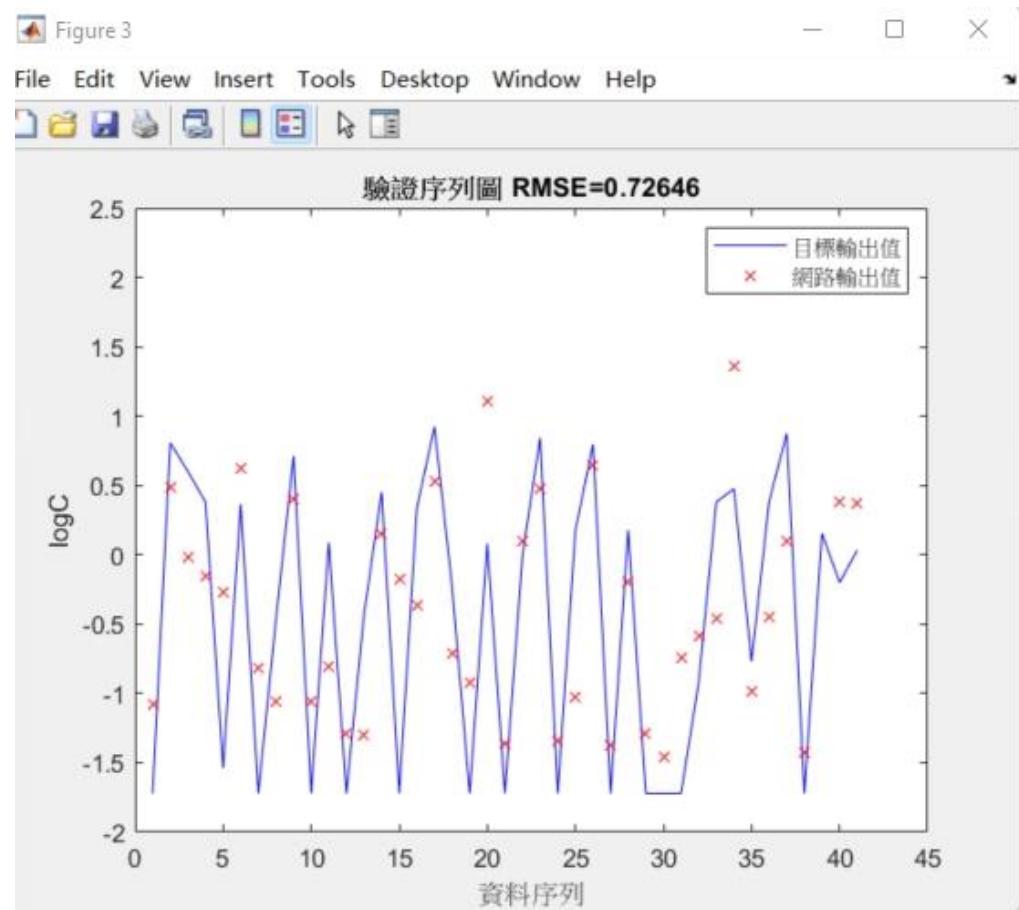
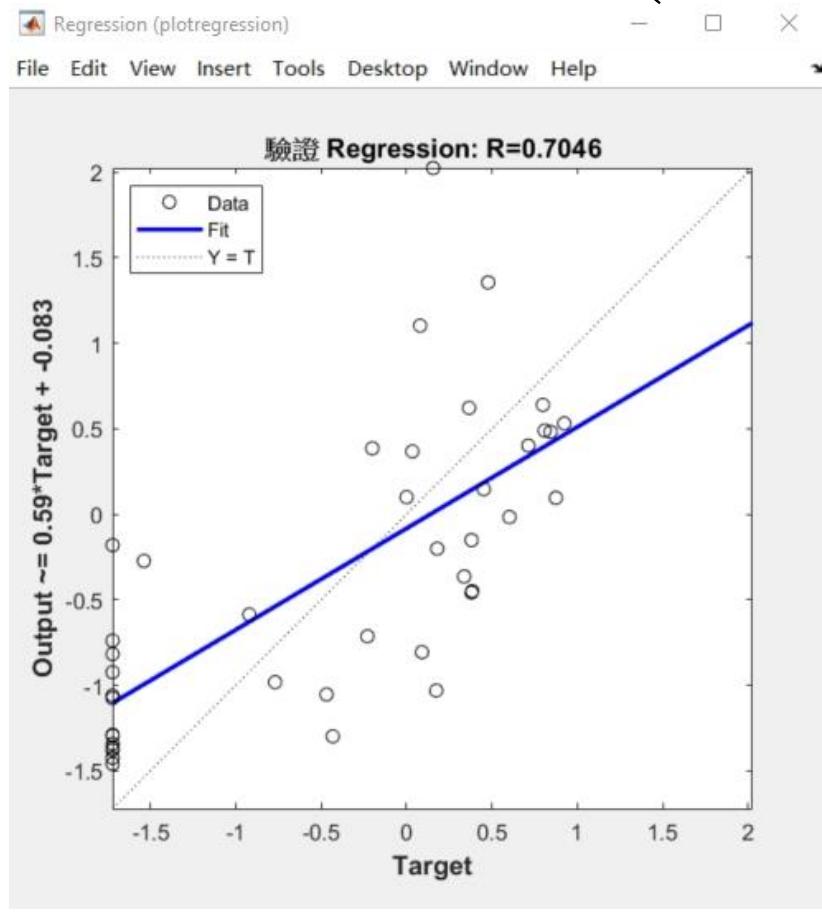
Results and discussion(train)



train

	Parameter(A)	Parameter(B)	Parameter(C)	Parameter(D)
Well(1)	10	6	3	7
Well(2)	20	1	3	5.5
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Results and discussion(test)



	Parameter(A)	Parameter(B)	Parameter(C)	Parameter(D)
Well(1)	10	6	3	7
Well(2)	20	1	3	5.5
Well(3)	30	2	5	11.5
Well(4)	50	5	4	?

test

Water Quality Projects and Standards

project	Drinking water quality standard (mg/L)	Water quality standard for irrigation (mg/L)
As[1]	0.01	0.05
Cd[1]	0.005	0.01
Cr[1]	0.05	0.1
NO ₃ ⁻ -N[2]	10.0	-
Fe	0.3	5.0
Mn	0.05	0.2
Cu	1.0	0.2
Zn	5.0	2.0
Cl ⁻	250	175
SO ₄ ²⁻	250	200
NH ₄ ⁺ -N	0.1	-

From Environmental protection administration and Council of agriculture

Note: [1] International Agency for Research on Cancer rated as a class 1 carcinogen

[2] International Agency for Research on Cancer rated a class 2A carcinogen

4. Conclusions and Future work

This research uses excel and ArcGIS in data collection and processing.

And use the artificial neural network to obtain a comprehensive database to provide the government or related units with a reference basis.

I go to NTU every Monday this semester to learn how artificial neural network work. And I am still constructing to code now.

Finally, compare to water quality projects and standards to get the position where are suitable area for ASR.

An aerial photograph showing a wide river flowing from the top left towards the bottom right. The river is surrounded by a dense, green forest. In the background, there are some buildings and hills under a clear sky.

Thanks for the attention ☺

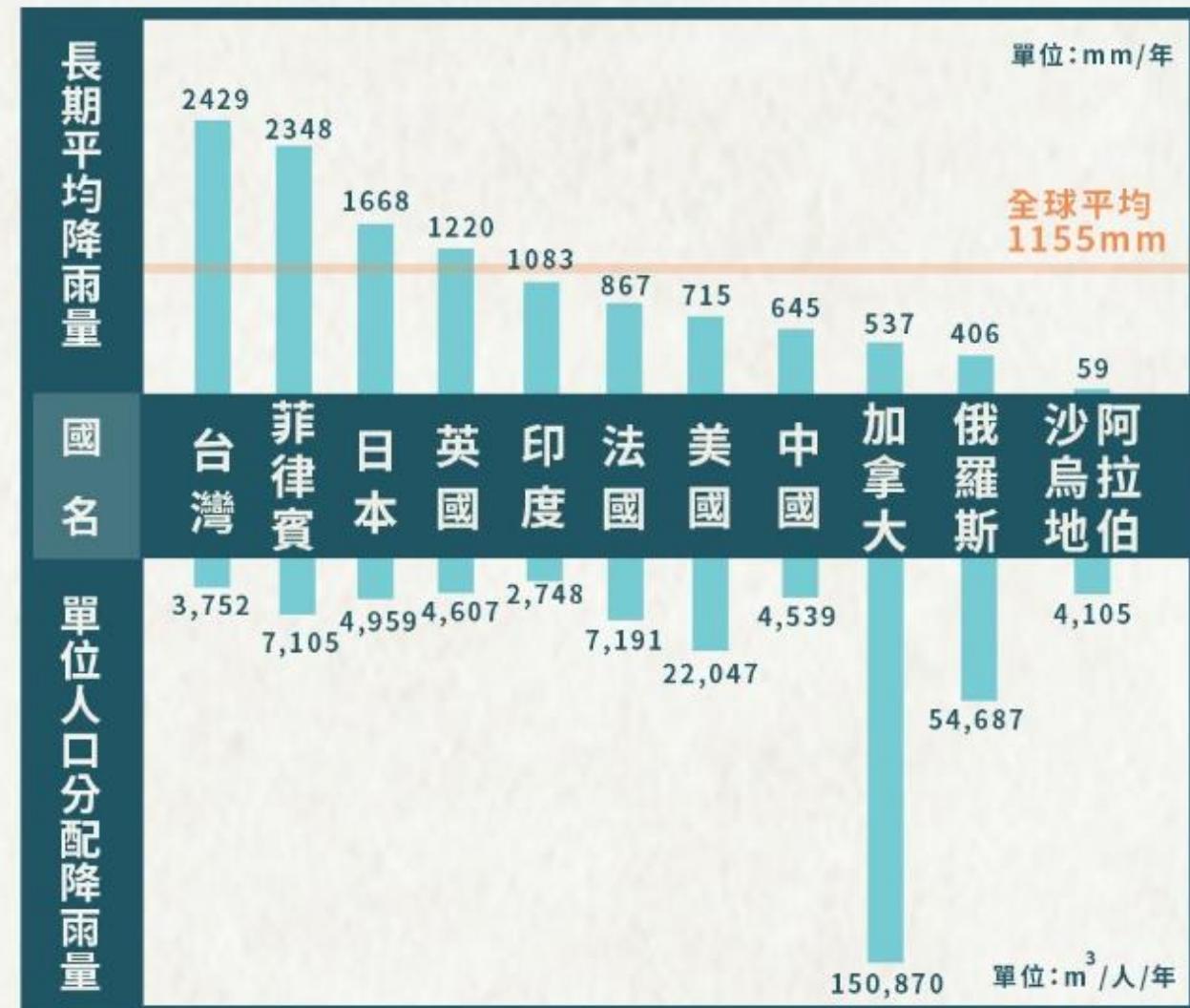


TABLE 2. ASR criteria with weights.

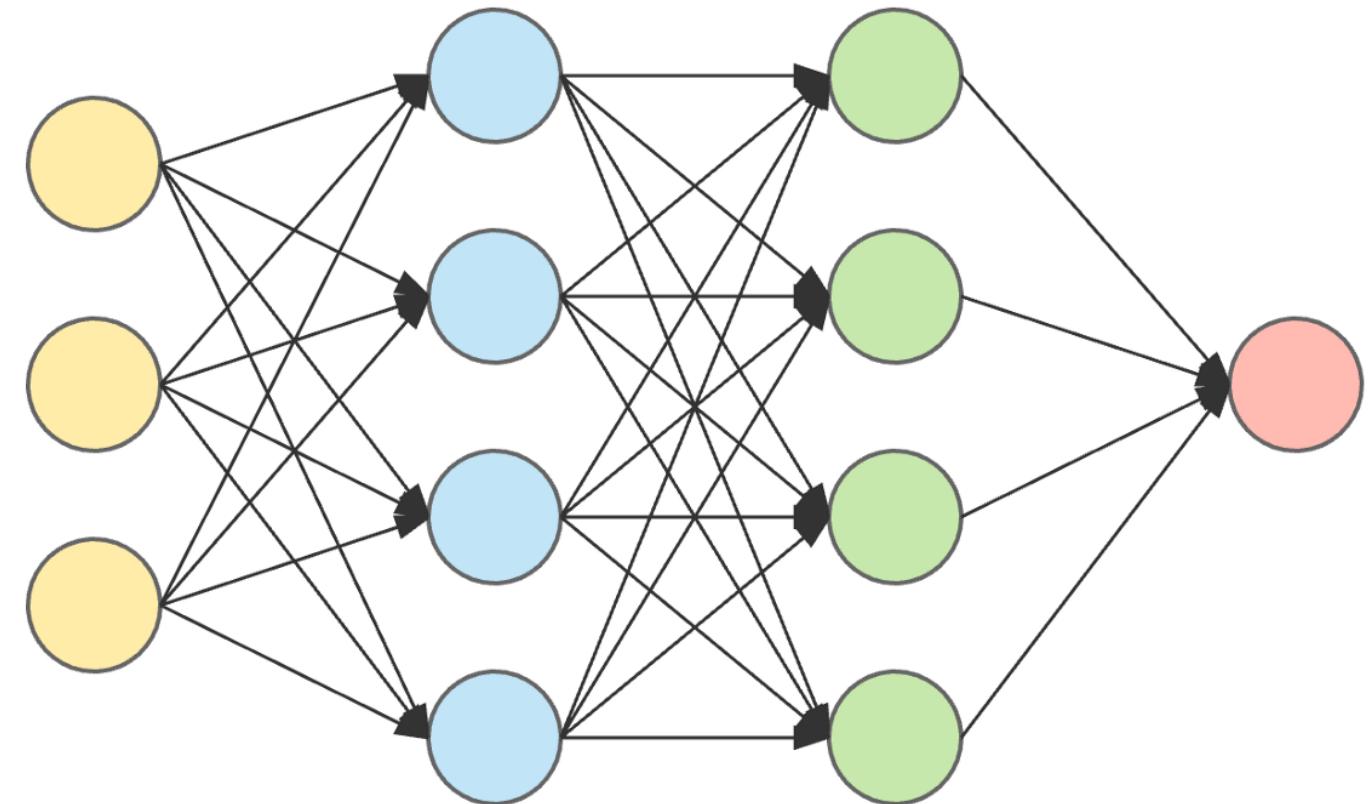
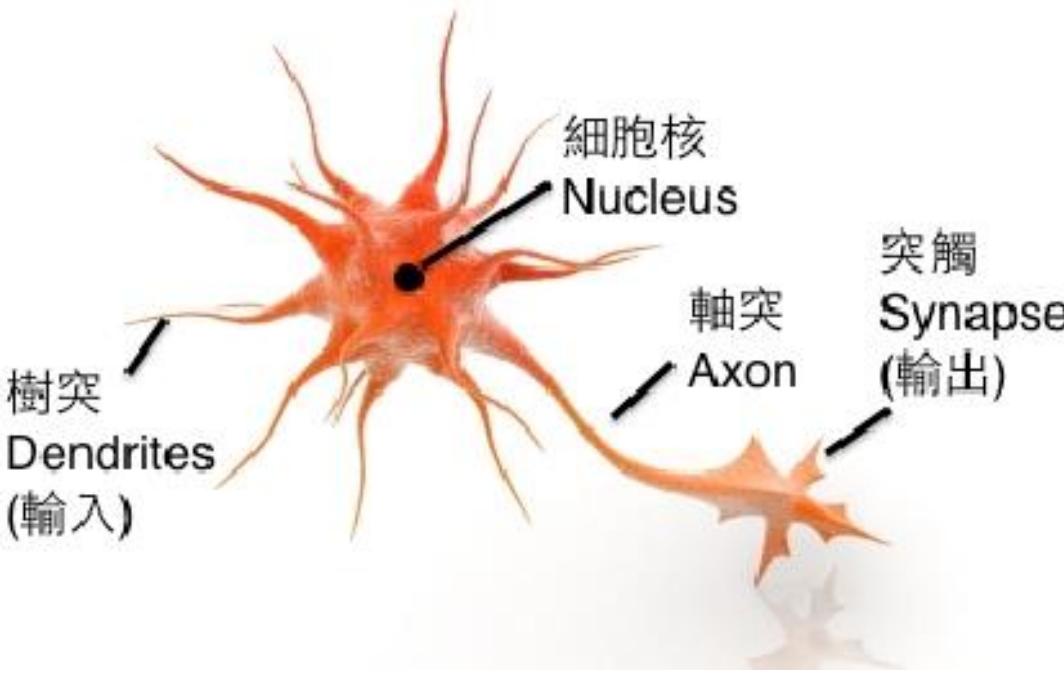
Category	Criteria	Weight
Aquifer characteristics	Depth to thickest sand layer	4
	Hydraulic gradient	3
	Storage zone thickness	6
	Transmissivity	3
Water availability	Excess surface water	6
	Groundwater availability	5
	Average stream size weighted by stream order	5
Water quality	Chlorides in groundwater	4
	Total dissolved solids in surface water	6
Land use	% Developed land cover	5
	% Cultivated crop cover	6
	Well density per km ²	2

第三章 研究方法

3-1 ASR 場址選定評估

ASR 於設置之前，美商西圖公司[37]將選擇場址評估要件依照其影響成程度，將各單項分數分為不同權重分，權重越高則越重要，並且各單項分數滿分為 10 分加總可評估廠址合適程度，下表為各項考慮條件及權重：

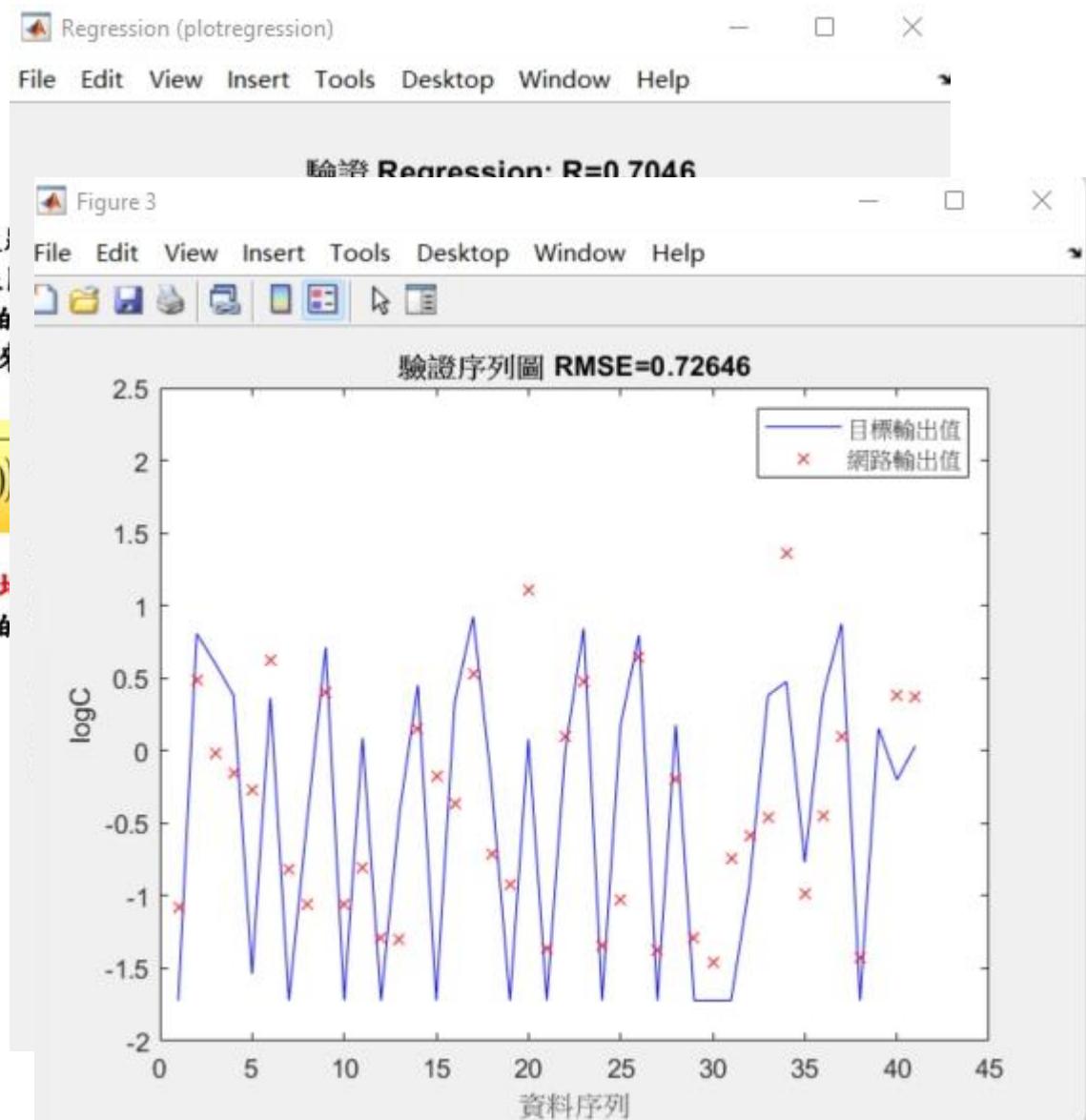
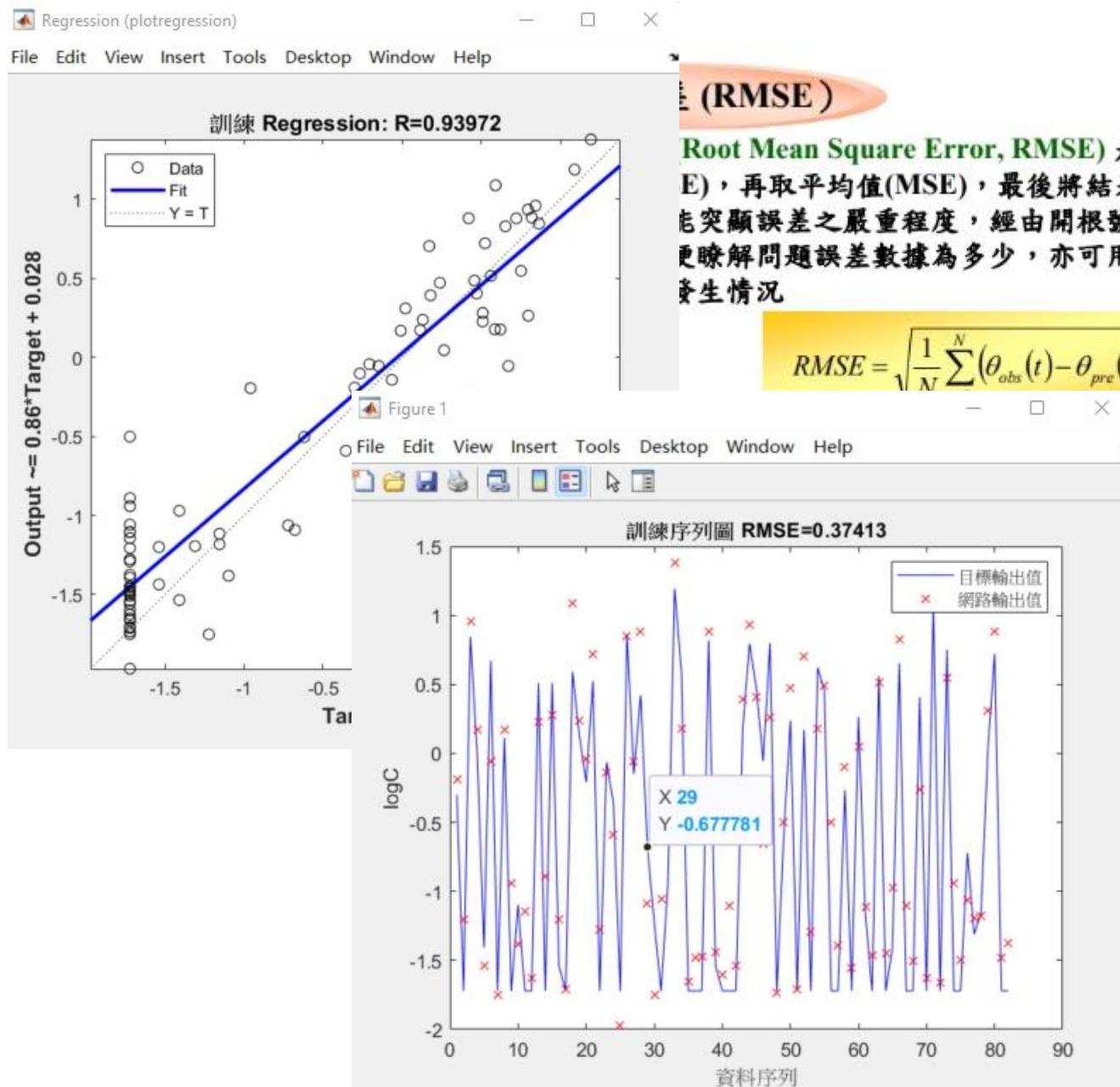
條件	權重
可用之土地面積	5
地下水位深度	4
含水層流通係數	7
水源水量	9
水源水質	10
地下水水質	8
距離自來水廠/工業區淨水廠	6
場址之聯外道路	3
安全需求	2
水處理費用	7
附近環境之影響	3
拘限或非拘限含水層	0



input layer hidden layer 1 hidden layer 2 output layer

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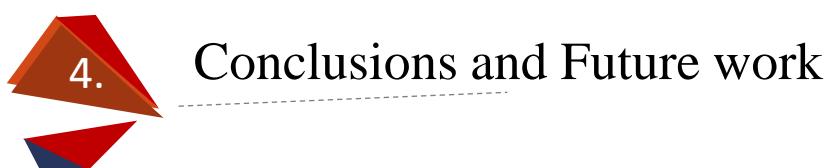
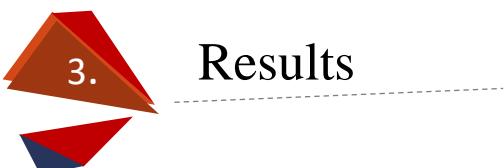


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Outline



1. Introduction

Due to Taiwan's rapid economic development and high population density, agriculture, industry and people's livelihood .

Water resources has become a very important issue.



Picture source:Shutterstock

The problem we facing

TSMC currently accounts for 3% of Taiwan's water consumption, and it will increase to 10.5% in 2025.

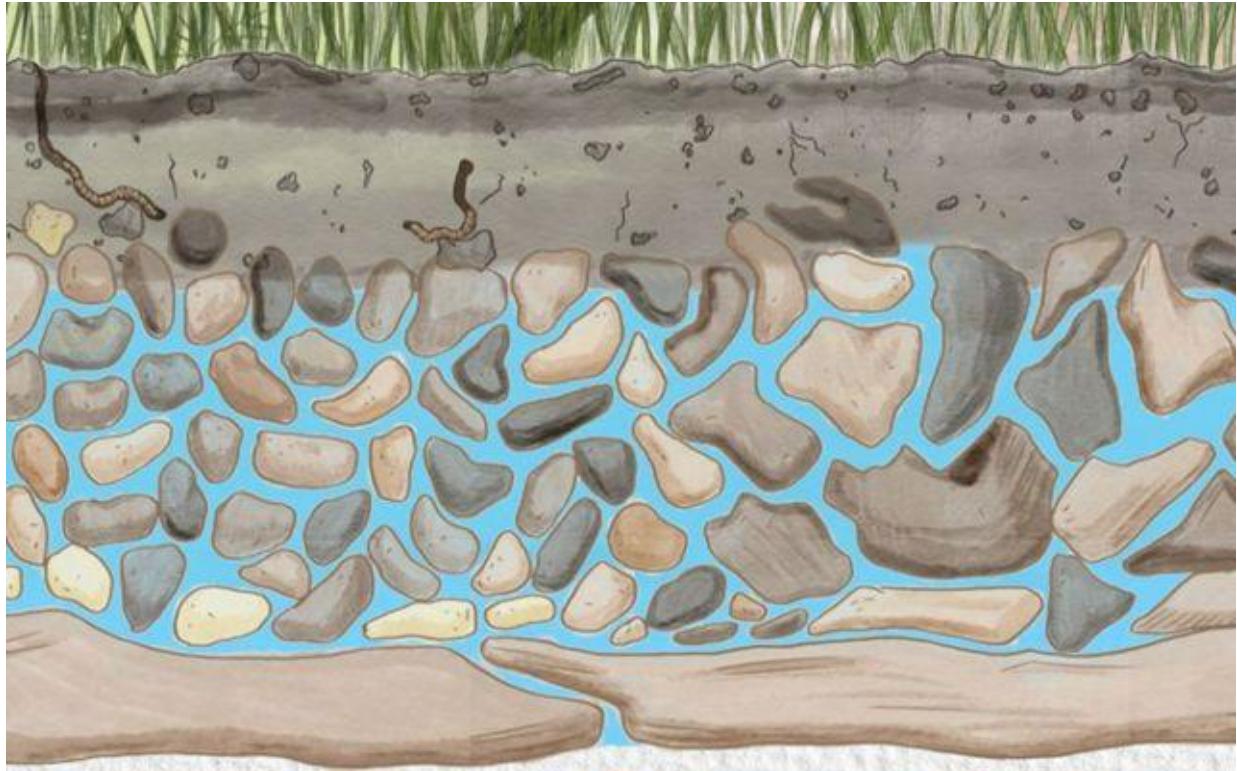
And droughts like the one in 2021 will repeat in the future.



【Reporter Xu Cuiling/Taipei Report】
September 6, 2022

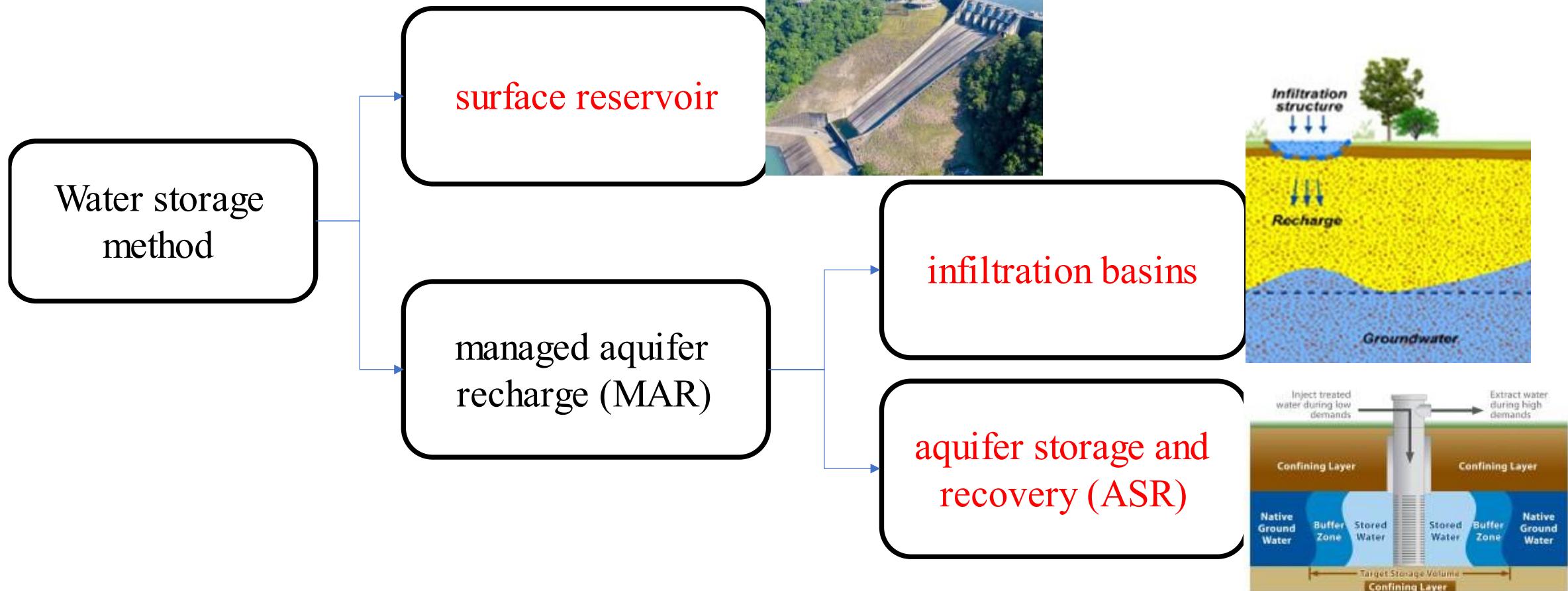
Groundwater's advantage

- 1.considerable storage space
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Picture source:The Nature Conservancy

Water storage method



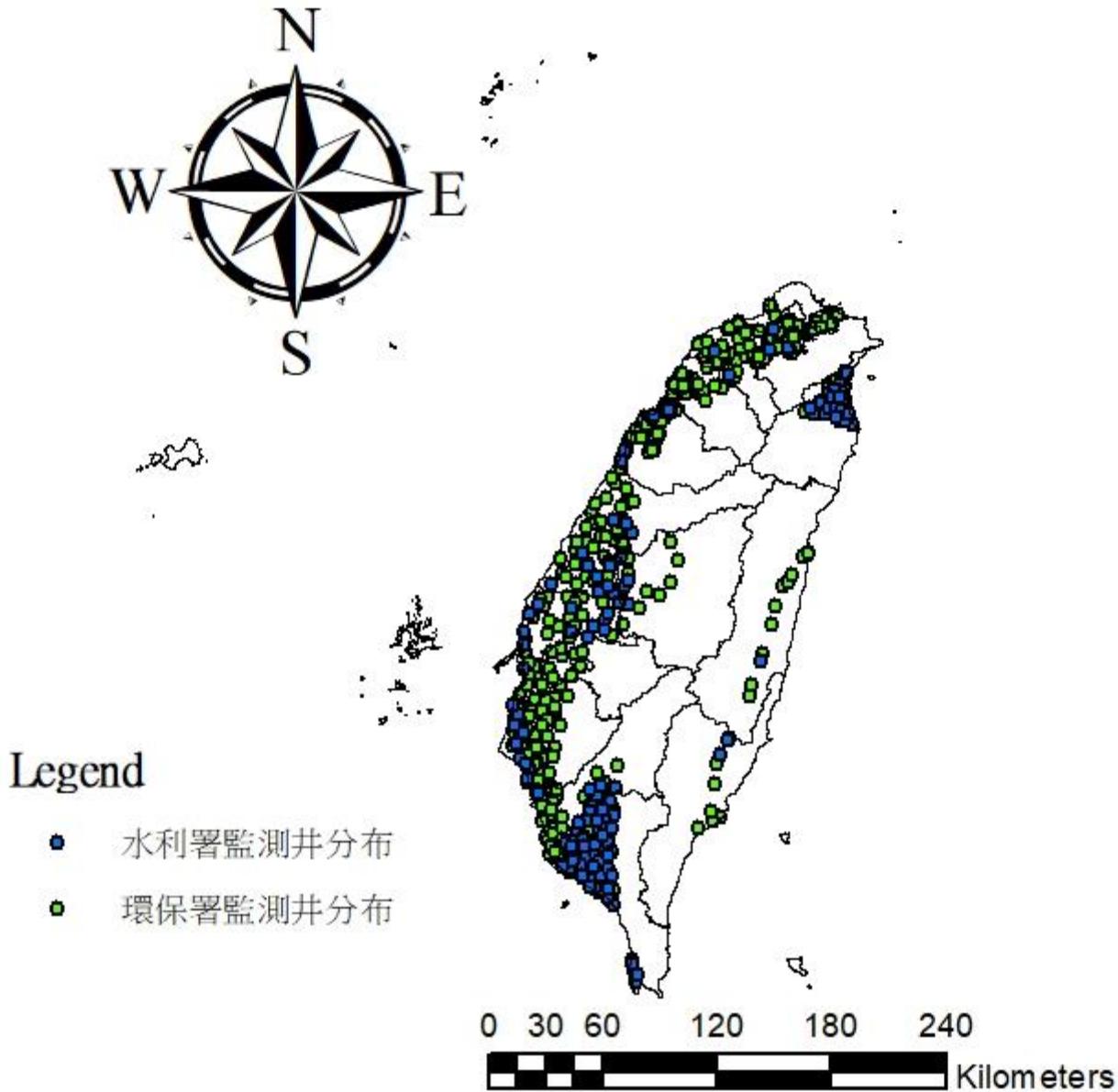
Objective

Using **excel** and **ArcGis** to collect and process the data to get the dataset.

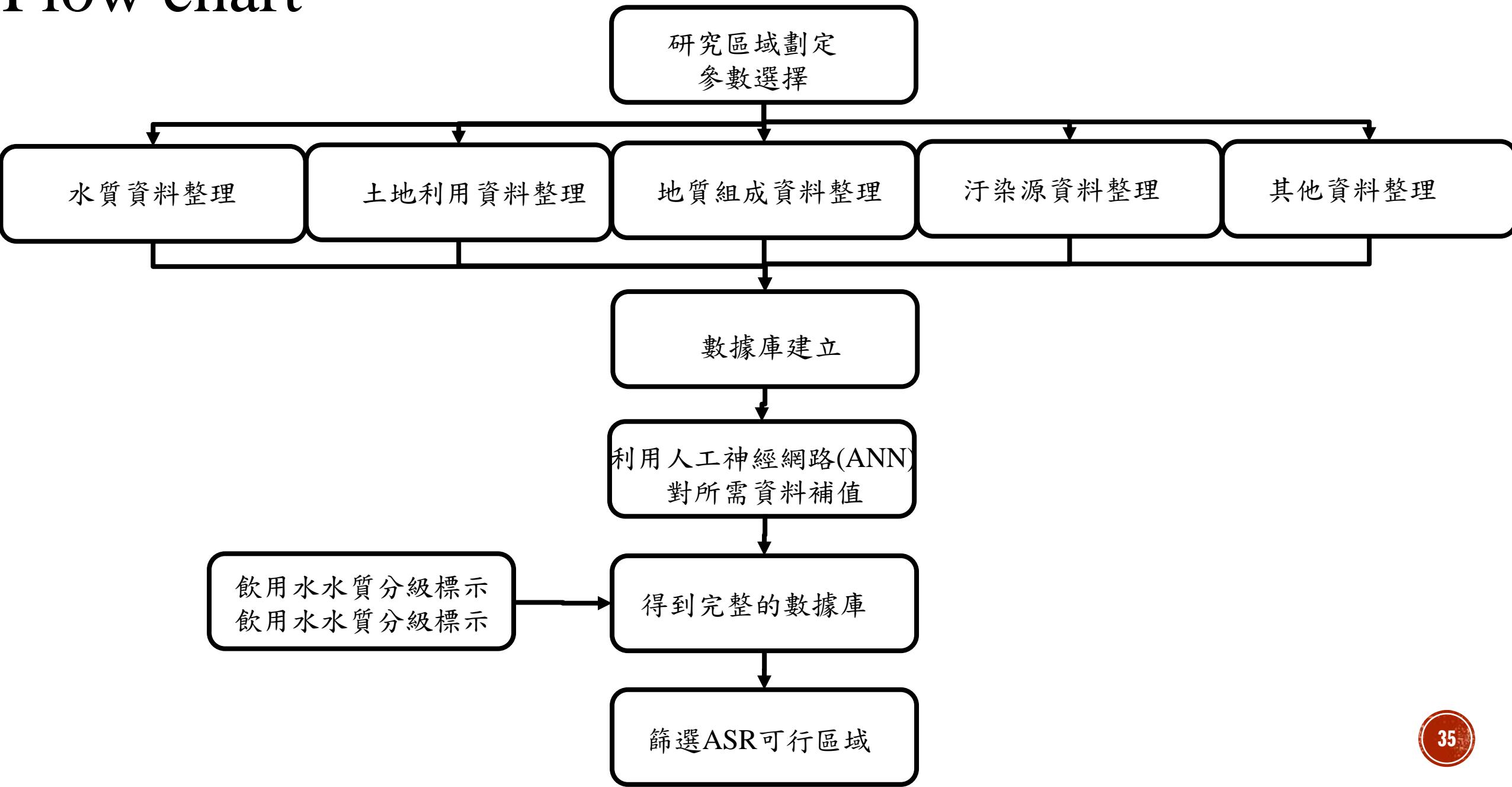
Using **artificial neural network** to make dataset more comprehensive.

Compare with Water Quality Projects and Standards to **select the feasible site area for aquifer storage and recovery** in Taiwan .

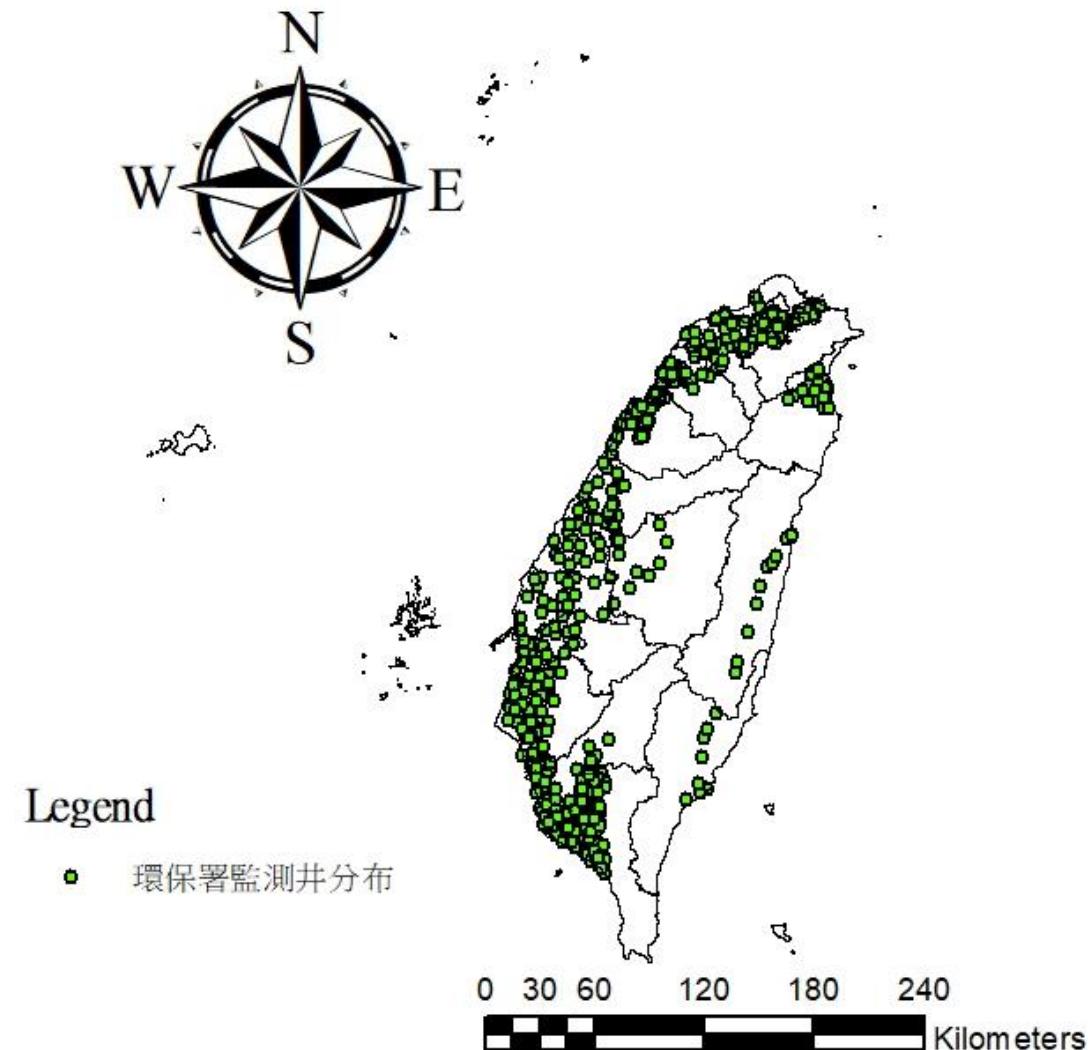
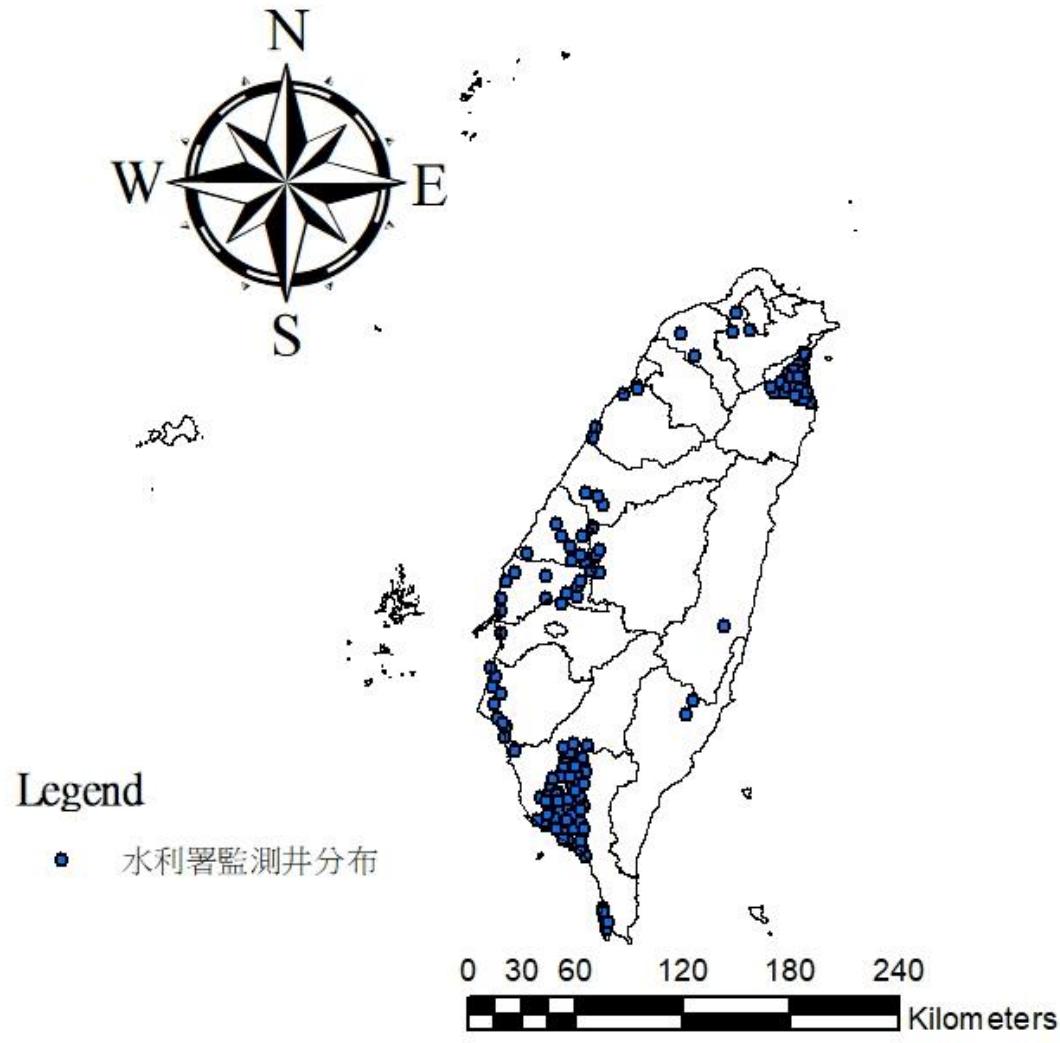
2.Method and materials



Flow chart

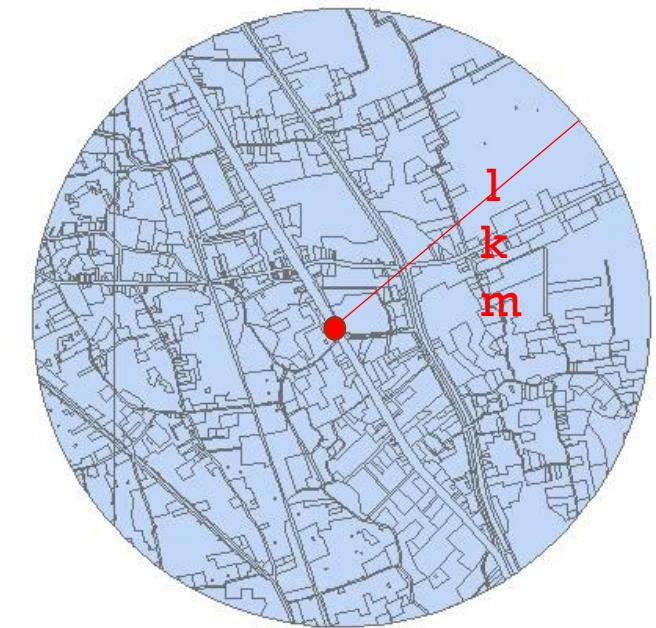


水利署與環保署監測井位置分布



分類	參數	參數(續)	參數(續)	參數(續)	參數(續)	參數(續)	描述	資料來源
水質參數 資料	水面至井口深度(m)	氧化還原電位(mV)	硝酸鹽氮(mg/L)	鉻(mg/L)	錳(mg/L)	鈉(mg/L)	2018環保署 公布之地下 水水質資料	環保署
	水溫(°C)	總硬度(mg/L)	硫酸鹽(mg/L)	銅(mg/L)	汞(mg/L)	鉀(mg/L)		
	導電度 ($\mu\text{mho}/\text{cm}^2$) 5°C	總溶解固體物(mg/L)	總有機碳(mg/L)	鉛(mg/L)	鎳(mg/L)	鈣(mg/L)		
	酸鹼值	氯鹽(mg/L)	砷(mg/L)	鋅(mg/L)	總酚(mg/L)	镁(mg/L)		
	溶氧(電極法)(mg/L)	氨氮(mg/L)	鎘(mg/L)	鐵(mg/L)	氯鹽(mg/L)	總鹼度(mg/L)		
水質參數 資料	溶氧(電極法)(mg/L)	單位洩降出水量 Q/s (cmh/m)	氯鹽(mg/L) 氨氮(mg/L)	總有機碳(mg/L) 砷(mg/L)	鉛(mg/L) 鋅(mg/L)	鎳(mg/L) 鈉(mg/L)	2018水利署 公布之地下 水水質資料	水利署
	氧化還原電位(mV)	透水係數K (m/min)	硝酸鹽氮(mg/L)	鉻(mg/L)	鐵(mg/L)	鉀(mg/L)		
	總硬度(mg/L)	導水係數T (m ² /min)	硫酸鹽(mg/L)	鉻(mg/L)	錳(mg/L)	鈣(mg/L)		
	總溶解固體物(mg/L)			銅(mg/L)	汞(mg/L)	镁(mg/L)		

分類	參數	參數(續)	描述	資料來源
土地利用資料	農業利用土地(%)	建築利用土地(%)	2006年內政部公布之土地利用資料，並依照水質井之位置，以井為圓心，半徑設一公里化圓，查之各土地利用所占圓面積之百分比	內政部



分類	參數	描述	資料來源
地質組成資料	礫石組成(%)	以粒徑做分類,2.00mm以上為礫石,0.25~2.00mm為砂土,0.063~0.25mm為粉土,<0.063為黏土,並查看水質井周圍之工程鑽探,計算地表至地下水位之各成分地質組成百分比	工程地質資料庫
	砂土組成(%)		
	粉土組成(%)		
	黏土組成(%)		

工程名稱：-

地點：內湖區大湖街131巷

鑽孔編號：BH-03

深 度：15.03 M

鑽孔標高：32.20 M

坐標系統：TWD97

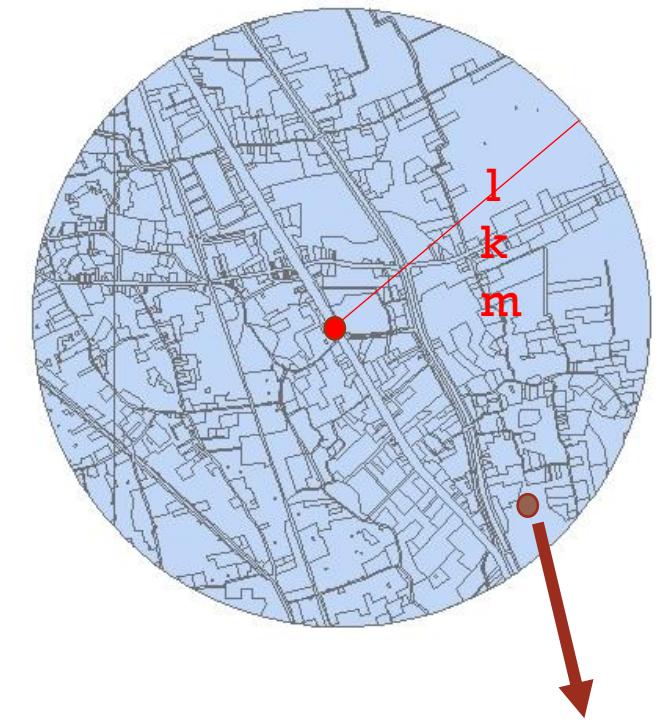
地下水位：7.10 M

坐 標 N：2775958.45



分類	參數	描述	資料來源
汙染源資料	縣市人口數(人) 縣市面積(平方公里) 縣市人口密度(人/平方公里) 縣市豬屠宰頭數(頭) 縣市牛屠宰頭數(頭) 縣市羊屠宰頭數(頭) 縣市豬養殖面積(公頃) 縣市牛養殖面積(公頃) 縣市羊養殖面積(公頃)	人類與動物活動可能是造成汙染的來源之一,因此收集水質井所在縣市人類與牲畜數量.面積.密度	內政部戶政司 行政院農委會

分類	參數	描述	資料來源
其他資料	aqi so2 co o3 pm10 pm2.5 No2 垃圾掩埋場距離井之位置(km) 垃圾掩埋場處理量(公噸)	空氣汙染指標關聯性可能較低,先收集後面是否採用可以再討論,而垃圾掩埋場則是看水質井半徑一公里內是否存在,並且存在的話其掩埋量為多少	行政院環保署



是否存在垃圾掩埋場

Artificial neural network

supervised learning technique(Often use in prediction)

	A	B	C	D
Well(1)	10	6	3	7
Well(2)	20	1	3	5.5
Well(3)	30	2	5	11.5
Well(4)	50	5	4	?

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	A	B	C	D
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Well(2)	20	1	3	5.5
Well(3)	30	2	5	11.5
Well(4)	50	6	4	12

$$D=0.1A+0.5B+C$$

水質項目及標準

項目	飲用水水質標準(mg/L)	灌溉用水水質標準(mg/L)
As[1]	0.01	0.05
Cd[1]	0.005	0.01
Cr[1]	0.05	0.1
NO ₃ ⁻ -N[2]	10.0	-
Fe	0.3	5.0
Mn	0.05	0.2
Cu	1.0	0.2
Zn	5.0	2.0
Cl ⁻	250	175
SO ₄ ²⁻	250	200
NH ₄ ⁺ -N	0.1	-

擷取自環保署及農委會

附註:[1]IARC評定為1級致癌物

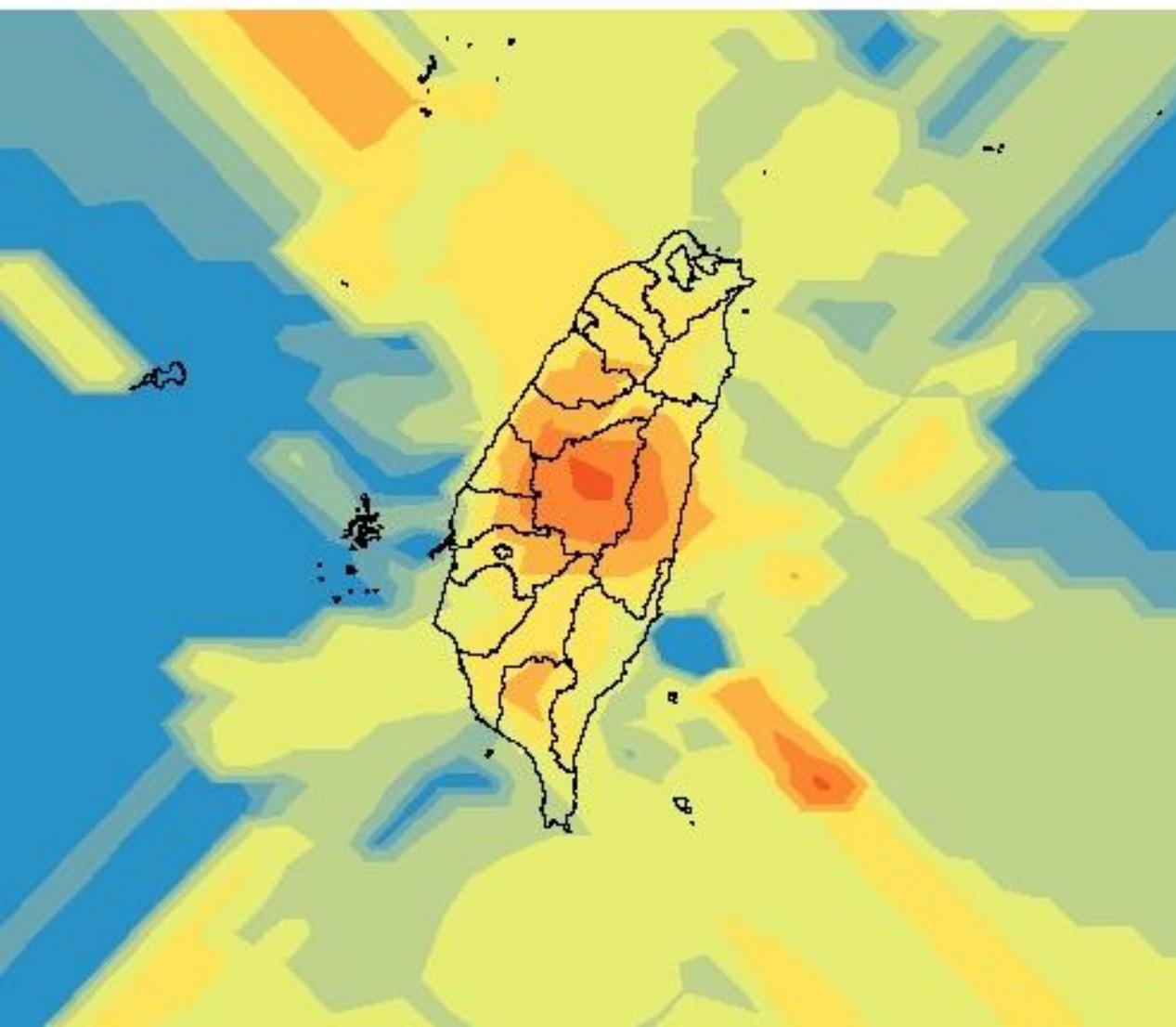
[2]IARC評定為2A級致癌物



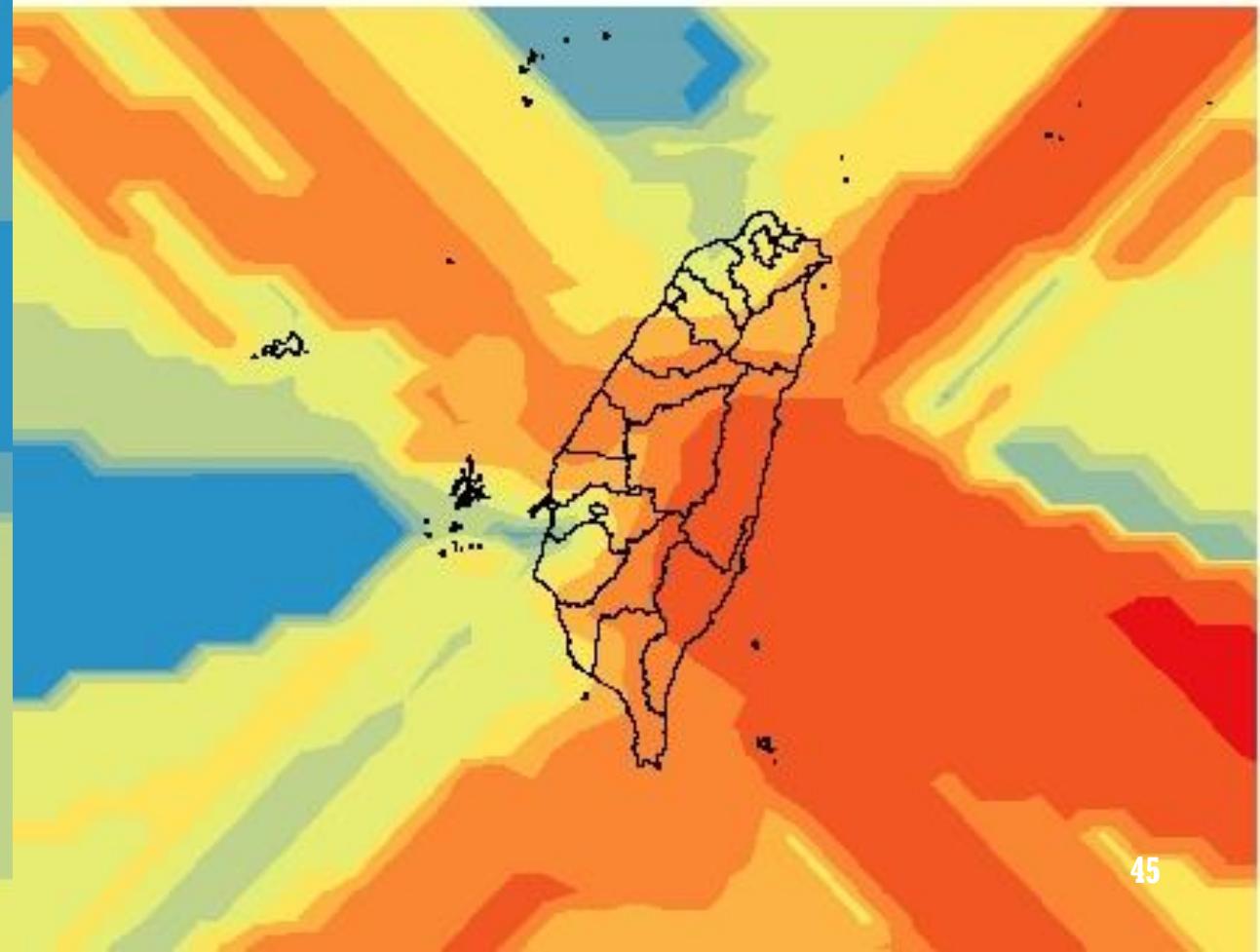
3. Results and discussion



將整理好之硝酸鹽氮濃度
利用**GIS**內建的克利金內插示意圖
(未來將改用**ANN**內插)



將整理好之透水係數K
利用**GIS**內建的克利金內插示意圖
(未來將改用**ANN**內插)



4. Conclusions and Future work

This research uses excel and ArcGIS for data collection and processing.

And use the artificial neural network to obtain a comprehensive database to provide the government or related units with a reference basis.

Finally, compare the complete database with the published water quality projects and standards to get the position where are suitable area for ASR

An aerial photograph showing a wide river flowing through a vast, dense forest. The river has several sharp turns or bends. In the background, there are some buildings and possibly a bridge. The overall scene is very green and natural.

Thanks for the attention ☺