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Taiwan's water resources policy and water scarcity response in 2020-2021

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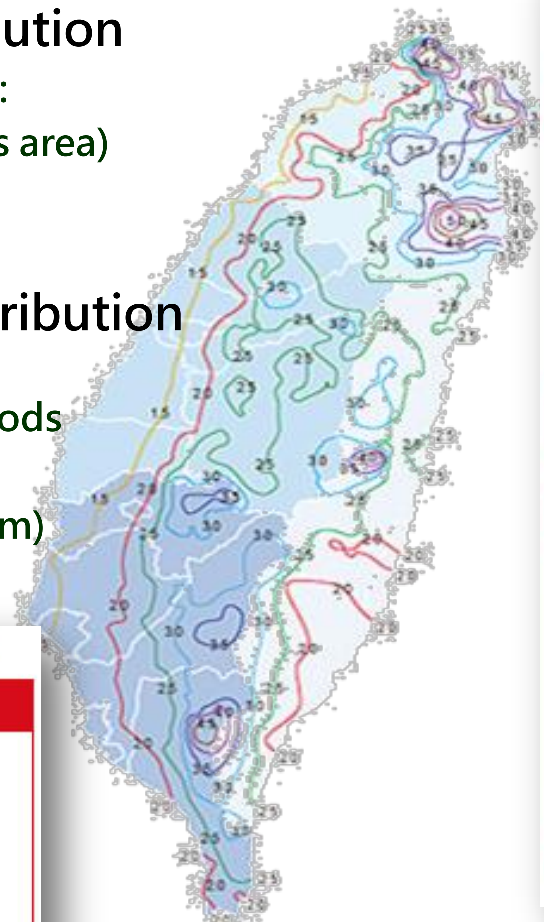
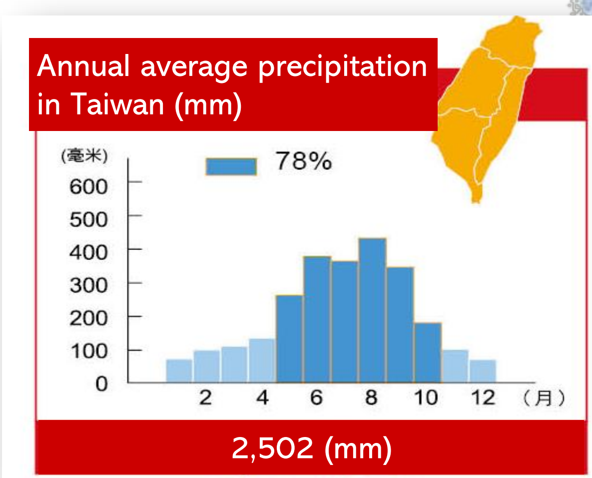
Deputy Chief Engineer,
Water Resources Agency

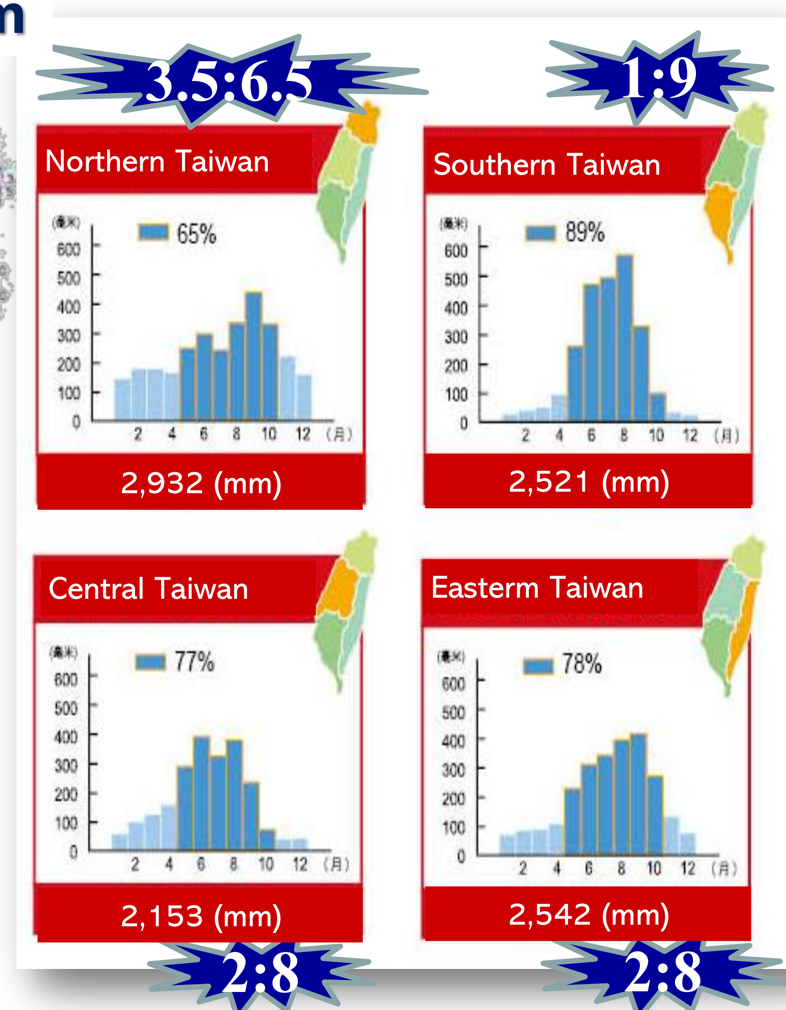
Taiwan's Annual Precipitation Characteristics

Annual average precipitation is 2500 mm

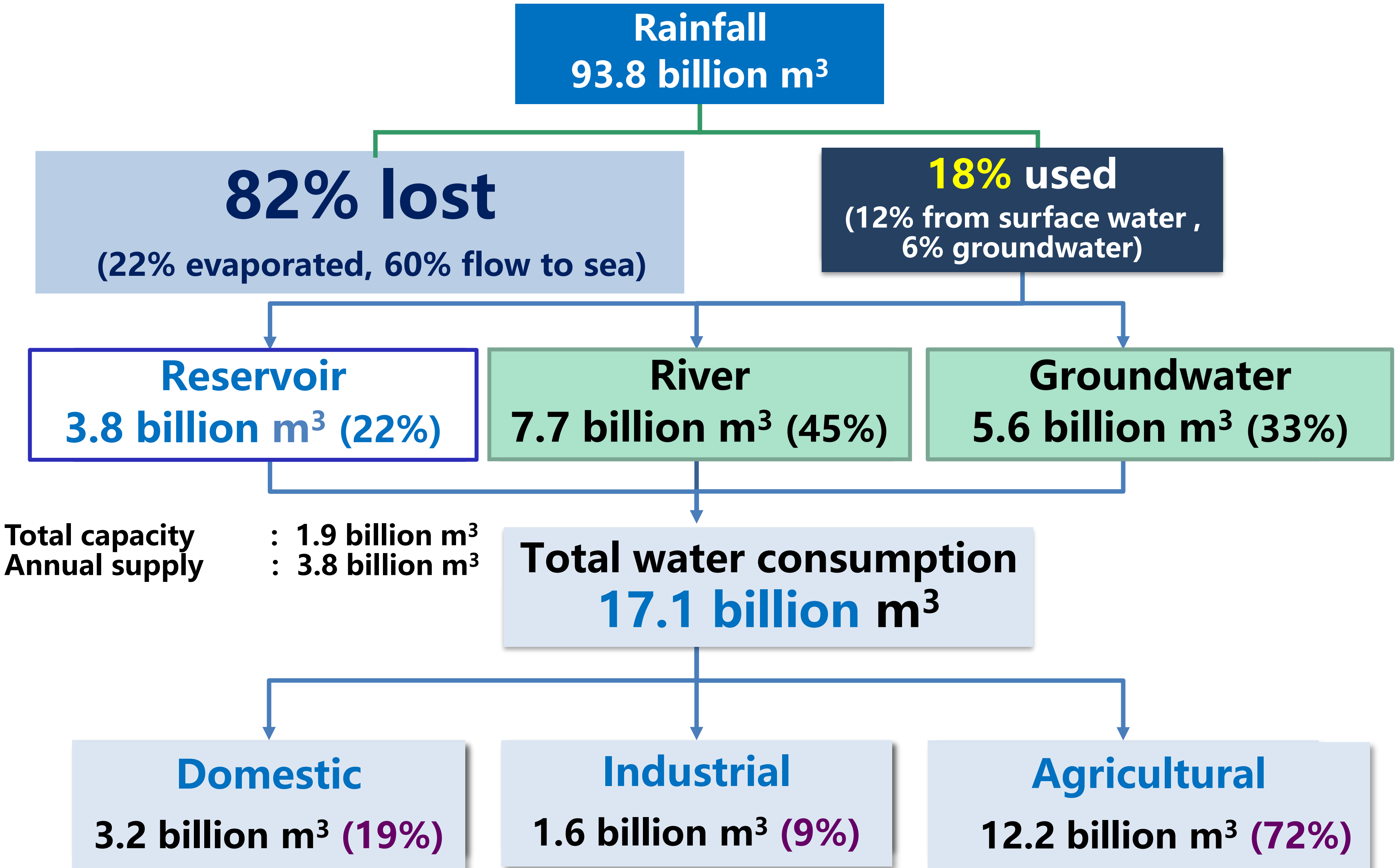
- **Uneven spatial distribution**
  - ✓ Highest precipitation rate:
    >8,000 mm (mountainous area)
  - ✓ Lowest precipitation rate:
    <1,200 mm (plains area)
- **Uneven temporal distribution**
  - ✓ Distinct precipitation rate between wet and dry periods
  - ✓ Annual Precipitation rate difference (>1,500 mm)





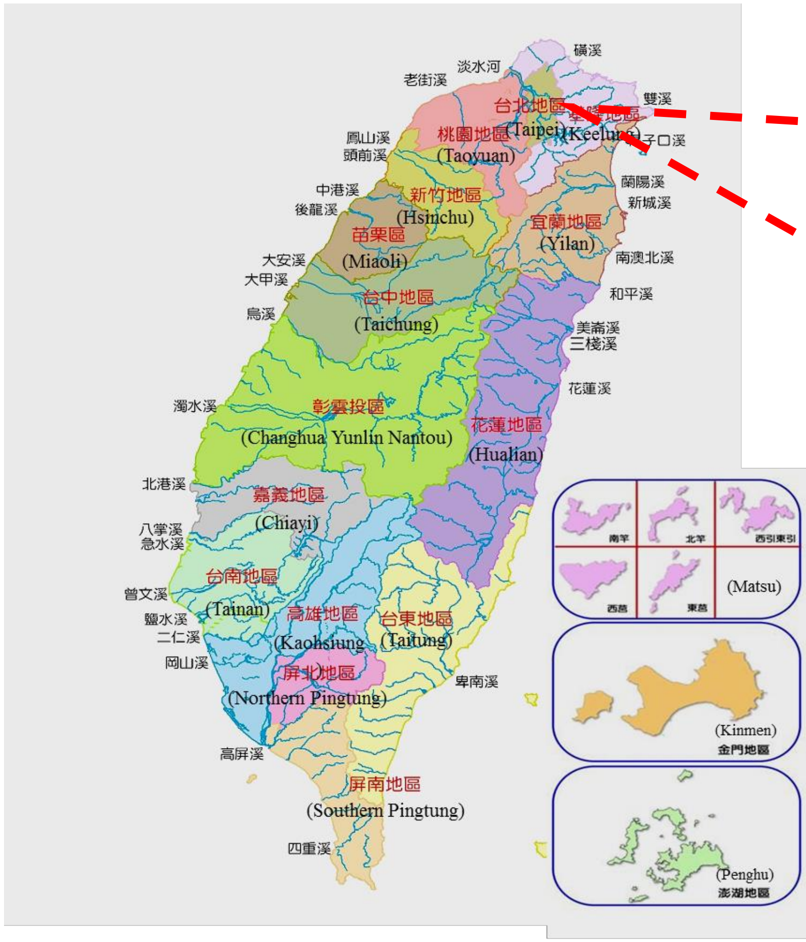


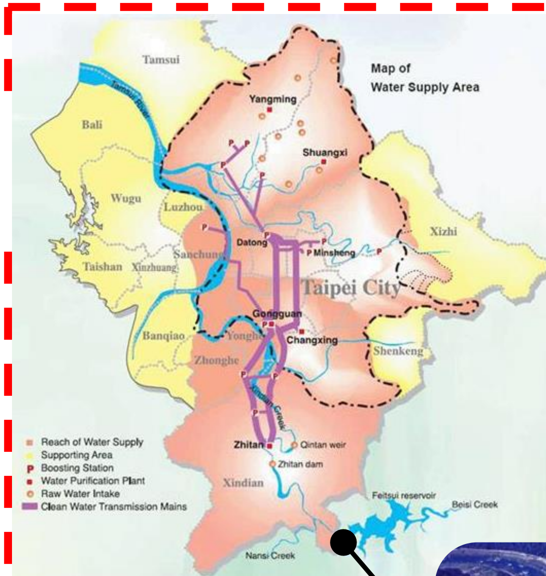
Water Resource Allocation



Water Supply Regions

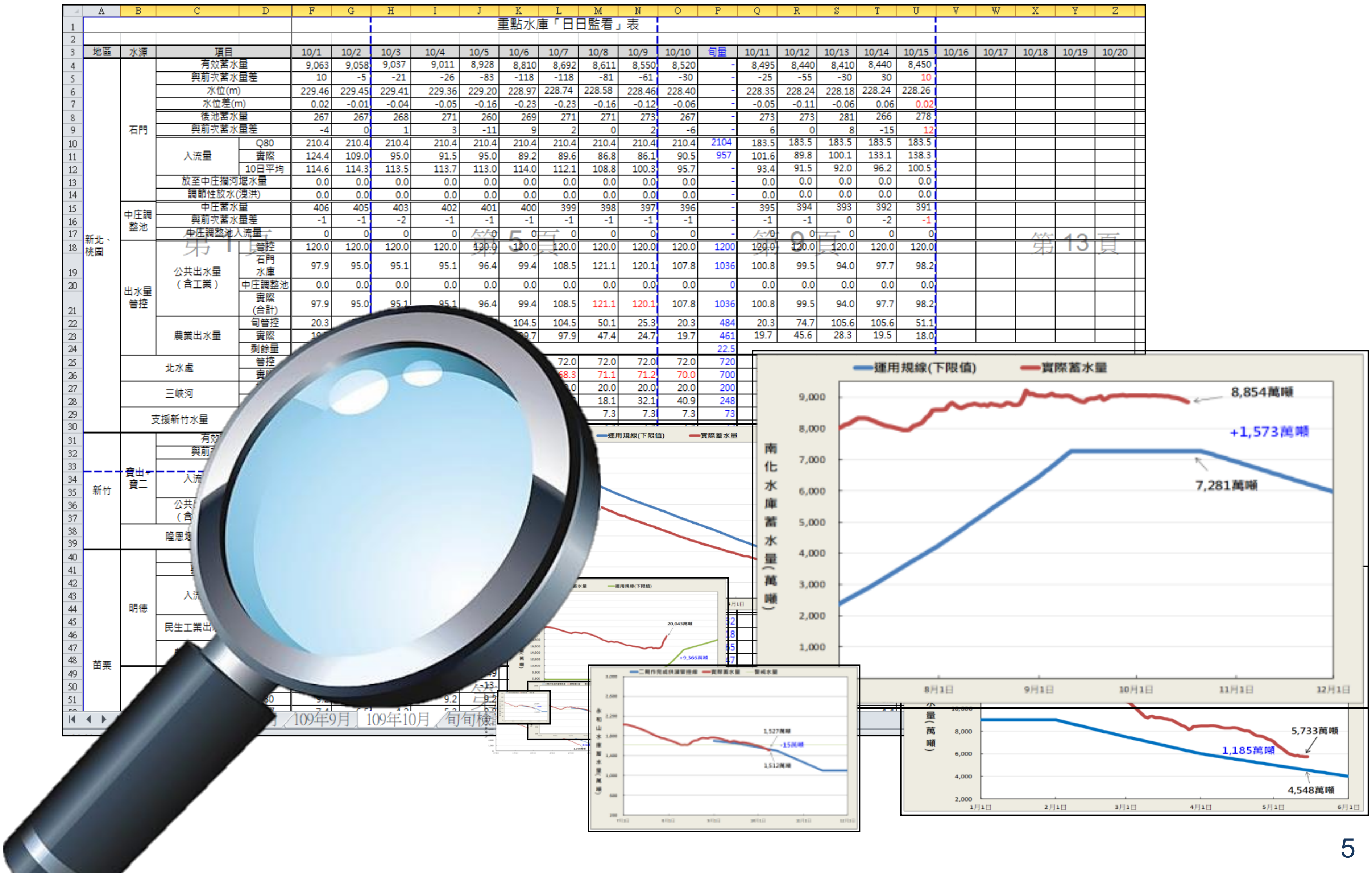
18 water service regions are defined based on the water use/supply system.





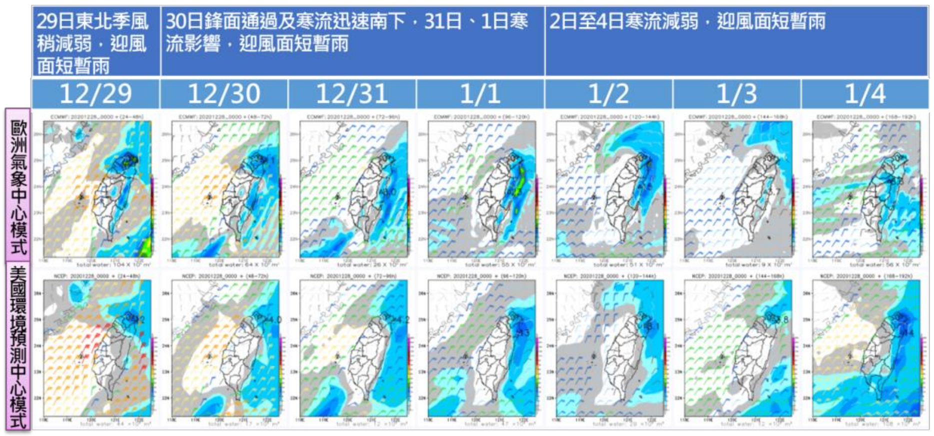
Feitsui Reservoir

Daily Monitoring & Early Warning

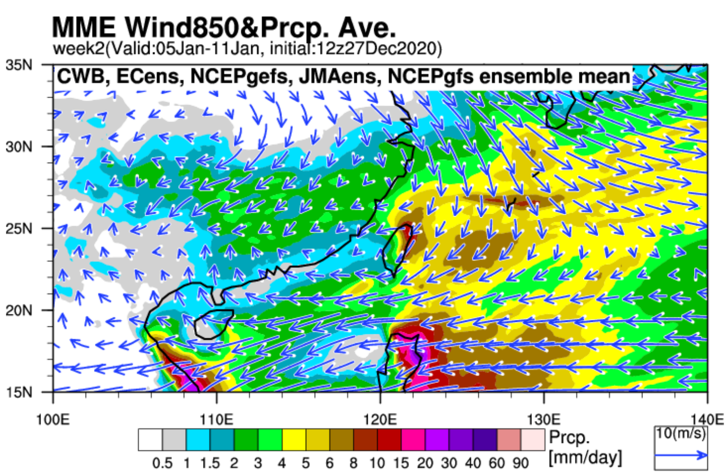


Daily Monitoring & Early Warning

daily rainfall forecast



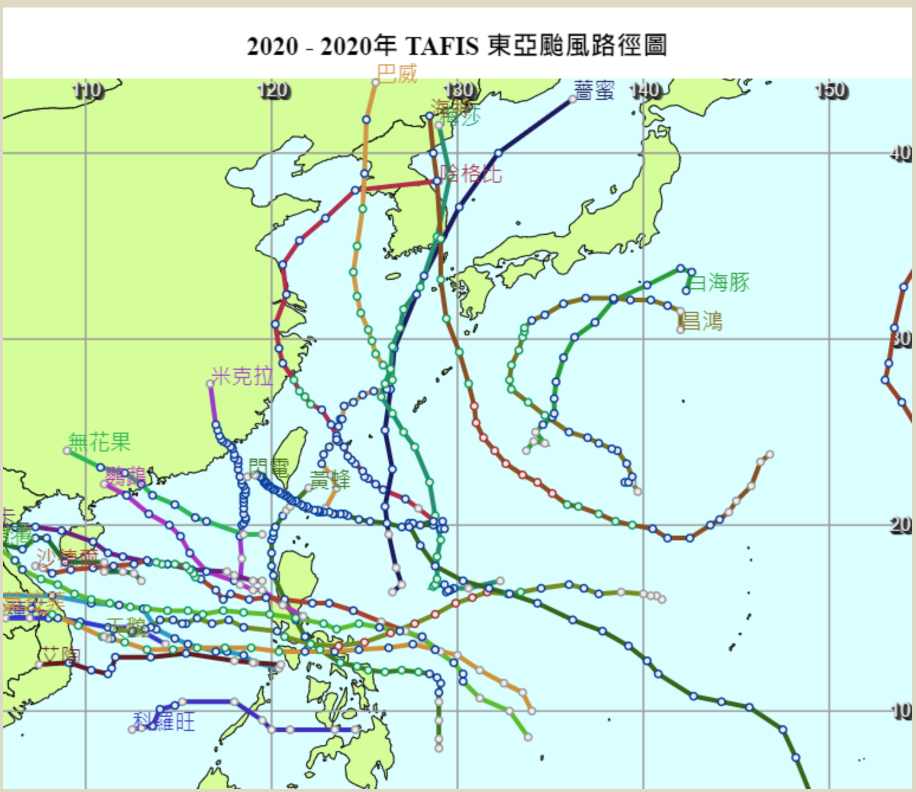
weekly rainfall forecast



No Typhoon in 2020

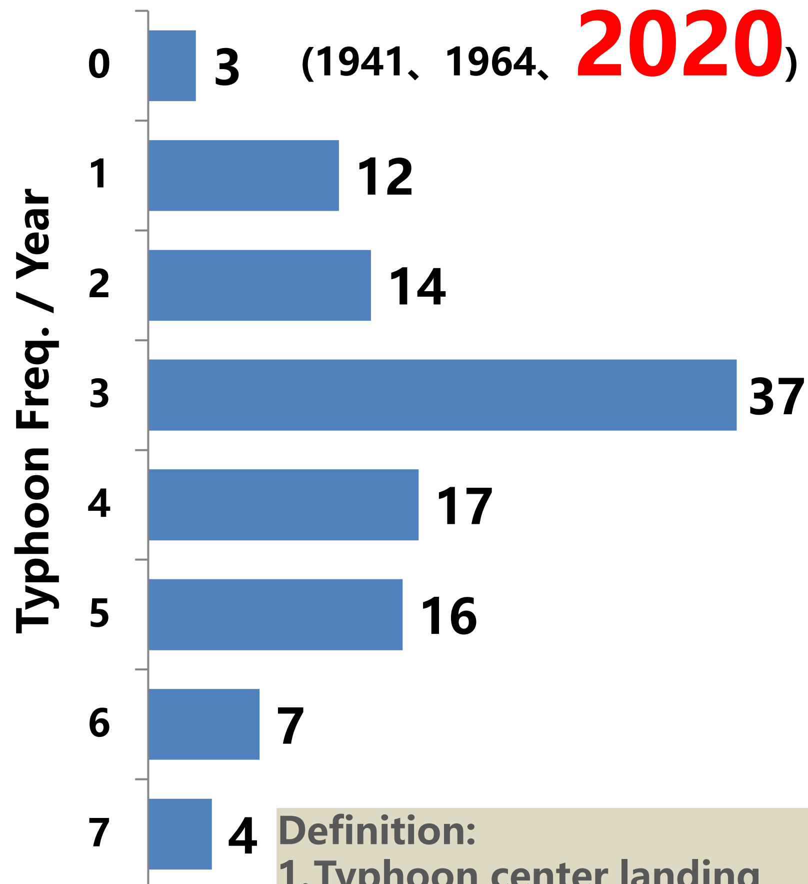
Avg. 3.5 typhoons/year in 1911-2020

Typhoon Paths in 2020



Source: Central Weather Bureau

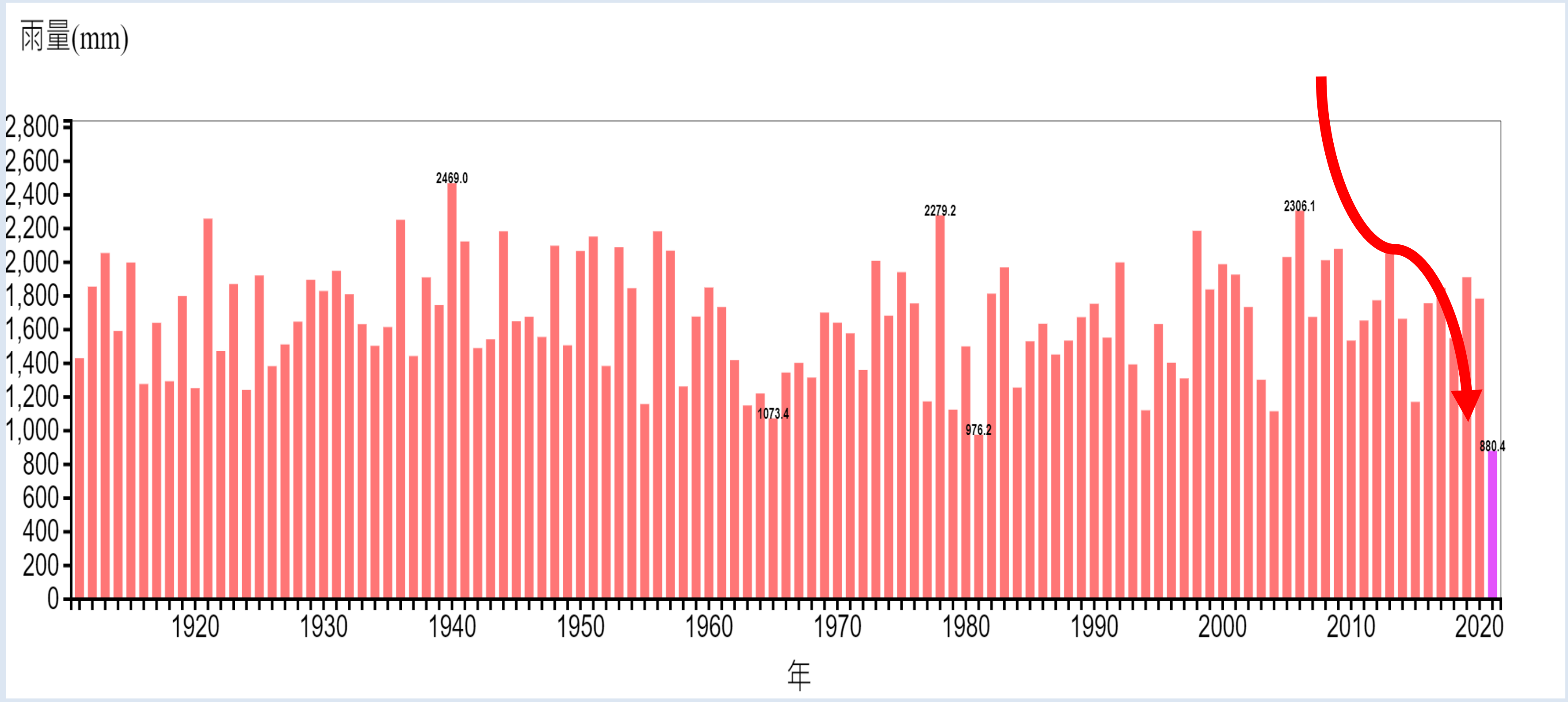
About 3.5 typhoons / year



Definition:
1. Typhoon center landing
2. With no center landing, but cause disaster on land

Abnormal weather in 2020

In June 2020 – May 2021,
Taiwan recorded lowest precipitation rate (880 mm) since 1911.



(Data source: Prof. H.H. Hsu, Atmospheric Sciences, NTU)

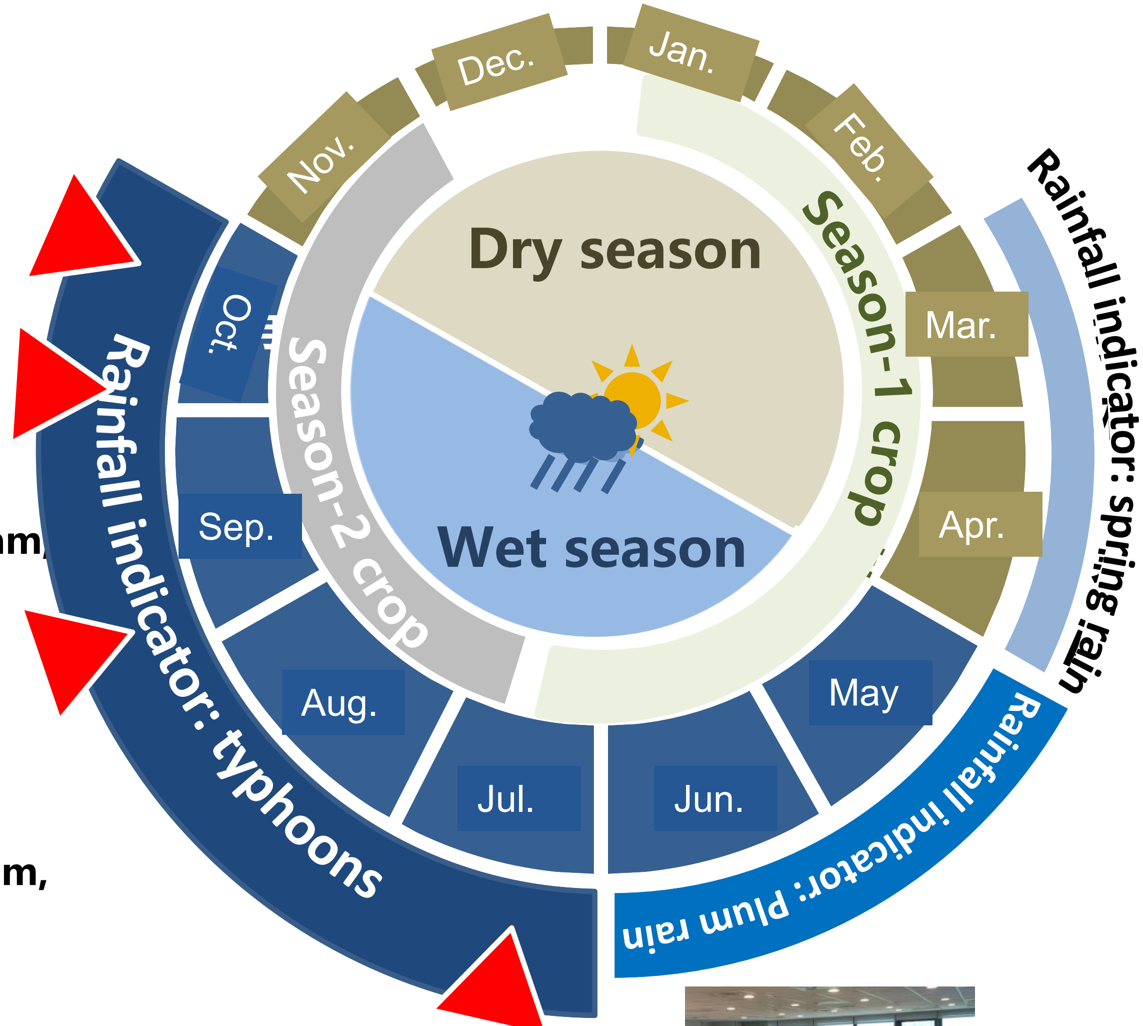
1911-2021

Early preparedness & response

2020.10.14
The Central Emergency Operation Center

2020.10.1
Drought emergency response team, MOEA

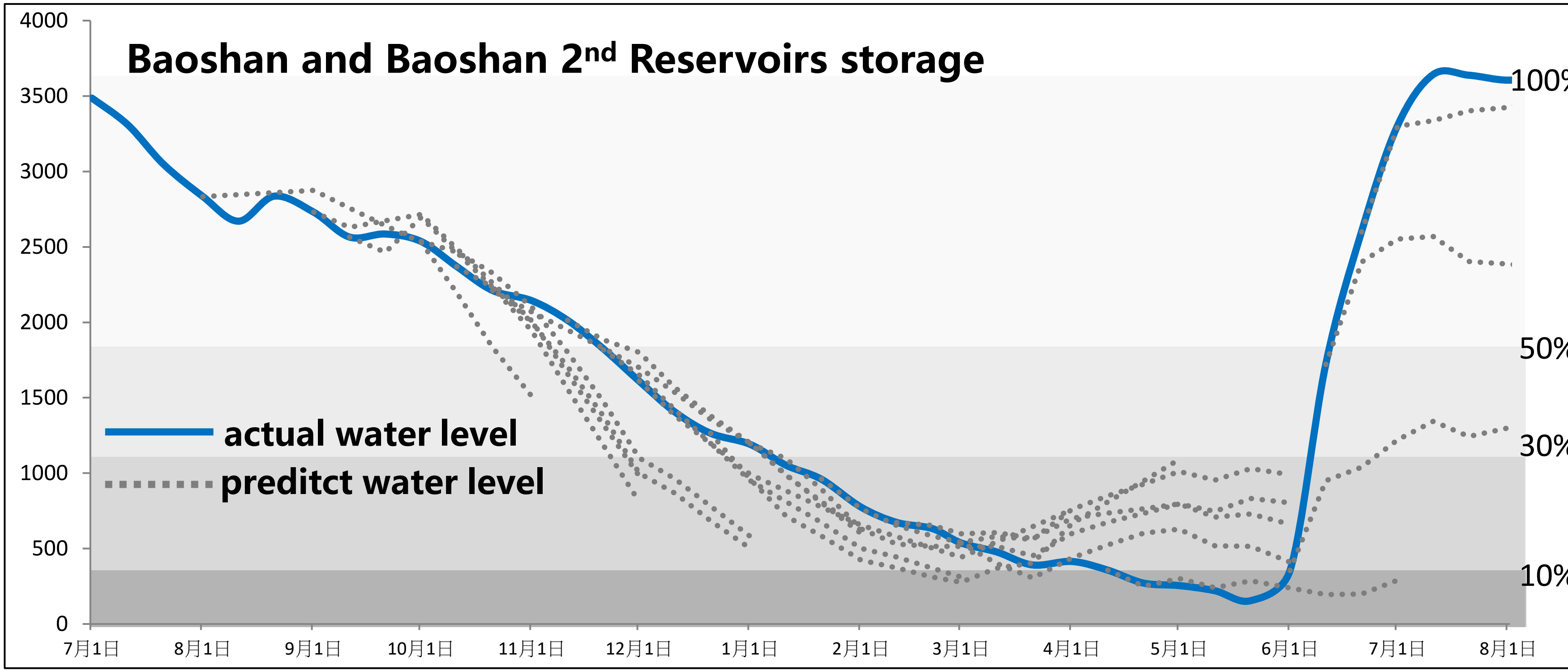
2020.9.16
Drought emergency response team, WRA



2020.7.13 Water allocation Meeting

Analysis & Decisions

Estimation of Water Storage in Different Scenario



Industrial Water	-5%	-7%	-11%	-13%	15%	-7%
Non-Industrial		-10%	-20%	-10%		
Domestic Water	Low pressure (Pm11~Am5)	Extend lower pressure (Pm10~Am6)	All Day Low Pressure	Low pressure (Pm11~Am5)		

Analysis & Decisions

Green
Reminder

Water condition not favorable, to implement contingency plans or enhance water allocation.

Yellow
Reduce water pressure

Phase 1 water rationing:
1. Lower water pressure at night and particular time
2. Stop water for fountain, street washing, and irrigating in governmental agencies.

Orange
Reduce water supply

Phase 2 water rationing:
1. Stop water for fire hydrants testing etc.
2. Reduce water for:
   (1)Water users over 1,000 m3/month (5~20%).
   (except medical or public interests use)
   (2)Swimming pool, car wash and sauna (20%).
   (3) All non-urgent water use.

Red
Partitioned water supply

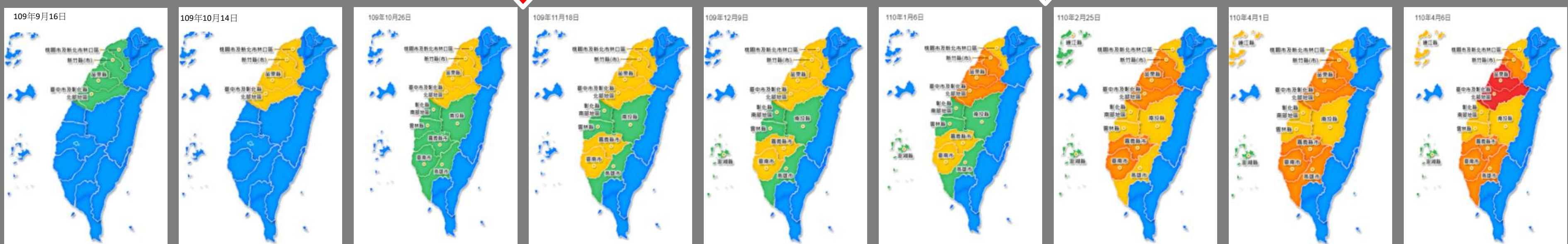
Supply water in turns

Red
Fixed water supply

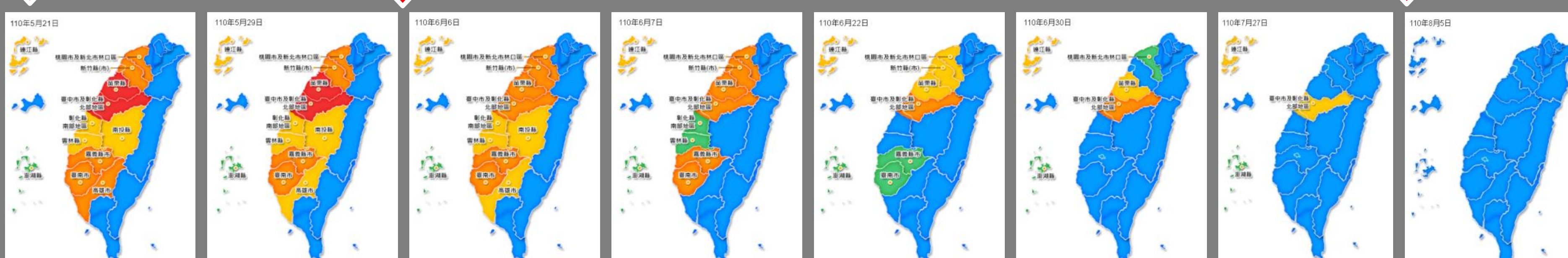
- Quantitative regular water supply according to follow priorities :
1. Residential
2. Medical
3. National defense
4. Industrial and commercial
5. Others

Gradually strengthen water reduction measures and areas

No typhoons → Nov. → Less winter rain → Feb. → No spring rain



May → Late Plum rain → Jun. → Consecutive Plum rain from typhoons can gradually increase water supply and reduce drought risks. → Aug.



Joint Actions towards Extreme Droughts in Taiwan

All levels of governments and private sector organizations strive to cooperate on fighting drought and stabilizing water supply.

MOEA | COA | CWB | MND | MOEST | MOE | MOHW | EPA | County (City) Government

1 **Save water**

2 **Allocate water**

3 **Find water**

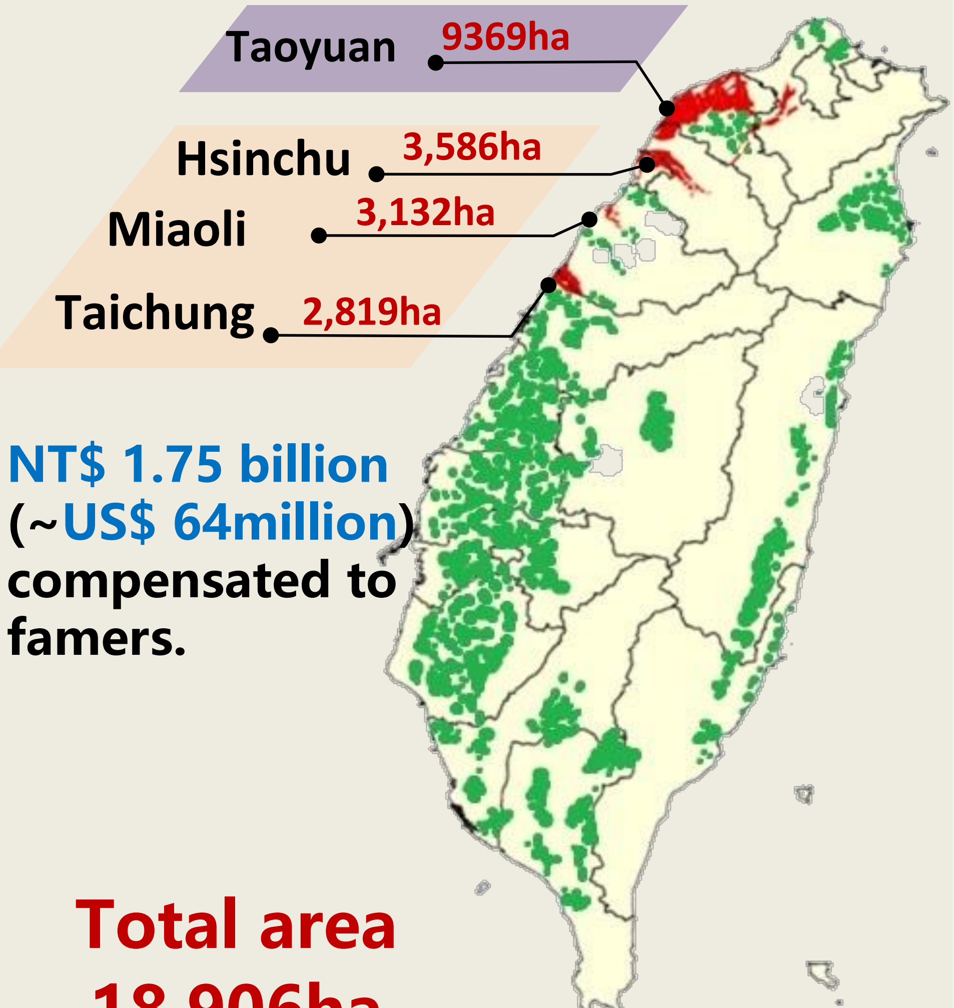
Keep Water Stored in Reservoirs

Save Water - Domestic/Industrial Sectors

	Domestic Water	Industrial Water	Non-essential uses	Non-Industrial Water
Green	Low pressure (Pm11~Am5)	- 5%		
Yellow	Extend lower pressure (Pm10~Am6)	-5~-7%	Prohibited	
Orange	All Day Low Pressure	-7~-15%	Prohibited	-10~-20%
RED	2 days off in a week	-15%	Prohibited	-20%

Save Water- Agriculture

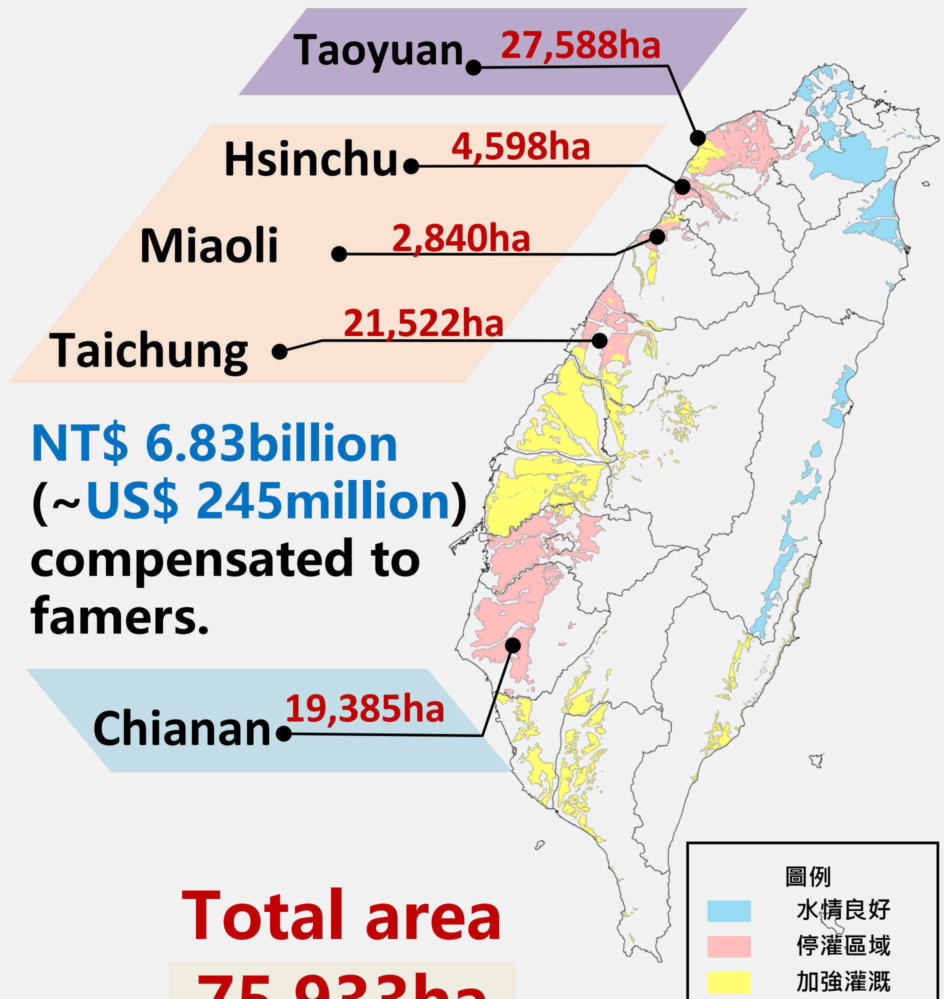
2020 Second Season Crop



NT$ 1.75 billion (~US$ 64million) compensated to famers.

Total area 18,906ha

2021 First Season Crop



NT$ 6.83billion (~US$ 245million) compensated to famers.

Total area 75,933ha

Save water - **Impact Reduction**

Hospitals & clinics/schools/ social welfare institutions **Installation of tanks**

Flood prevention & **water saving volunteers help** people receive water

A construction site in Taichung provides **water transport for industries**

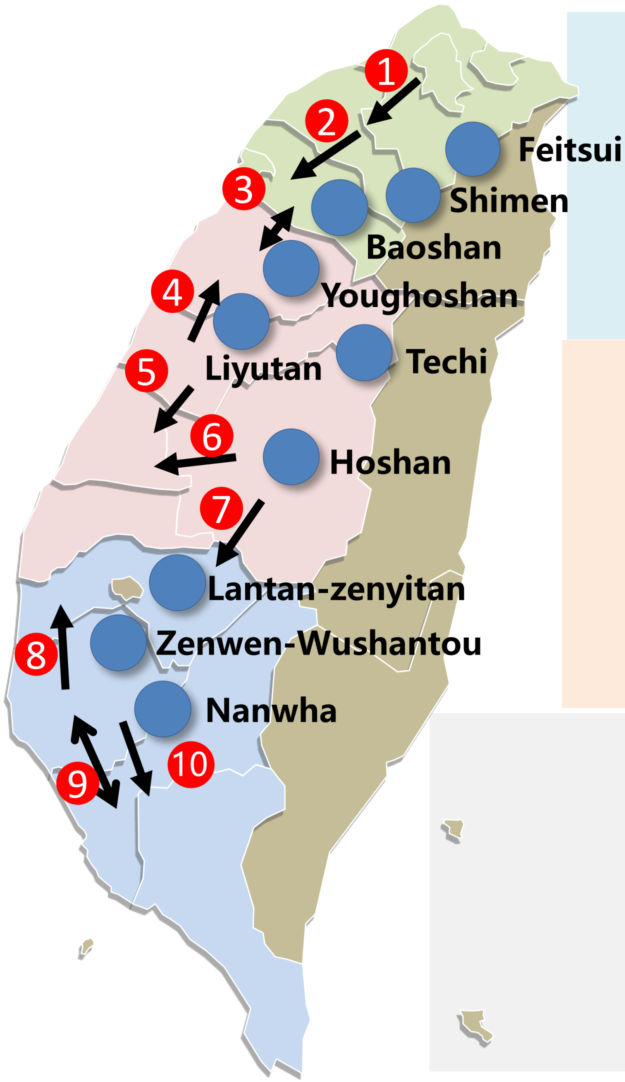
Dispatchments of mobile water supply trucks in areas

Providing **Water cleansing Facilities** Supports for household & industrial sector (from military)

Dedicated citizen communication line To assists public for water resources information.

Allocate water - Regional Allocation

Available water supply will be allocated to each region based on its conditions.



1. The Feitsui Dam supports Ban-Xin area with max. **840,000** ton daily
2. The Shimen Dam supports Hsinchu with max. **225,000** ton daily
3. Hsinchu support Miaoli with max. **30,000** ton daily

4. Liyutan supports Miaoli with max. **60,000** ton daily
5. Taichung supports Changhua with max. **80,000** ton daily
6. Yunlin supports Changhua with max. **50,000** ton daily
7. Yunlin supports Chiayi with max. **100,000** ton daily

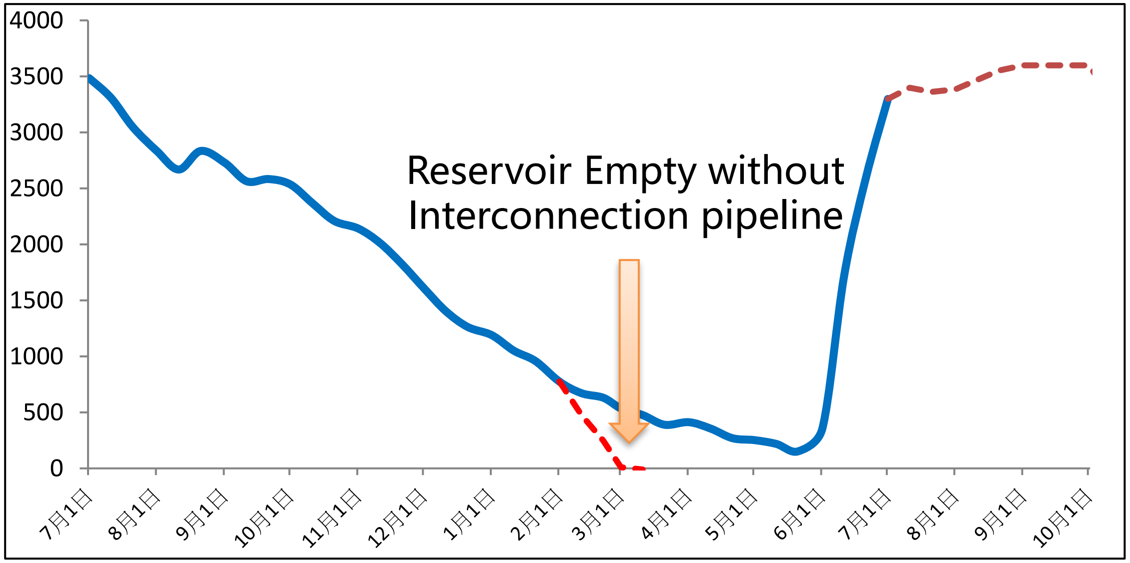
8. Tainan supports Chiayi with max. **20,000** ton daily
9. Tainan supports Kaohsiung with max. **20,000** ton daily
10. The Nanhua-Kaoping connection pipe has max. **500,000** ton daily

Allocate water - Regional Allocation

Interconnection Pipelines

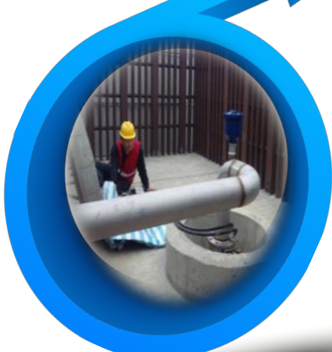
24/7 Construction Works

- Taoyuan to Hsinchu interconnection pipeline was completed ahead of schedule in Feb. 2021 (originally to be June).
- Supply Hsinchu 200,000 tons/day, about 40% of the water demand.
- About 23 million tons was supplied, about 60% of the totally volume of the Reservoir.



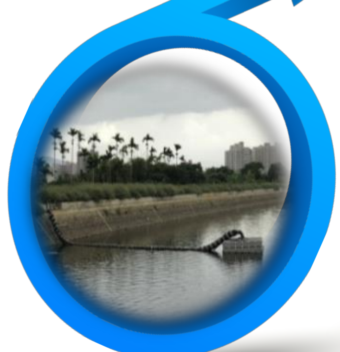
Find water - Emergency Water Supplies 1.0

- Nov. 2020 – Feb. 2021
- **Increase additional water supply of 780,000 ton/day**
- Funding: NT$ 1.4 billion



Groundwater Wells

160 wells
340,000 ton/day



Agricultural pond water
64 ponds
2.09 million ton/day

Reuse water from wastewater treatment plants
65 plants 425,000 ton/day

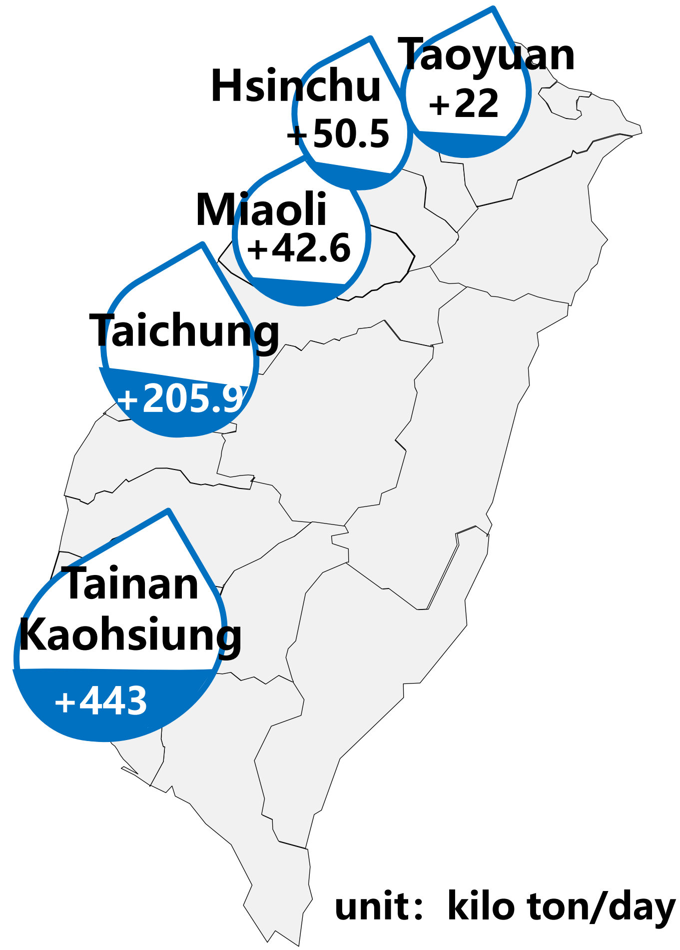
Desalination water
13,000 ton/day

Find water - Emergency Water Supplies 2.0

- Plan 2.0 was completed in May, 2021

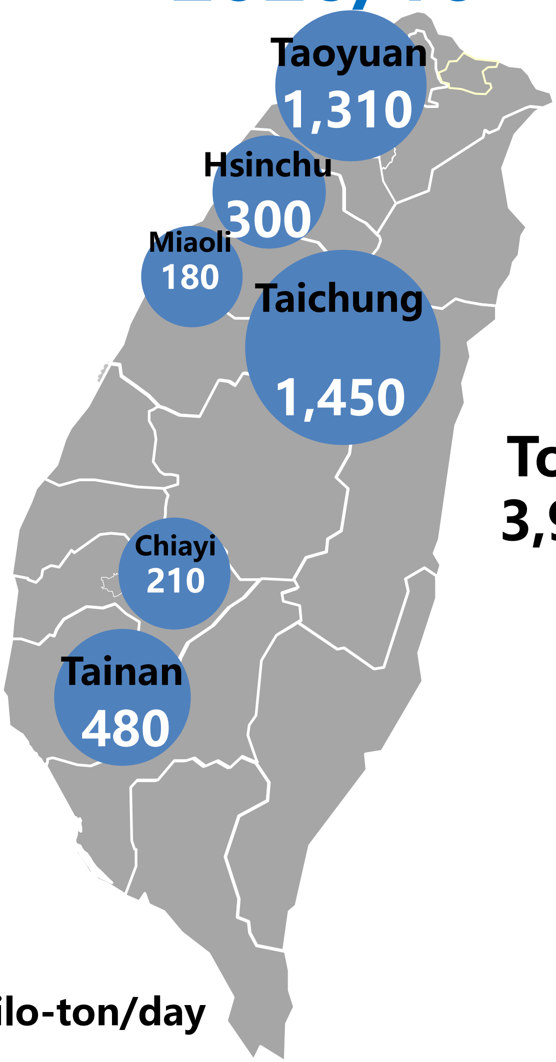
  Increase to 764,000 ton/day (Original to be 168,000 ton/day)
- Funding: NT$ 4.92 billion

- Emergency interconnections with nearby water utilities (+333,000 ton/day)
- Groundwater Wells (+229,000 ton/day)
- Subsurface Water (+50,000 ton/day)
- Emergency Desalination Water (+15,000 ton/day)
- Construction Site Dewatering System Water Use (+67,000 ton/day)
- River downstream water pumping back (+ tons/day 70,000 ton/day)



Reducing Reservoir Discharge Rate

Water supply from reservoirs
2020/10

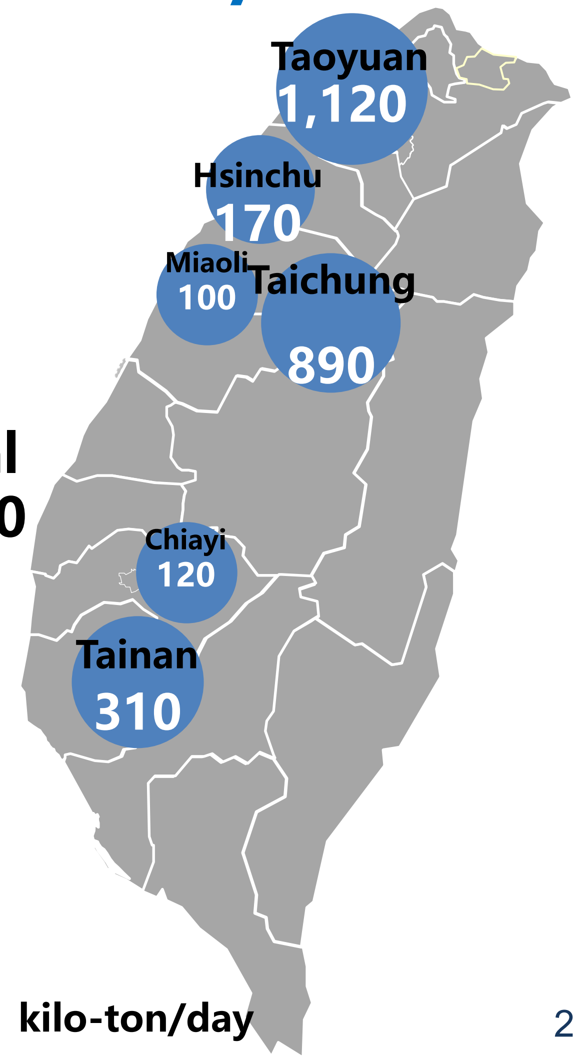


Total
3,930

31%
Reduced

Total
2,710

Water supply from reservoirs
2021/5



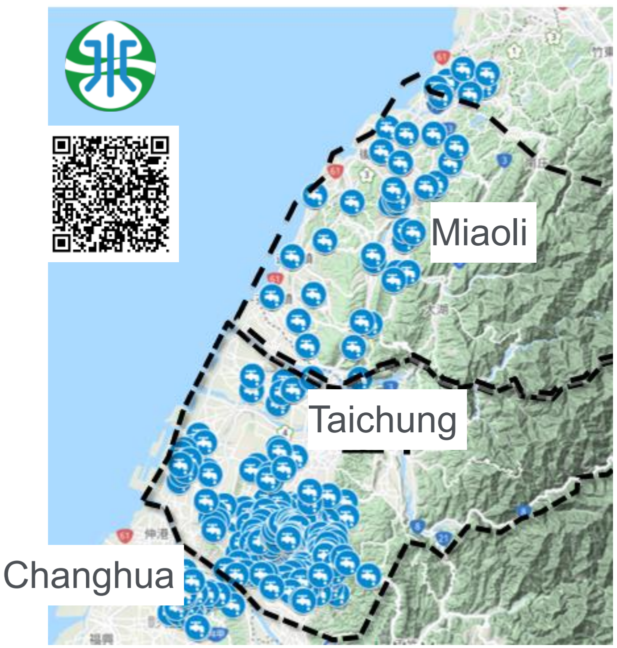
unit：kilo-ton/day

unit：kilo-ton/day

Water supply in turns

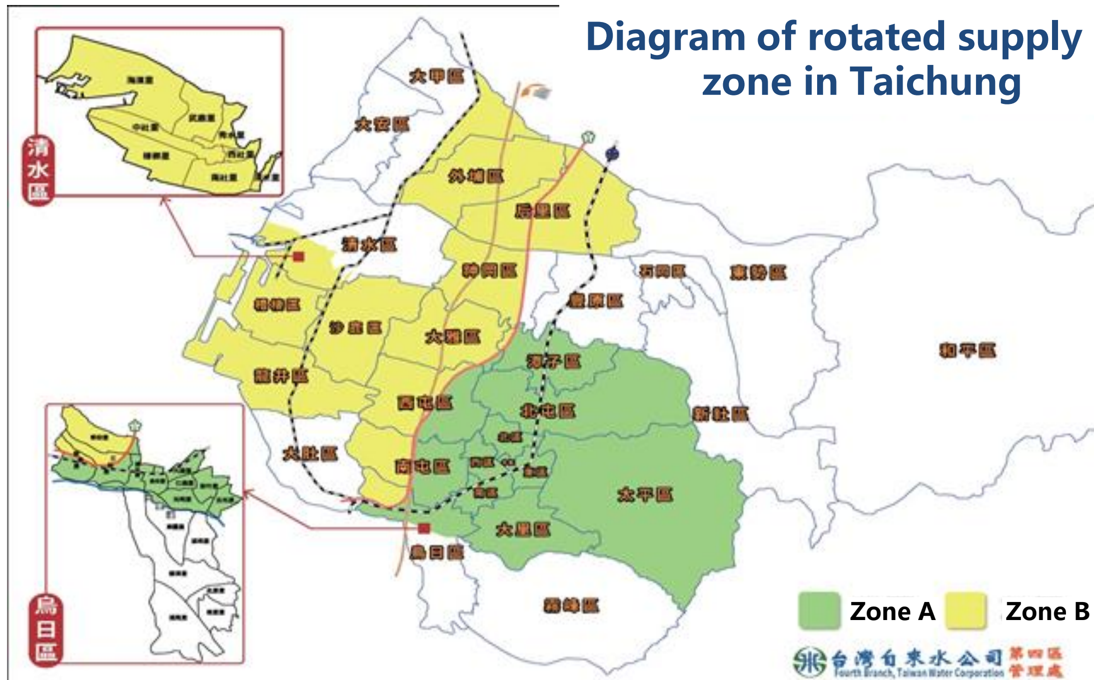
- ✓ Period of exercise: 2021/4/6-2021/6/6
- ✓ Scope of exercise: North Miaoli, Taichung, north Changhua (1.06 million households)
- ✓ Method of exercise: 5-day per week supply

Taiwan Water Corp. map of temporary supply stations



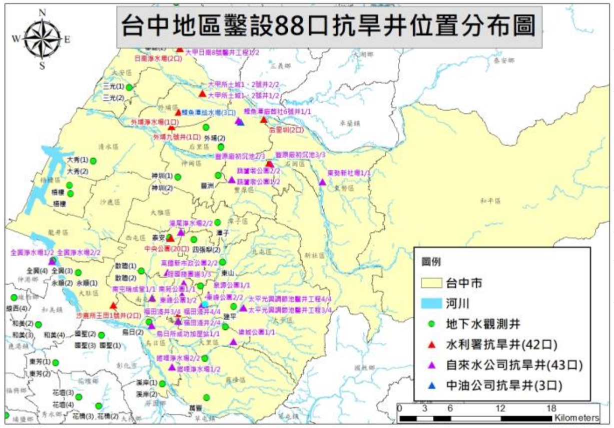
Customer service: 1910

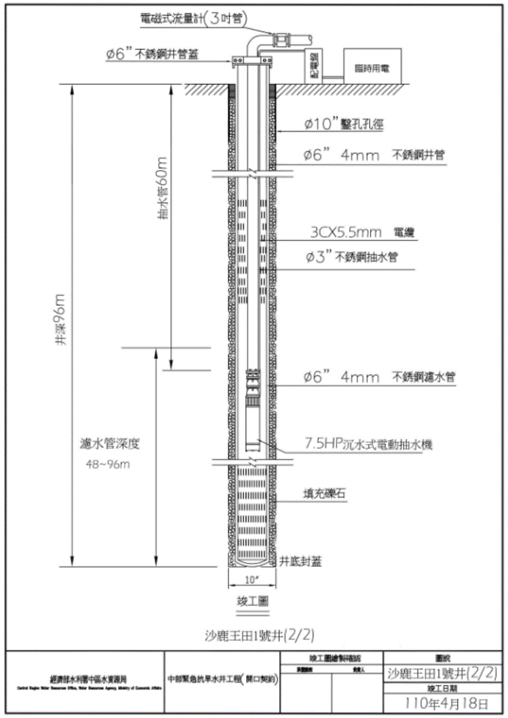
Diagram of rotated supply by zone in Taichung



Zone A	Zone B
Tue. - Wed. 0:00 - 24:00	Thur. - Fri. 0:00 - 24:00

Response to drought in Taichung - wells





- Succesfully built 88 wells that have rich groundwater supplies and located in the areas with low potential of land subsidence.
- Priority was given to areas near with water treatment plants or purification plants.
- Priority was given to areas with good water quality according to EPA, WRA, and surrounding work sites data of groundwater quality test.

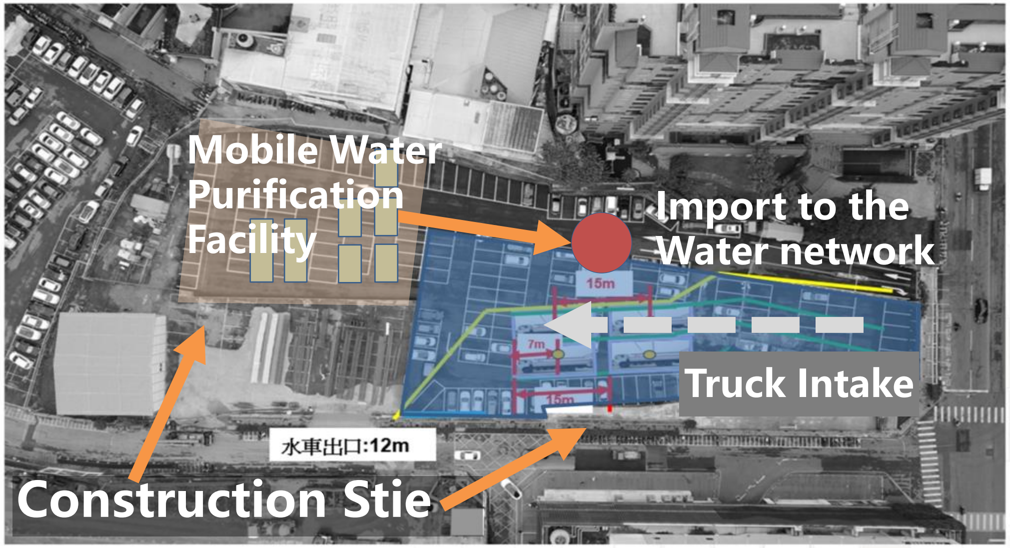
Anti-drought well at Liyutan supply plant, Taichung
Setup & drilling equipment at night

Anti-drought well at Taichung Central Park
Drilling work

Anti-drought well at Taichung Central Park
Pilot run

Response to drought in Taichung-
Construction Site Well Point Groundwater Reclaimation

11 sites to provide 100,000 ton/day



Pipelines

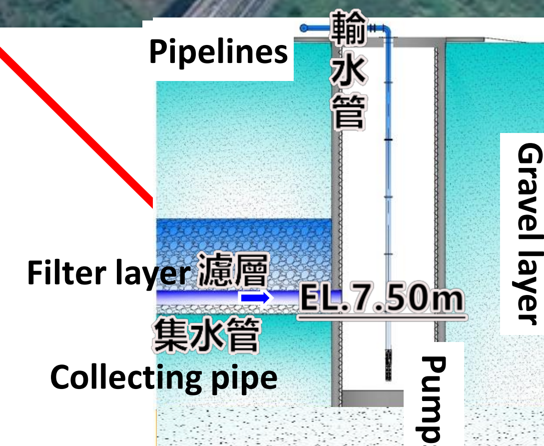
Mobile Water Purification Facility

Import to the water network

Response to drought in Taichung

Hyporheic Flow

Hyporheic Flow in Wu River: 40,000 ton daily



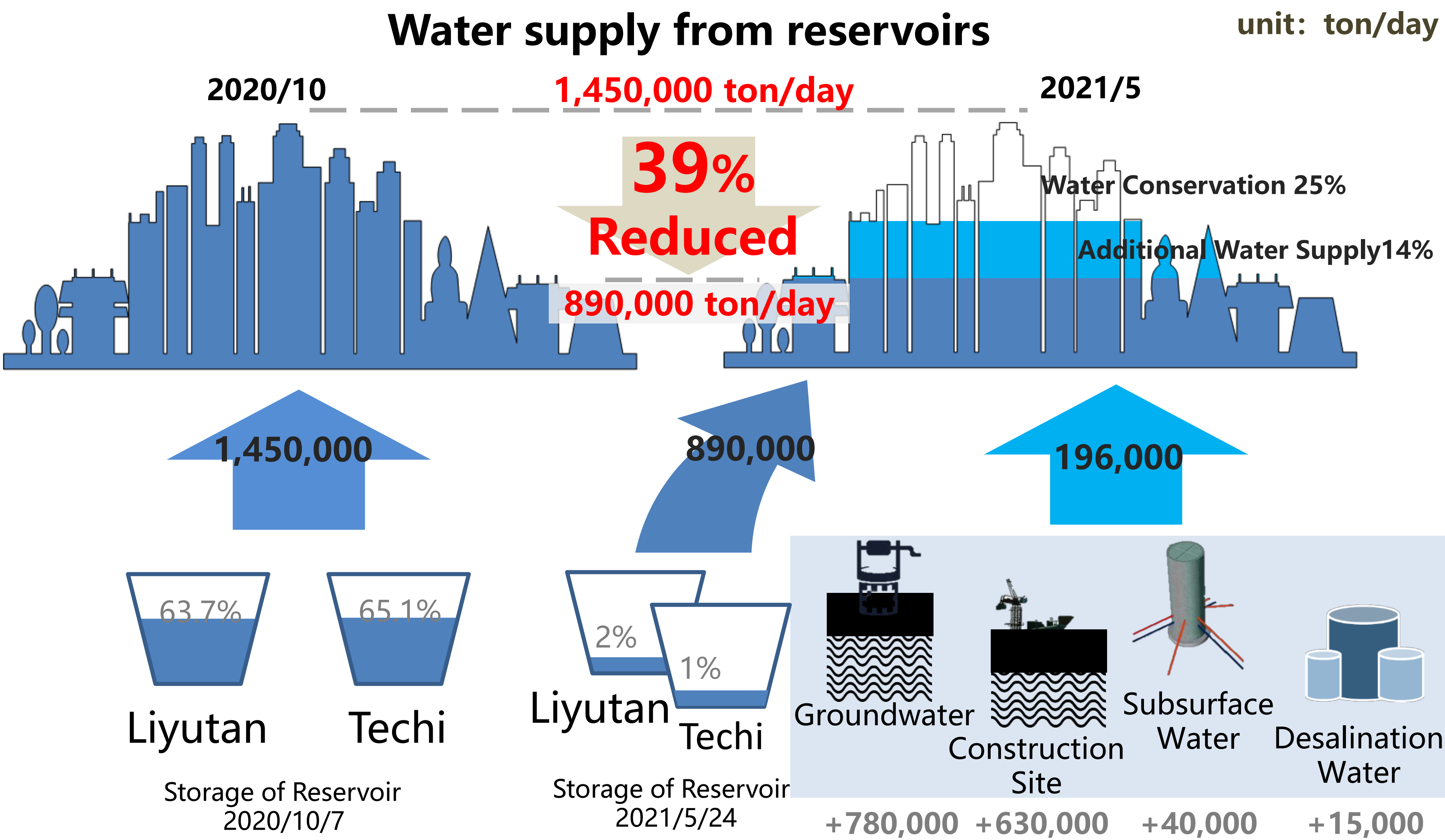
Response to drought in Taichung
Desalinated water

Mobile emergency desalination units

- 15,000 ton/day completed by 5/31
- Exchange water supply to nearby factory (Dragon Steel) for tap water source, achieving the object of saving dam discharge

Response to drought in Taichung

Reduce 0.56 million ton reservoir discharge

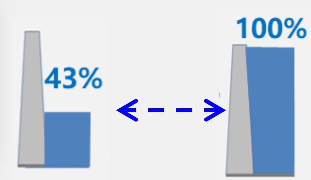


Increasing Water Resources Flexibility

Construction

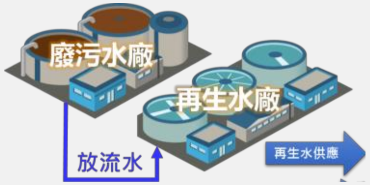
Increase capacity & storage

Regional allocation



Promoting subsurface water usage

Water / Wastewater Purification plants



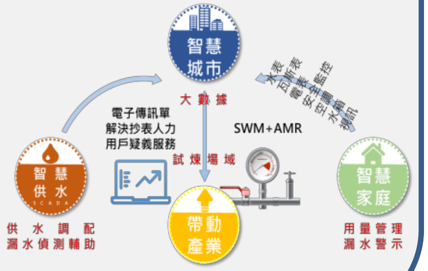
Management

Conservation at catchments

Dam dredging

Reducing tap water leak

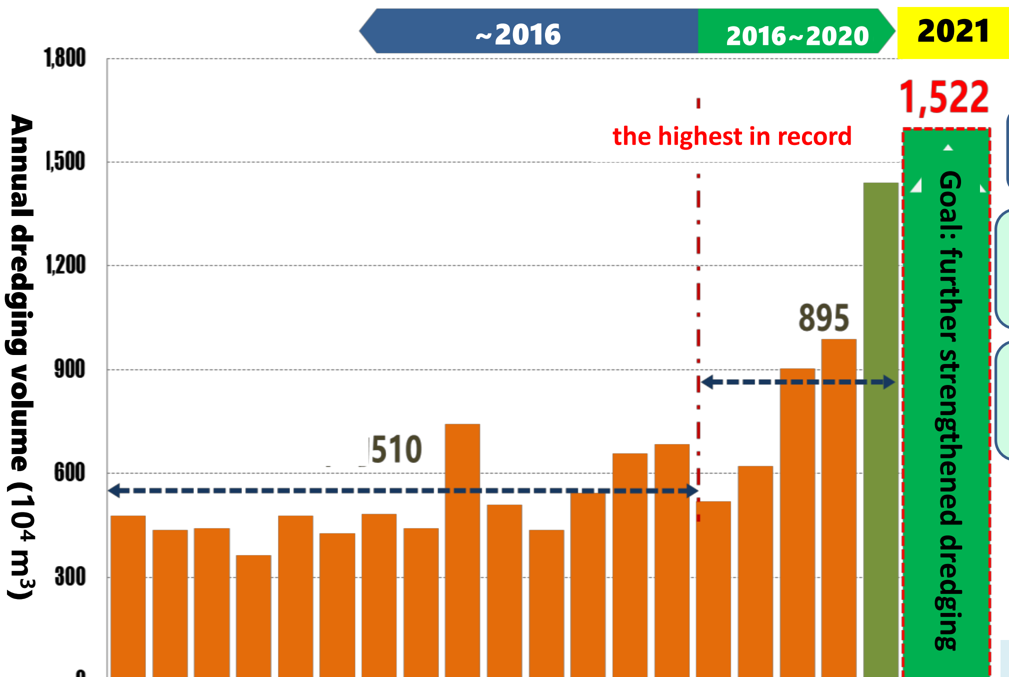
Technological applications



Reservoir Sediment Dredging

Maximizing dredging process：excavation, hydraulic dredge, hydraulic desilting tunnel.

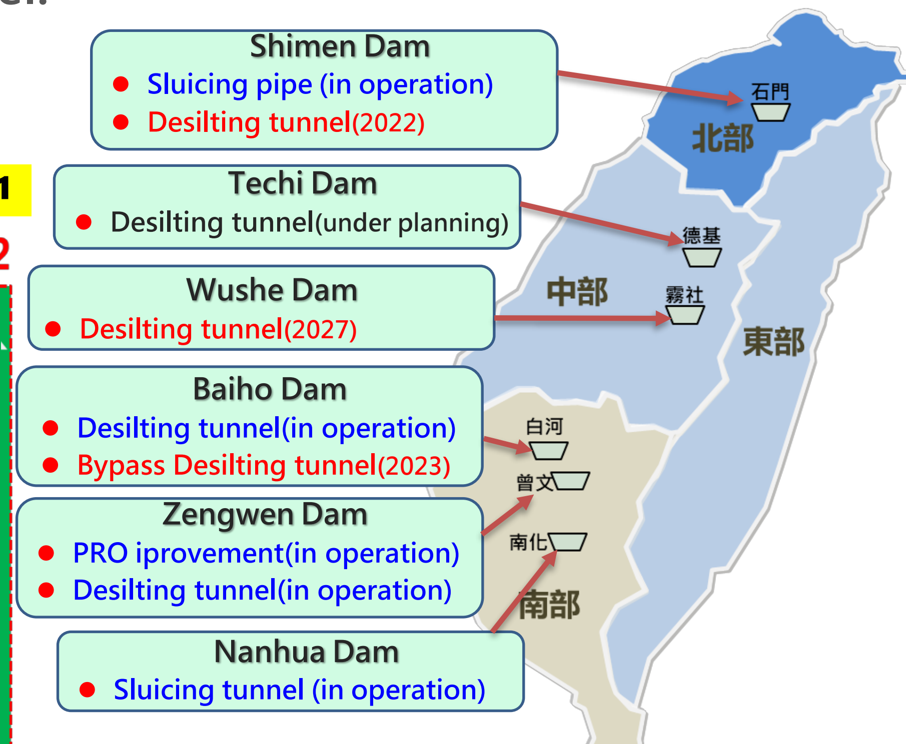
As the results, the capacity of Shimen and Zengwen Reservoir **increased in 2020**

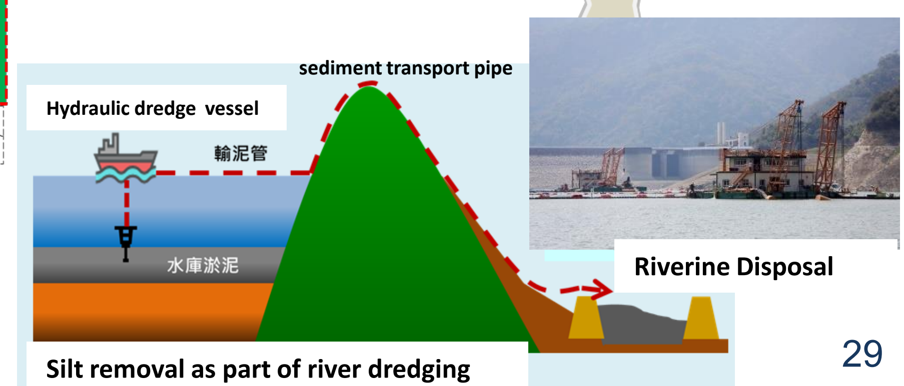


	91年	92年	93年	94年	95年	96年	97年	98年	99年	100年	101年	102年	103年	104年	105年	106年	107年	108年	109年	110年
陸挖及抽泥	479.0	437.2	440.9	362.4	477.3	426.6	483.2	441.1	742.3	510.3	437.3	543.8	658.0	683.4	520.0	620.7	903.5	987.7	1,440.	1.522

Accumulated dredging volume 140 million m3
(or 190 million m3 including hydraulic sluicing)

hydraulic desilting tunnel





Dams Heightening

- ✓ **Zengwen dam gained 3 m in height and the capacity increased ~ 55 million tons.**
- ✓ **Dam heightening also improves safety measures for environmental disasters**
  - ☐ Baoshan 2nd Dam is heightened by 1.35m, increases capacity by 1.92 million m^3
  - ☐ Nanhua Dam is heightened by 1.8m, increases capacity by 9.23 million m^3

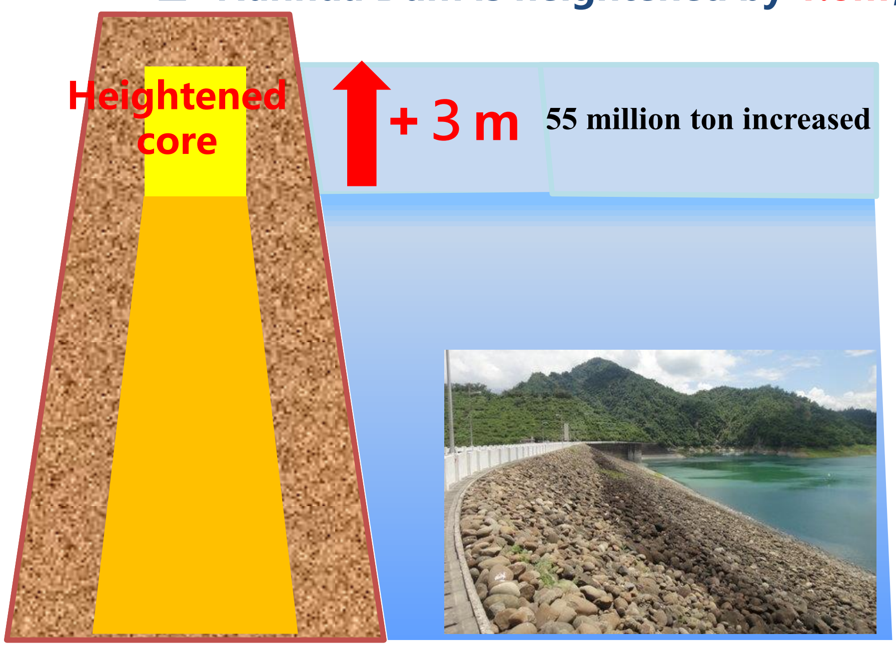
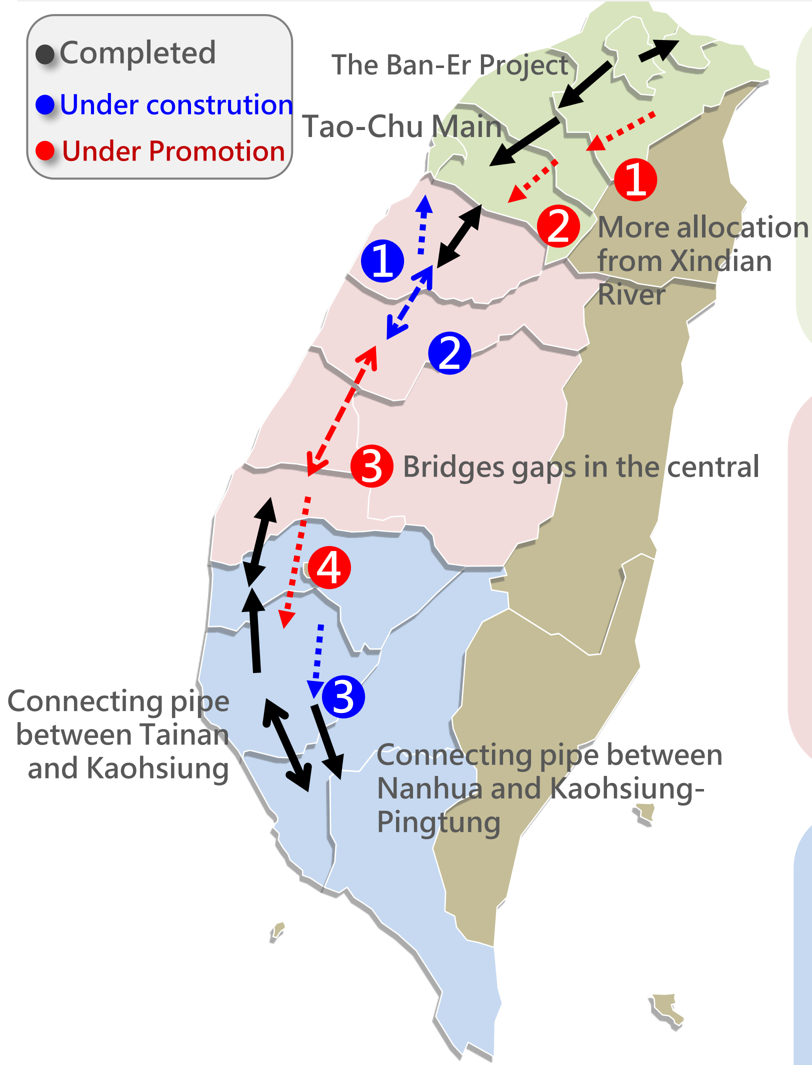


Diagram of heightening of Zengwen Dam

Heightened overflow weir of Nanhua Dam

Enhancing Water Supply Allocation and Reservoir Connections



North

❶ Channeling water from Nanshi River to Shimen Dam

(further increases 66.3 million ton/year in Shimen Dam)

❷ Shimen Dam to Hsinchu primary pipe

(further increases support capacity for Hsinchu by 300,000 ton/day)

Central

❶ Liyutan supplies northward to Miaoli

(will be completed in 2024)

❷ Connecting pipe of Dajia River and Da-an River

(will be completed in 2026)

❸ improvement pipe-connection from Taichung to Yunlin

South

❸ Zengwen-Nanhua connection pipe

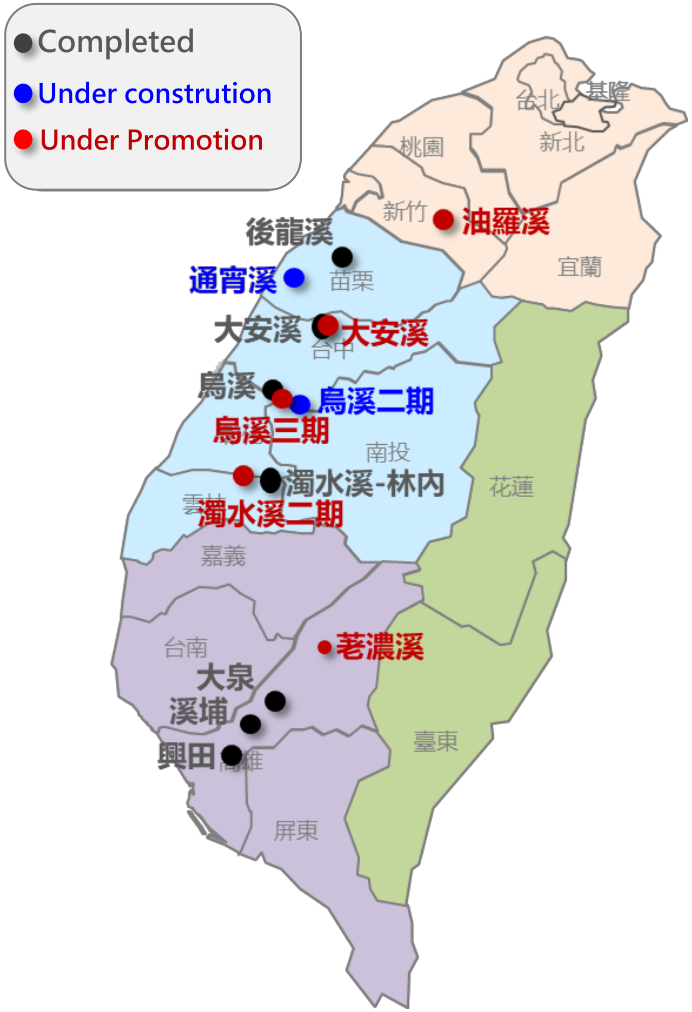
(will be completed in 2024)

❹ Connection of Yunlin and Chianan Agriculture Canal

(increased irrigation in Chiayi and Tainan by 10M ton annually)

Promote more hyporheic flow complying with locality

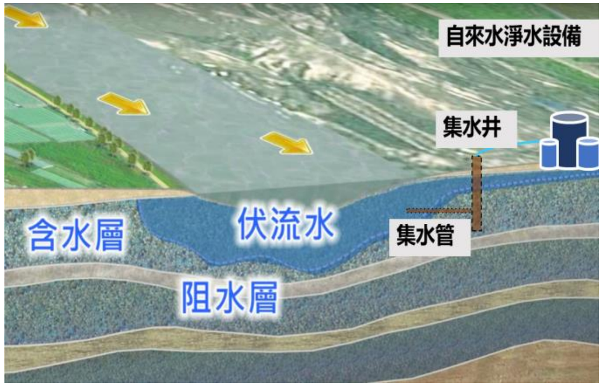
Potential development in Yuluo, Da-an, Wu, Zhuoshui and Kaoping Rivers

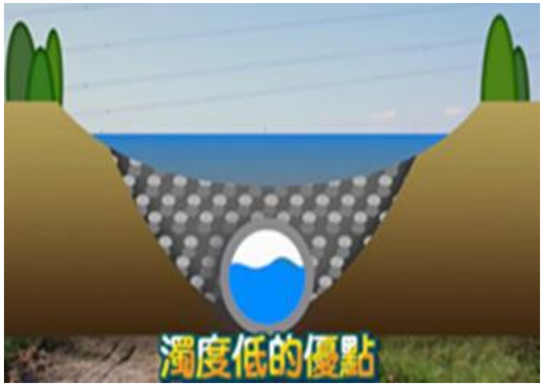


7 cases of hyporheic flow completed in past 4 years, increasing water supplies around 505,000 ton/day

5 cases are under promotion：

1. Yuluo River (+40,000 ton/day)
2. Da-an River(+50,000 ton/day)
3. Wu River, 3rd phase(+100,000 ton/day)
4. Zhuoshui River, 2nd phase(+30,000 ton/day)
5. Laonong River (+100,000 ton/day)





Desalination and Reclaim Water

- **Seawater desalination plants** will adopt **energy-saving production plan** which complement its water supply service with regional water supply (rivers or dams). Water supply from dams and rivers will be used in wet seasons, and water supply from desalinated water plants will be used in dry seasons.

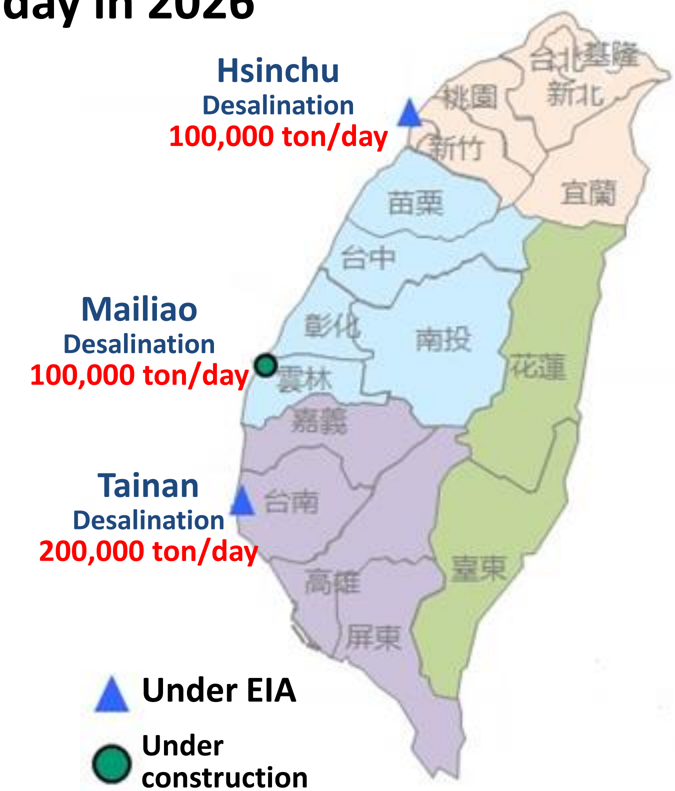
- **11 reclaim water plants – to achieve 289,000 ton/day in 2026**

2019
Kaohsiung
Fongshanshi Reclaim plant
45,000 ton/day

2021
Tainan
Yongkang Reclaim plant
8,000 ton/day

2021
Kaohsiung
Linhai Reclaim plant
33,000 ton/day

2026
Taoyuan, Hsinchu Taichung, 8 plants
203,000 ton/day




THANK YOU

BUREAU OF RECLAMATION

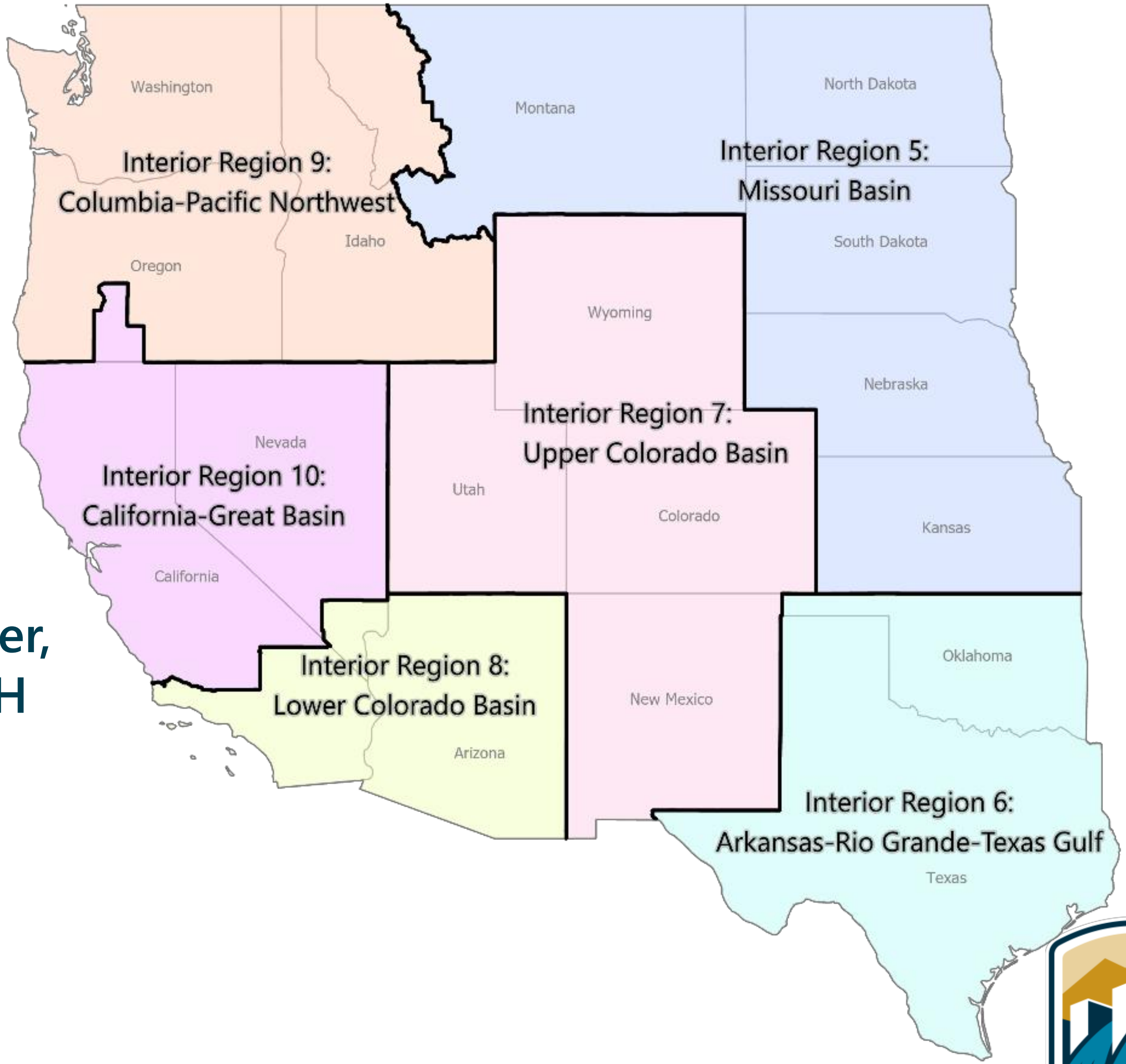
Water Supply Projects in an Arid Zone of the Southwestern United States

Alexander Smith

October 15, 2021

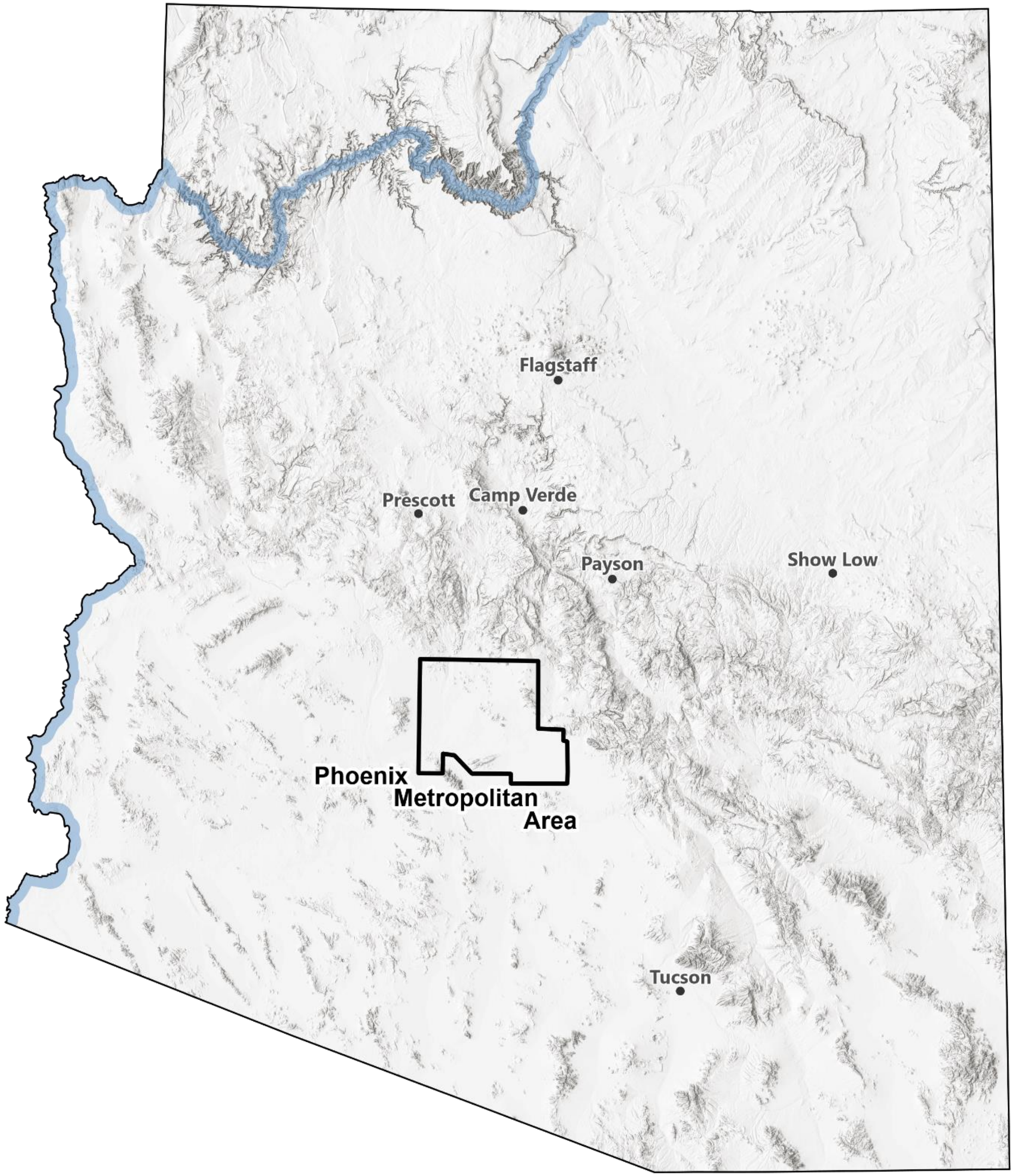
U.S. Bureau of Reclamation

- U.S. Department of the Interior agency
- Established in 1902 in the 17 western United States
- Largest wholesaler of water in U.S., providing water to over 40 million people
- Provides water to irrigate 10 million acres of farmland, producing 60% of the nation's vegetables
- Second largest producer of hydroelectric power, with 58 powerplants producing 40 billion KWH
- Over 600 dams and reservoirs
- Includes Hoover, Davis, and Parker dams and infrastructure for water delivery on the lower Colorado River



Phoenix Metro Area

- “The Valley of the Sun”
- Climate – June-September average high temperatures ~ 40°c
- Precipitation – 20.4 cm/yr
- Population – 4.9 million (2019)
- Rapid growth
  - Third largest growth in US (2010-2019)
- Per capita water use – 680 L/day
- Water usage
  - Agricultural, M&I, and Tribal

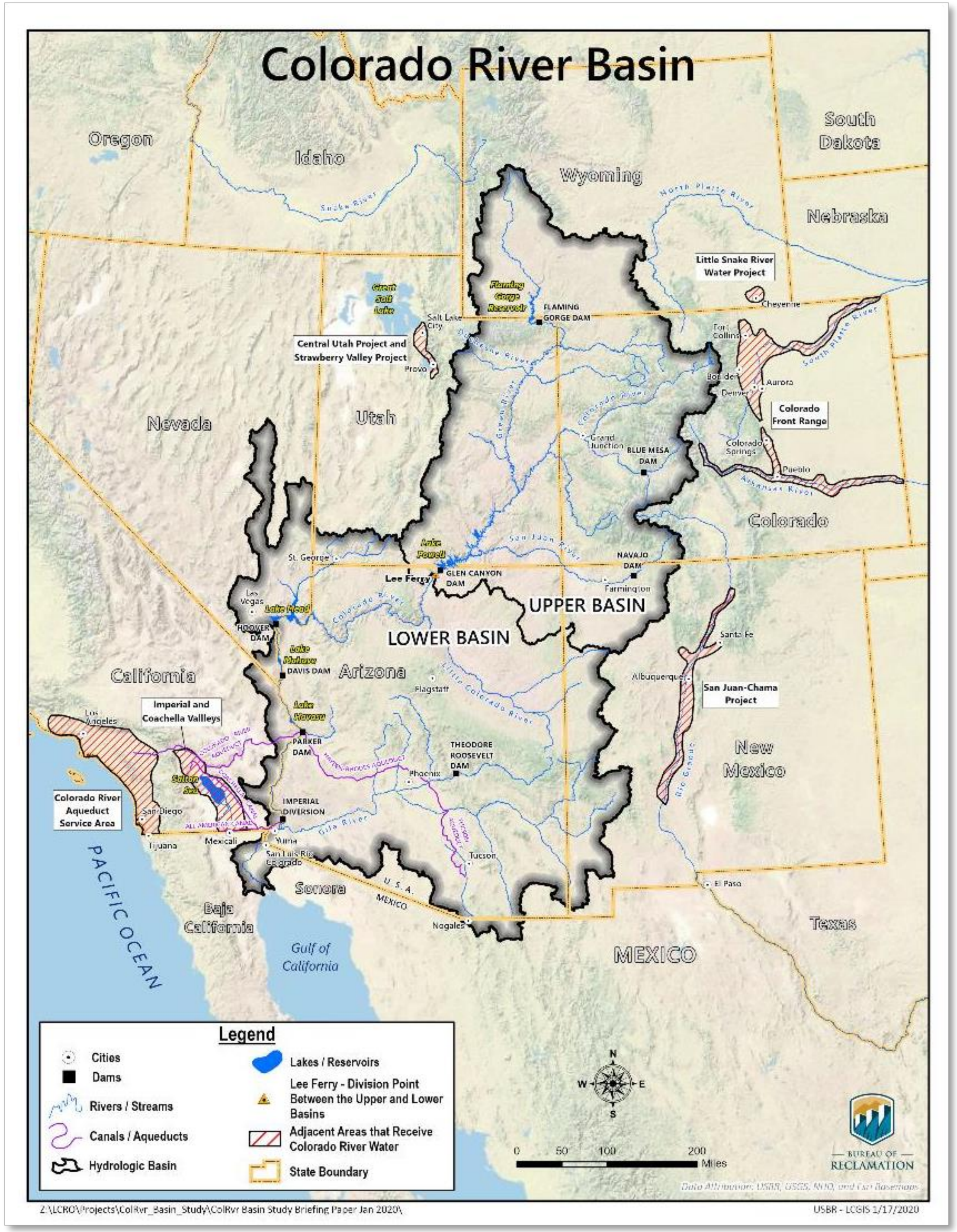


Phoenix Water Supply

- Colorado River Basin
  - Watershed - Colorado, Wyoming, and Utah
- Salt River Project
  - Watershed - Northern and Eastern Arizona
- Phoenix Area Groundwater
- Variety of Water Sources
  - Increase reliability
- Distribution/Delivery Systems
  - Federal, state, and local ownership

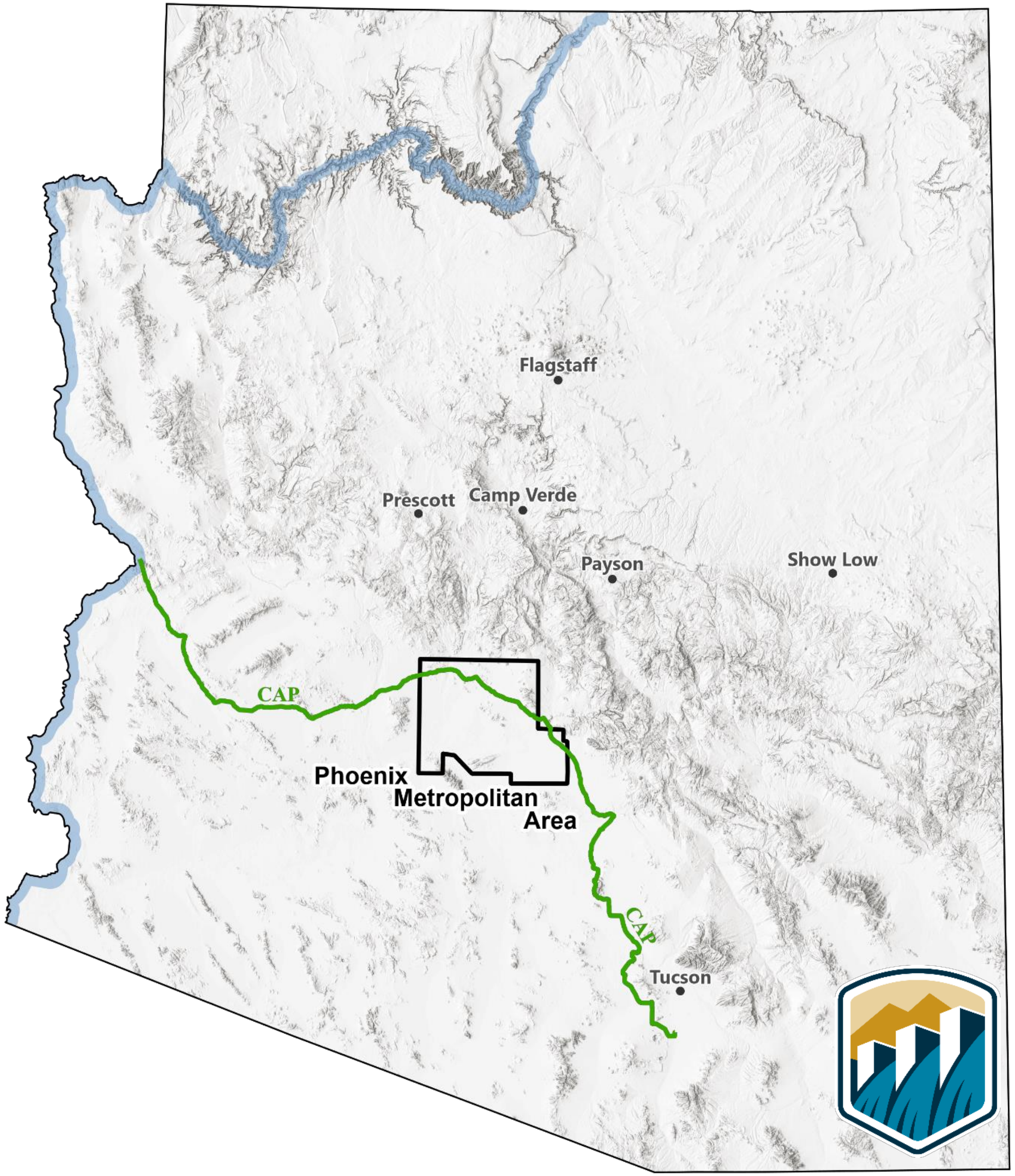
Colorado River Basin

- 20.35 bcm/year of allocations
  - 9.25 bcm to the Lower Basin States including Arizona
- Approximately 19.7 bcm average annual “natural flow”
  - Inflows are highly variable year-to-year
  - Current 22-year drought is among the driest periods of last 1,200 years
- 74 bcm of storage (approximately four times the annual average inflow)
- Colorado River water taken off river by Central Arizona Project for use in Central Arizona



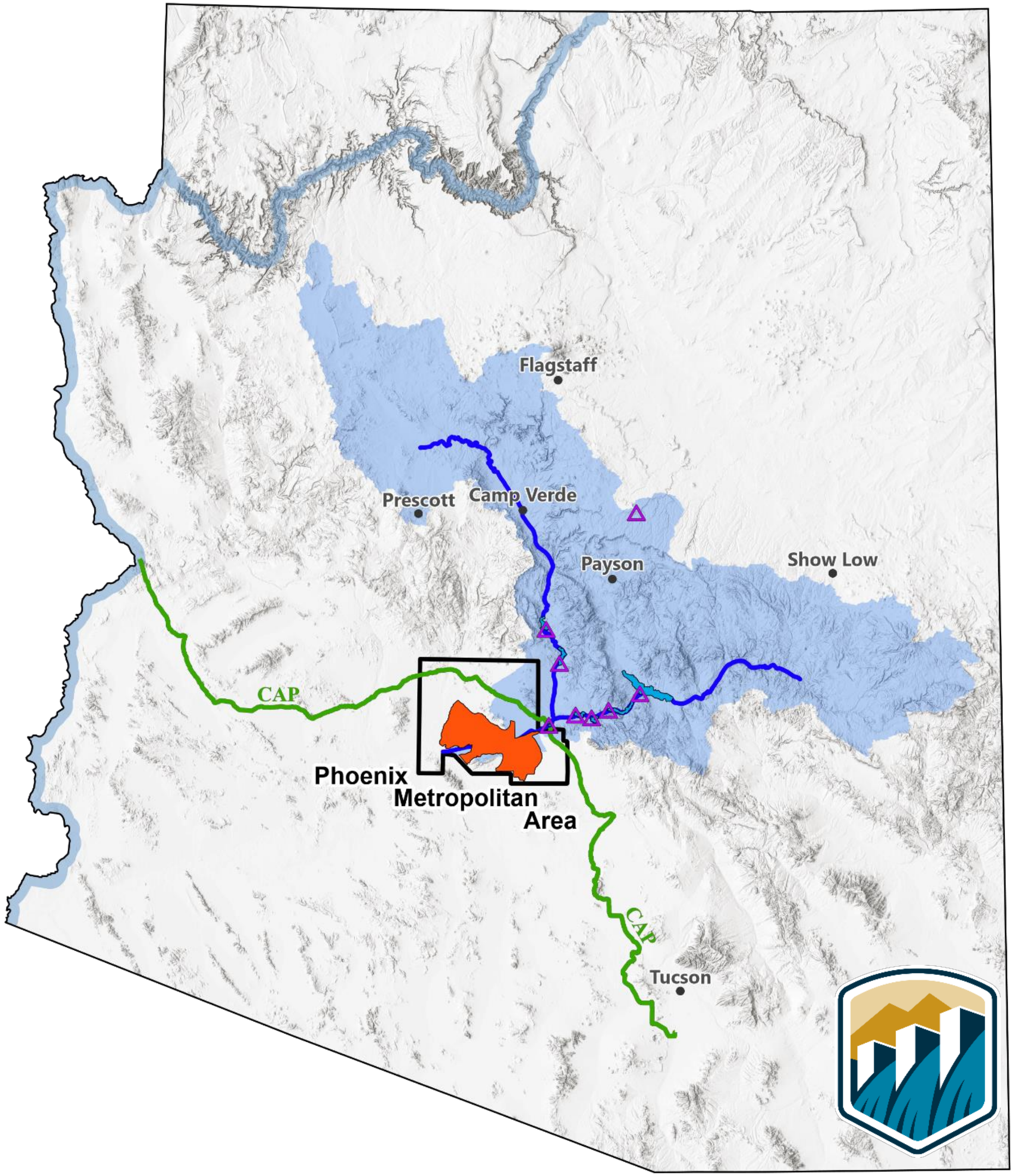
Central Arizona Project

- Delivers Colorado River Water to federal, state, and local distribution systems
- Tribal, Agricultural, Municipal & Industrial uses
- 1.8 bcm/year
- 540 km length
- 915 m rise
- 14 pumping plants



Salt River Project

- Service Area - Phoenix metropolitan area
- Watershed mountains of northern and eastern Arizona
- 7 dams – Storage 2.8 bcm
- 270 groundwater wells
- 1,930 km of canals
- Conjunctively operated
- Deliveries 990 mcm year

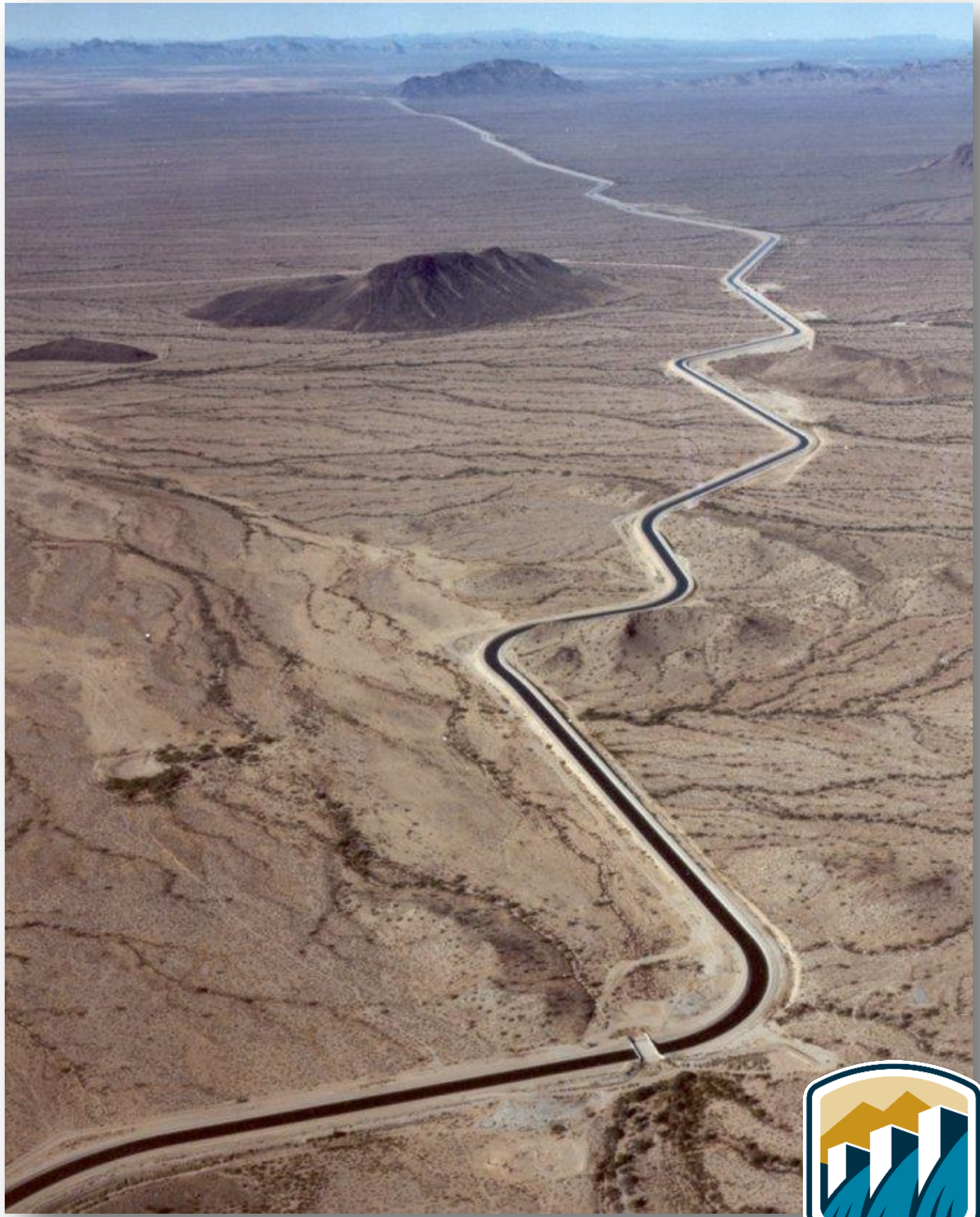


Phoenix Groundwater Supplies

- Regulated under 1980 Groundwater Management Act
- Established Active Management Areas
  - In areas of high groundwater overdraft
- Limits new groundwater pumping
- Incentivizes storage of water underground
  - Credits that are marketable and extractable

Water Supply Reliability

- Diverse Source Supplies
  - Upper Colorado River Basin/Arizona
  - Surface Water/Groundwater
- Groundwater storage incentivized
- Large storage volumes
  - Colorado River/SRP reduce impacts of drought
- Systems interconnections increase flexibility – CAP → SRP
- Water leases/exchanges
- Shortage sharing



Evolving Water Management

- Continuing drought
  - Colorado water delivery reductions
  - 2022 Arizona – 632 mcm reduction
  - Shortage sharing agreements
- New intersystem connections
- Wheeling of non-project water
- Canal capability projects
- Storage studies
  - Restore lost capacity/create new capacity
- Transfers of mainstem Colorado River rights to central Arizona
- Watershed Restoration

Alexander Smith – alexandersmith@usbr.gov

BUREAU OF
RECLAMATION

Variability of Droughts in Southern Africa

C.M. Tfwala, Irrigation and Soils Agronomist, Ubombo Sugar Ltd

Smart Water Management, Taiwan ICDF, October 2021

Introduction

- Drought - natural hazard that results from below-normal precipitation -beyond a given threshold over time - negatively affects ecosystems and society in several ways (Karavitis et al., 2011; Van Loon, 2015)

- Better understanding of inter annual drought occurrences - crucial for planning mitigation and adaptation measures for agricultural planning and water resources management

DROUGHT AND ARIDITY

Drought	Aridity	Water Scarcity:
Drought is a relative deficit in a given area compared to its average or usual water availability, either in the form of rainfall, river flow, surface/ ground water storages or due to combination of these for certain period of time. **Thus drought is a temporary phenomenon.**	**Aridity refers to persistently short supply of water even in normal circumstances. It is a climatic attribute of the region. It applies to the persistently dry regions like arid areas & deserts, where, water is always in short supply.** **It is a permanent climatic feature of the region**	**The water scarcity refers to long-term unsustainable use of water resources, which water managers can influence. *Or in other words,* it is associated to over exploitation of water resources when demand for water is more than its availability.** **Thus water scarcity is a human induced phenomenon.**

CASE STUDIES

Nationwide spatial and temporal variability of droughts in Eswatini: 1961-2018

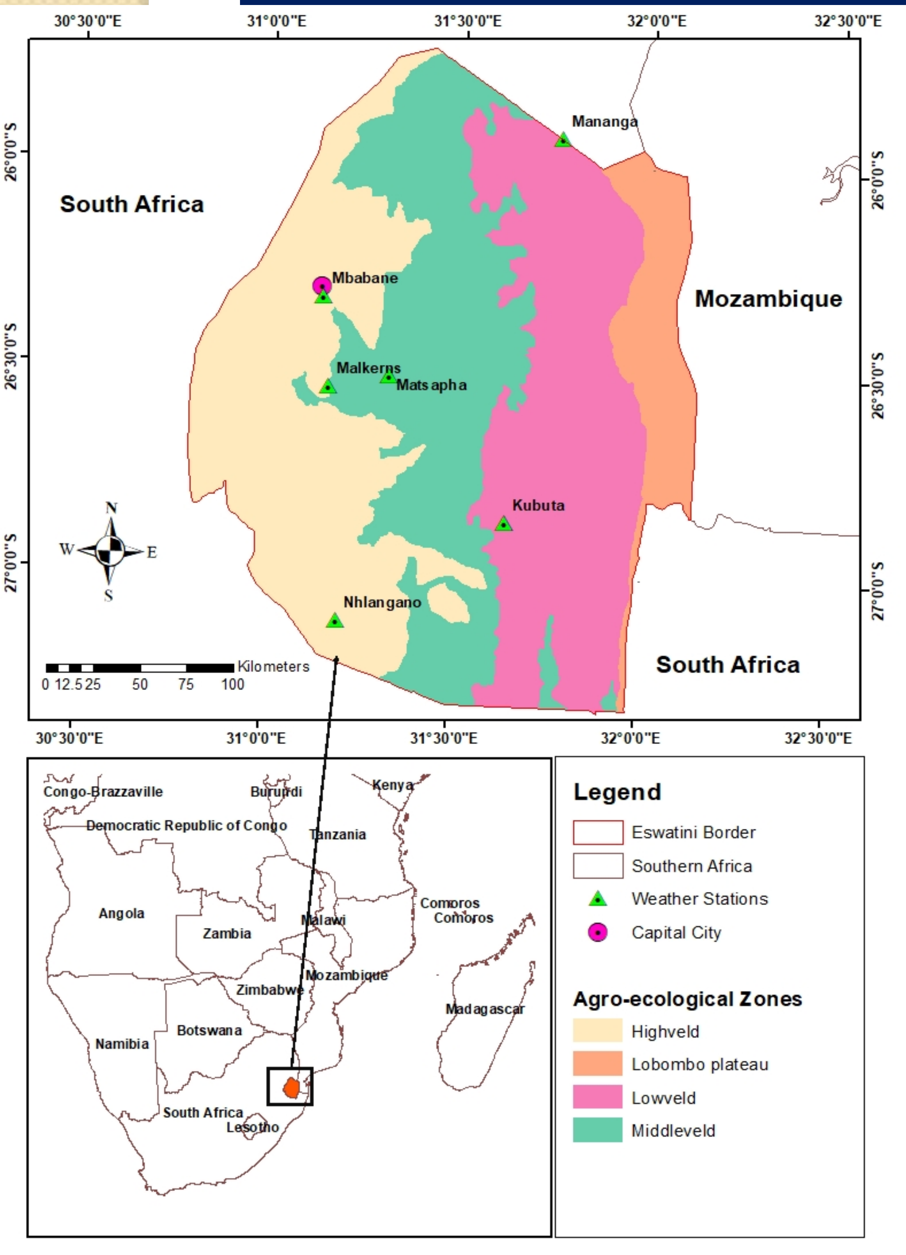
(Published in Heliyon Journal, 2021)

C.M. Tfwala, A. Mengistu, E. Seyama, M.S. Mosia, B. Mvubu, M. Mbingo, P. Dlamini

Objectives

- Were to determine:
  - i) the occurrence and severity of droughts
  - ii) the frequency of occurrence of droughts across the agro-ecological zones.

Meth. Cont.…



- Two meteorological stations were selected from different agro-ecological zones

- Monthly rainfall data for these met. stations were sourced from the Department of Meteorology

- SPI, developed by Mckee et al. (1993) was used, long-term precipitation data is fitted to a probability distribution function to transform it into a normal distribution so that the mean SPI = 0.

SPI classes (Guttman, 1999)

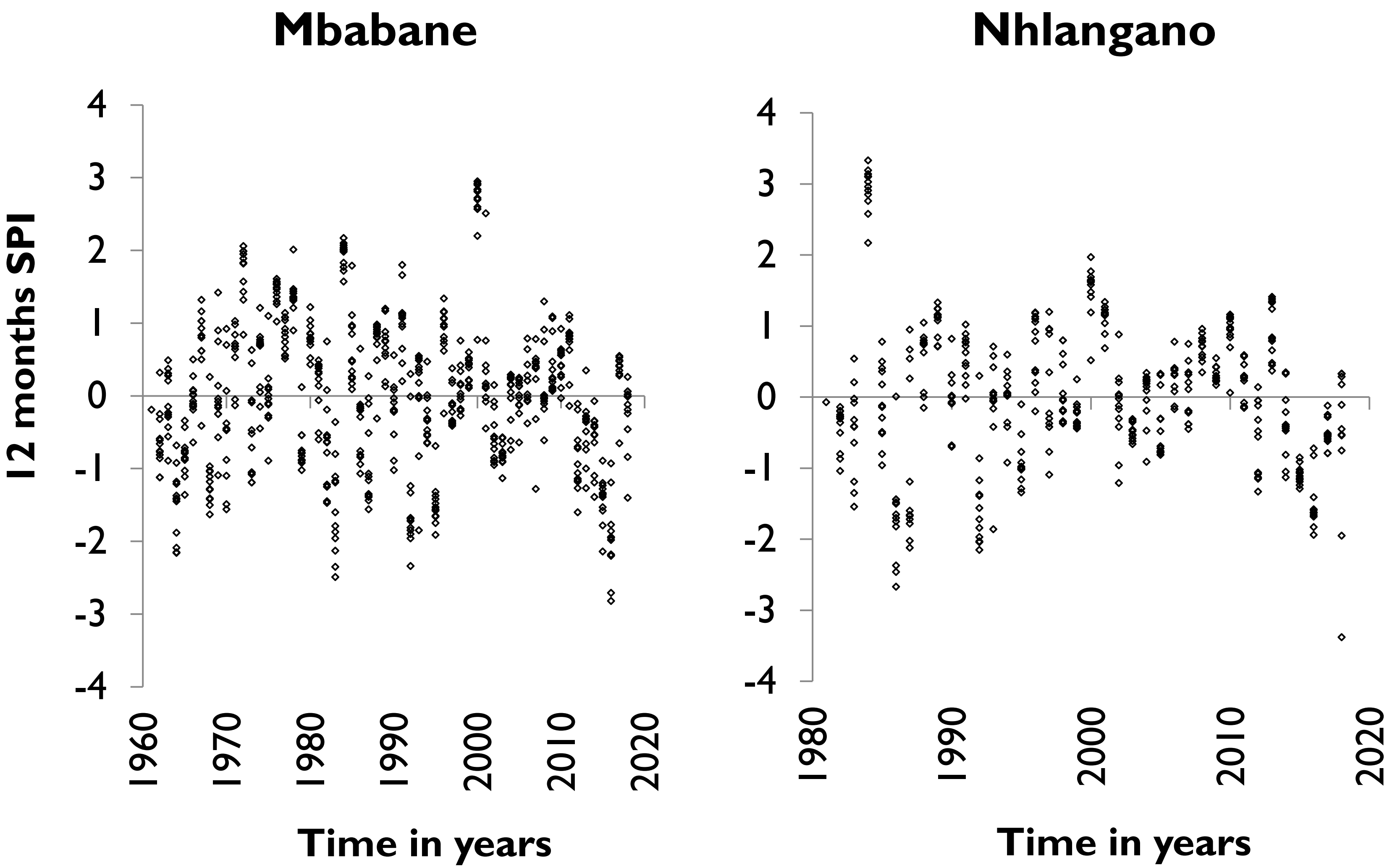
SPI value	Classification
2.0 +	Extremely wet
1.5 to < 2.0	Very wet
1.0 to < 1.5	Moderately wet
>-1.0 to < 1.0	Near normal
-1.0 to > -1.5	Moderately dry
-1.5 to > -2.0	Severely dry
-2.0 and less	Extremely dry

Metho. Cont….

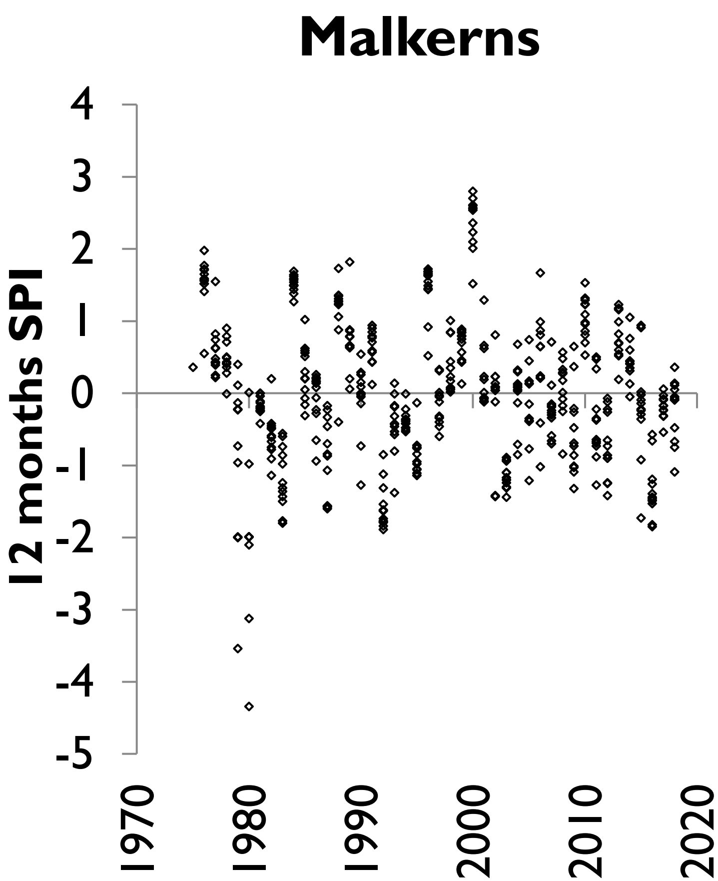
- A frequency analysis was carried out using Python (Version 3.6)

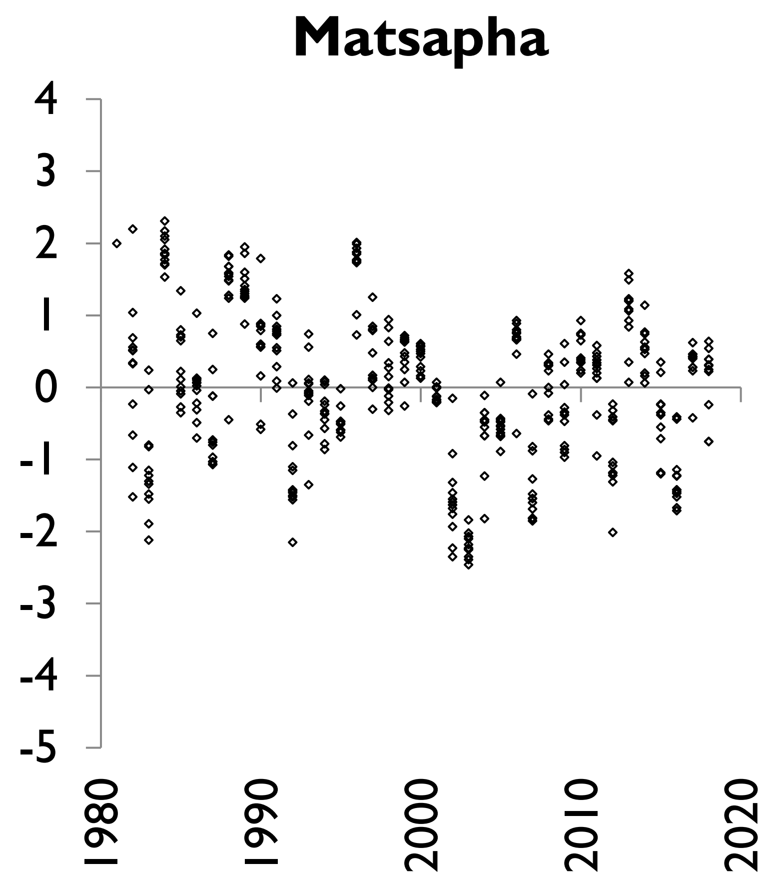
- To calculate re-occurrences of drought events of specific intensity over a period of time in years using SPI index values

Results – SPI Highveld



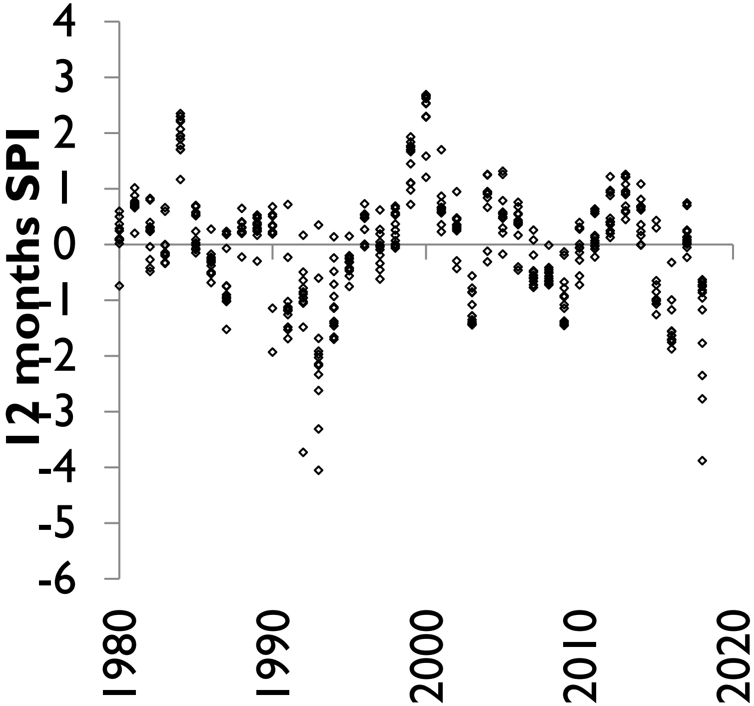
Results – SPI Middleveld





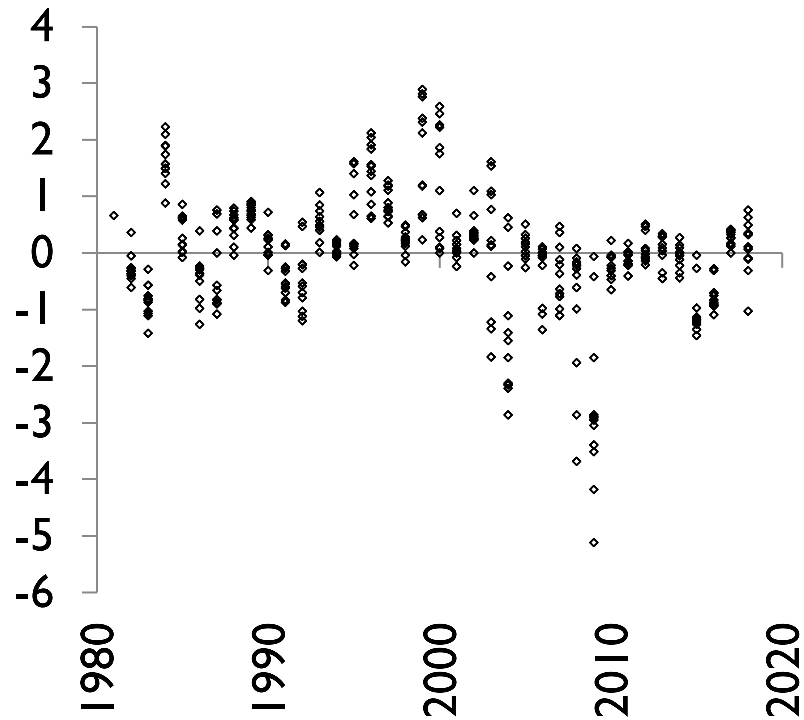
Results – SPI Lowveld

Mananga



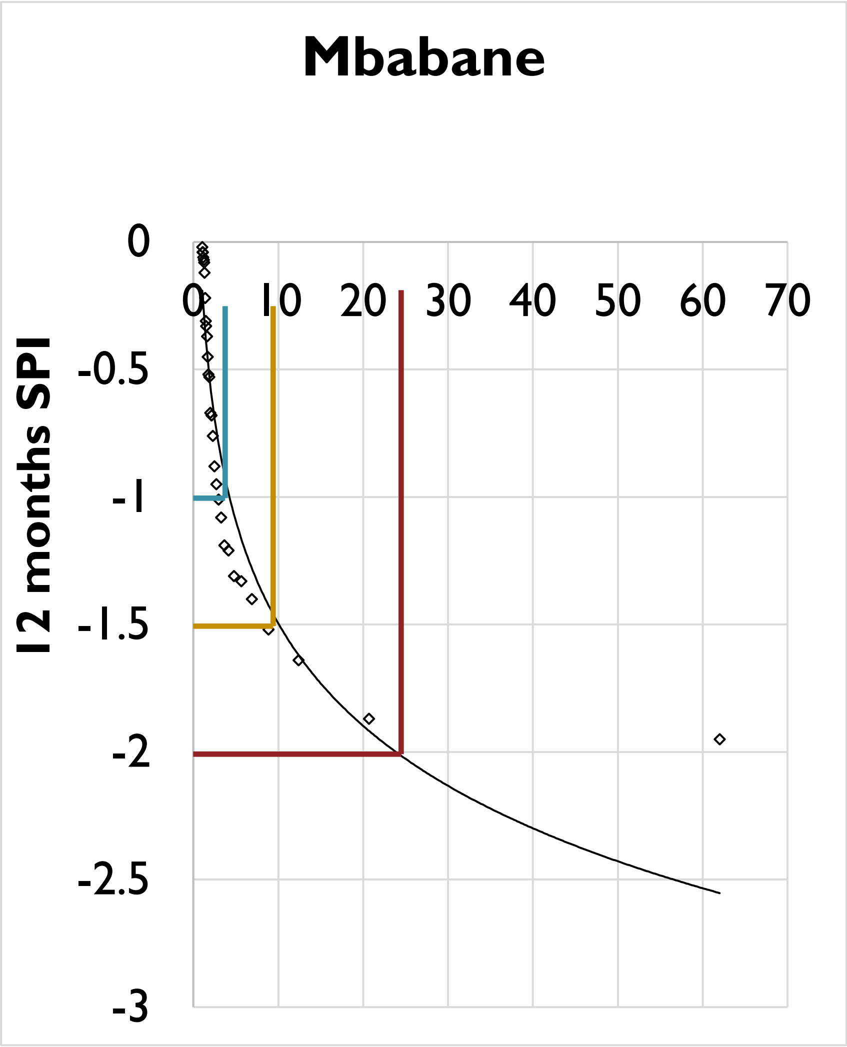
Time in years

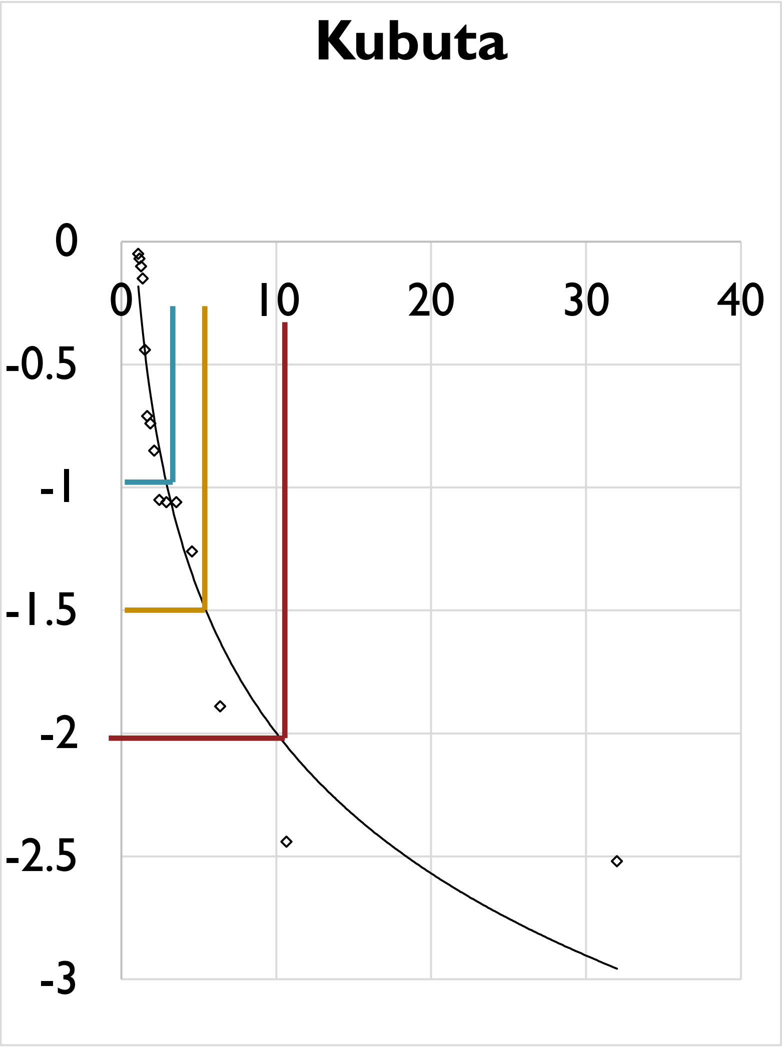
Kubuta



Time in years

Results – Frequency of re-occurrence





Conclusions

- Droughts have increased in prevalence and severity post the year 2000, especially in the dry areas (Lowveld), where (70%) of the droughts occurred during this period.

- The frequency of droughts is higher in the dry areas of the country compared to the high rainfall areas. For instance extreme droughts are expected every 21 years (Highveld), 14 years (Middleveld) and 13 years (Lowveld).

Drought dynamics and Interannual Rainfall Variability on the Ghaap Plateau, South Africa, 1918-2014

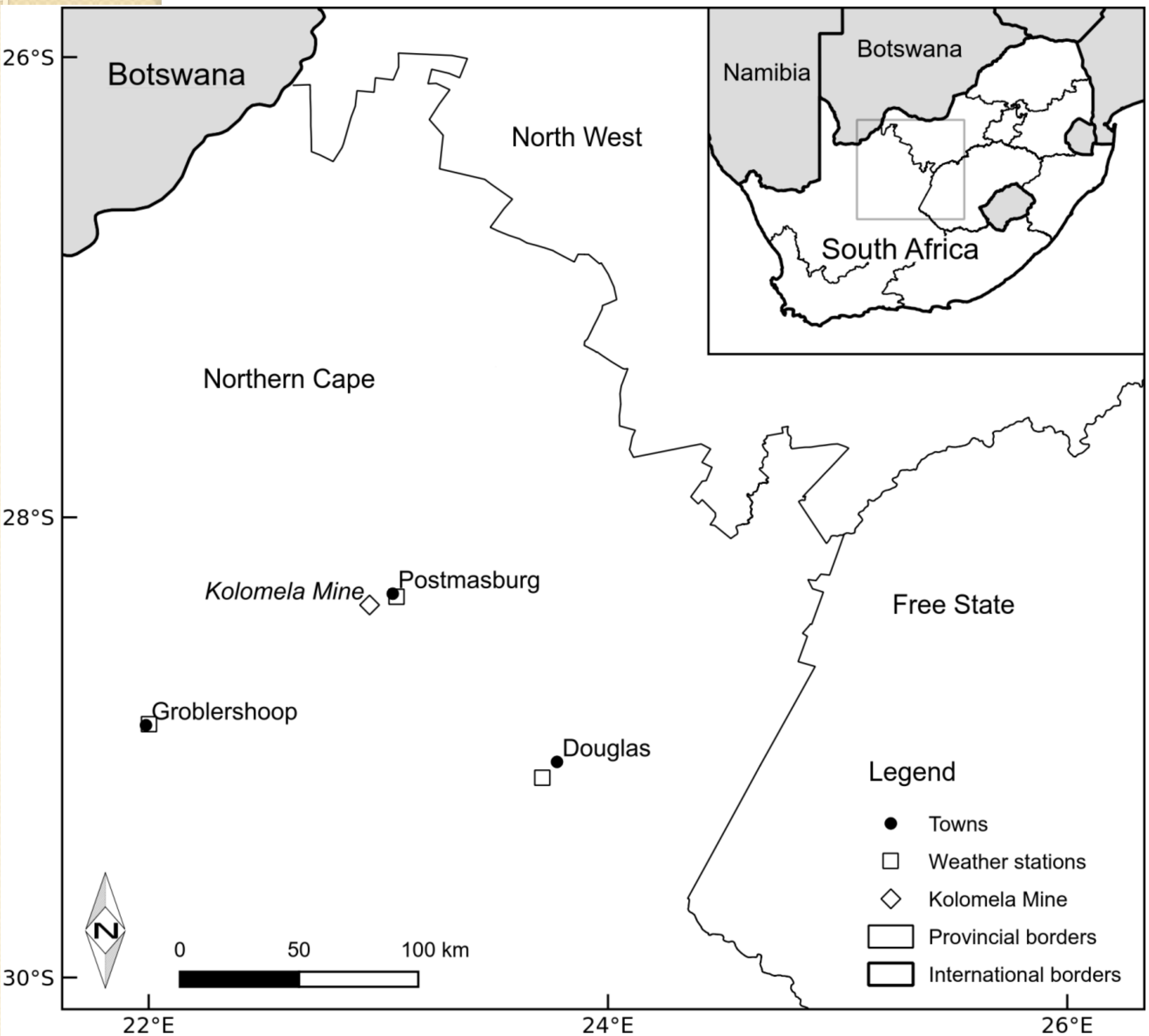
(Physics and Chemistry of the Earth, 2018)

C.M. Tfwala, L.D. van Rensburg, R. Schall and P. Dlamini

Objective

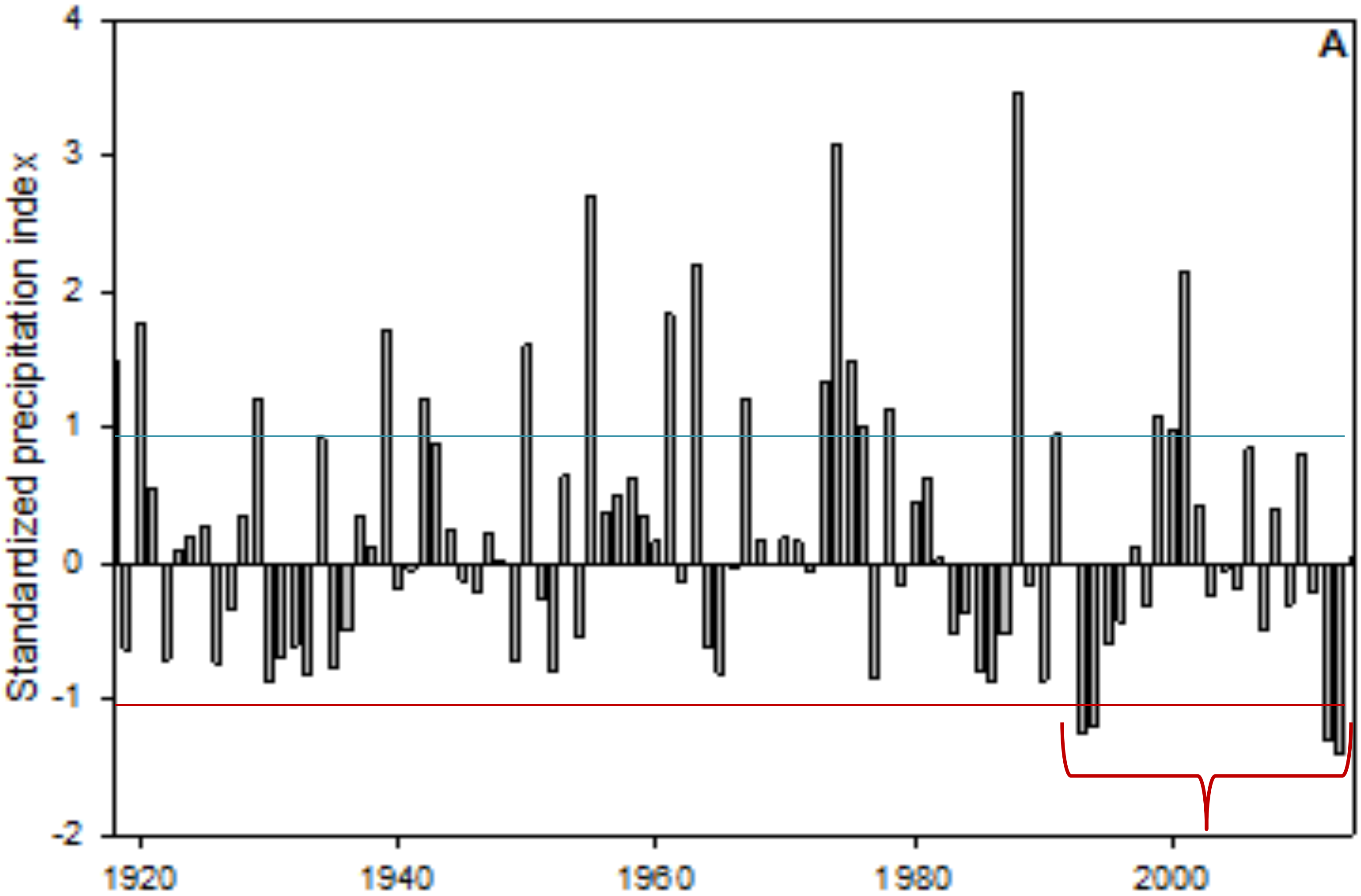
- The objective of this study was to determine the occurrence and severity of droughts in the Ghaap Plateau of South Africa

Methodology

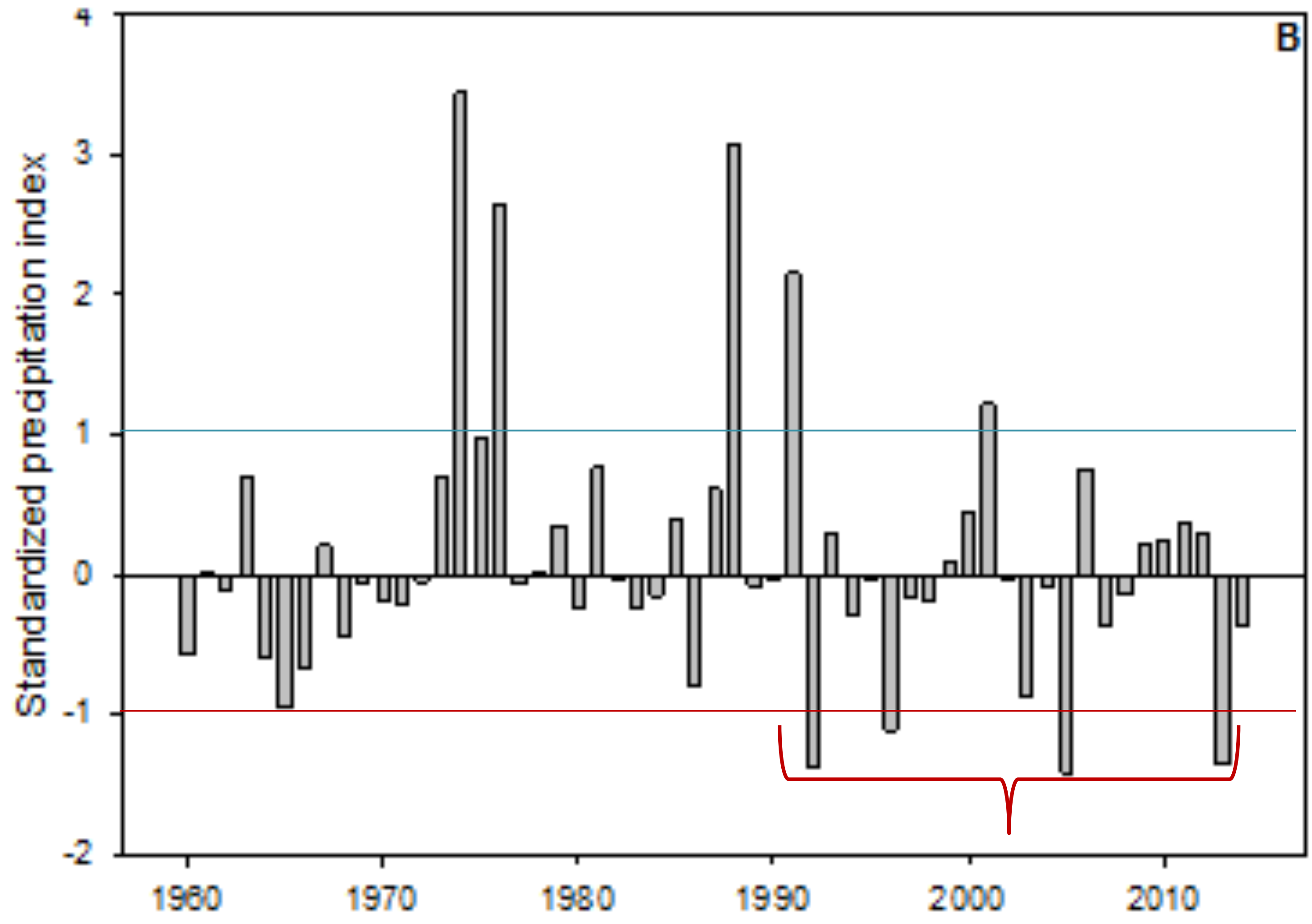


- 3 weather stations
- Representative of the plateau
- Central part of the Northern Cape Province
- **Occurrence & severity of droughts determined using the same SPI as in the 1st study**

SPI - Postmasburg

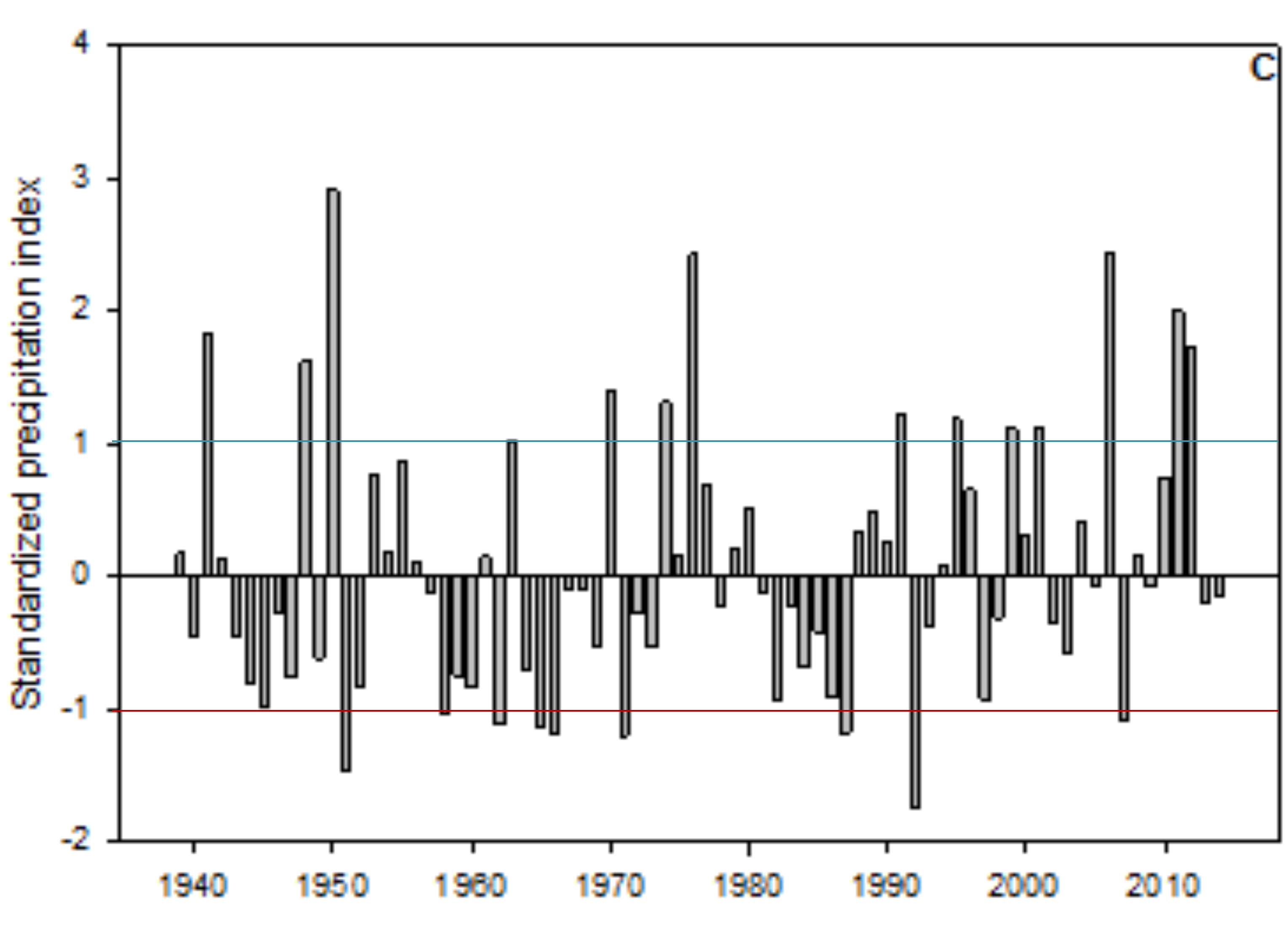


SPI - Douglas



B
Standardized precipitation index
4
3
2
1
0
-1
-2
1960
1970
1980
1990
2000
2010

SPI - Groblershoop



Conclusion

- Droughts have become more prevalent in the plateau post 1990, and a majority of them are moderate

Overall Recommendations for Adaptation

- Storage reservoirs to store water during times of abundance (National Projects and Estate Plantations)
- Continuous improvement on the efficiency of irrigation to improve water productivity
- Intensify on the early warning systems based on weather forecasting
- Crop diversity with particular focus to drought tolerant crops especially for the smallholder farmers on rainfed agric.

THANK YOU

XIE XIE

Taiwan Towards Intelligent City Flood Warning Systems

Li-Chiu Chang

Professor, Department of Water Resources and Environmental Engineering

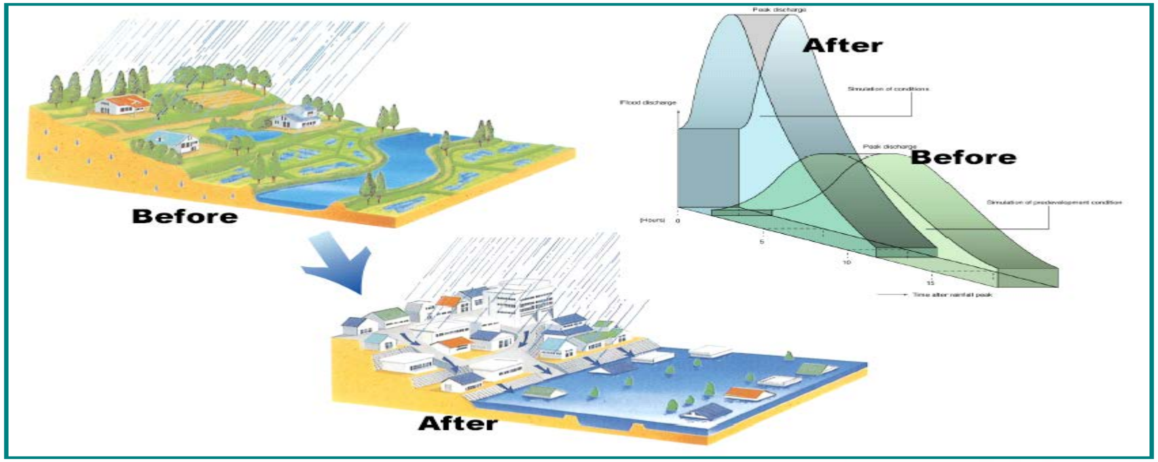
Director, Information Center for Water Environment

Tamkang University

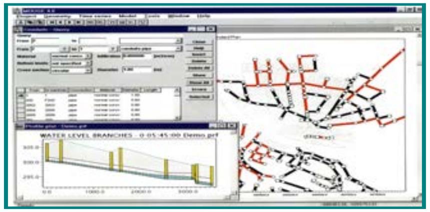
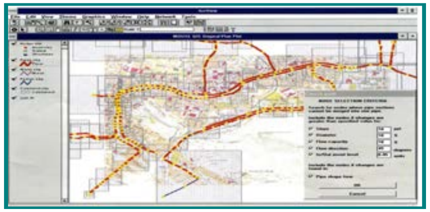
Study Motivation

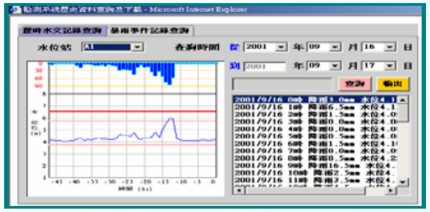
- Floods are among the **most common and deadly natural disasters** in the world.
- Urbanization **reduces the concentration time of rainfall.** Climate change accelerates the hydrological cycle and causes **rapidly rising peak flows.**
- Flood disasters made great impacts on city development. Therefore a flood warning system could be very beneficial to provide updated information for ensuring adequate decisions could be made.
- Urban flood forecast is a crucial task in developed cities. Artificial Intelligence (AI) provides a promising technique for flood forecasting.









The Bottleneck of building AI smart city flood inundation forecasting systems

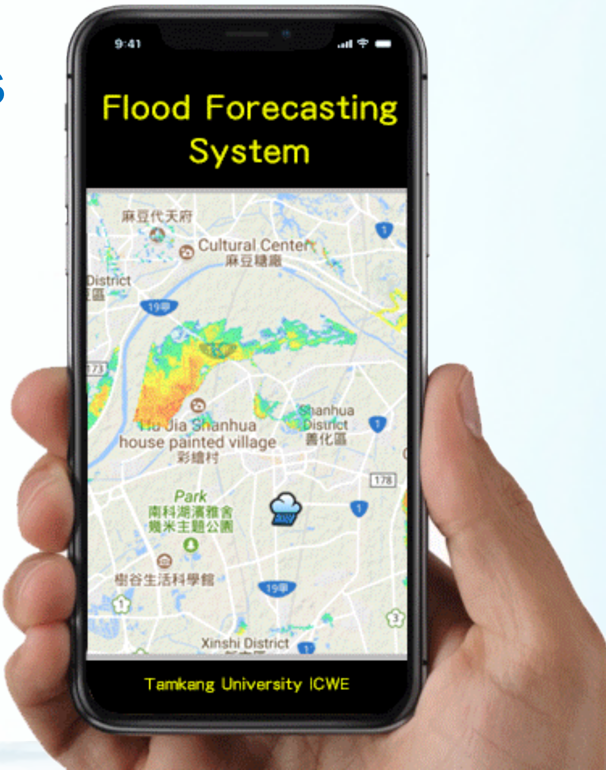
1. The **lack of observed data of historical events** to provide the material for building the ANN models.
   - **Using simulation models to generate a lot of events**
2. Collecting and managing the flood inundation data need the **higher hardware requirements (computation and storage)**.
   - High dimension(more than 100,000 grids)
   - Massive volumes
   - Rapid growth rate of data (one hour or shorter period)
3. The limits of AI in the cloud:
   - Cost
   - Non-present or unstable connection
   - Huge data delivered through internet

Outline

Propose a novel methodology for nowcasting regional flood inundation maps during heavy rain events.

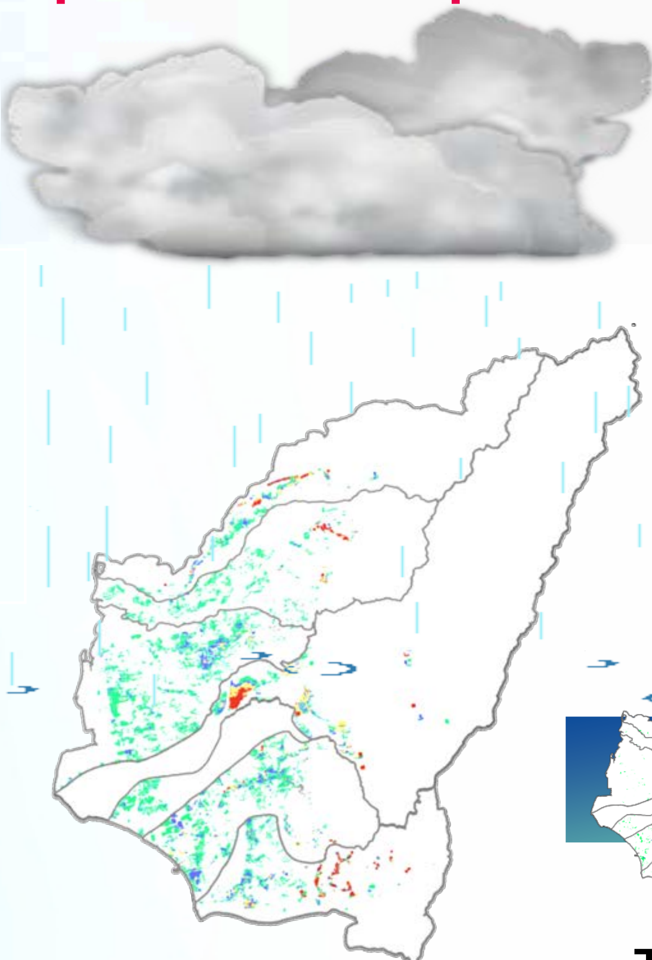
<u>Idea</u>

1. **Form a topology of inundation maps**
2. **Continuously update the selected map according to a forecasted average inundated depth**

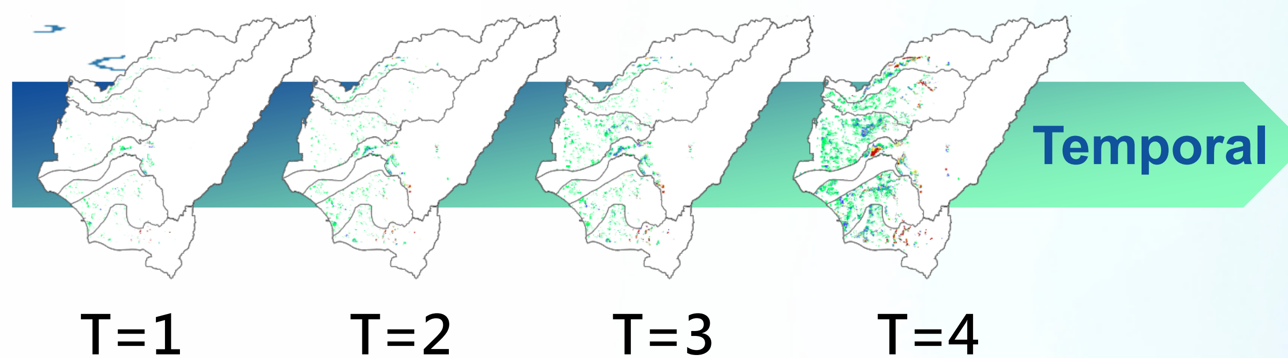


Characteristics of Regional Inundation Maps

- Flood inundation maps have two important characteristics: spatial and temporal distribution

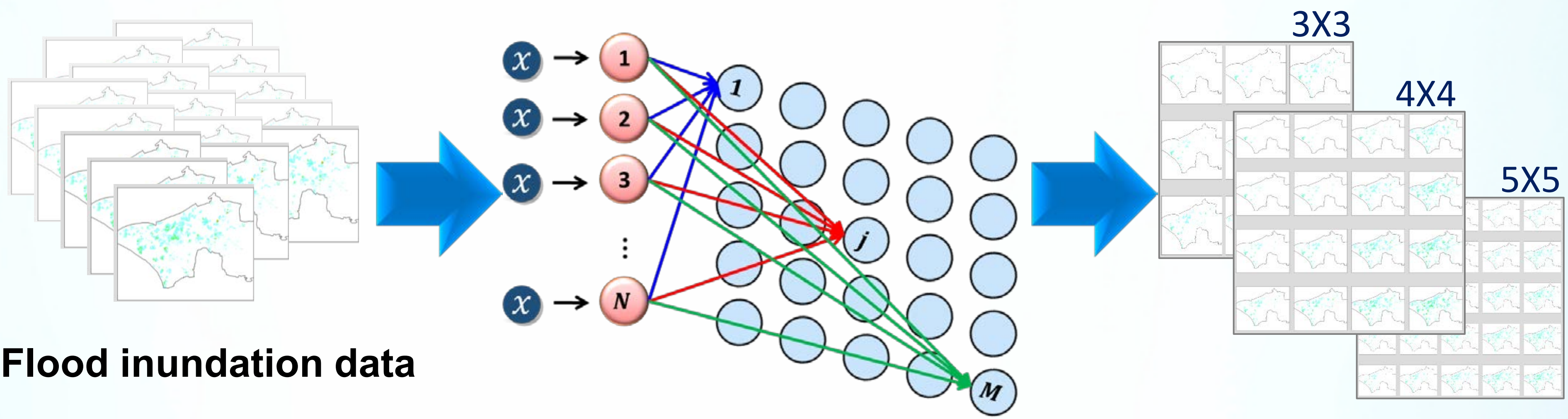


Influence of the spatial rainfall variability



Methodology – Self-Organizing Map (SOM)

- **SOM (to Classify the Spatial Distribution of Regional Flood Maps)**
  - **Input Data**: Flood inundation data
  - **Output Data**: Flood inundation topological map
- **Advantages**
  - To categorize regional inundation maps into a meaningful topological map
  - To classify **high-dimensional** data.
  - To **generate within few seconds** even in a large region



Flood inundation data

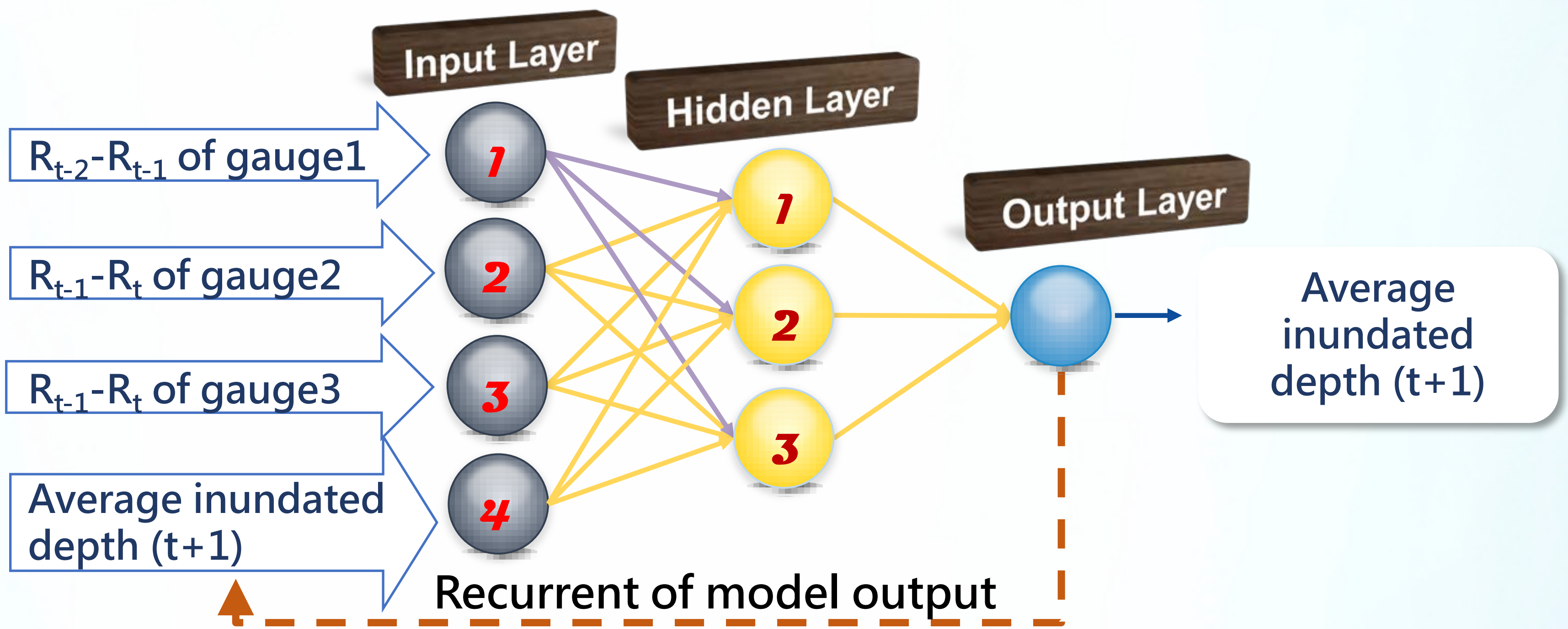
Train SOM model

Flood inundation topological map

Methodology- Recurrent-Nonlinear Autoregressive with exogenous input (R-NARX)

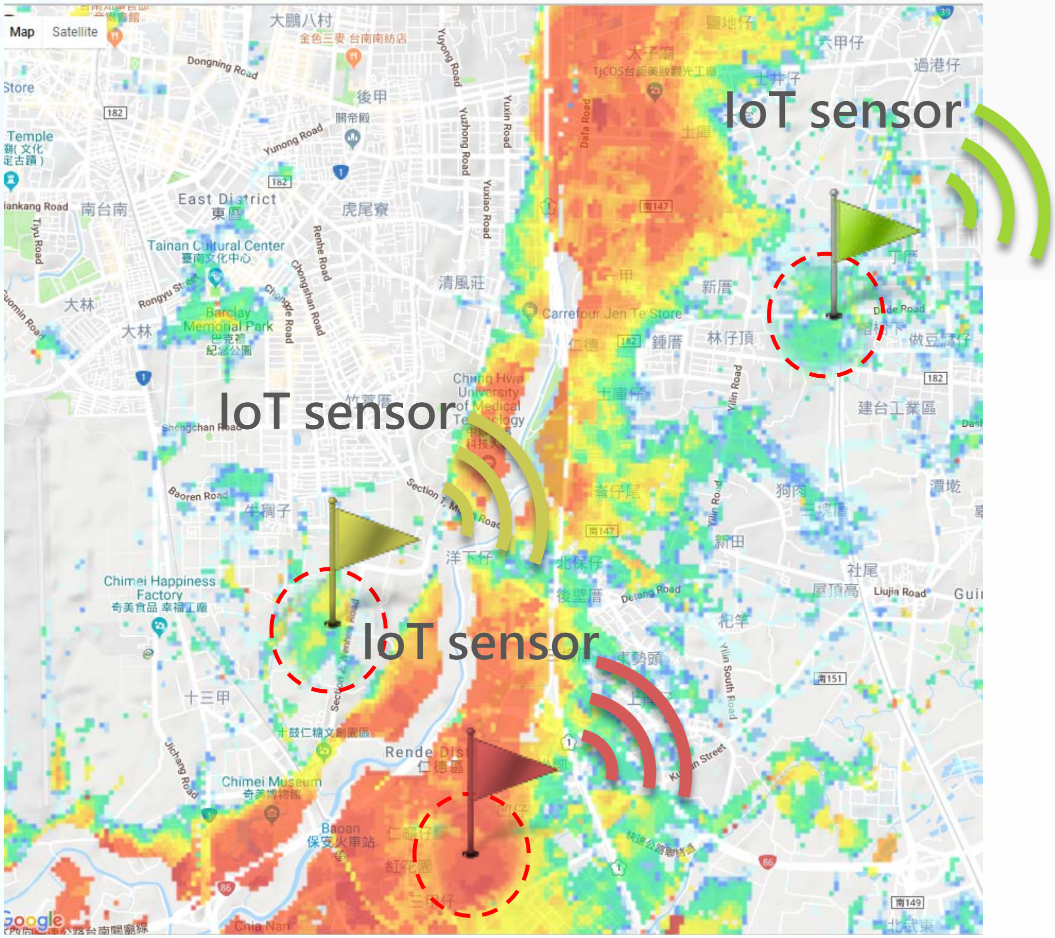
R-NARX (to Forecast Time Series of Regional Flood Maps)

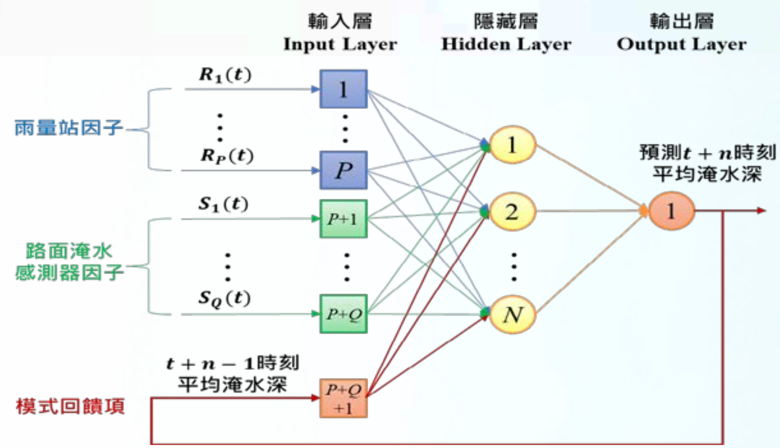
- **Advantages**
  - RNARX is a powerful dynamic model for **time series prediction**
  - The model is an **alternative** way to train and test the networks step-by-step in real time without using real-time observed data



Widespread Installation of IoT inundated sensors

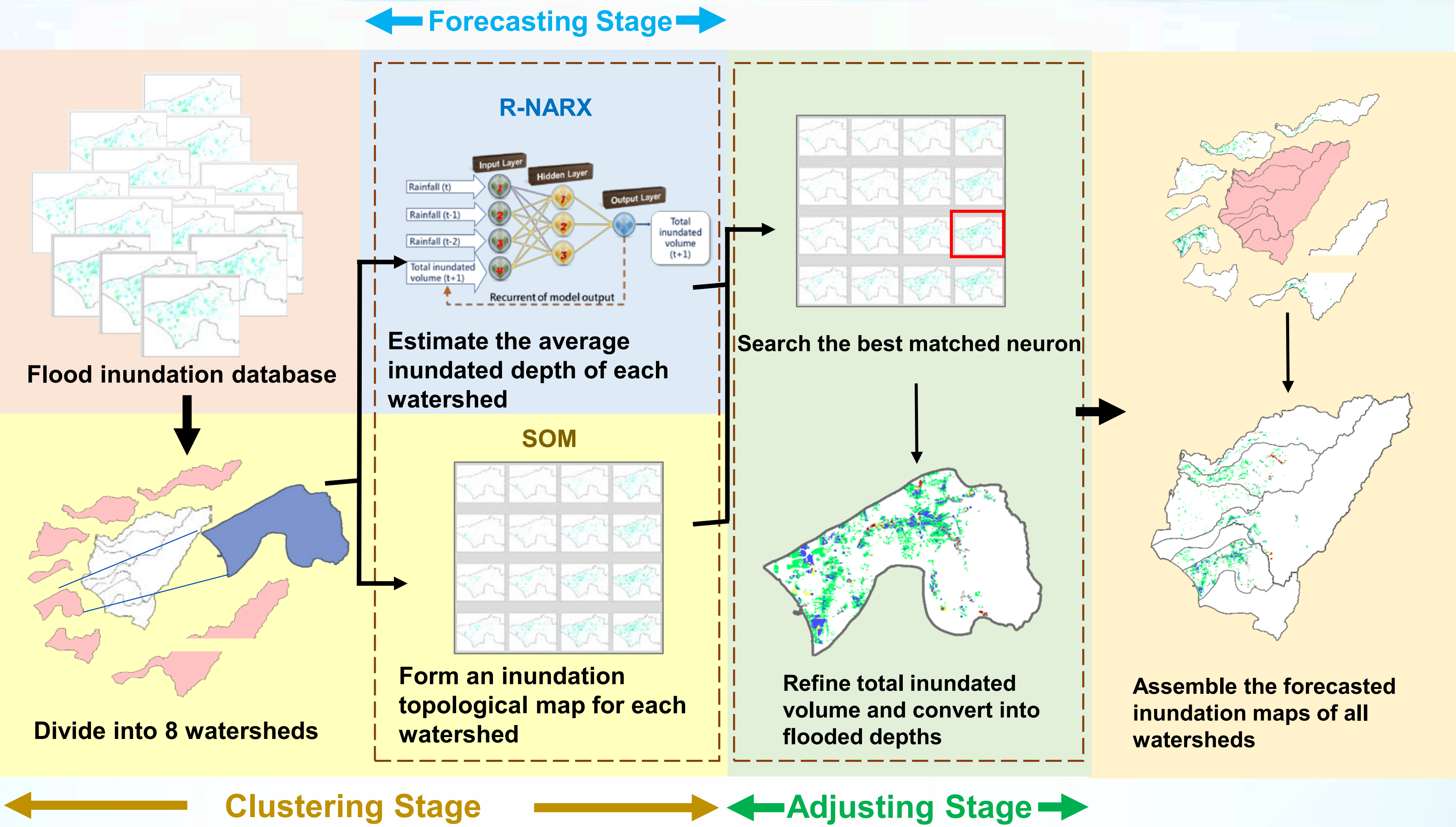
- **IoT sensor data can improve the multi-step forecast accuracy**





Adding IoT sensor data as input factors can improve the model performance

Model Construction

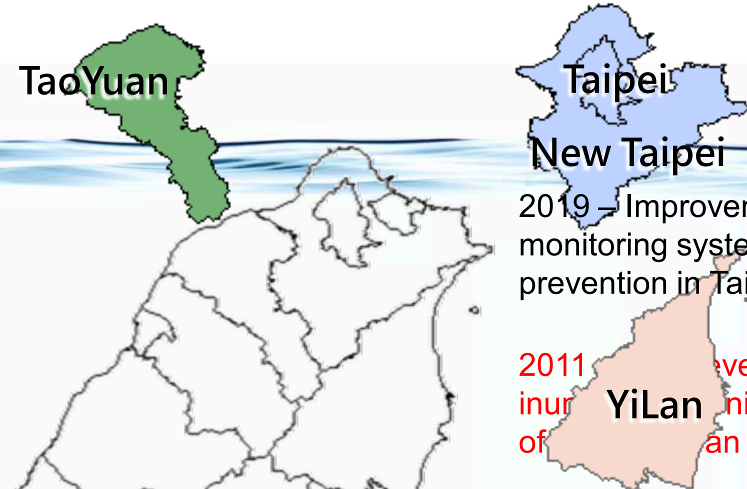


Intelligent City Flood Warning Systems: Demonstration

We proposes a hybrid SOM−RNARX methodology for nowcasting multi-step-ahead regional flood inundation maps during typhoon events.
The proposed models are trained and tested based on a large number of inundation data sets collected in Tainan City, Kaohsiung City, Taipei City, Taoyuan City, Yilan County, Yunlin County, Chiayi City/County, Changhua County, Pingtung County .
We also implemented the proposed system to the Kemamann River of Malaysia.

In these study areas, the synthetic hydrographs of inundation depths are generated by the 2-D flood simulation models. In Taiwan, we used the **SOBEK** to simulate City flood inundation process. In Malaysia, they used **InfoWorks RS** to generate the hydrographs of inundation depths of 8 events and some designed storm events

Implementations

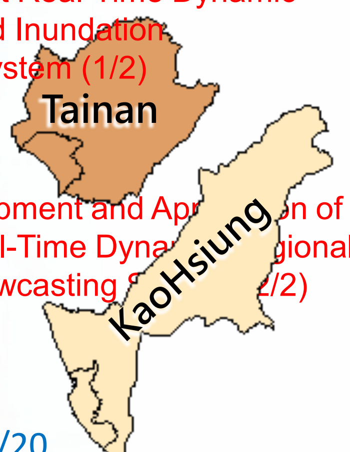


2019 – Improvement of water information monitoring system and disaster prevention in Taipei City

2011 – …evelopment of regional flood inun… …ning system - a study case of … …an

2010 – The development of regional internal flood inundation warning system - a study case of Yilan County

2017 - Development and Application of an Intelligent Real-Time Dynamic Regional Flood Inundation Nowcasting System (1/2)

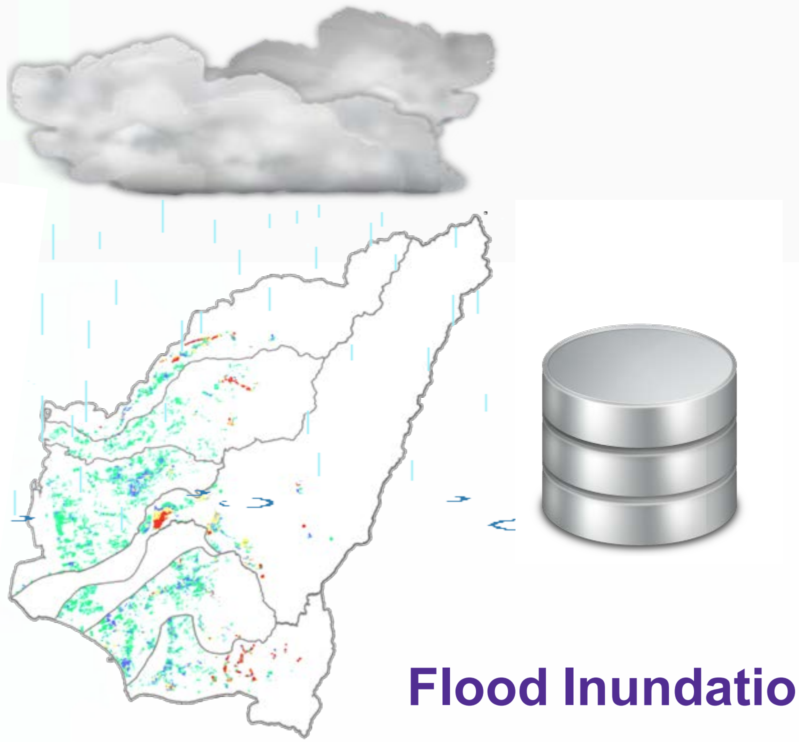


2018 - Development and Ap… …n of an Intelligent Real-Time Dyna… …gional Flood Inundation Nowcasting … …2/2)

Malaysia

Building an Early Flood Warning and Disaster Prevention System by Artificial Intelligence Techniques for Kemaman River Basin

Model Construction

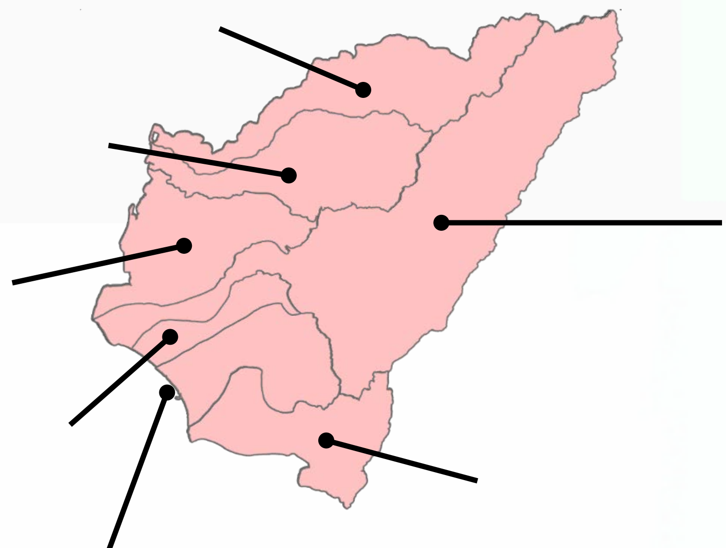


Flood Inundation Database

Regional flood inundation maps

The Intelligent Flood Warning System (IFWS) **automatically detects, adjusts and generates result files and flood maps**

Model Construction

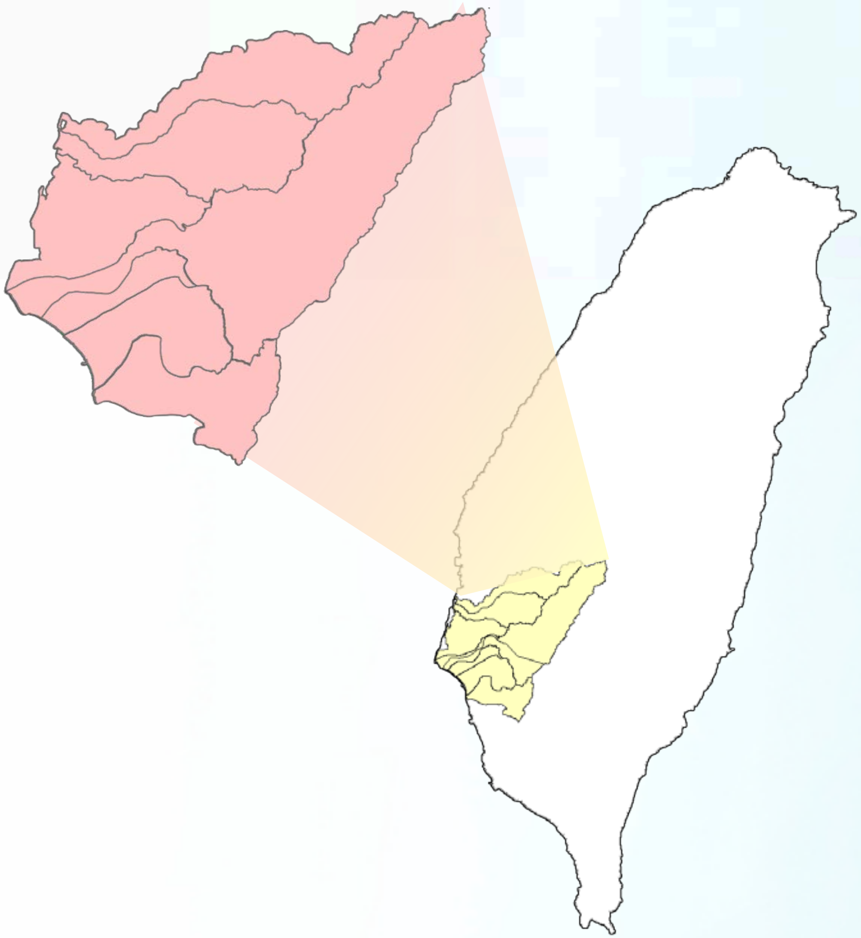


Tainan City contains eights watersheds

Study Area – Case 1

Tainan City, Taiwan

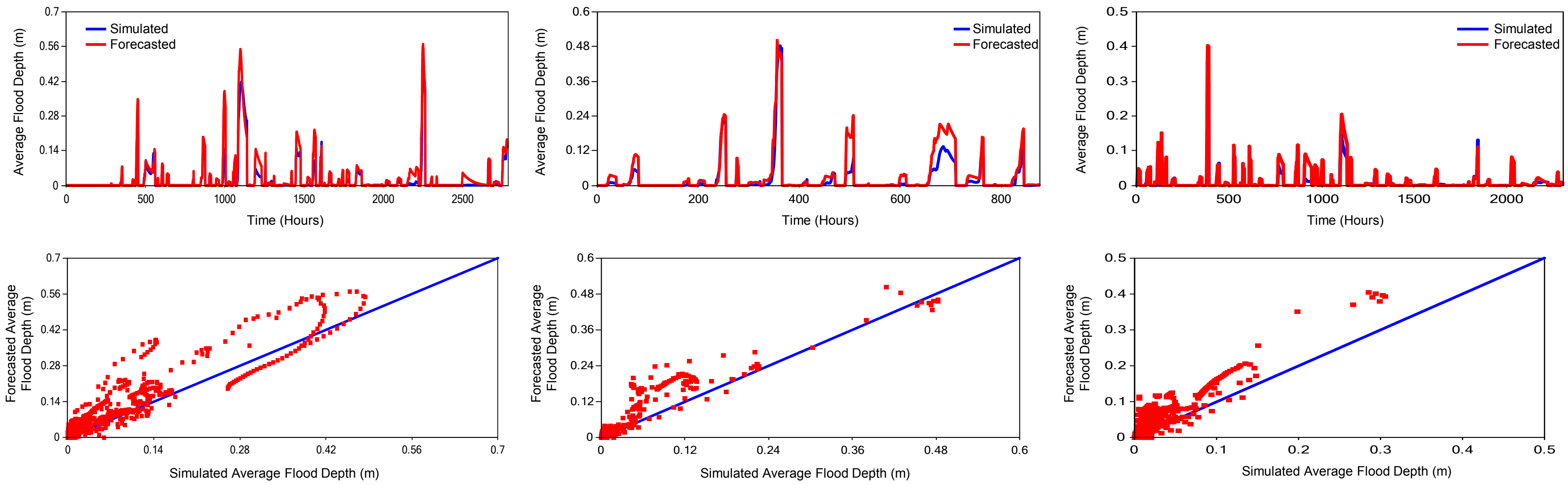
- 8 watersheds
- Inundation-prone region **(665 km^2)**
- A total of **415,380 grids** with a grid resolution of **40 m x 40 m**
- Data
    - **330 designed events** with various return periods



Results – R-NARX

Simulated vs one-hour-ahead forecasted average inundated depths in Luermen Creek Watershed

Training **Validation** **Testing**



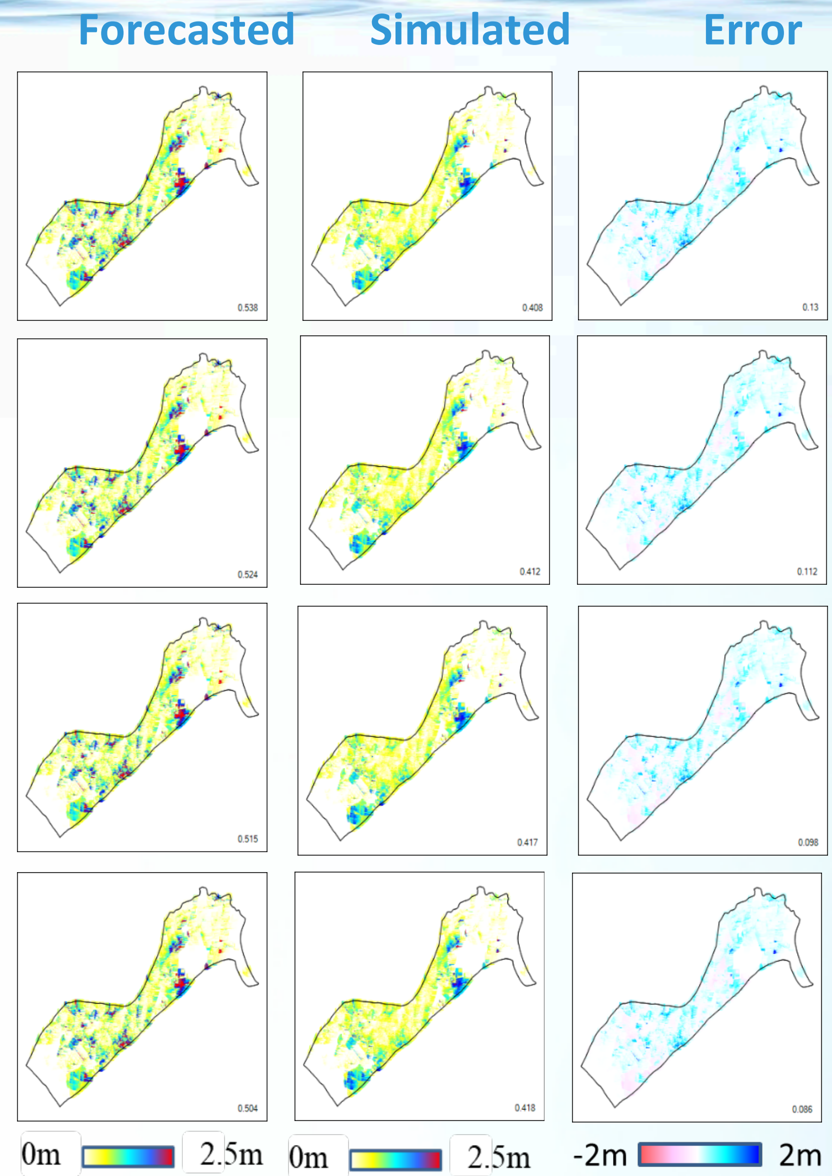
Results – R-NARX

Performance of 1- to 3-h-ahead forecasts of inundation depths in each watershed by the R-NARX models

Watershed	Time step	RMSE			R^2		
		Training	Validation	Testing	Training	Validation	Testing
Bazhang Creek	T+1	0.068	0.113	0.075	0.78	0.89	0.48
	T+2	0.076	0.127	0.077	0.79	0.94	0.44
	T+3	0.075	0.127	0.076	0.77	0.96	0.41
Jishui Creek	T+1	0.018	0.013	0.032	0.96	0.97	0.52
	T+2	0.019	0.017	0.028	0.95	0.97	0.62
	T+3	0.026	0.045	0.024	0.91	0.77	0.74
Chiangchun Creek	T+1	0.019	0.021	0.021	0.98	0.92	0.86
	T+2	0.022	0.02	0.019	0.97	0.92	0.87
	T+3	0.02	0.023	0.023	0.98	0.93	0.86
Luermen Creek	T+1	0.031	0.031	0.018	0.90	0.88	0.85
	T+2	0.031	0.031	0.018	0.90	0.88	0.85
	T+3	0.029	0.031	0.02	0.87	0.87	0.80
Yenshui Creek	T+1	0.021	0.017	0.013	0.92	0.89	0.91
	T+2	0.017	0.015	0.01	0.90	0.87	0.86
	T+3	0.024	0.02	0.014	0.87	0.82	0.90
Erren Creek	T+1	0.019	0.022	0.007	0.89	0.90	0.96
	T+2	0.022	0.022	0.009	0.85	0.83	0.93
	T+3	0.026	0.025	0.014	0.80	0.70	0.84
North Tsengwen Creek	T+1	0.033	0.023	0.024	0.85	0.74	0.79
	T+2	0.038	0.024	0.029	0.84	0.71	0.69
	T+3	0.038	0.023	0.032	0.82	0.73	0.62
South Tsengwen Creek	T+1	0.026	0.021	0.029	0.92	0.85	0.88
	T+2	0.027	0.019	0.034	0.90	0.86	0.84
	T+3	0.031	0.02	0.042	0.87	0.87	0.77

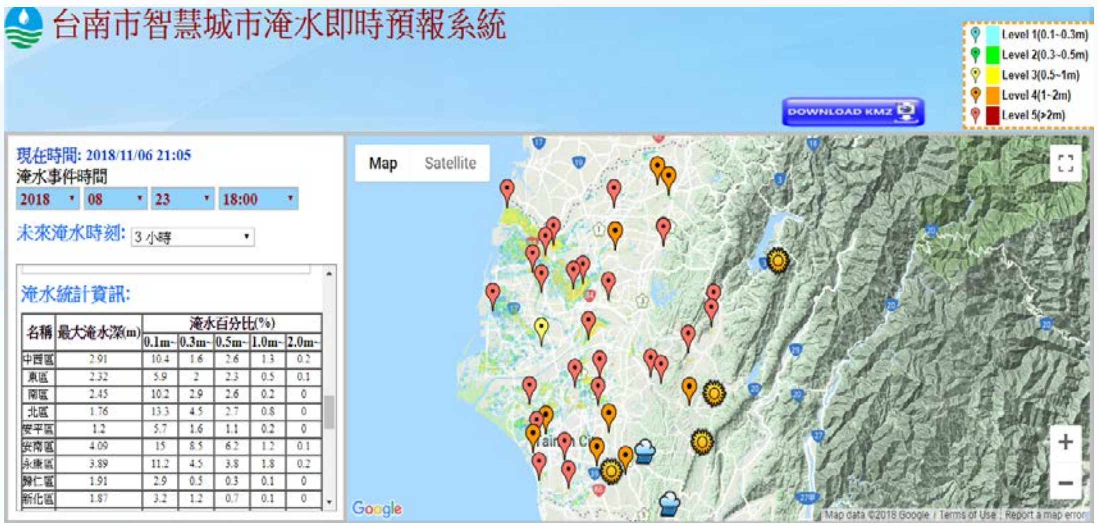
Results – SOM-R-NARX

T =33	ALL		各淹水級距					
			0m-0.1m	0.1m-0.5m	0.5m-1.0m	1.0m-1.5m	1.5m-2.5m	>2.5m
#of grids	41483		14454	13401	8654	3654	1283	37
index	RMSE	R^2	RMSE	RMSE	RMSE	RMSE	RMSE	RMSE
T+1	0.35	0.83	0.13	0.18	0.37	0.65	1.06	1.79
T+2	0.35	0.83	0.13	0.18	0.37	0.65	1.06	1.79
T+3	0.3	0.83	0.12	0.16	0.32	0.56	0.91	1.55
T =34								
#of grids	41483		14437	13283	8693	3663	1371	36
index	RMSE	R^2	RMSE	RMSE	RMSE	RMSE	RMSE	RMSE
T+1	0.34	0.83	0.12	0.17	0.37	0.63	1.01	1.75
T+2	0.34	0.83	0.12	0.17	0.37	0.63	1.01	1.75
T+3	0.29	0.83	0.11	0.15	0.32	0.54	0.85	1.49
T=35								
#of grids	41483		14326	13255	8700	3704	1462	36
index	RMSE	R^2	RMSE	RMSE	RMSE	RMSE	RMSE	RMSE
T+1	0.33	0.82	0.11	0.16	0.36	0.6	0.95	1.7
T+2	0.33	0.82	0.11	0.16	0.36	0.6	0.95	1.7
T+3	0.28	0.82	0.1	0.15	0.31	0.52	0.81	1.46
T=36								
#of grids	41483		14506	13063	8620	3714	1546	34
index	RMSE	R^2	RMSE	RMSE	RMSE	RMSE	RMSE	RMSE
T+1	0.32	0.81	0.11	0.16	0.36	0.59	0.91	1.65
T+2	0.32	0.81	0.11	0.16	0.36	0.59	0.91	1.65
T+3	0.27	0.81	0.1	0.15	0.3	0.5	0.76	1.37



Results Real-Time On-line Forecasting on Aug 23, 2018

Aug 23 6PM forecasts 3h-ahead (Aug 23 9PM)



AI forecasted / Report from residents	Flood	No Flood
Flood	29 **97%**	1
No Flood	4	3

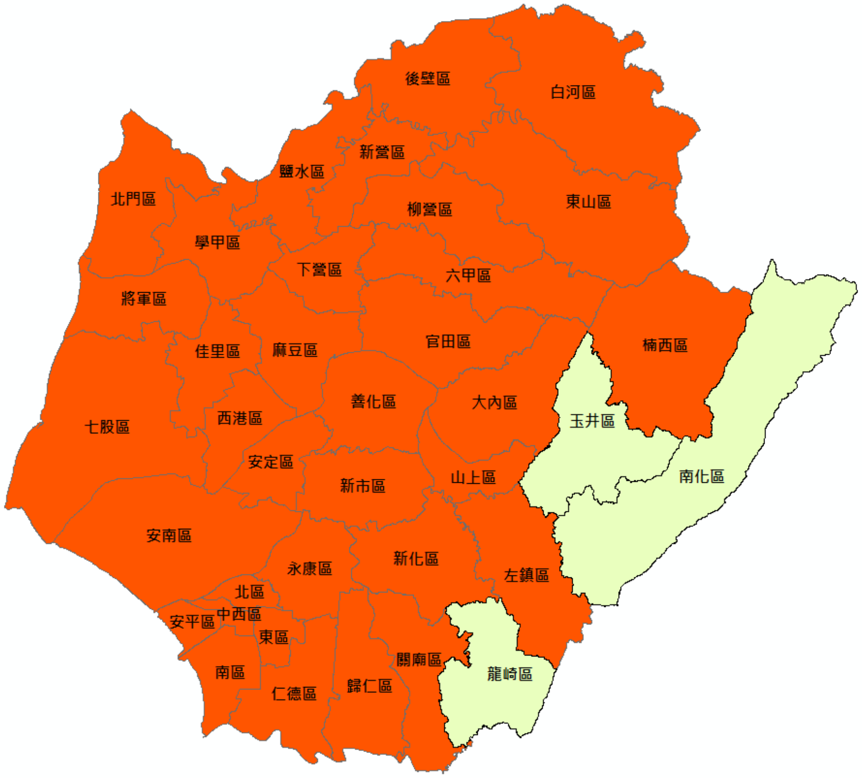
名稱	最大淹水深	淹水百分比(%)					
		0.1m~	0.3m~	0.5m~	1m~	2m~	累計
中西區	2.91	10.4	1.6	2.6	1.3	0.2	16.1
東區	2.32	5.9	2	2.3	0.5	0.1	10.8
南區	2.45	10.2	2.9	2.6	0.2	0	15.9
北區	1.76	13.3	4.5	2.7	0.8	0	21.3
安平區	1.2	5.7	1.6	1.1	0.2	0	8.6
安南區	4.09	15	8.5	6.2	1.2	0.1	31
永康區	3.89	11.2	4.5	3.8	1.8	0.2	21.5
歸仁區	1.91	2.9	0.5	0.3	0.1	0	3.8
新化區	1.87	3.2	1.2	0.7	0.1	0	5.2
左鎮區	2.37	1.8	0.5	0.4	0.1	0	2.8
玉井區	3.33	0.2	0.1	0	0.4	0	0.7
楠西區	5.02	0.5	0.2	0.2	0.2	0.1	1.2
南化區	1.21	0.1	0	0	0	0	0.1
仁德區	3.3	15.1	4.5	3.6	0.7	0.1	24
關廟區	1.82	0.8	0.2	0.1	0	0	1.1
龍崎區	0	0	0	0	0	0	0
官田區	3.19	1.7	0.9	1.2	0.4	0	4.2
麻豆區	3.85	14.5	7.9	9	3.8	0.3	35.5
佳里區	3.05	15	4.2	2.5	0.4	0	22.1
西港區	0.92	10	2.2	0.2	[illegible]	0	12.4
七股區	3.93	24.4	7.6	4.8	0.3	0.1	37.7
將軍區	4.14	[illegible]	7.2	[illegible]	0.3	0.2	32.8
學甲區	[illegible]	[illegible]	15.6	12.9	[illegible]	0.5	61.3
北門區	3.61	24.9	18.2	21.6	[illegible]	0.3	69
新營區	2.27	5.6	0.5	0.2	[illegible]	0	6.3
後壁區	1.66	8	1.7	0.5	0	0	10.2
白河區	1.49	0.9	0.2	0.2	0	0	1.3
東山區	2.85	1	0.5	0.4	0	0	1.9
六甲區	1.17	1.3	0.3	0.2	0	0	1.8
下營區	3.39	25.6	9	8.5	2	0.1	45.2
柳營區	2.23	3.3	1	0.8	0.1	0	5.2
鹽水區	4.98	14	4.4	4.6	1.7	0.2	24.9
善化區	2.59	7.1	3.2	4.9	1.6	0	16.8
大內區	2.24	1.3	0.2	0.2	0.2	0	1.9
山上區	4.36	2.8	1.3	2.7	0.2	0.1	7.1
新市區	3.94	13.8	6.4	6.2	2.1	0.3	28.8
安定區	2.25	20.8	9.5	4.9	0.5	0	35.7

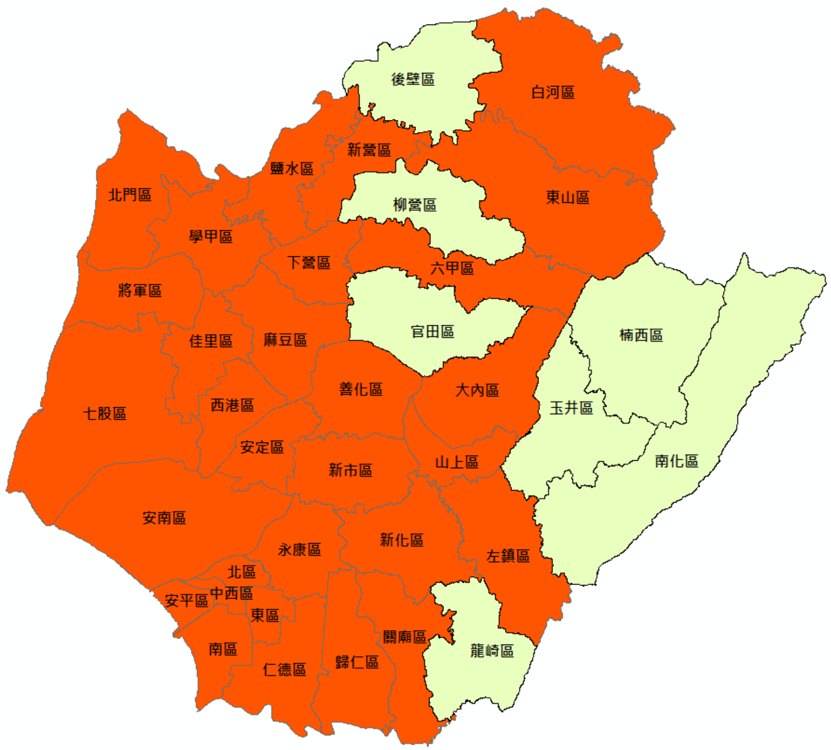
WELL FORECAST!

Results

Real-Time On-line Forecasting on Aug 23, 2018

Flood No Flood





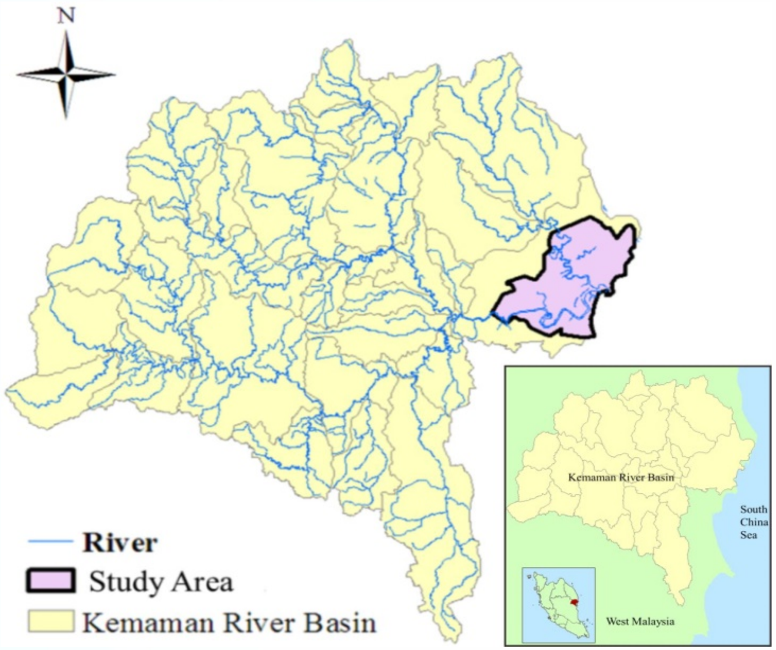
AI forecasts 3h-ahead (Aug 23 9PM) flooded area on Aug 23 6PM forecasts

Report from residents on Aug 23 9PM

Study Area – Case 2

Kemaman Basin, Malaysia

- Malaysia is situated in Southeast Asia. The annual precipitation ranges from 2,000 mm to 4,000 mm with the temperature ranging from 26°C to 32°C .
- Kemaman basin, located on the east coast of the West Malaysia, is one of the most frequent and serious flood regions in Malaysia.



Study Area – Case 2

Data Description

Runoff gauging stations

Station No.	Year Open
4131453	Apr-73
4232401	Dec-85
4332401	May-86

Rainfall gauging stations

Station no.	Duration ofdaily data
4131001	1/1/1986-9/9/2015
4232002	1/1/1986-9/9/2015
4232104	1/1/2003-9/9/2015
4234109	29/6/1970-9/9/2015
4332001	1/1/1986-9/9/2015
4333001	3/1/2003-9/9/2015
4333096	15/2/2006-9/9/2015
4231103	28/6/1970-9/9/2015
4232001	2/1/2003-9/9/2015
3933001	1/1/1986-9/9/2015

Study Area – Case 2

Events used for Hydrodynamic Modelling (Real Events, 11,026 grids)

Event	Beginning	Ending	Duration (hr)	Maximum Flow(m^3/s)			Accumulated Average Rainfall (mm)	Maximum Average Inundation Depth(m)
				St. 4131453	St. 4232401	St. 4332401		
1	2001/12/20, 05:00AM	2001/12/27, 09:00 AM	172	731	814	84	453	1.70
2	2003/12/05, 12:00PM	2003/12/12, 09:00 AM	165	554	433	183	396	1.67
3	2006/12/20, 02:15AM	2006/12/26, 08:30 AM	150	534	207	87	268	1.48
4	2008/12/31, 19:30AM	2009/01/08, 07:30 AM	180	478	487	96	390	1.74
5	2012/01/10, 07:15 AM	2012/01/17, 04:00 PM	177	453	506	39	255	1.70
6	2012/12/13, 12:15 AM	2013/01/13, 00:00 AM	744	509	920	75	973	3.28
7	2013/11/28, 09:30 PM	2013/12/06, 09:30 PM	192	745	1142	63	996	4.17
8	2014/12/13, 12:00PM	2015/01/01, 04:00 PM	460	634	801	57	1653	3.35

Model Construction

R-NRAX models' inputs settings to forecast the average inundated depths (AID)

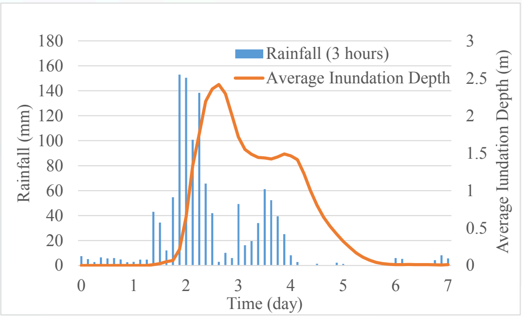
Forecasting Time-step	Sg. Kemaman Average Rainfall	Sg. Cherul Average Rainfall	Flood Depth
T+1	T-2	T-2	-
T+2	T-1	T-1	-
T+3	T	T	-
T+4	T	T	T+3 (forecast)

Dataset	Model (Real Events)	Model (Designed Events)	
		Return period (year)	Accumulated rainfall in hours
Training	Event 3 Event 5 Event 6 Event 7	100 50 20 50 20 100	12 24 48 48 72 72
Validation	Event 2 Event 4	20 20 100	12 24 48
Testing	Event 8	50 100 50	12 24 72

Model Construction

8 Events for modelling rainfall and average inundated depths (AID)

1



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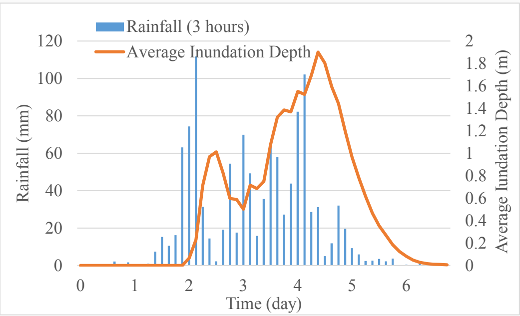

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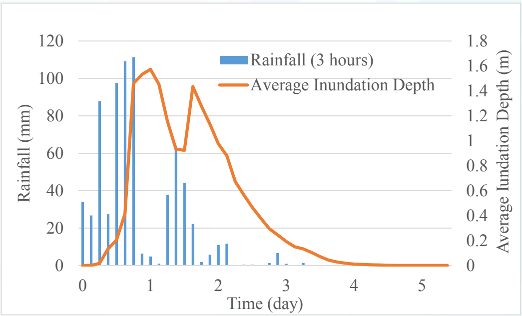

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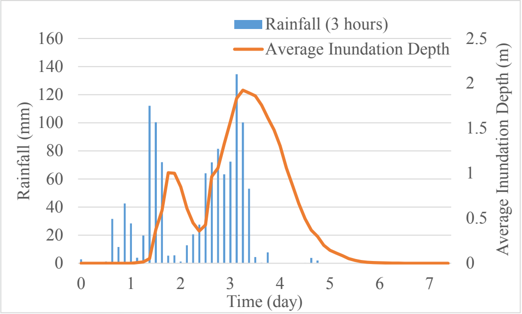

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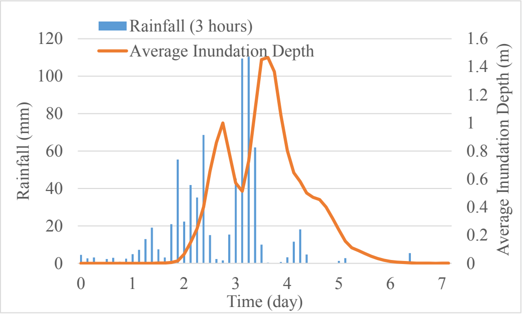

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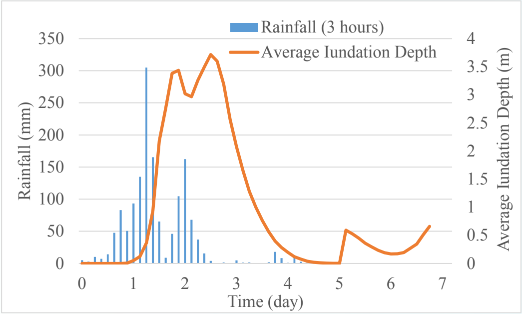

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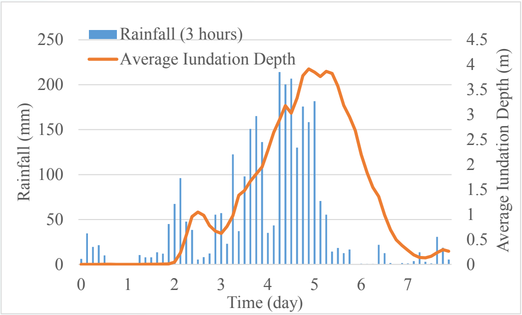

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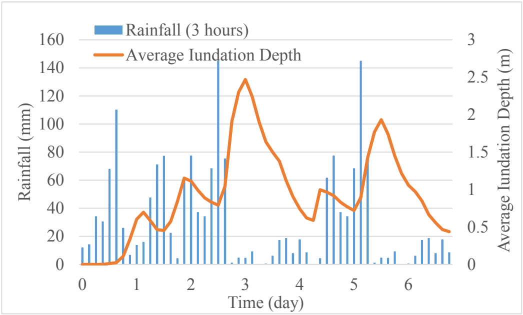
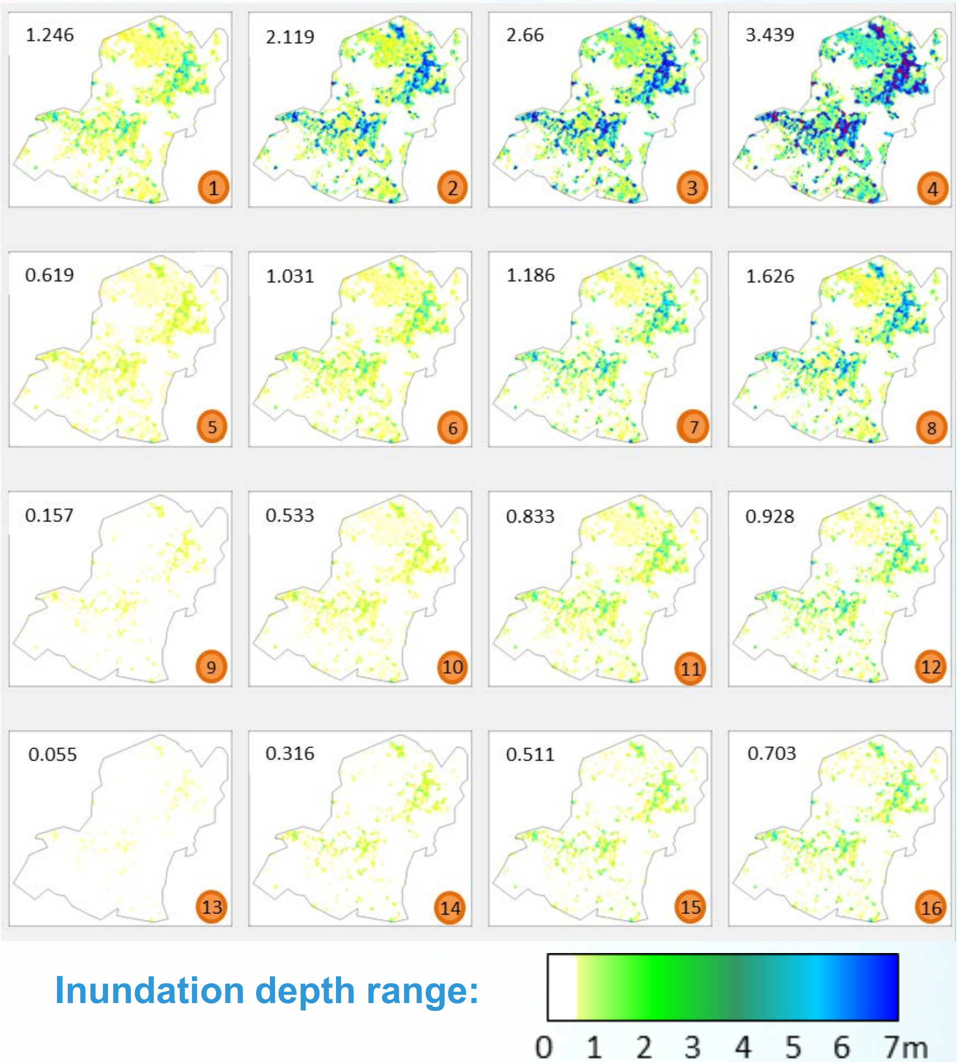


Results

Clustering results of SOM

- There are 365 data sets (regional inundation depths - 10,774 grids) classified into the 16 neurons in the training phase.
- The 4 × 4 network is used for producing the clustering topology (from most serious AID-3.439 in #4 neuron to lightest AID-0.055 in #13 neuron.
- Each neuron contains 10,774 grids' inundated depths (map of 100km^2).



Topology of 4x4 clustering maps

Results

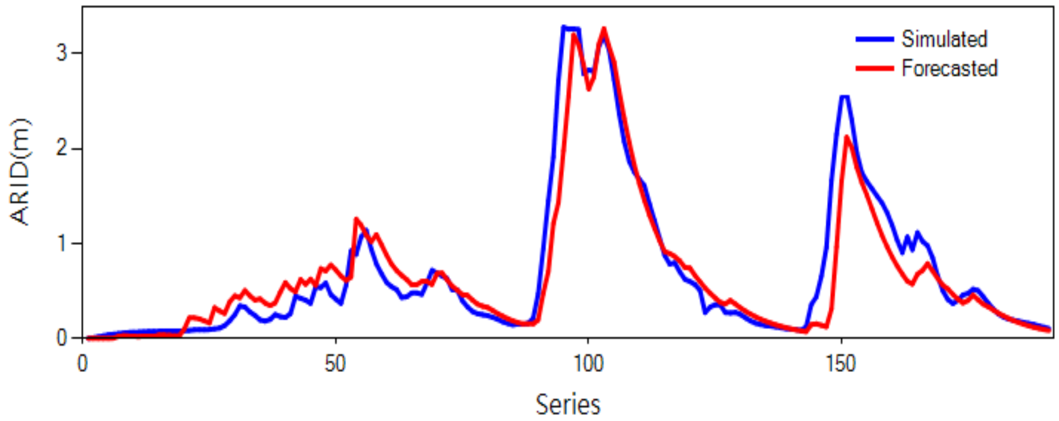
Performance of 3- to 12-h-ahead forecasting of the average inundation depths by using the R-NARX networks

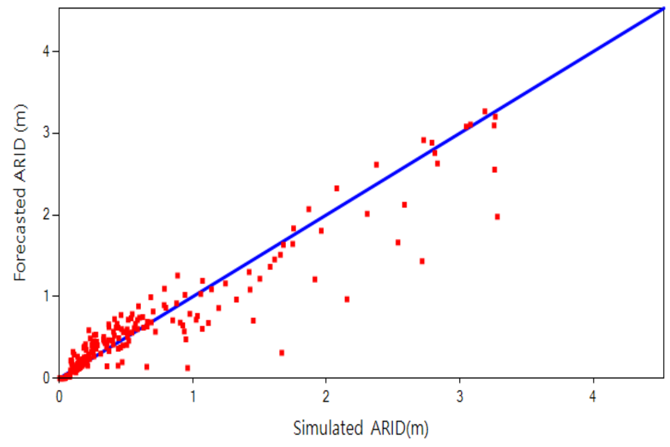
Forecasting Time-step	RMSE(m)			R^2		
	training	validation	testing	training	validation	testing
3h ahead	0.36	0.45	0.36	0.92	0.90	0.90
6h ahead	0.35	0.45	0.35	0.92	0.90	0.90
9h ahead	0.36	0.46	0.36	0.92	0.90	0.90
12h ahead	0.41	0.52	0.40	0.90	0.87	0.88
Linear Modification						
3h ahead	0.28	0.30	0.34	0.92	0.90	0.90
6h ahead	0.28	0.30	0.34	0.92	0.90	0.90
9h ahead	0.29	0.30	0.33	0.91	0.90	0.90
12h ahead	0.31	0.34	0.35	0.90	0.87	0.89

Results

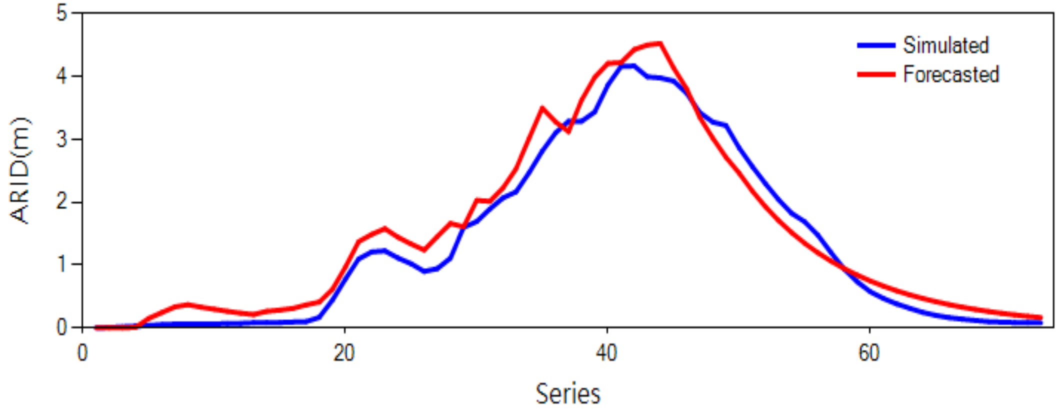
R-NARX Forecasting 3-h ahead for AID
Training Events 6,7

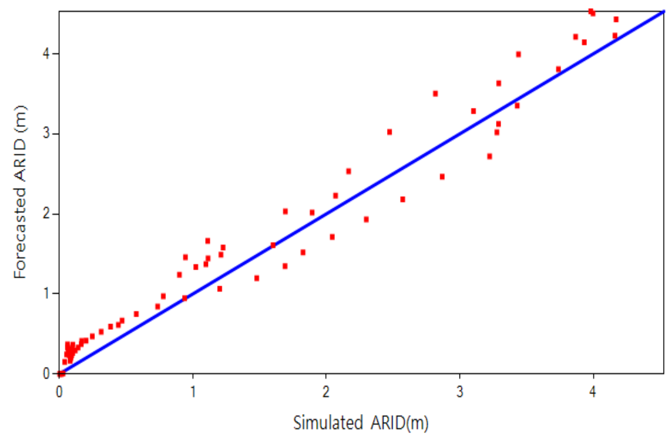
Event 6





Event 7

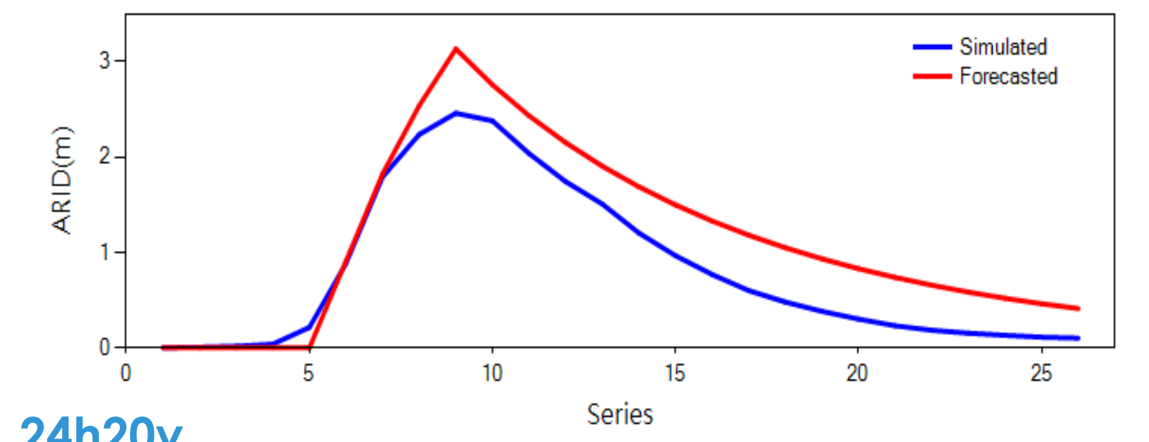


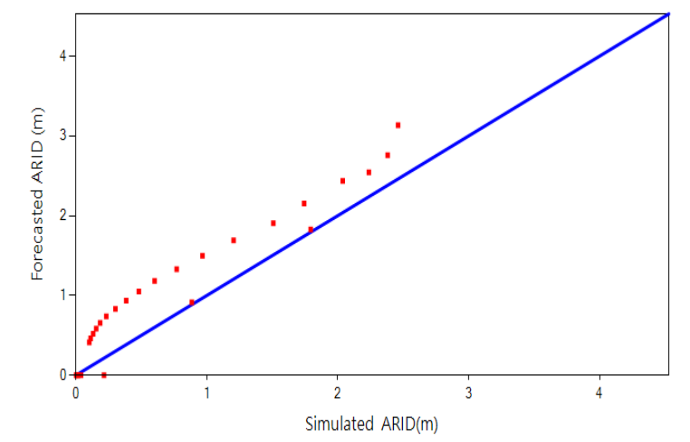


Results

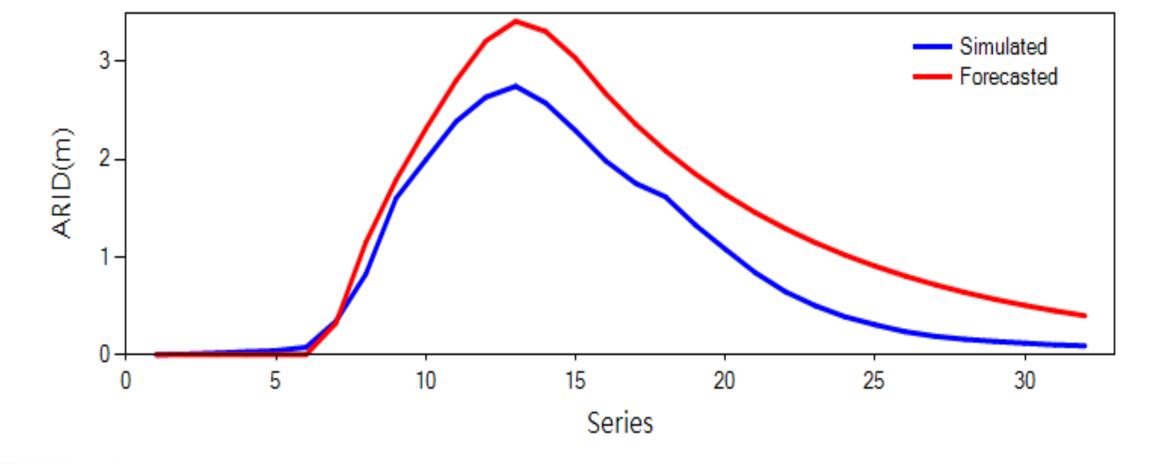
R-NARX Forecasting 3-h ahead for AID Validation Events 12h20y & 24h20y

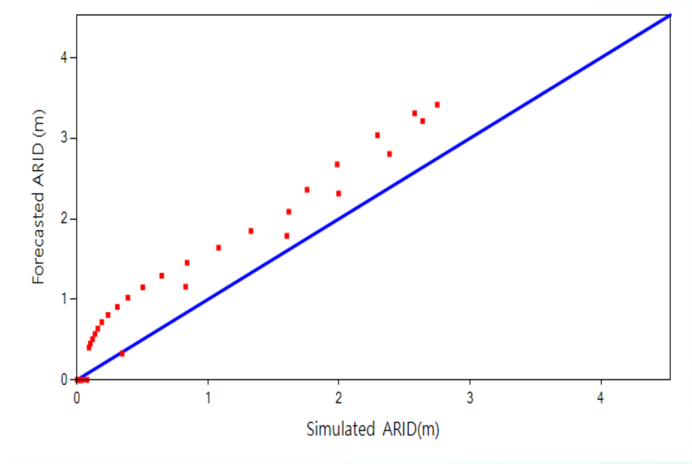
12h20y





24h20y

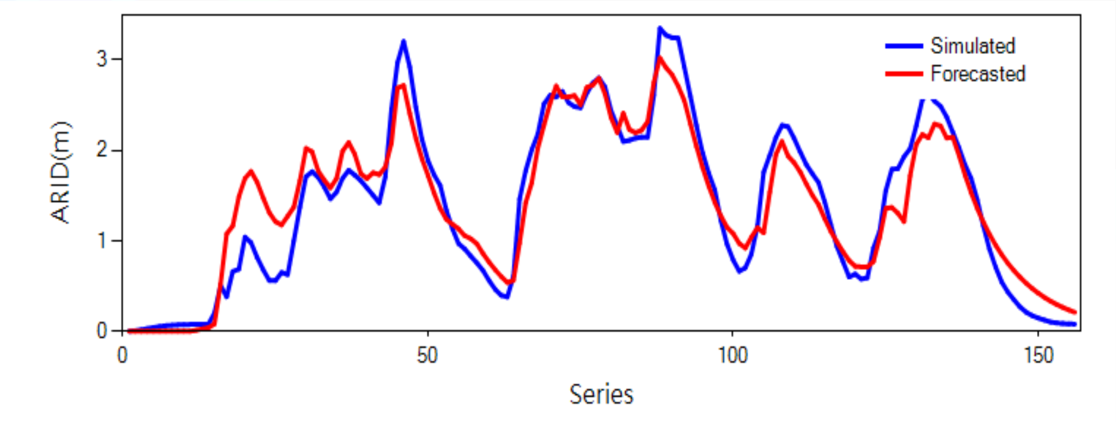


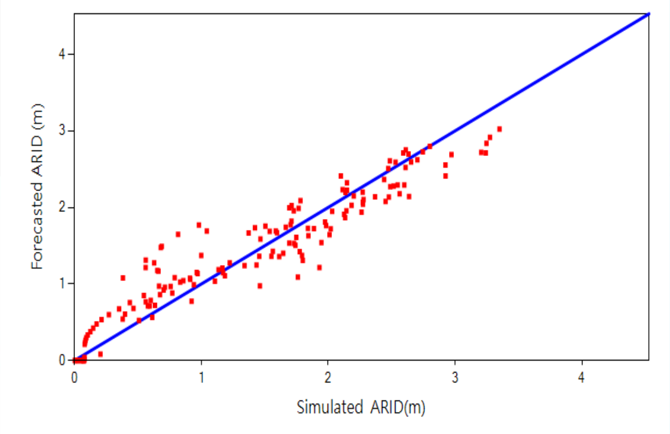


Results

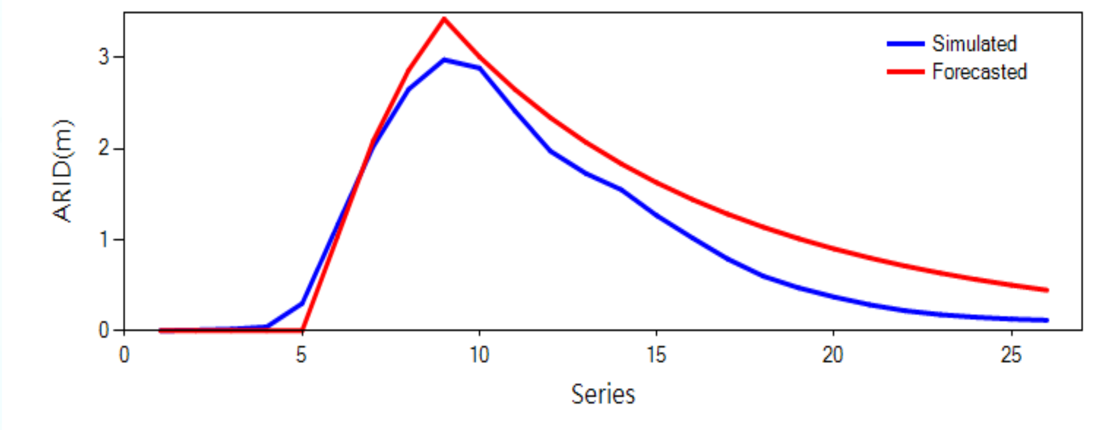
R-NARX Forecasting 3-h ahead for AID Testing Events Event 8 & 12h50y

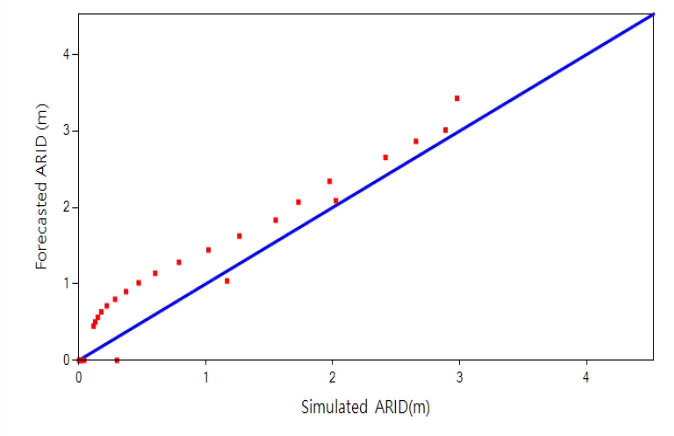
Event 8





12h50y



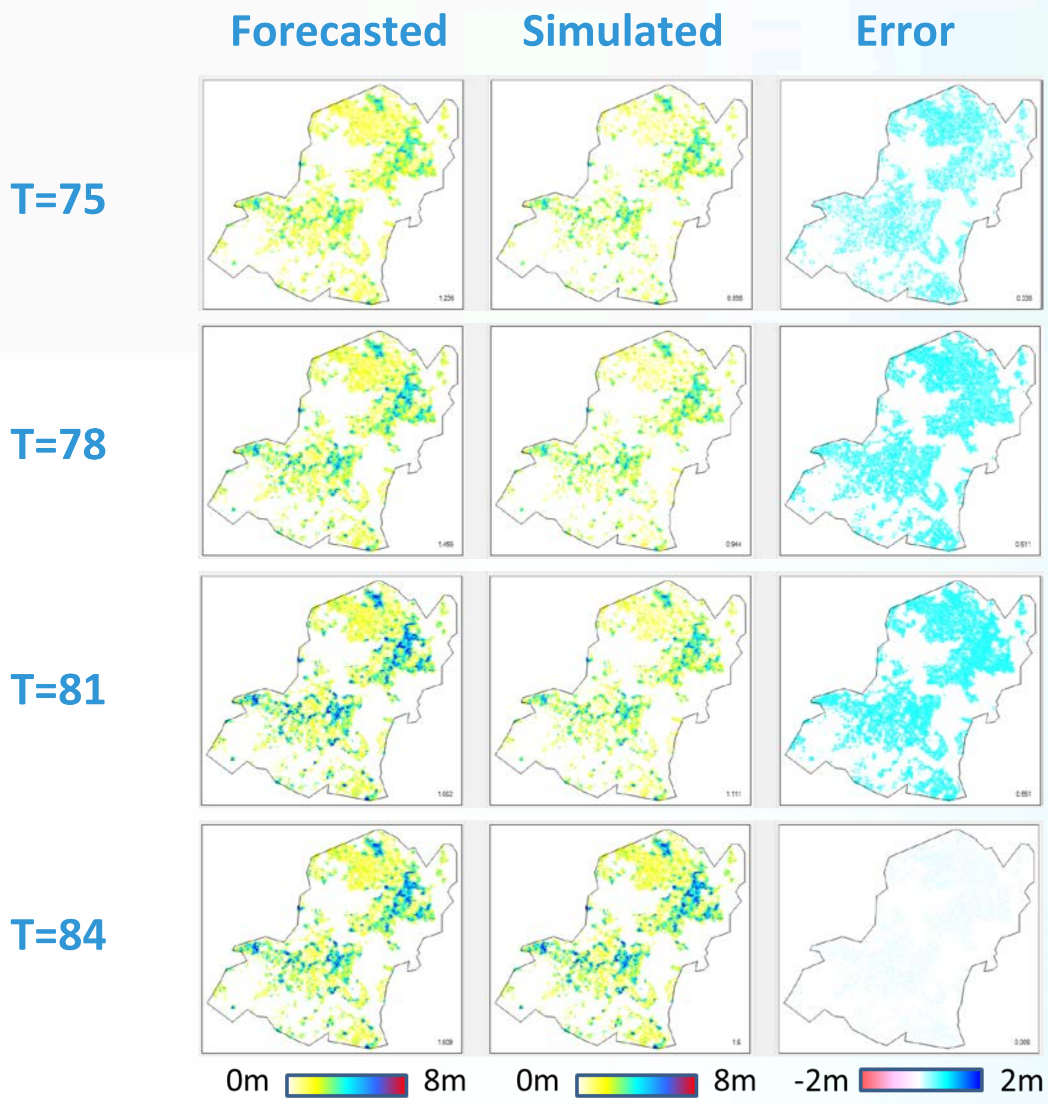


Results

Event 7

Comparison of Model Forecasting Reliability

Regional Inundation Maps T=75-120

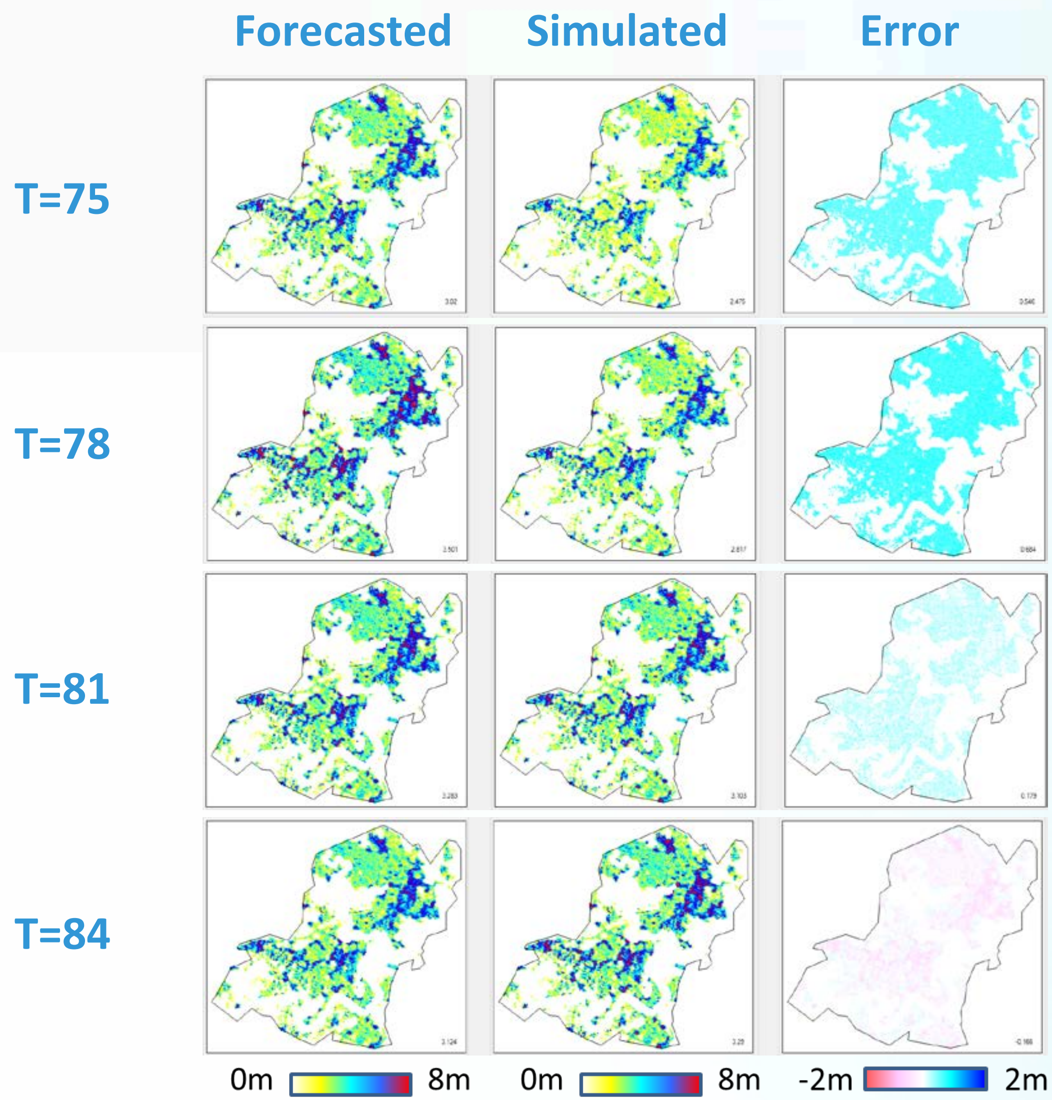


Results

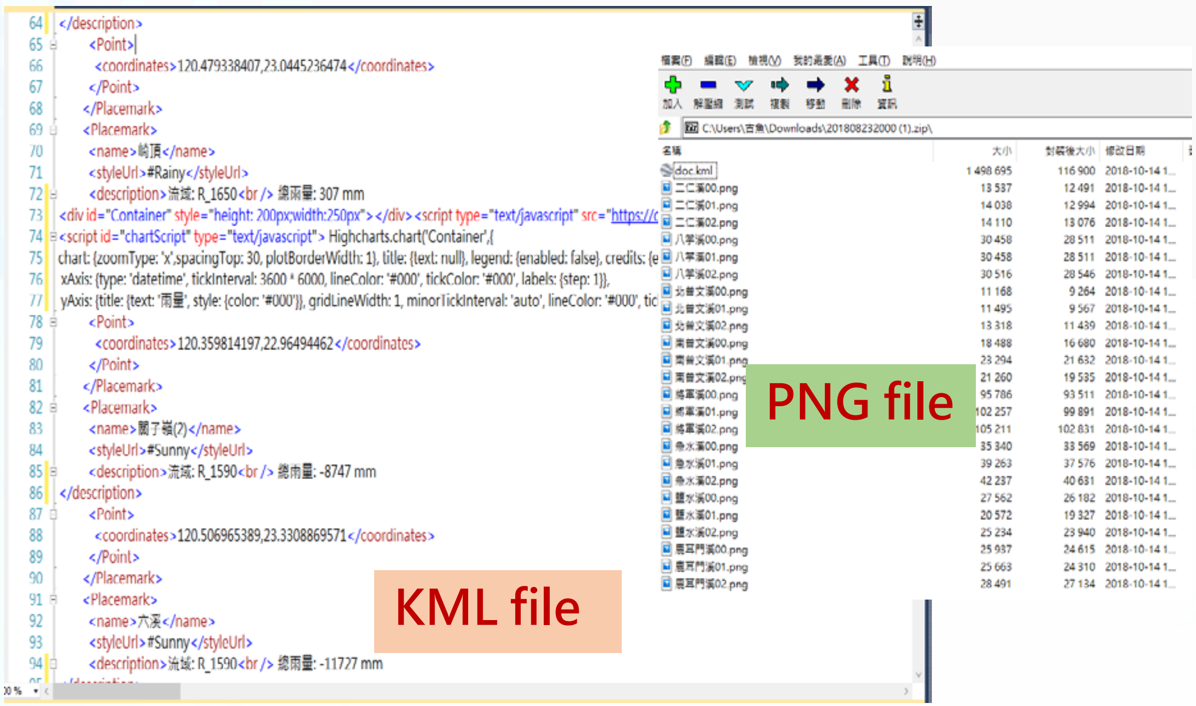
Event 7

Comparison of Model Forecasting Reliability

Regional Inundation Maps T=75-120



Automatically Generate output files



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"Points":[
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"Area": "22.11",
"Pop": "138537",
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"MaxDepth":0.09,
"GridId": "MDL_0001008_001610",
"FloodPercentage": [0,0,0,0,0]
},
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"Pop": "190458",
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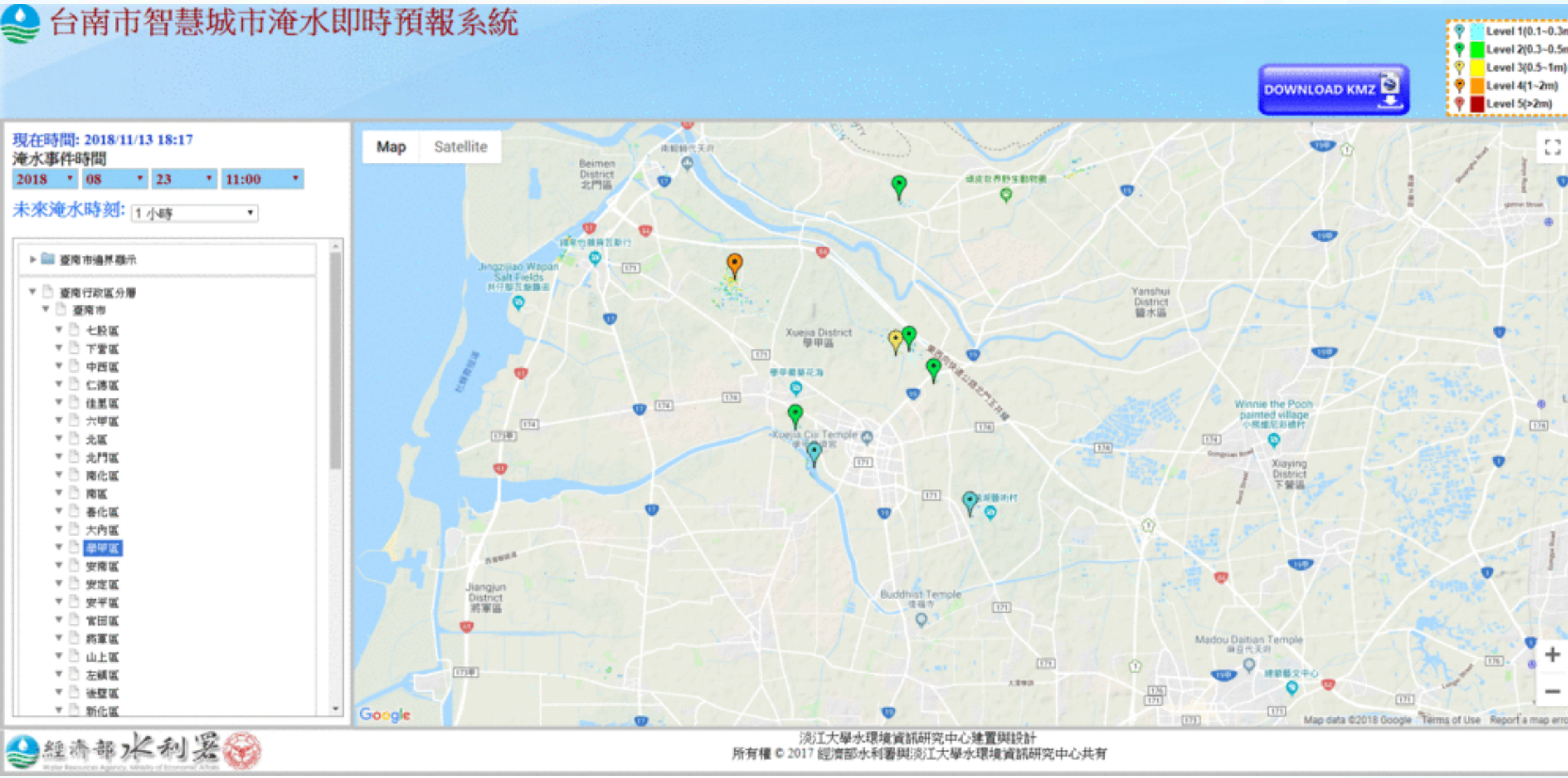
JSON files

✓ For displaying on Google Map、Google Earth and QGIS

Real-time Flood Forecast Result Display on Google Map

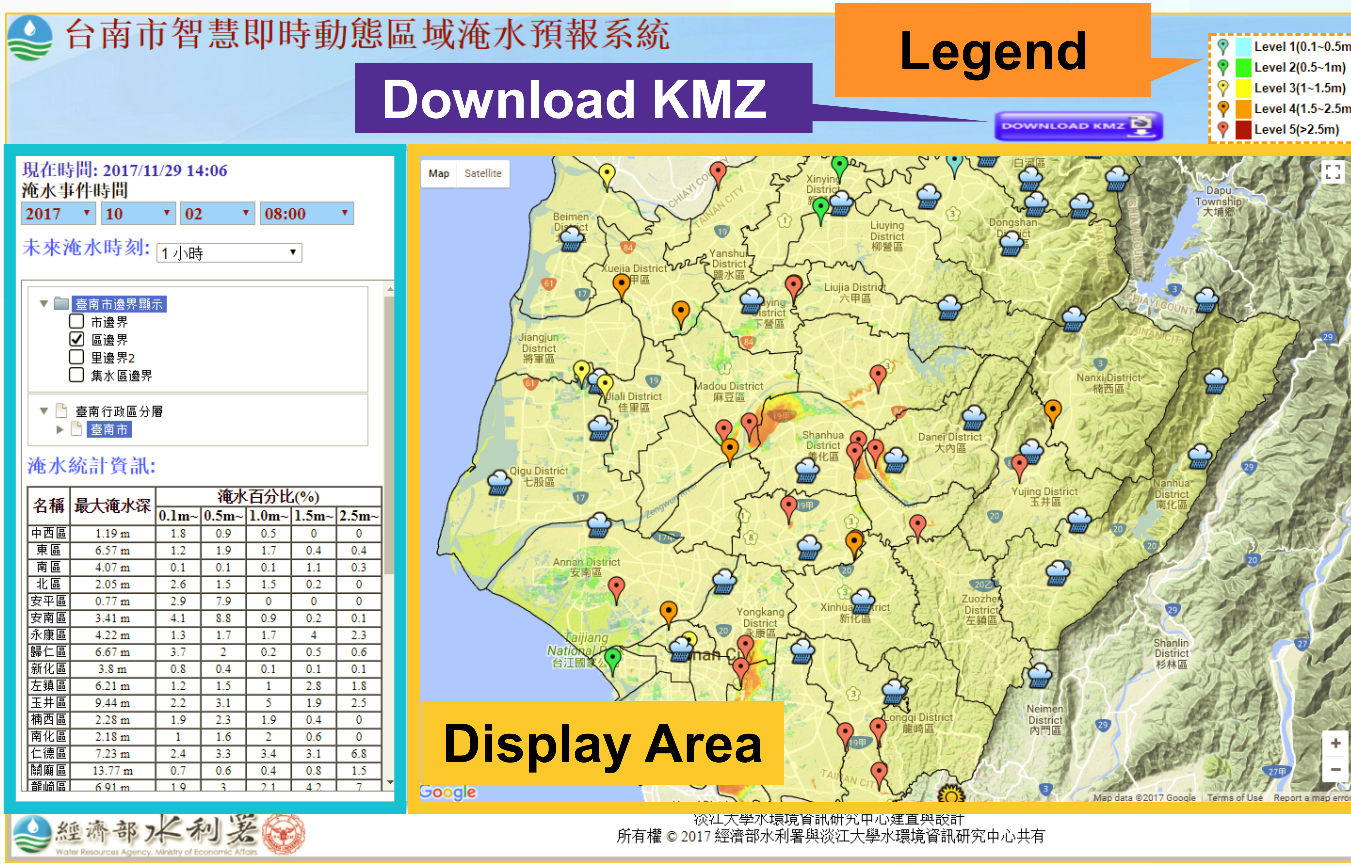
Example: Heavy Rain Event on Aug 23, 2018



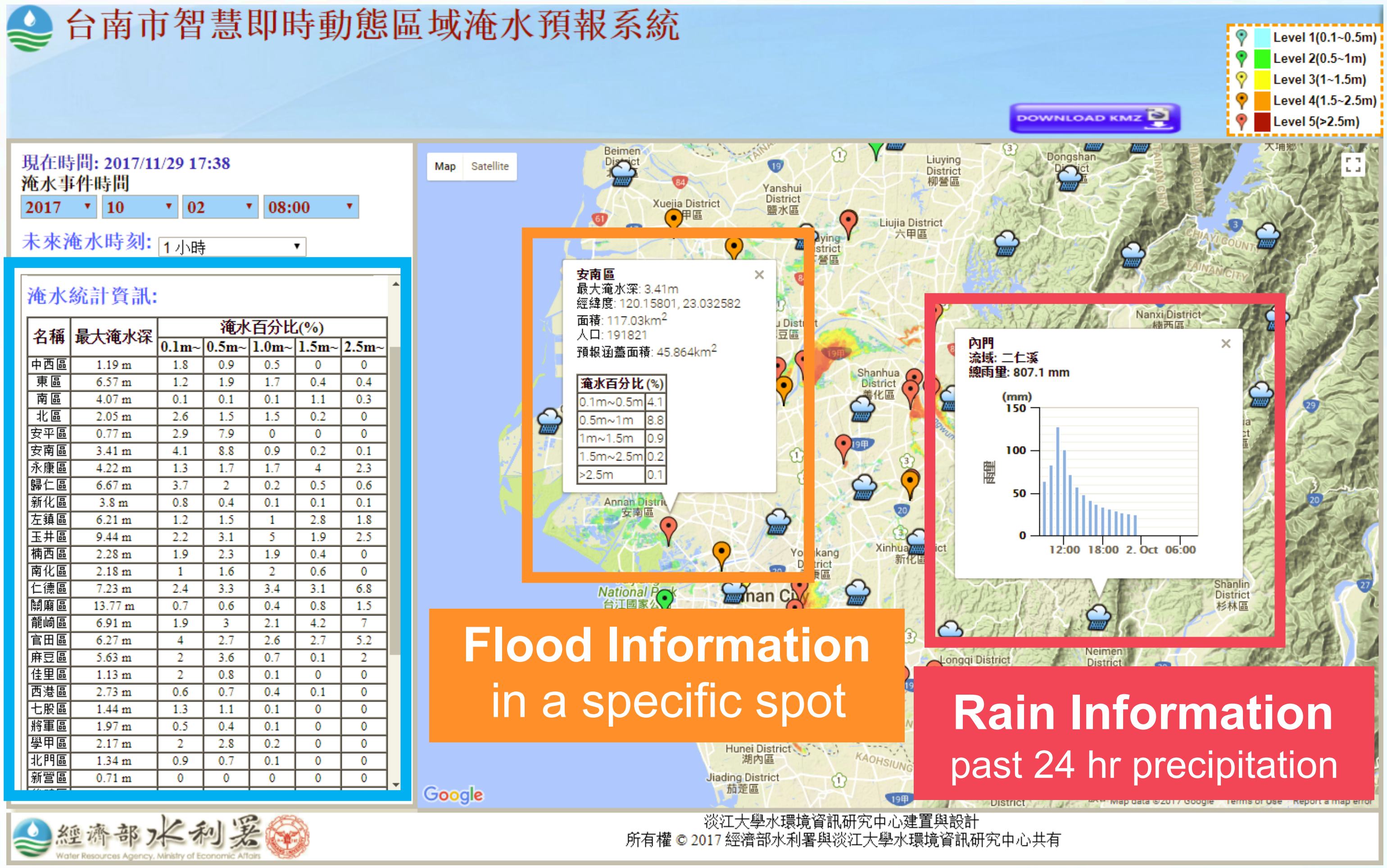
Real-time Flood Forecast Result Display on Google Map

Select Items and Information

(1) Issue Time
(2) Boundaries
(3) Administrative Layers



Real-time Flood Forecast Result Display on Google Map



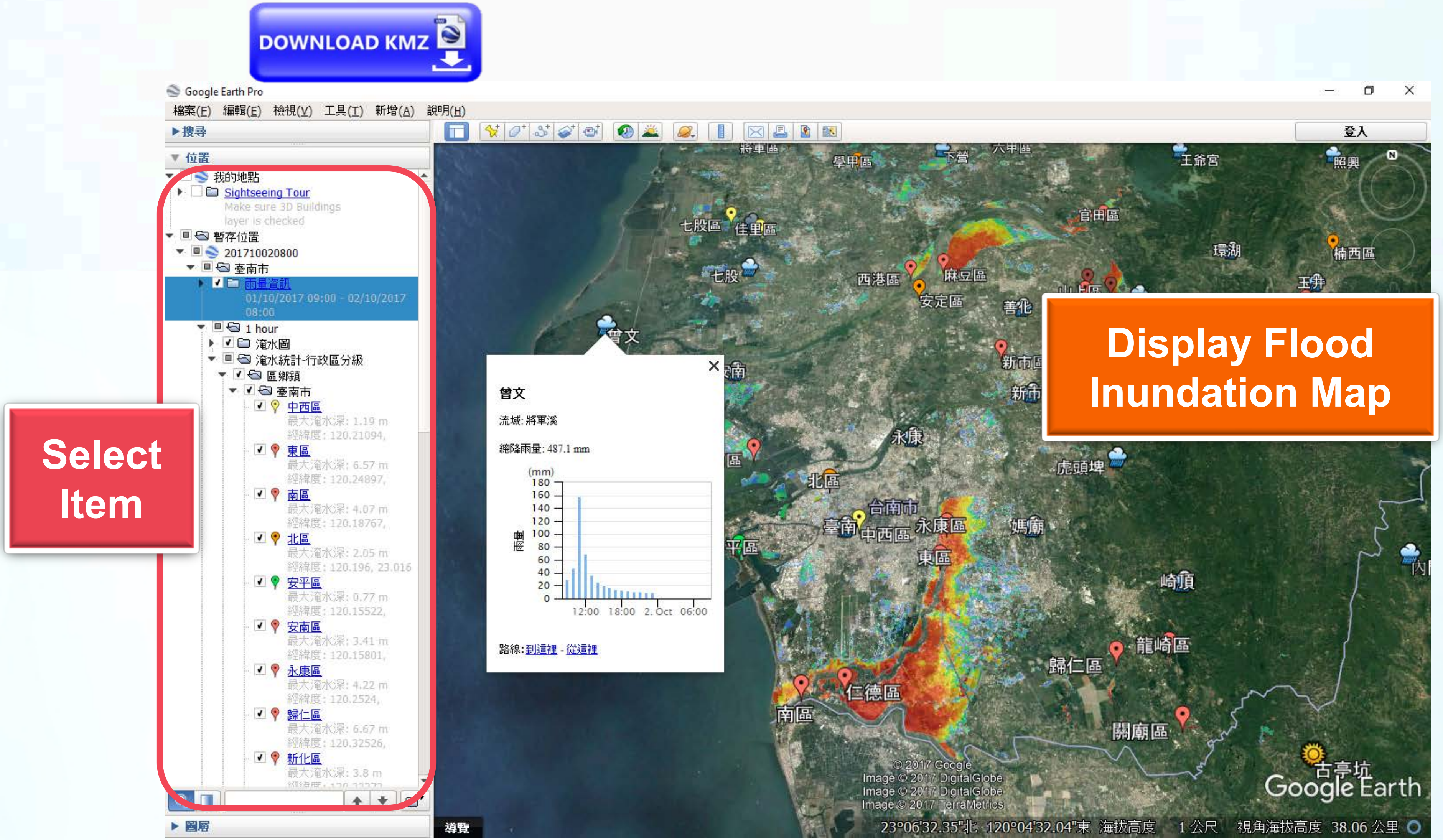
名稱	最大淹水深	淹水百分比(%)				
		0.1m~	0.5m~	1.0m~	1.5m~	2.5m~
中西區	1.19 m	1.8	0.9	0.5	0	0
東區	6.57 m	1.2	1.9	1.7	0.4	0.4
南區	4.07 m	0.1	0.1	0.1	1.1	0.3
北區	2.05 m	2.6	1.5	1.5	0.2	0
安平區	0.77 m	2.9	7.9	0	0	0
安南區	3.41 m	4.1	8.8	0.9	0.2	0.1
永康區	4.22 m	1.3	1.7	1.7	4	2.3
歸仁區	6.67 m	3.7	2	0.2	0.5	0.6
新化區	3.8 m	0.8	0.4	0.1	0.1	0.1
左鎮區	6.21 m	1.2	1.5	1	2.8	1.8
玉井區	9.44 m	2.2	3.1	5	1.9	2.5
楠西區	2.28 m	1.9	2.3	1.9	0.4	0
南化區	2.18 m	1	1.6	2	0.6	0
仁德區	7.23 m	2.4	3.3	3.4	3.1	6.8
關廟區	13.77 m	0.7	0.6	0.4	0.8	1.5
龍崎區	6.91 m	1.9	3	2.1	4.2	7
官田區	6.27 m	4	2.7	2.6	2.7	5.2
麻豆區	5.63 m	2	3.6	0.7	0.1	2
佳里區	1.13 m	2	0.8	0.1	0	0
西港區	2.73 m	0.6	0.7	0.4	0.1	0
七股區	1.44 m	1.3	1.1	0.1	0	0
將軍區	1.97 m	0.5	0.4	0.1	0	0
學甲區	2.17 m	2	2.8	0.2	0	0
北門區	1.34 m	0.9	0.7	0.1	0	0
新營區	0.71 m	0	0	0	0	0

Flood Information
in a specific spot

Rain Information
past 24 hr precipitation

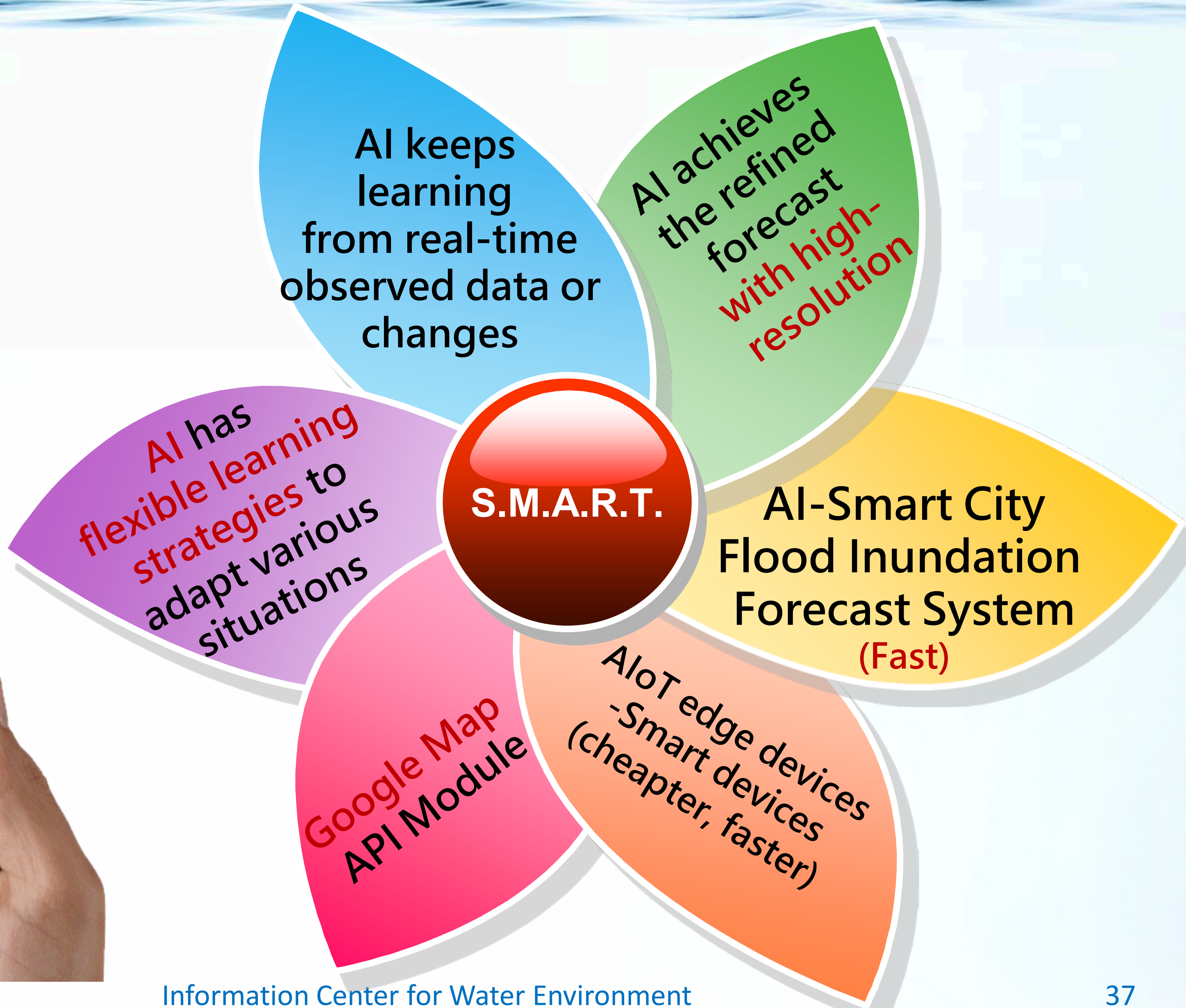
Flood Statistical Information of each village

Real-time Flood Forecast Result Display on Google Earth



Conclusions-S.M.A.R.T. Goal

- Self-Monitoring, Analysis and Report Technology



A New Era of Smart Flood Defense

1 — **2005**

International Telecommunication Union proposed **Internet of Things (IoT)** report

2 — **2012**

The New York Times
The Age of Big Data
was announced


The New York Times

The Age of Big Data

By STEVE LOHR FEB. 11, 2012

GOOD with numbers? Fascinated by data? The sound you hear is opportunity knocking.
Mo Zhou was snapped up by I.B.M. last summer, as a freshly minted Yale M.B.A., to join the technology company's fast-growing ranks of data consultants. They help businesses

3 — **2016**

World Economic Forum
Artificial Intelligence (AI)
as the core of Industry 4.0

4 — **Development of low-cost IoT sensors** for Water Resource and Weather

- Reduce cost of data monitoring
- Understand spatial distribution
- Collect Big data

5 — **AI** serve on **Flood Forecast** and **Water Resources Management**

AI + Big Data:

- Excellent learning ability
- Massive volumes of data
- Fast computation

6 — **Integrate Wide-spread IoT sensors with AI** in the near future

- **Keep Learning** from real-time data
- **Flexible learning strategies** depend on locations and desity of IoT sensors

Publications

Related Publications of City Flood Inundation Forecasting Models

- Chang, L. C., Shen, H. Y., Wang, Y. F., Huang, J. Y., & Lin, Y. T. (2010). Clustering-based hybrid inundation model for forecasting flood inundation depths. Journal of Hydrology, 385(1-4), 257-268.
- Chang, L.C., Shen, H.Y., Chang, F.J. (2014). Regional flood inundation nowcast using hybrid SOM and dynamic neural networks. Journal of Hydrology, 519: 476-489
- Chang, L. C., Amin, M., Yang, S. N., Chang, F.J. (2018). Building ANN-Based Regional Multi-Step-Ahead Flood Inundation Forecast Models. Water, 10(9), 1283.
- Chang, L. C., Chang, F. J., Yang, S. N., Kao, I., Ku, Y. Y., Kuo, C. L., & Amin, I. (2019). Building an Intelligent Hydroinformatics Integration Platform for Regional Flood Inundation Warning Systems. Water, 11(1), 9
- Yang, S. N., Chang, L. C. (2020) Regional Inundation Forecasting Using Machine Learning Techniques with the Internet of Things. Water, 12(6), 1578
- Chang, L. C., Wang, W. H., Chang, F.J. (2021) Explore training self-organizing map methods for clustering high-dimensional flood inundation maps. Journal of Hydrology, 595, 125655.

The best System makes IoT smarter with AI

Li-Chiu Chang
Department of Water Resources and Environmental Engineering
Tamkang University
changlc@mail.tku.edu.tw

Thank You

Inundation Monitoring Technology and Application

Lin, Yi-Sheng, Chief
Water Hazard Mitigation Center
Water Resources Agency, MOEA, R.O.C. (Taiwan)

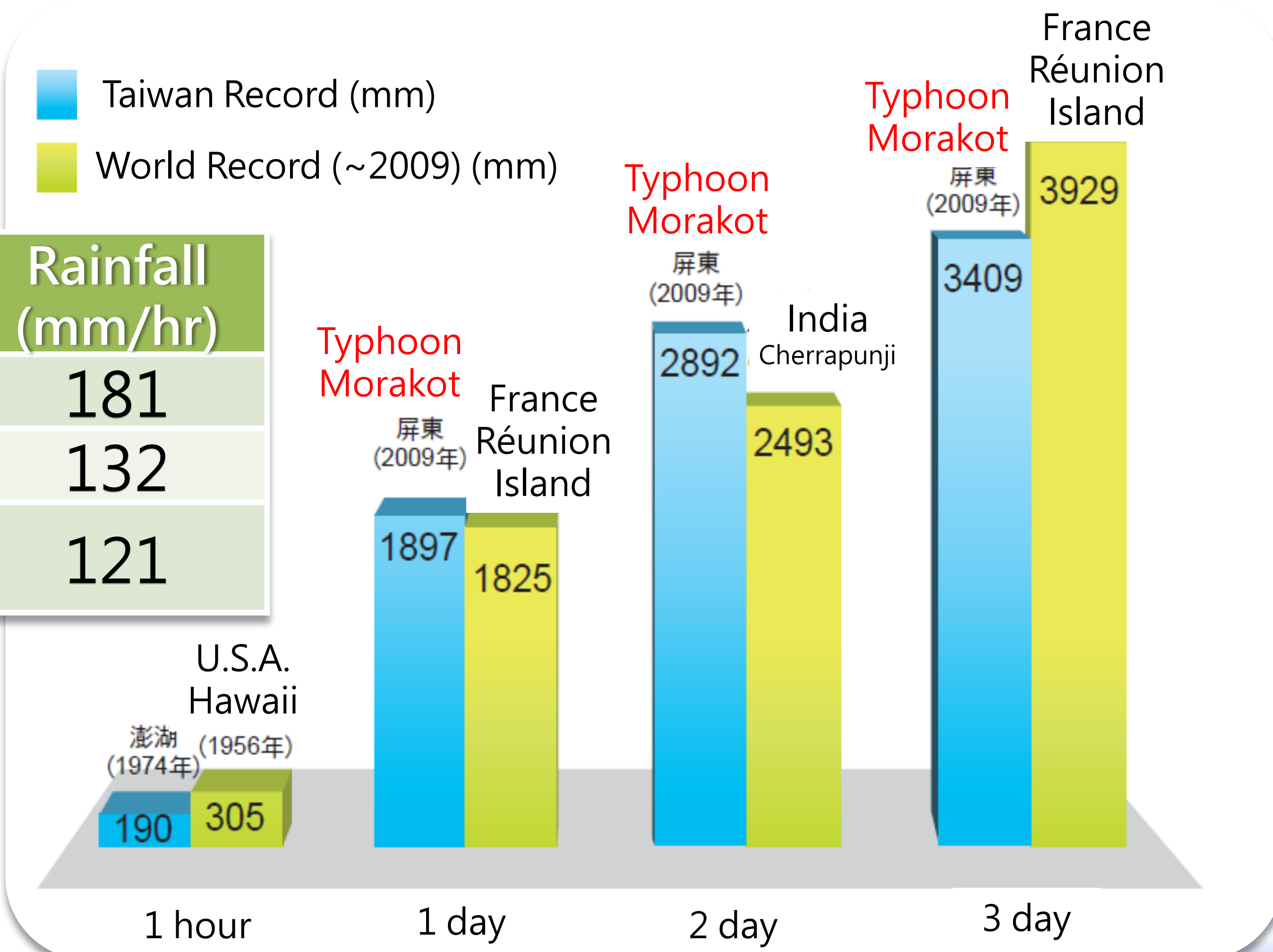
Taiwan faces the challenge of climate change

Climate change has led to the alternation of drought and flood in Taiwan

More Severe and Frequent Drought and Flood

Extreme Storm Rainfall reaches World Record

Storm Events	Rainfall (mm/hr)
2016/ 尼莎	181
2017/ 0601	132
2018/ **0823**	121



資料來源：中央氣象局, 2017

Before

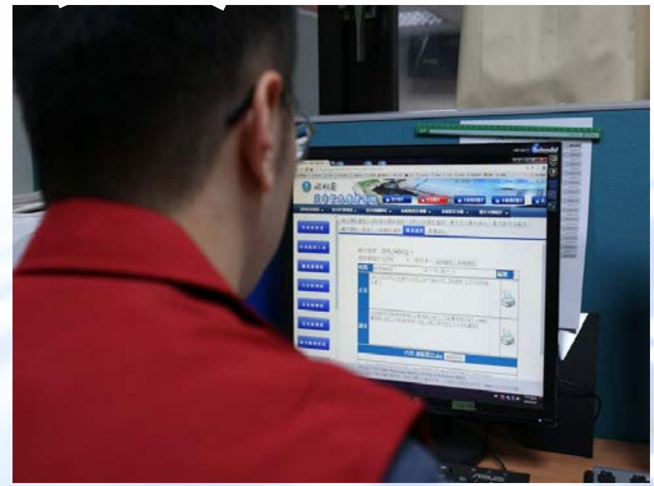
Insufficient Information of Disaster

Highest inundation level of Typhoon Morakot

Crest Gage

Before

Inaccurate Disaster Reports

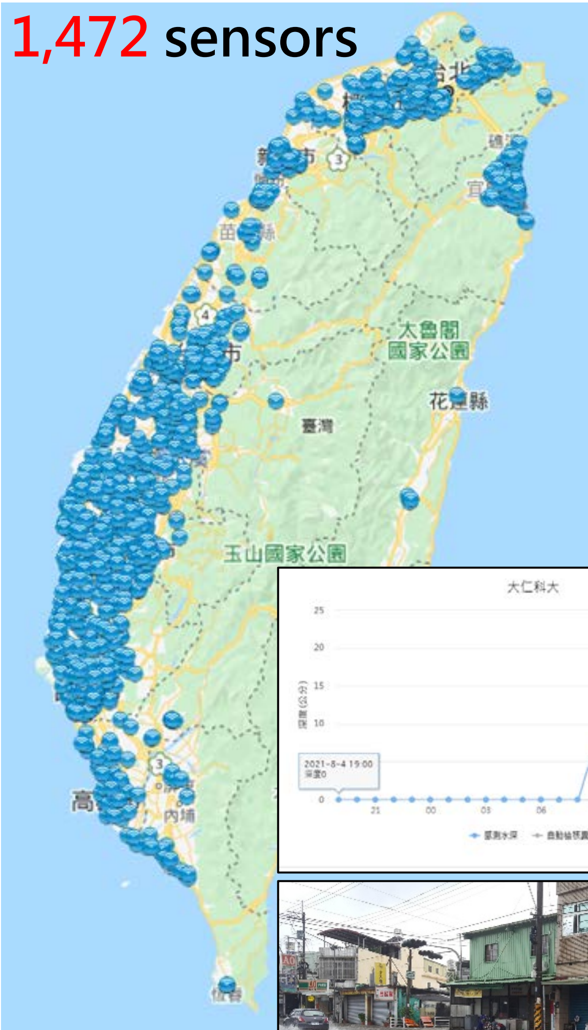


? ?

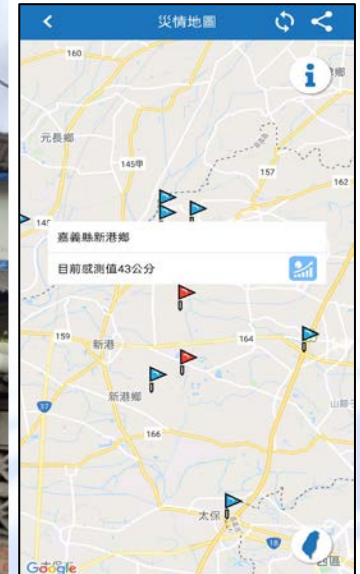
20cm？ 50cm？

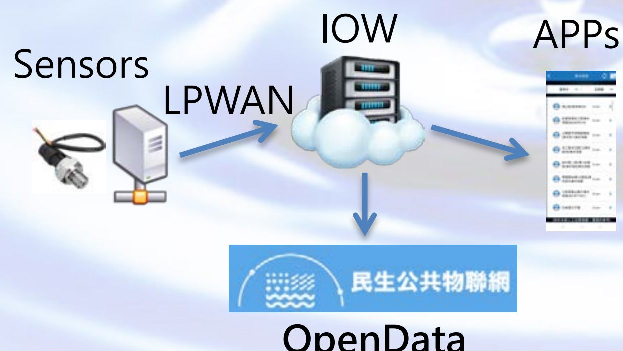
Now

Widespread flood sensors



APP





Data interval:
1 hour normally,
5~10 mins. during inundation

Now

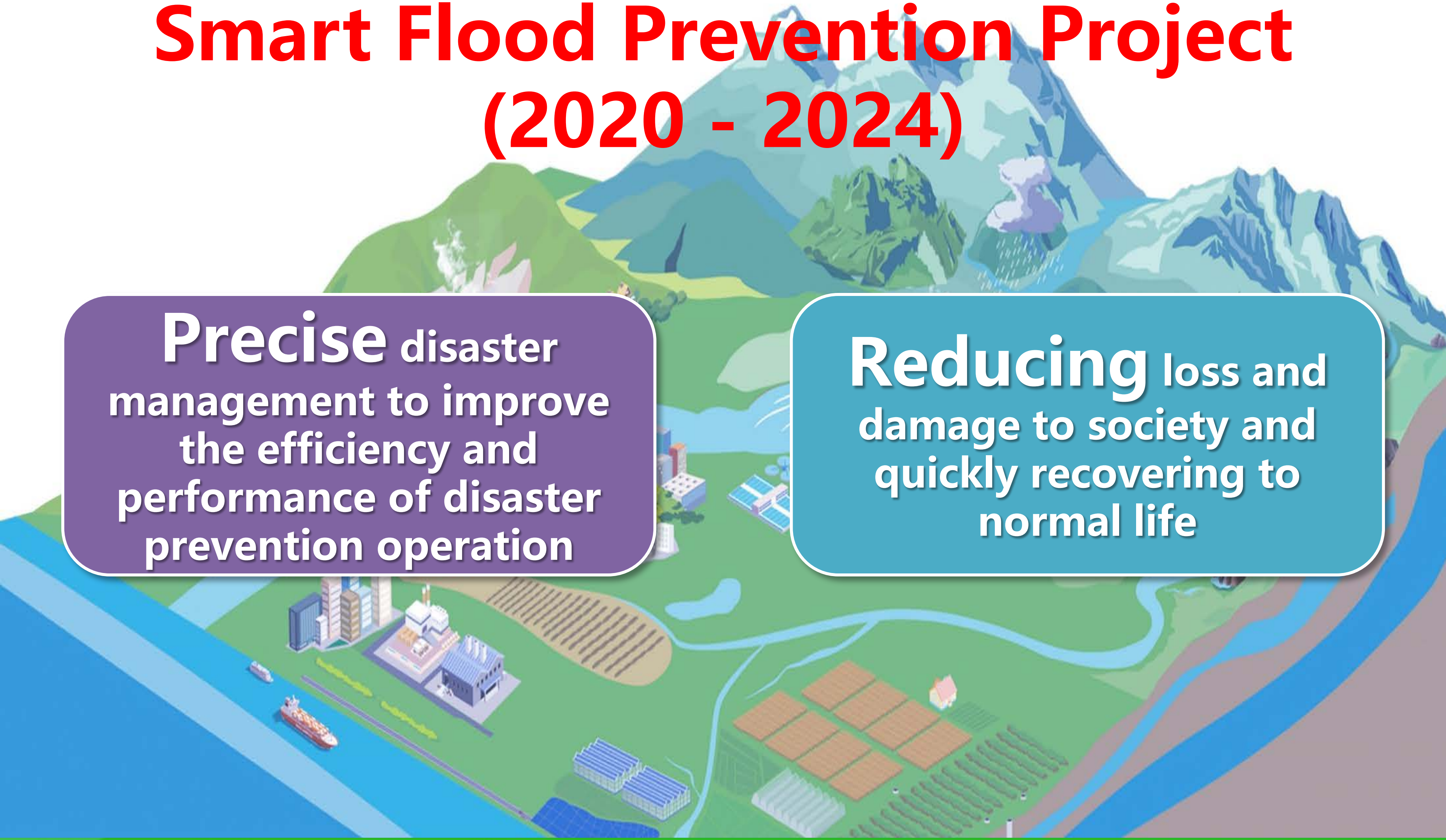
Widespread CCTV

Image Recognition of Inundation depth

Integrated Inundation Information

How We Did It

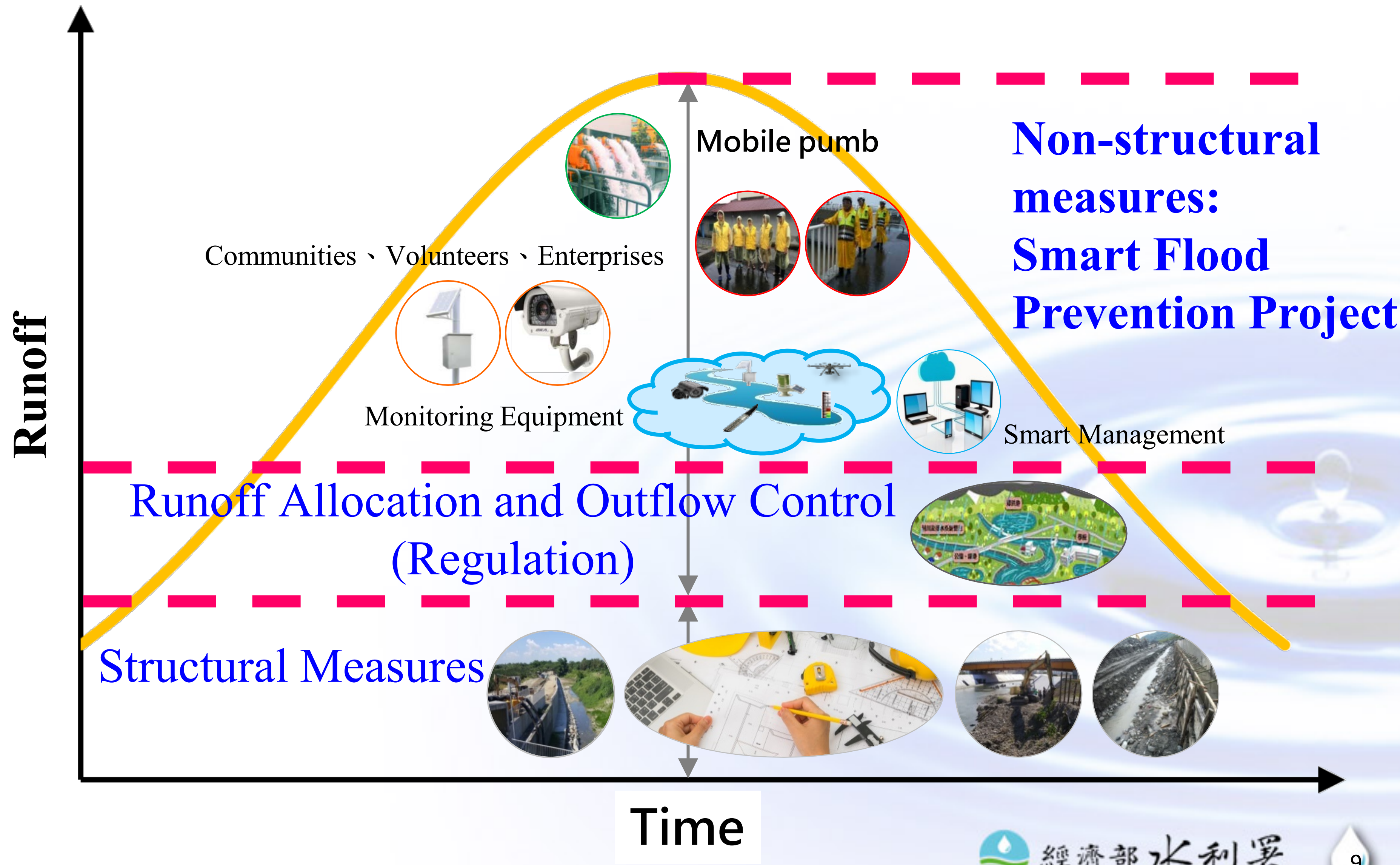
Smart Flood Prevention Project (2020 - 2024)



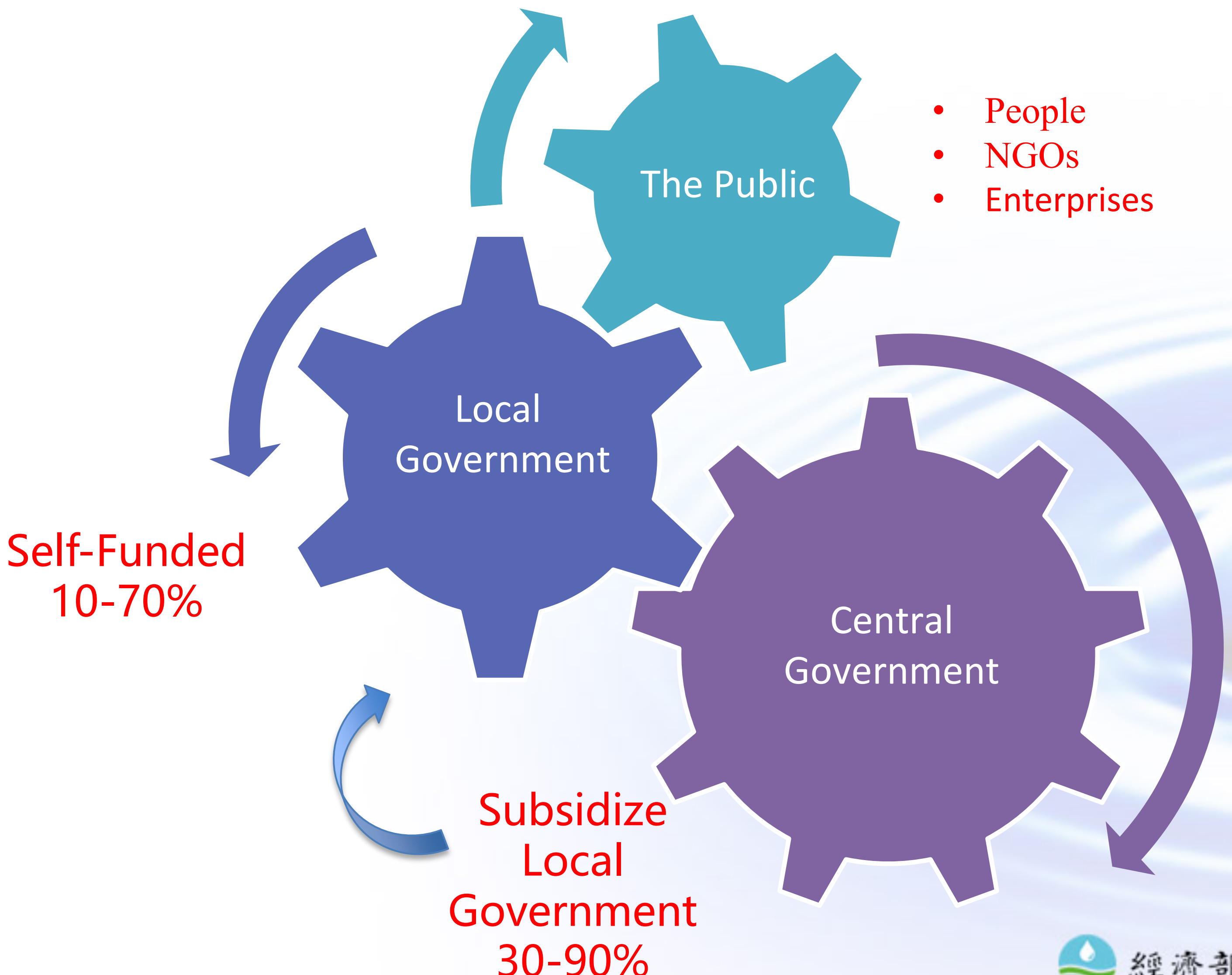
Precise disaster management to improve the efficiency and performance of disaster prevention operation

Reducing loss and damage to society and quickly recovering to normal life

Impact Mitigation of Extreme Events



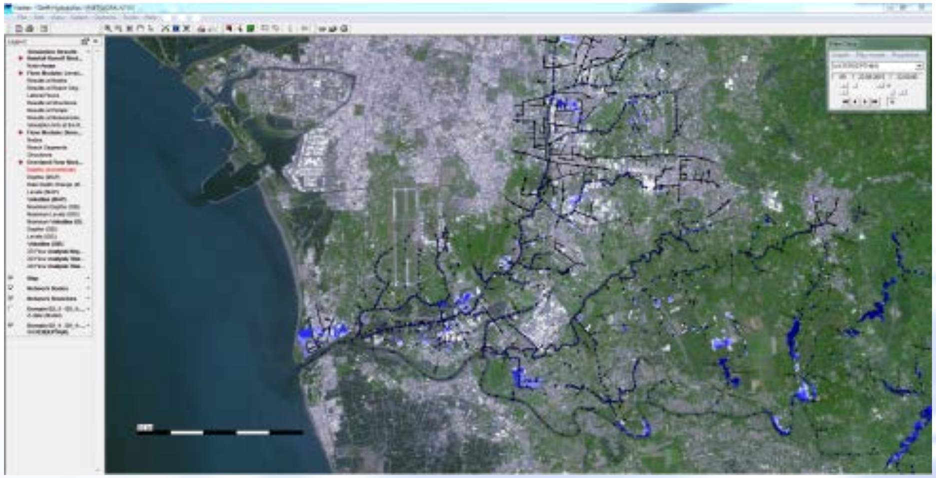
Public-Private Collaboration



Application of Inundation Sensor Data

Improve accuracy of Forecast and Simulation Model

Rainfall Threshold Value Method
(Black box model)



SOBEK (Hydrodynamic Model)

SOM-RNARX (AI Model)

Conclusion

- Inundation sensor is helpful for immediately collecting disaster information and forecast model improvement.
- Automatic sensor data verification is required in case of equipment malfunction. CCTV is useful to verify if the sensor works well.
- To enhance accuracy of inundation forecast or simulation model, continuing collection of sensor data is necessary, especially for the AI model.

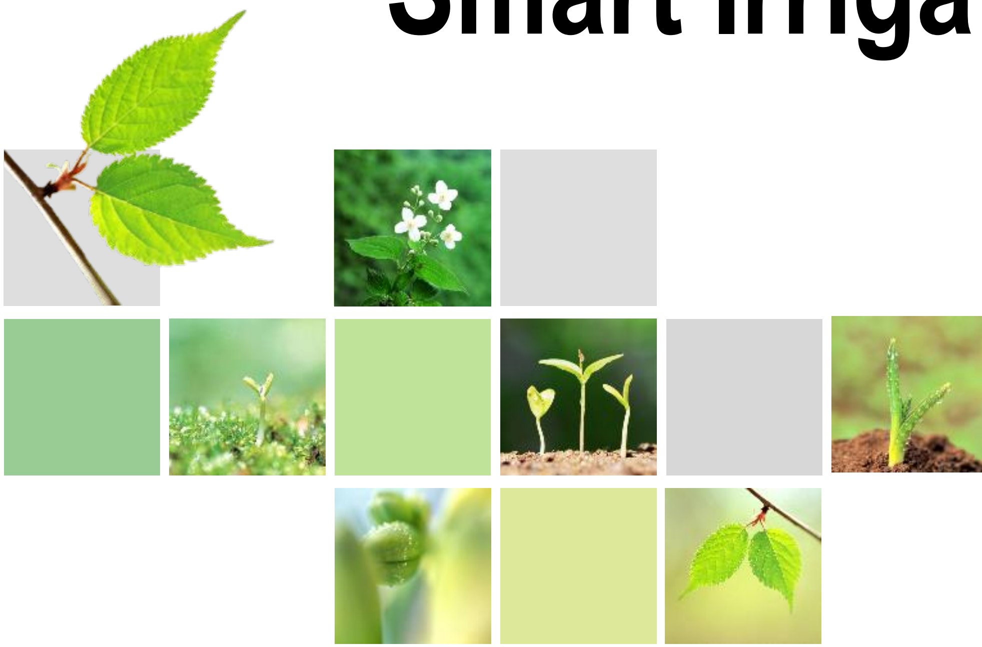
簡報結束 敬請指教

Thanks for your attention~

經濟部水利署

WATER RESOURCES AGENCY

Smart Irrigation Management



Chih-Hung Tan, PhD

CTO
Agricultural Engineering
Research Center

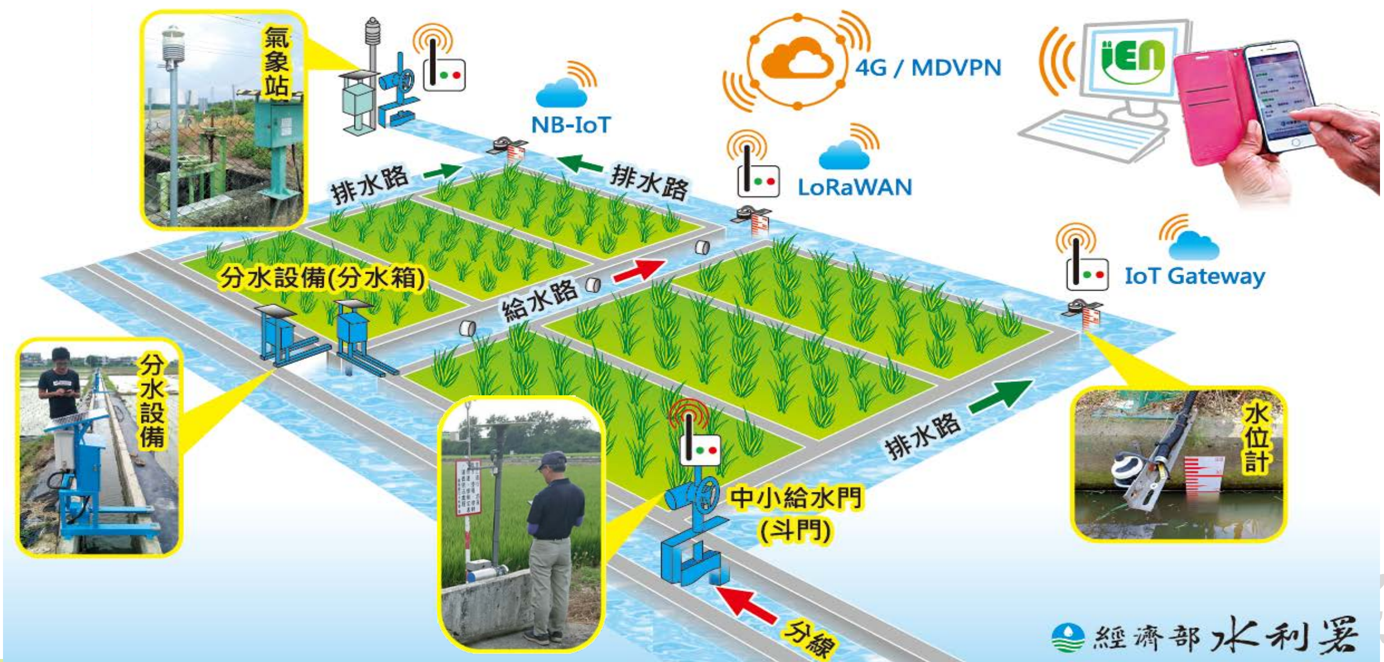
Smart Irrigation?

- Pressurized pipeline irrigation
- Green houses, plant factories, etc.
- Usually not applicable to open channels

Irrigation in Taiwan

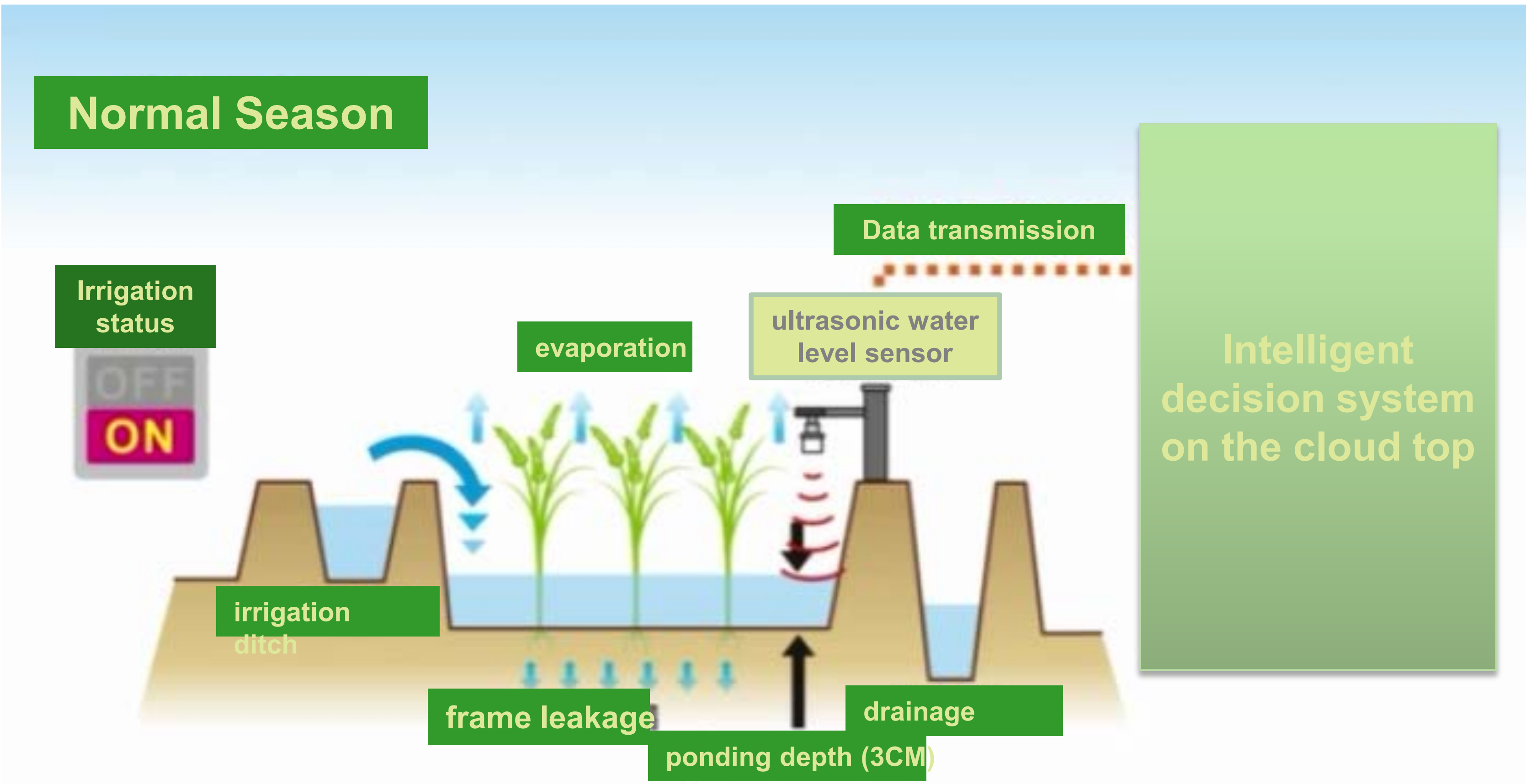
Diligence Irrigation Project

- Agricultural consumption 70%, what if 5% saving?
- Large scale paddy field experiment, 2017-2020
- integrate weather forecast, water sensors, IoT, gate control, cloud-top computing, etc.



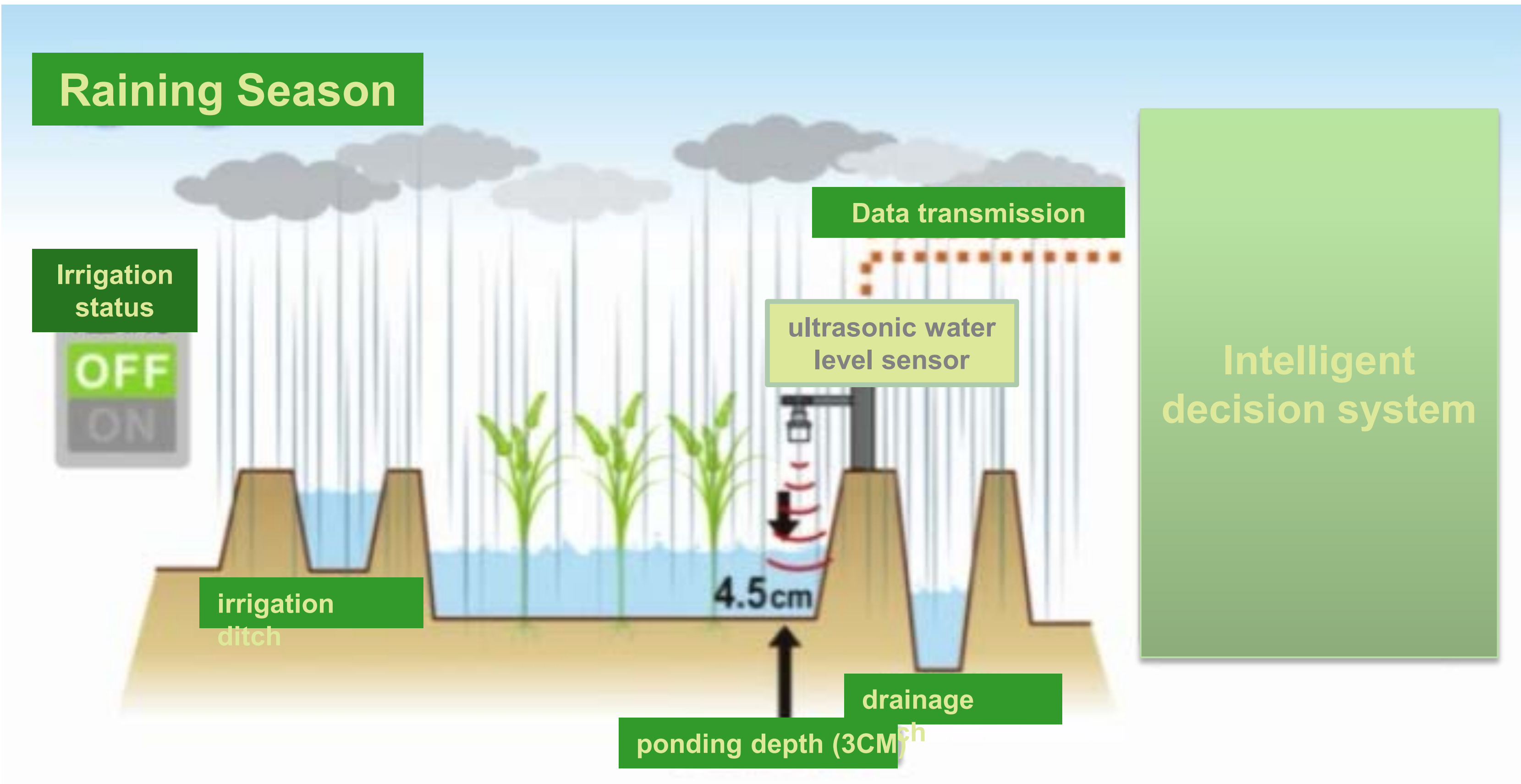
Concept of system

- Paddy field



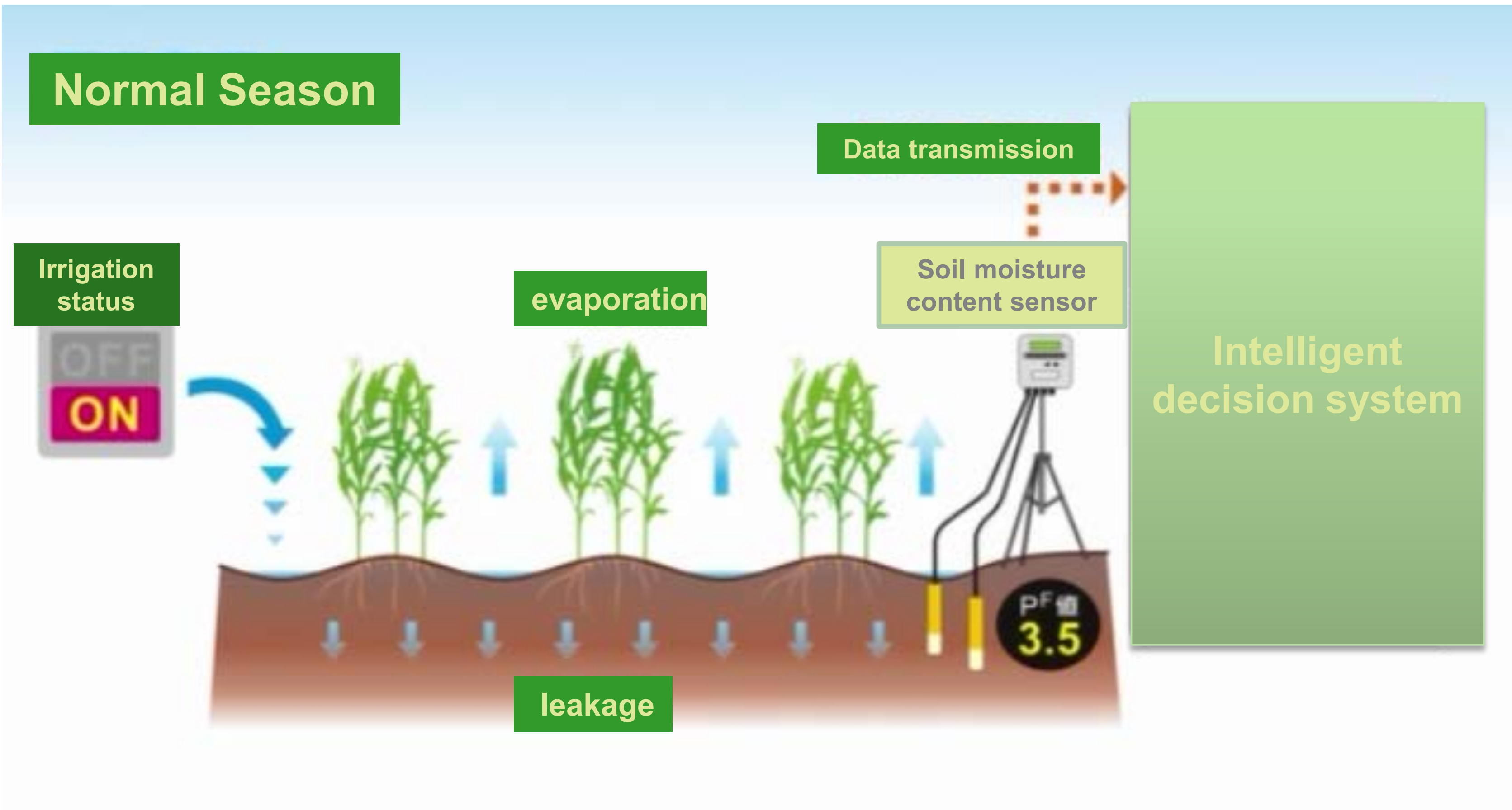
Concept of system

- Paddy field



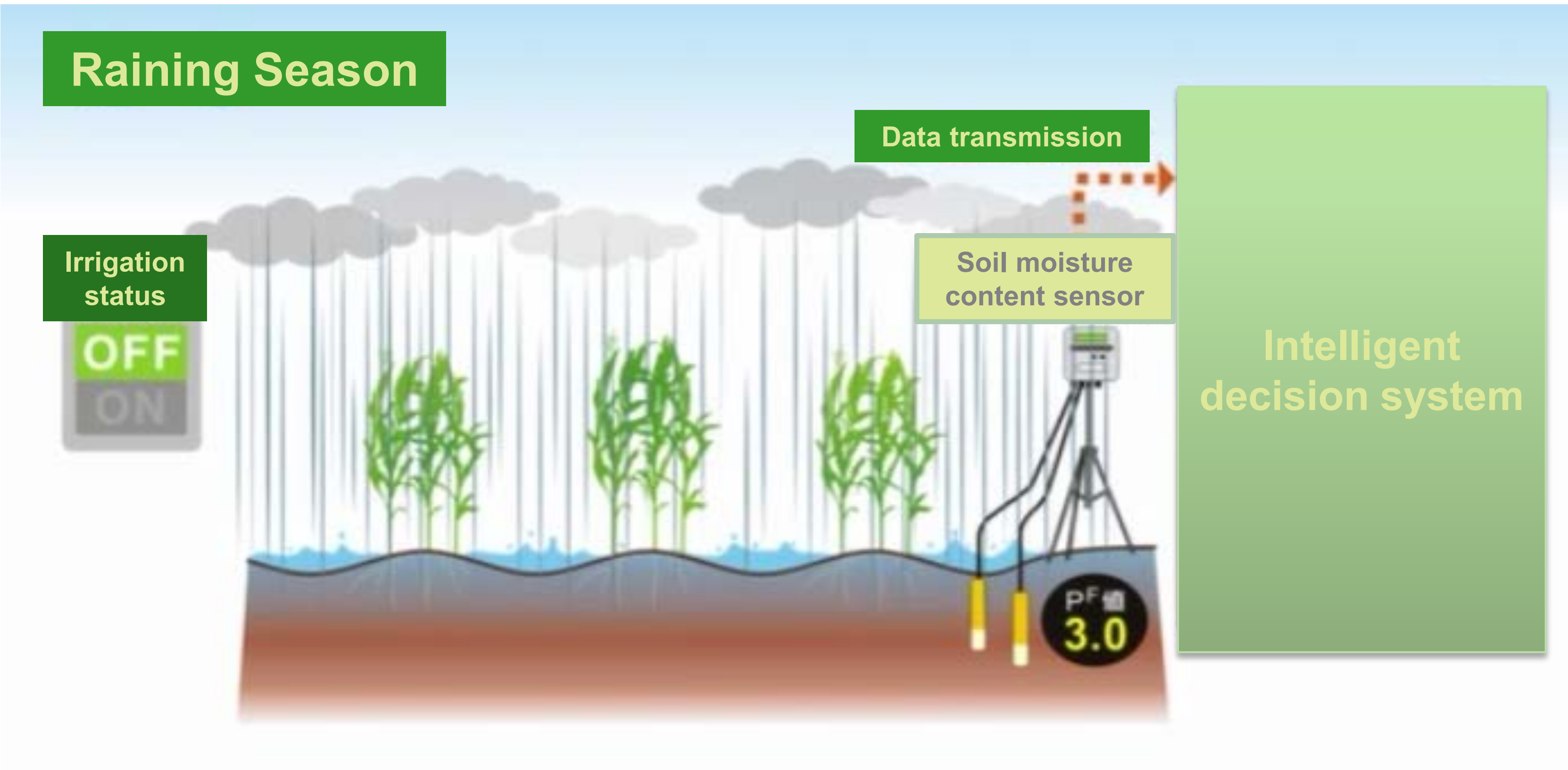
Concept of system

- Dry field

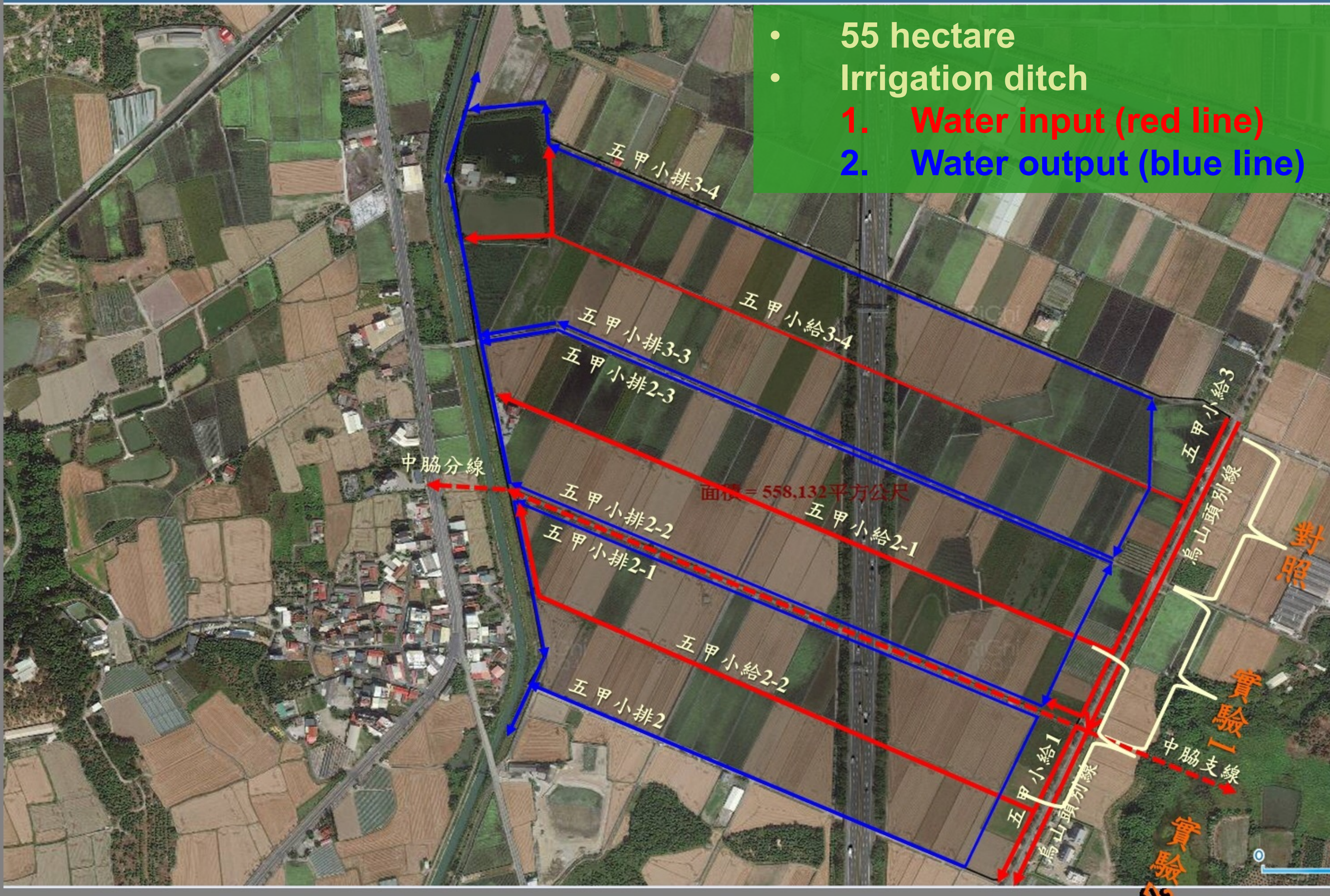


Concept of system

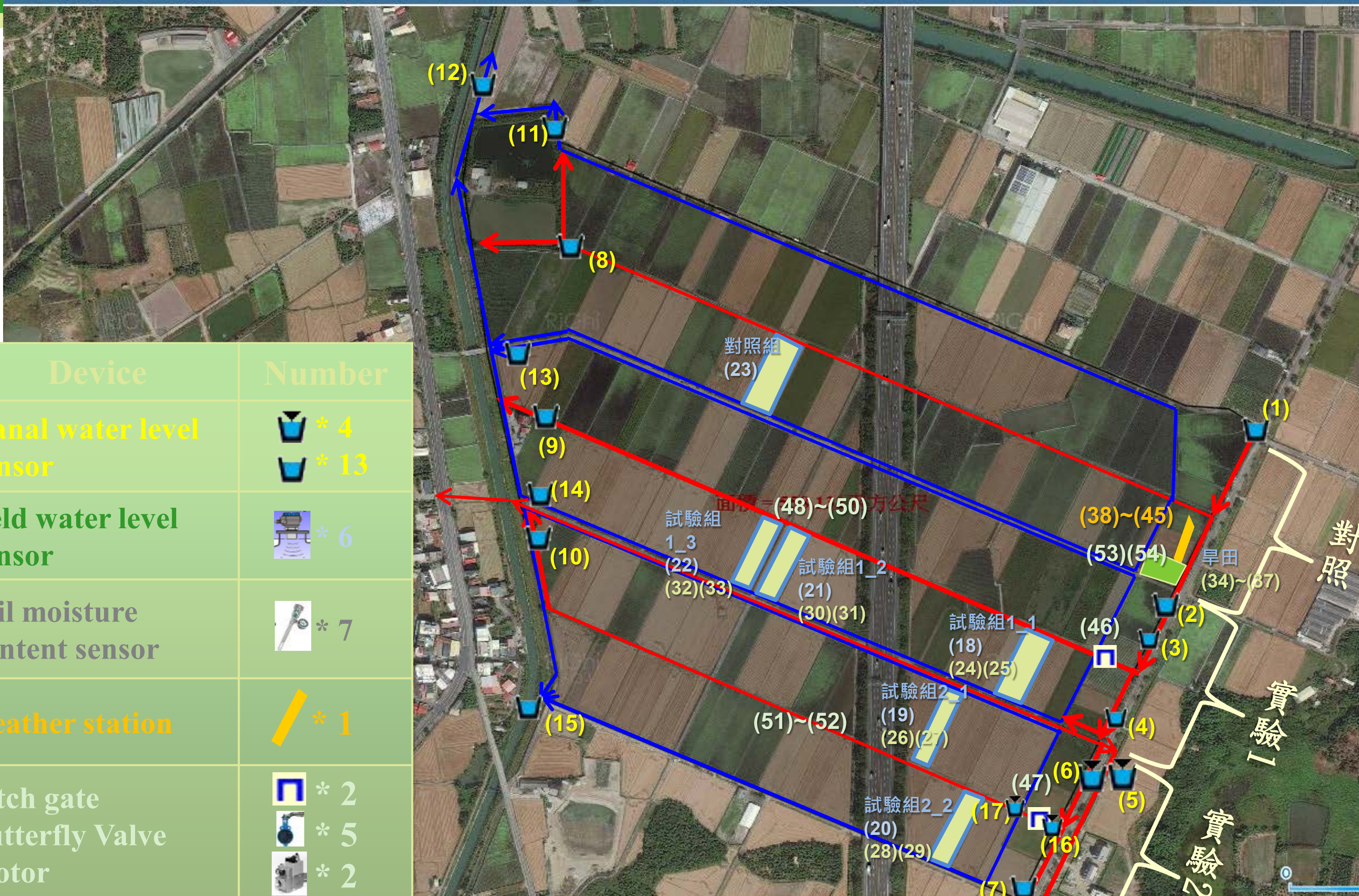
- Dry field



Experimental Field

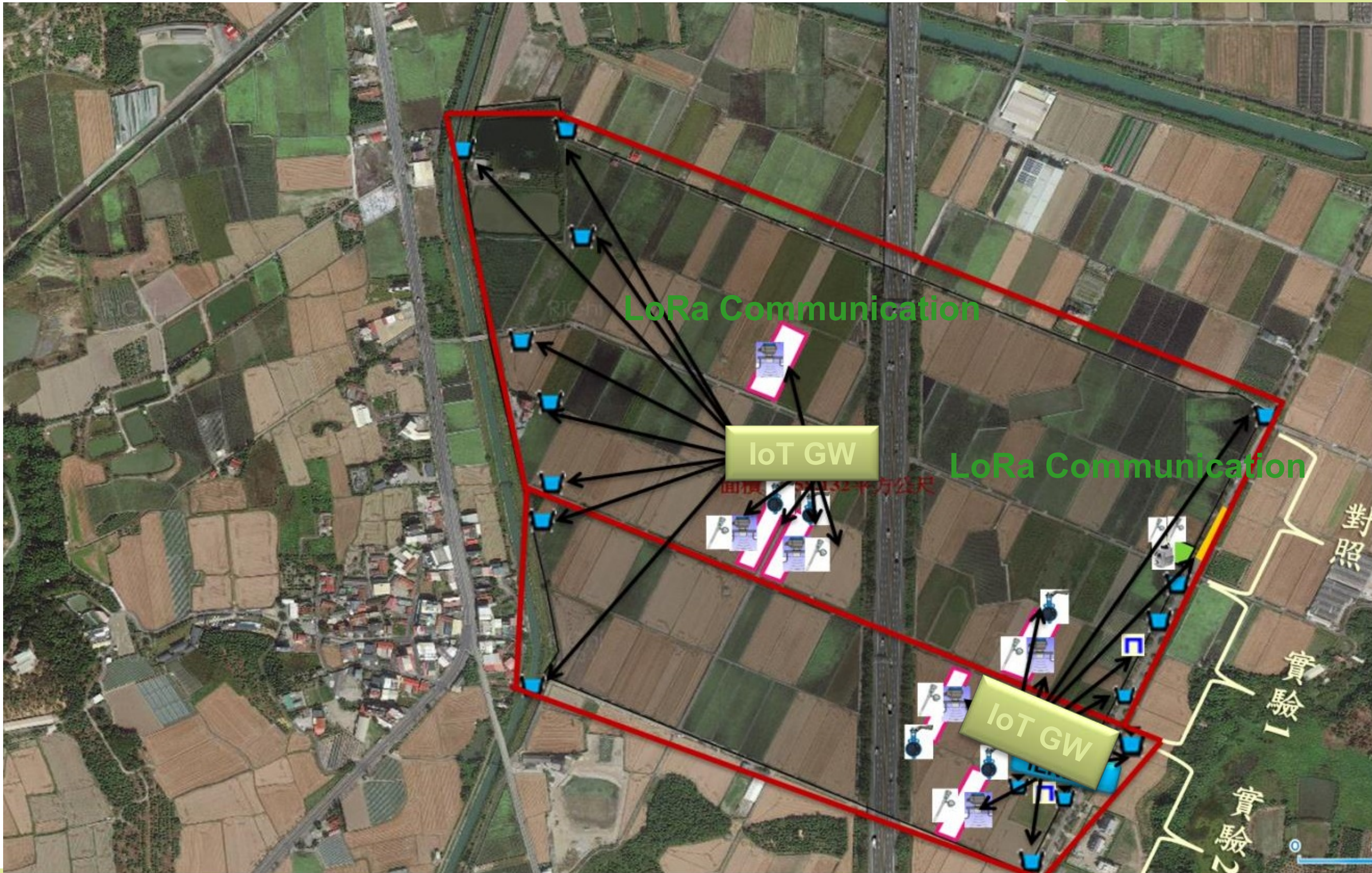


Sensor Setup



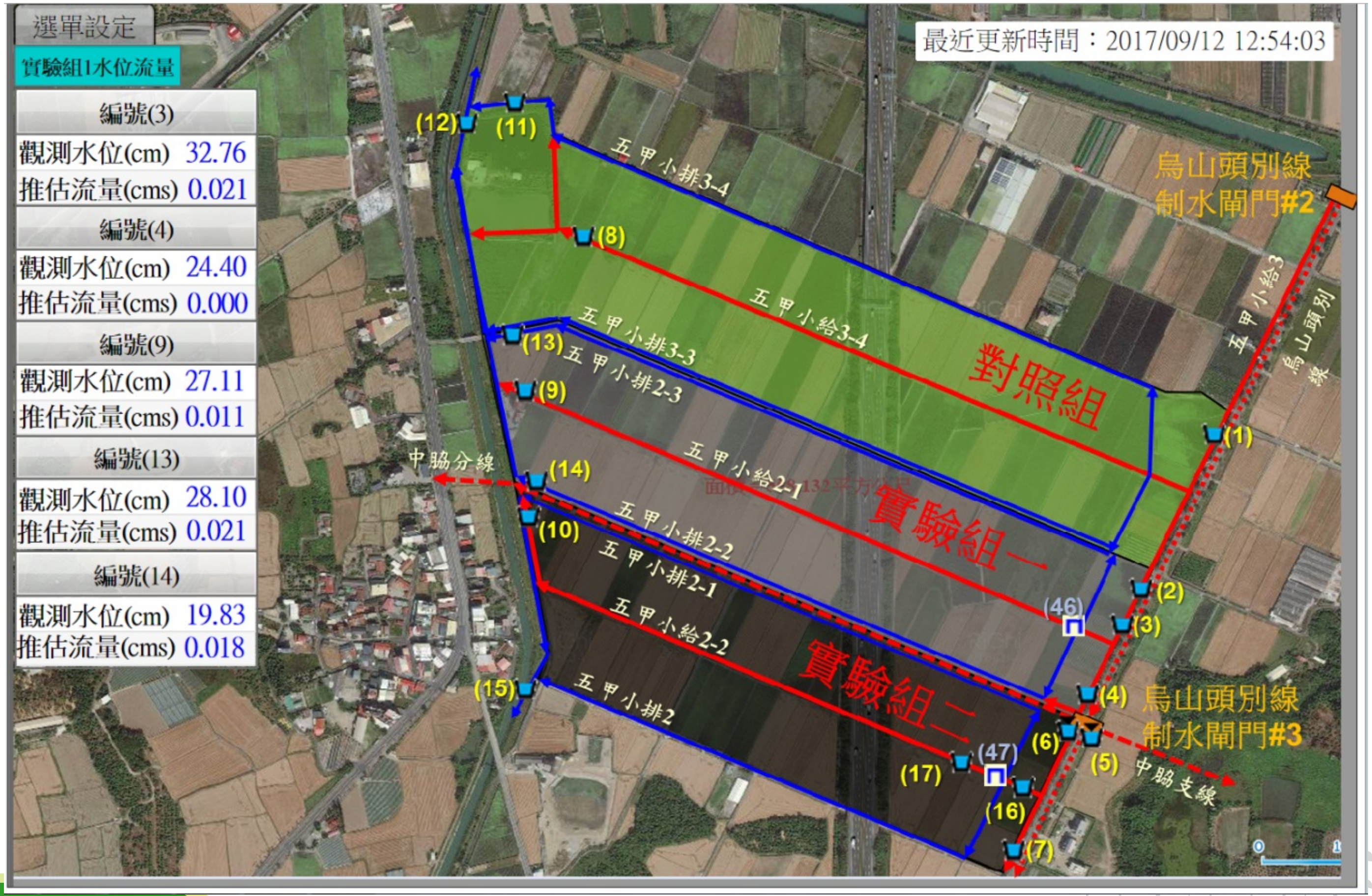
Device	Number
Canal water level sensor	* 4 * 13
field water level sensor	* 6
soil moisture content sensor	* 7
weather station	* 1
ditch gate butterfly Valve motor	* 2 * 5 * 2

Communication plan

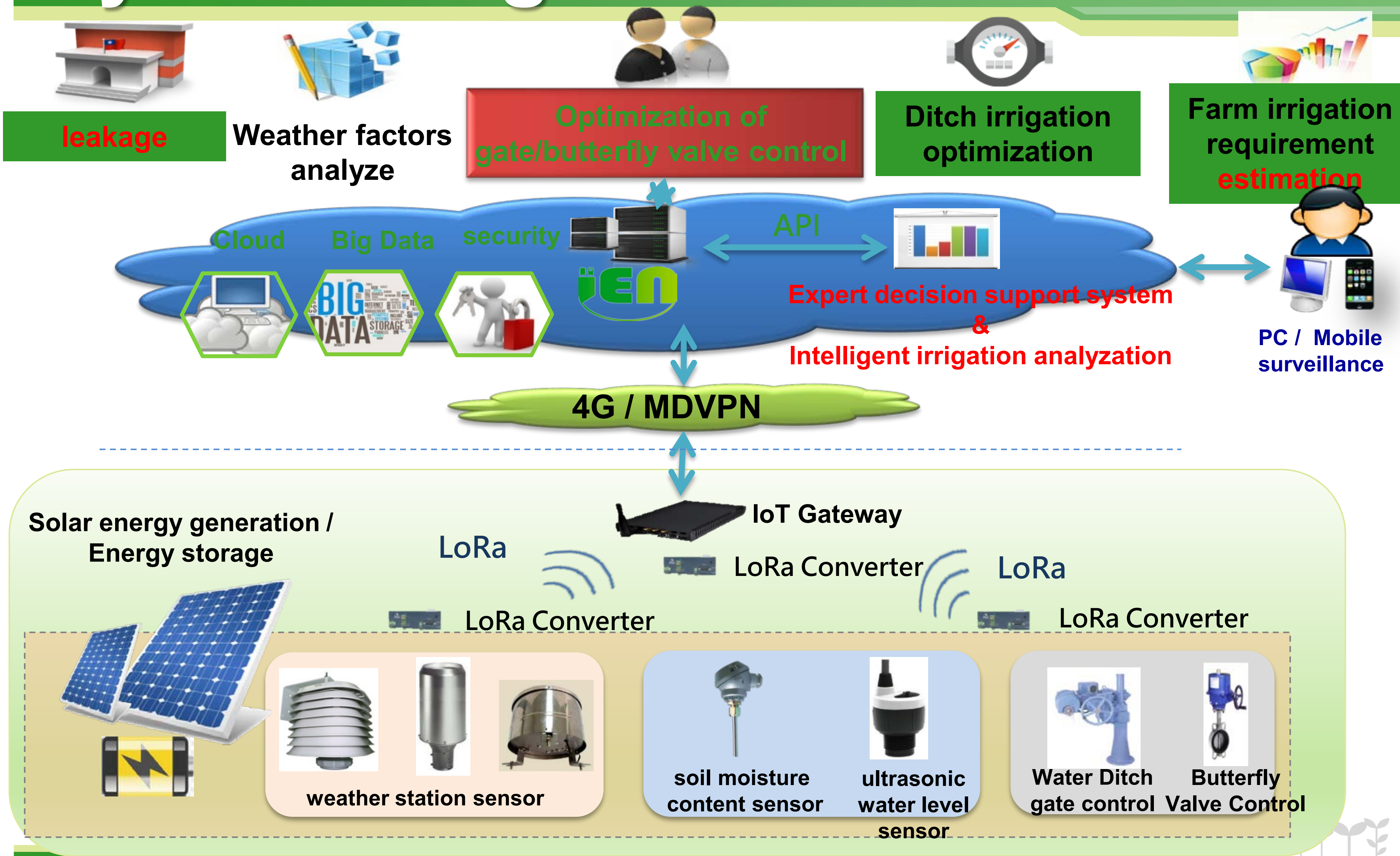


Decision platform

- **Monitoring**：**Ditch water level** and **estimated water flow**
- **Controlling**：**Opening percentage** of the ditch gate
- **Expert decision**：**Optimized irrigation amount**.

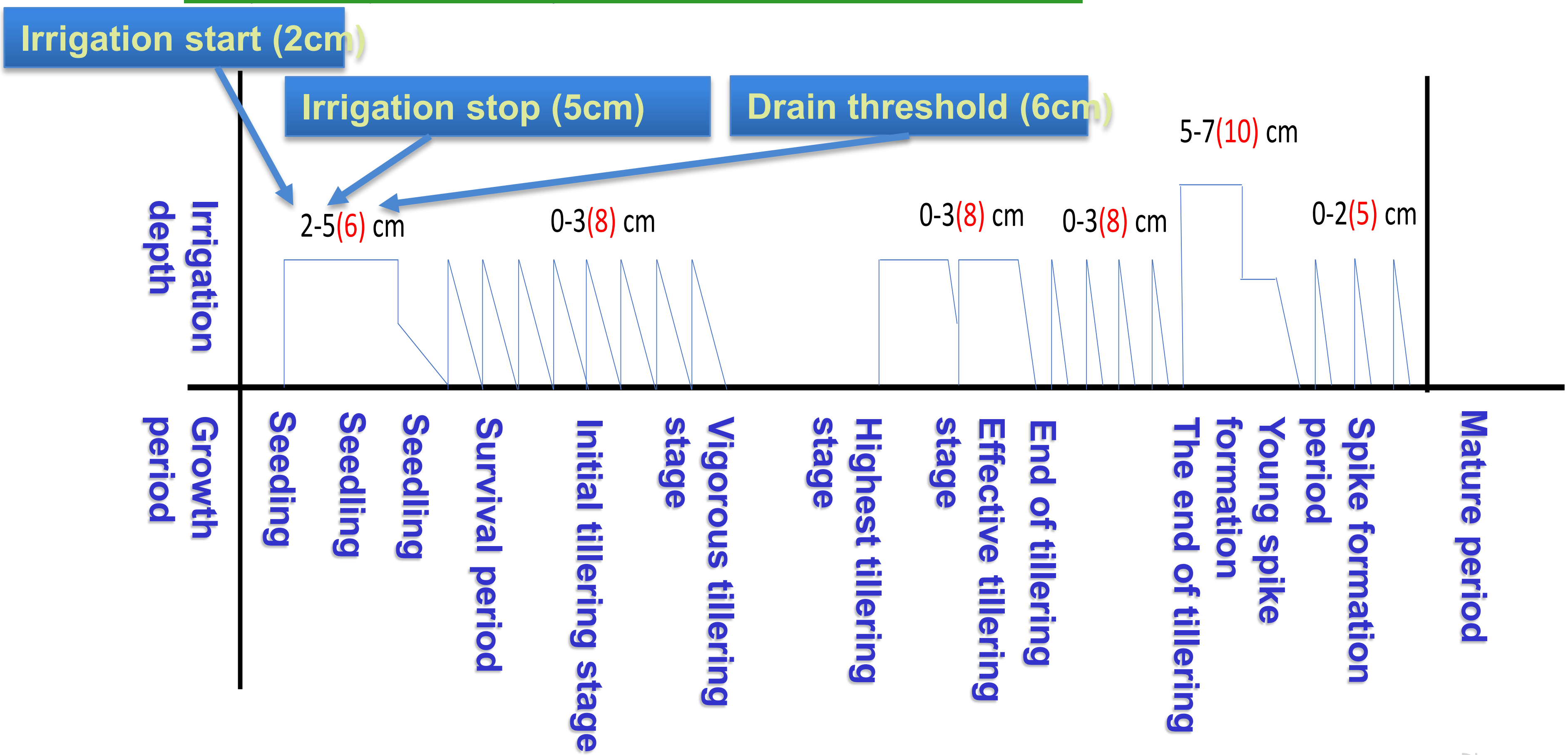


System Diagram



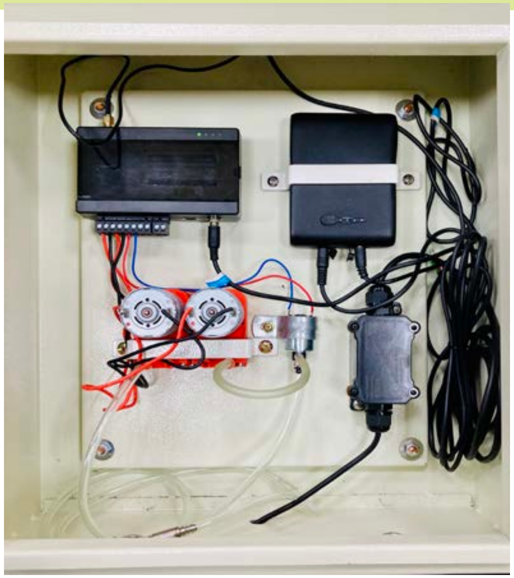
Irrigation Decision

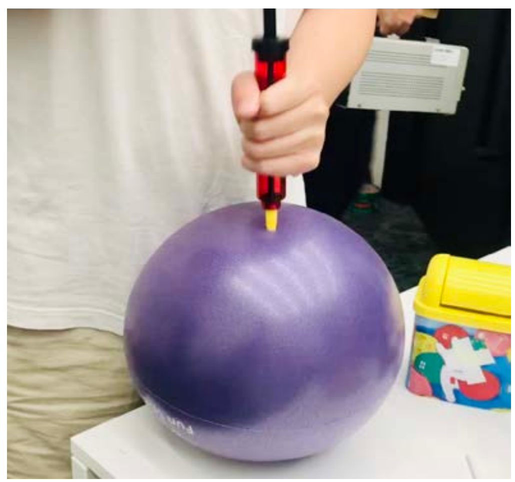
Paddy field water management



Gate Control in Irrigation Canal

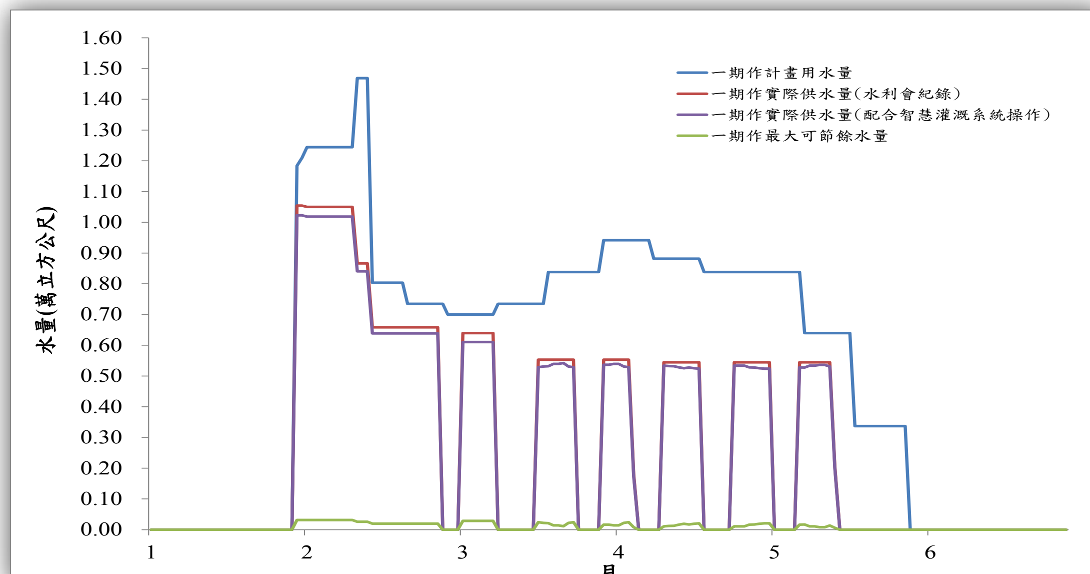
Valve from Canal to Field





Water Saving Results

- Reduced 7.9% irrigation in first crop season
- Reduced 13.3% in second crop season
- Average 1338 m^3/ha water saved in Wushantou reservoir
- Equivalent 18 days water consumption for Tainan city



Highlights of project

- Cross-department integration

經濟部水利署 Water Resources Agency, MOEA

行政院農業委員會 COUNCIL OF AGRICULTURE, EXECUTIVE YUAN

- Win-win strategy for agriculture and science park

行政院農業委員會農田水利署 Irrigation Agency, Council of Agriculture, Executive Yuan 嘉南管理處

南部科學園區 SOUTHERN TAIWAN SCIENCE PARK

- Cultivation of smart water industry (IoT, sensors, control chips, automation, etc.)

中華電信 Chunghwa Telecom

tsmc 灣積體電路製造股份有限公

國立成功大學 National Cheng Kung University

九品股份有限公司 水工機械：攔污機、閘門、吊門機

Conclusions

- Smart irrigation is a solution to climate change and extreme weather condition
- Smart irrigation need to balance the water savings and costs
- Agriculture and Industry not necessary to compete for water, but collaborate to save water (win-win situation)





Thank You!

Qwater

High Mobility Water Purification System

康淳科技股份有限公司
CONCORD TECHNOLOGY CO., LTD.

3	4	5
Goals	Applications	Features

Goals

Reliable + Potable + Sanitary

Applications


Rural Area


Emergency

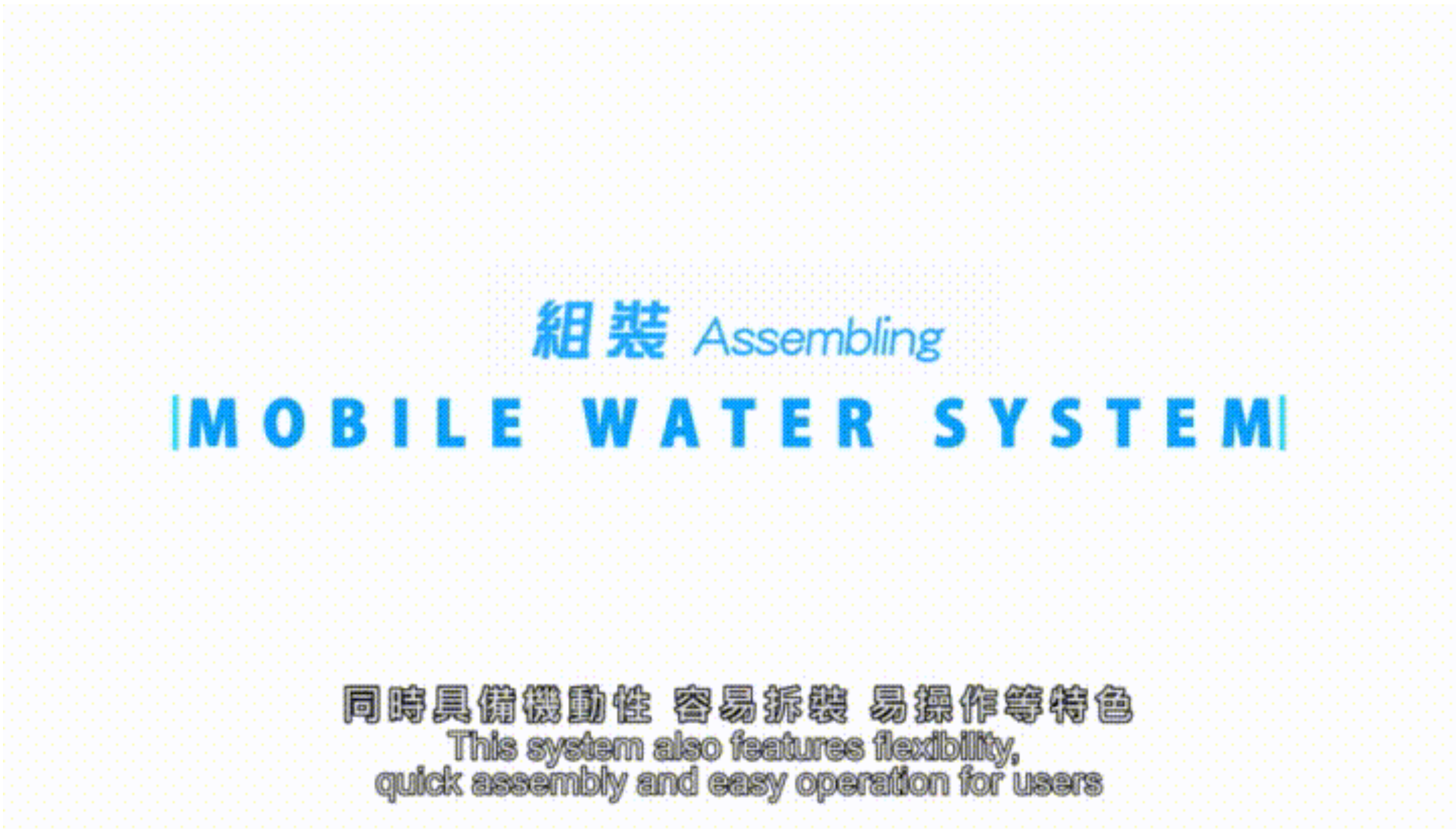

Desalination


Natural Water

康淳科技股份有限公司
CONCORD TECHNOLOGY CO., LTD.

Features-Quick Assembly

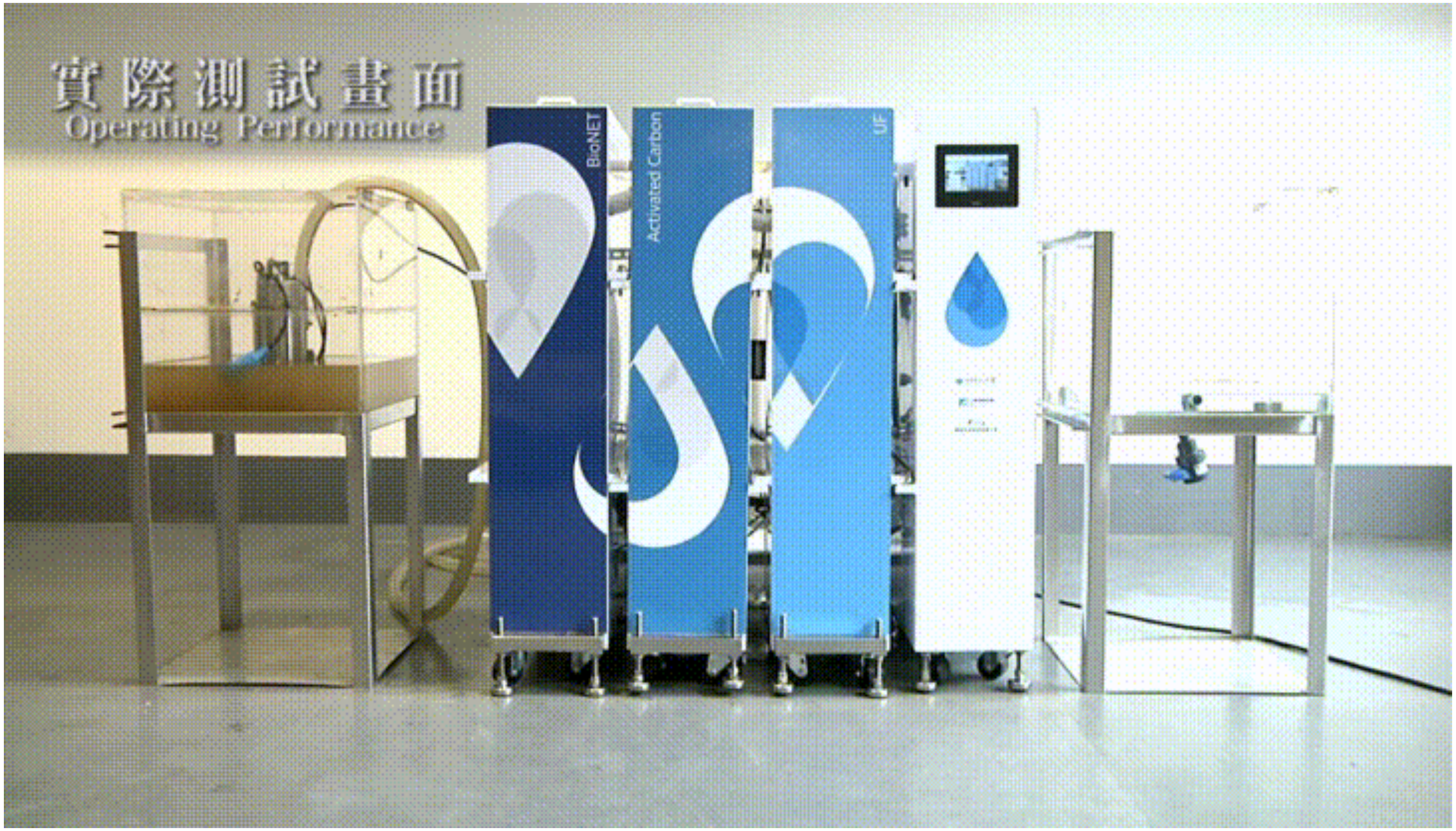
Assembly can be completed within 90 minutes by two operators, and 30 minutes by professional operators



康淳科技股份有限公司
CONCORD TECHNOLOGY CO., LTD.

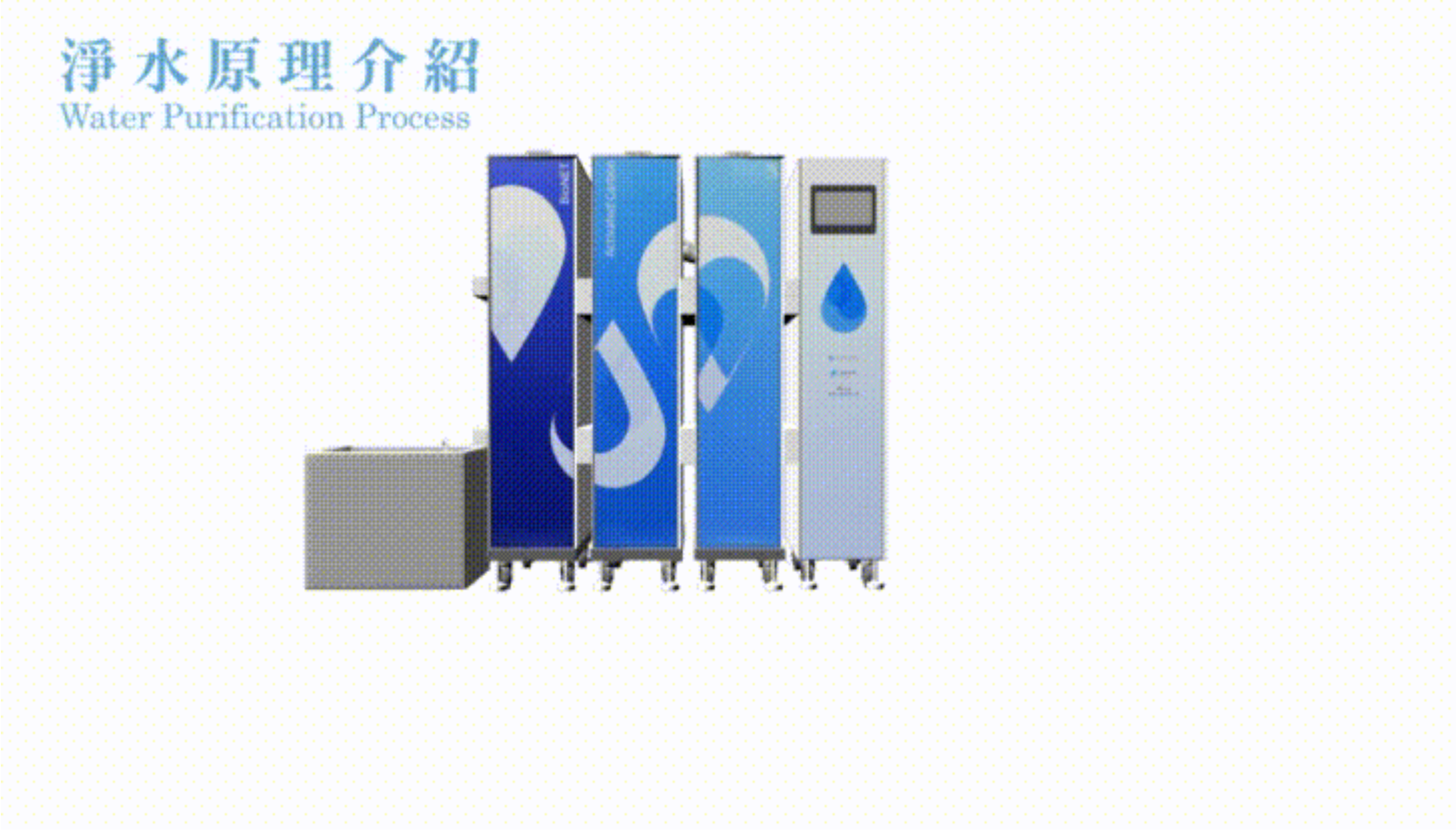
Features-Stable Production

Serving 5000 L/d for roughly 2000~2500 people per day



Features-Modularized

Parallel modules flow upon gravity makes it power efficient.



Features-Simple Operation

Fully automatic with user-friendly HMI touch screen

Features-Flexible

Compact design makes it easy to transport or modified.

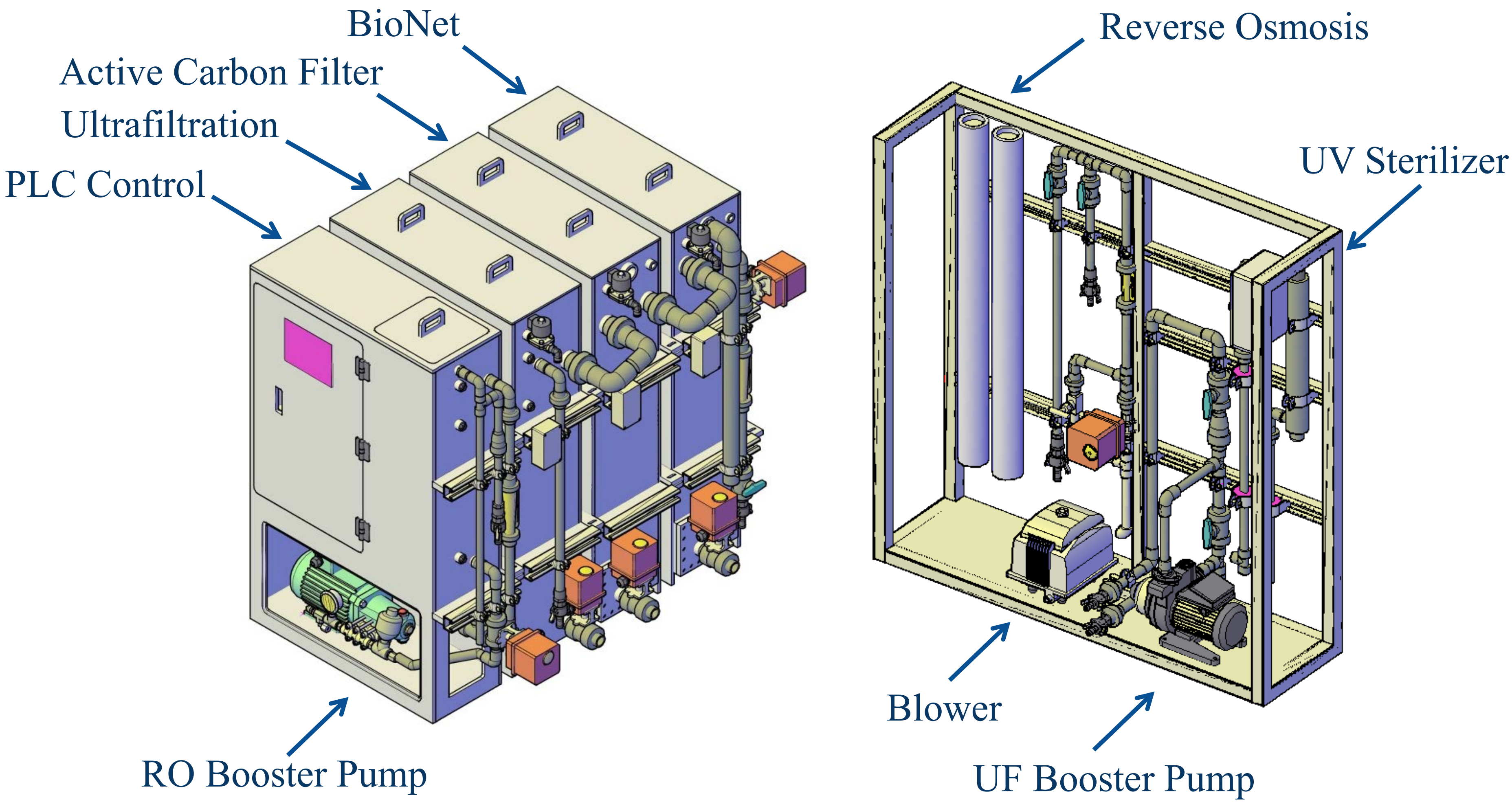
CONCORD 康淳科技股份有限公司
CONCORD TECHNOLOGY CO., LTD.

Specifications

Capacity 10 m³/d	Power 3.5 kW/h	UF + RO
BioNet	Voltage 220-380V	Weight 300 kg
Length 1500mm	Width 1600mm	Height 1550mm

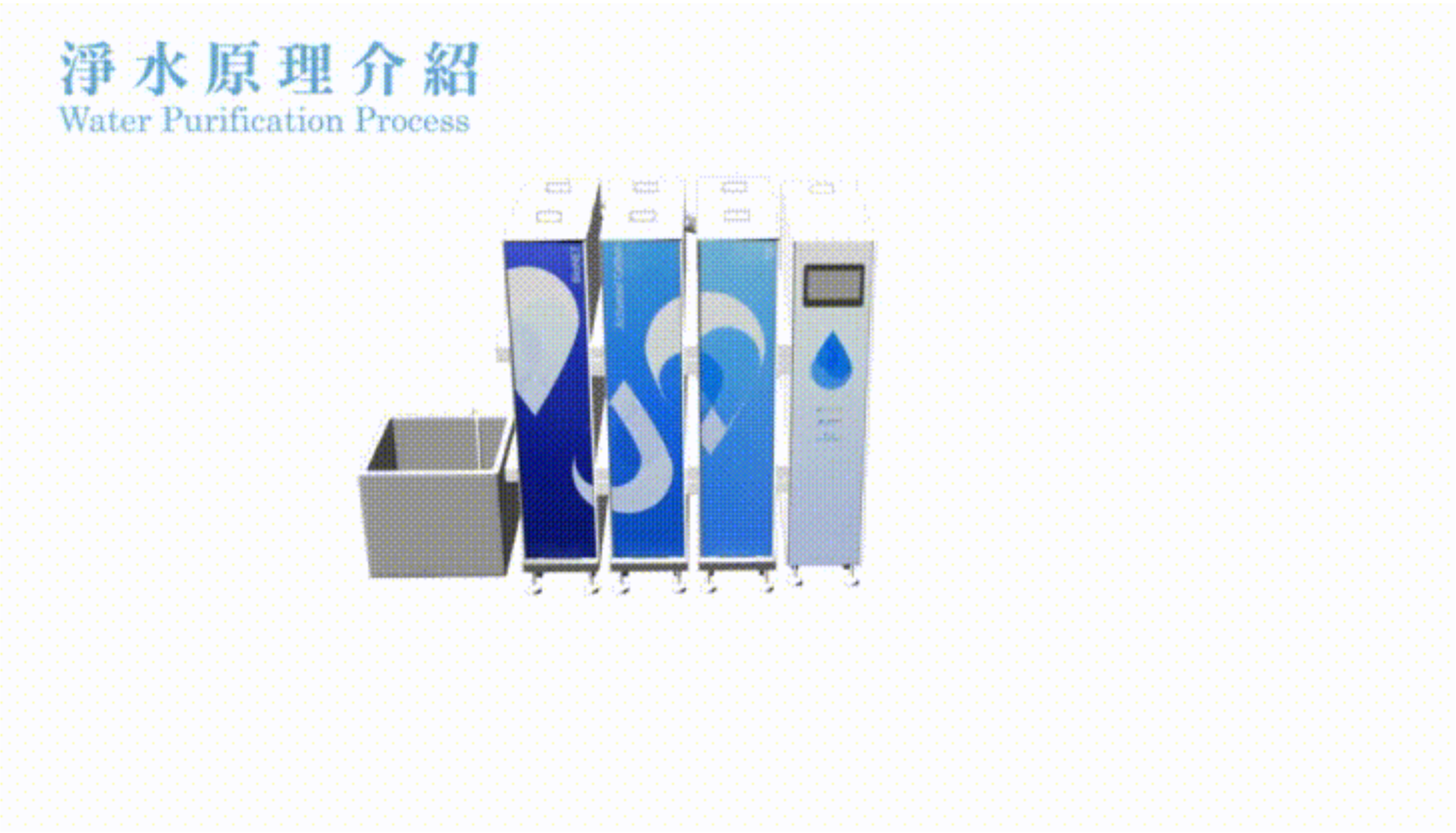
康淳科技股份有限公司
CONCORD TECHNOLOGY CO., LTD.

Layout



BioNet
Active Carbon Filter
Ultrafiltration
PLC Control
RO Booster Pump
Reverse Osmosis
UV Sterilizer
Blower
UF Booster Pump

Process



Gallery

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Gallery

Thank You !

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