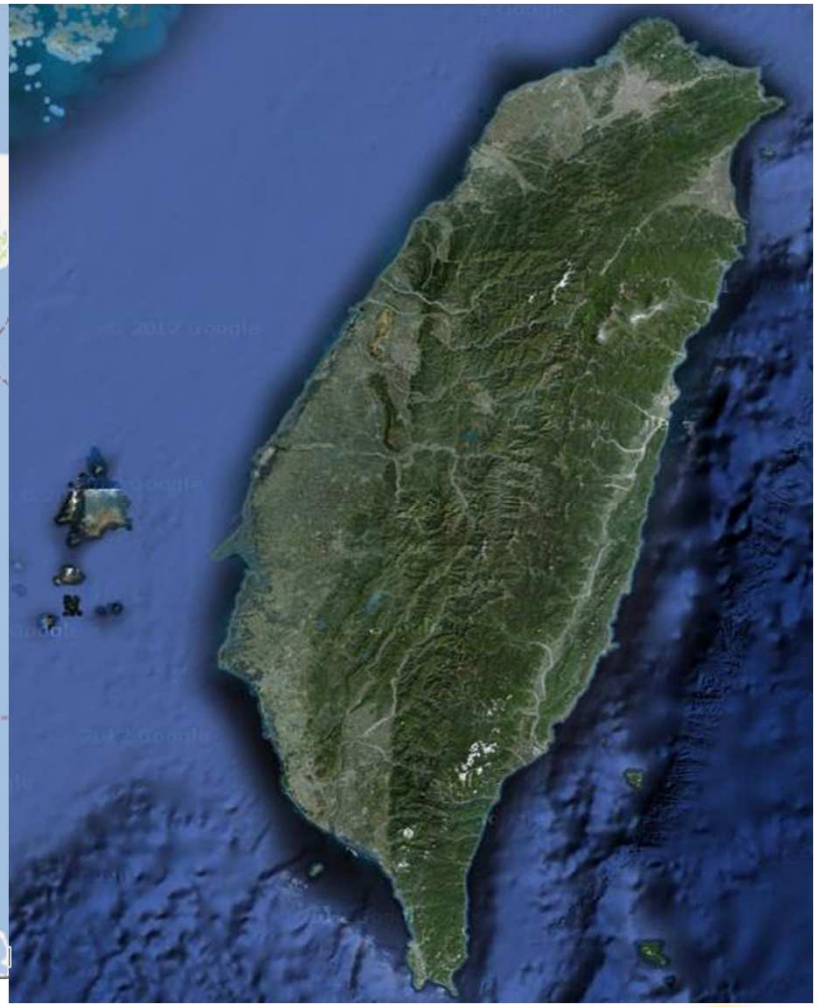
HydroPredict'2012

Distributed Adaptive Capacity Building to Reduce Climate Change Impacts on Water Supply Systems

Ching-Pin Tung, Tzu-Ming Liu, Wan-Yu Lien, Chia-Yu Lin, Wei-Ting Liao

Bioenvironmental Systems Engineering
National Taiwan University

Location-Taiwan



Changes in Climate in Taiwan

- Main Island of Taiwan has area of 36,000 km^2.
- Temperature has been increased 0.7~1.4 ^oC in the past 100 years.
- Annual precipitation does not change significantly.
- However, difference between dry (winter and spring) and wet season (summer) increases significantly.
- Besides, rainfall intensity become stronger and dry day lasts longer.

More Frequent and Intensive Extreme Events

Flooding in Taipei
Sept. 17, 2001
Return Period of Rainfall more than 150 years

Drought in Taipei Area
Spring, 2002

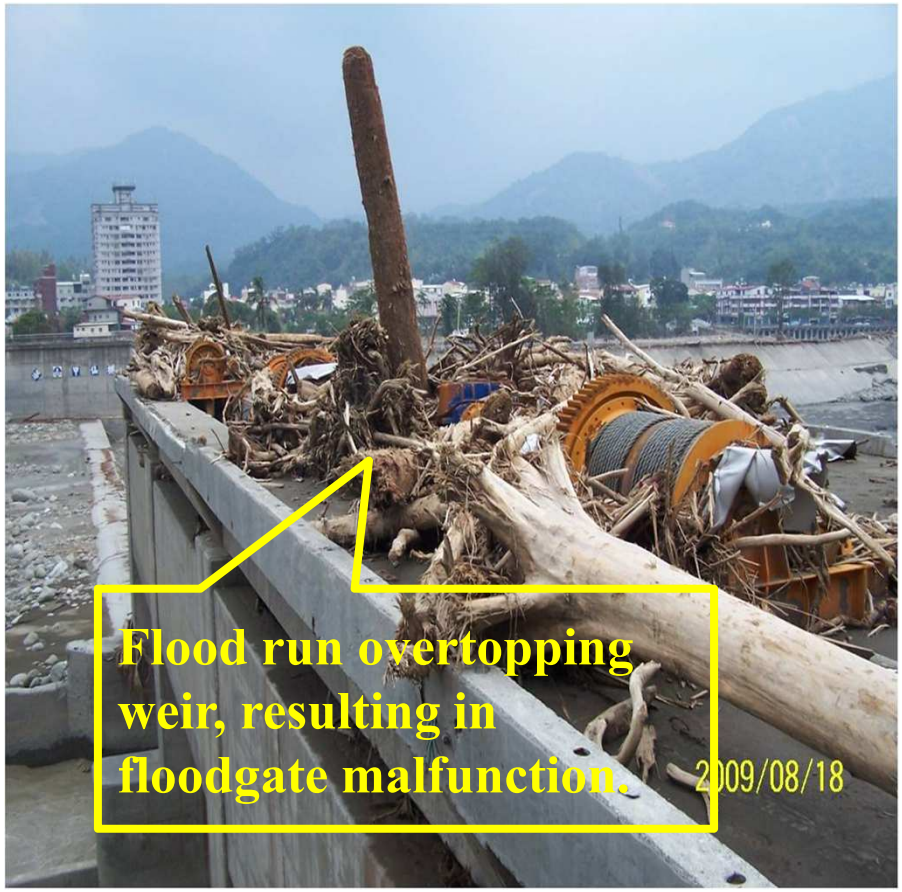
Shihmen Reservoir

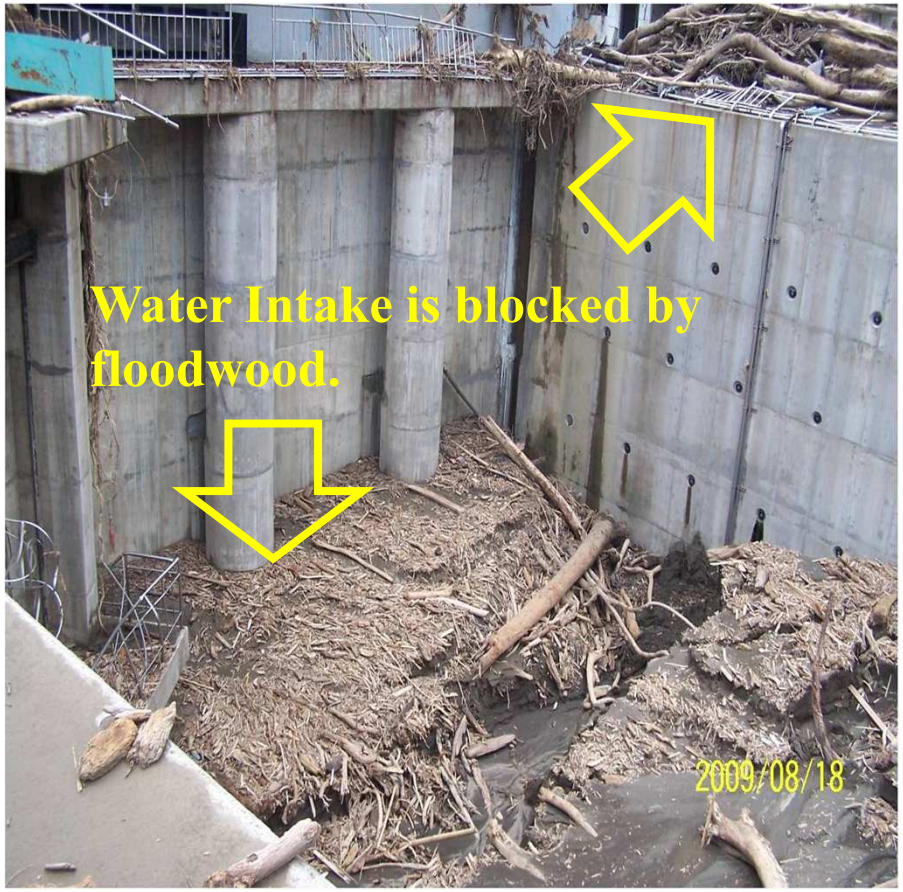
High Flow with High Turbidity, but Low Water Supply

Typhoon Morakot
August 7-8, 2009

ChiaXian Weir

(2009／8／18, ten days after typhoon)





Typhoon Morakot

- The Typhoon Morakot intruded Taiwan during 7th to 8th in 2009 and brought about 2,700 mm total rainfall.
  - The annual rainfall in Taiwan is about 2,550mm.

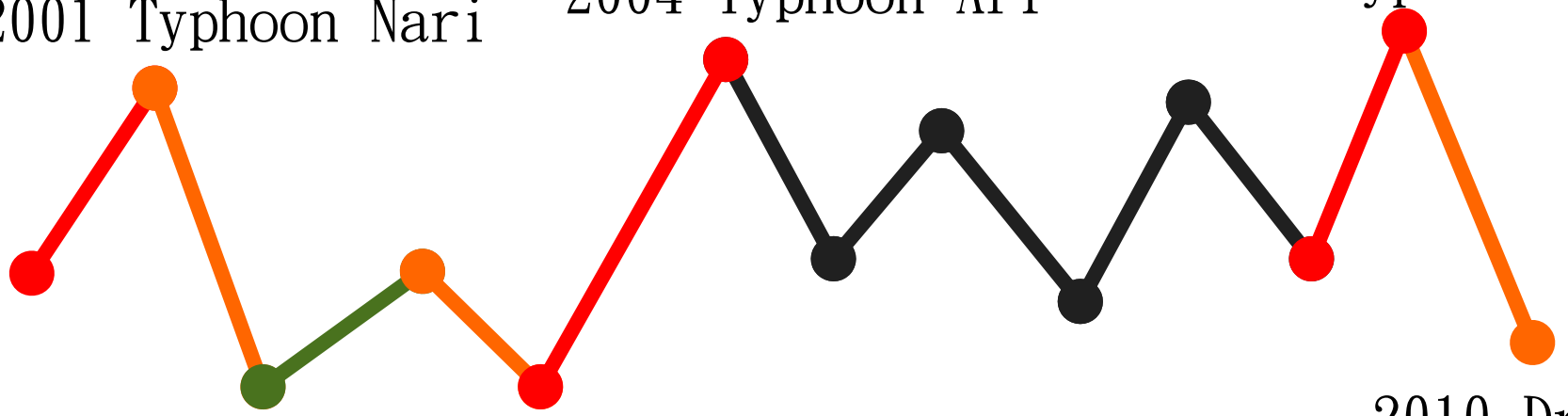
http://www.boston.com/bigpicture/2009/08/typhoon_morakot.htm

http://img200.imageshack.us/img200/961/shiaolinaftermorakot.jpg

2001 Typhoon Nari

2004 Typhoon Ari

2009 Typhoon Morakot



2002、2003 Drought

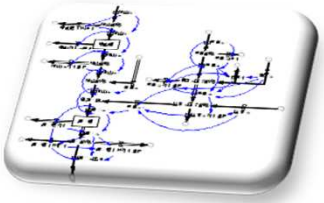
2010 Drought

Facts Learned From Climate Change Study

- Climate change may cause more frequent and intensive drought and flood events.
- Uncertainty limits adaptation plans, which requires better projection skills and more flexible measures.
- Centralized system has less flexibility, though it has more effectiveness.
- Distributed adaptive capacity building is required to increase flexibility.

Goals

Smart Living with Changing Climate



Strategies on hotspots

- Reduce the vulnerability of hospots
- Strengthen resilience of system

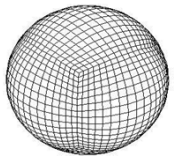
Water resources vulnerability map

- Find where the hotspots are
- Find where the vulnerability from

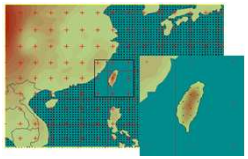
Goals

- Evaluate spatial distribution of vulnerability for a water supply system
- Identify hotspot (the most vulnerable areas and reasons to cause vulnerability)
- Develop distributed response systems and increase resilience

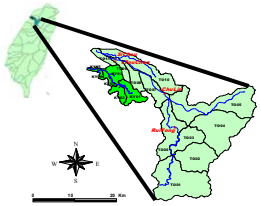
Procedure for Impact Assessment



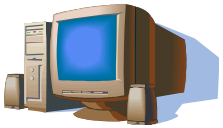
GCM Projections



Downscaling



Future
Climate Scenarios

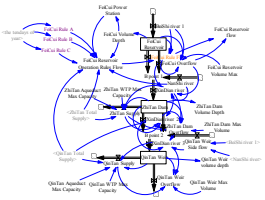


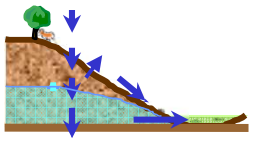
Weather Generation

Hydrological Model

Water Supply System
Dynamics Model

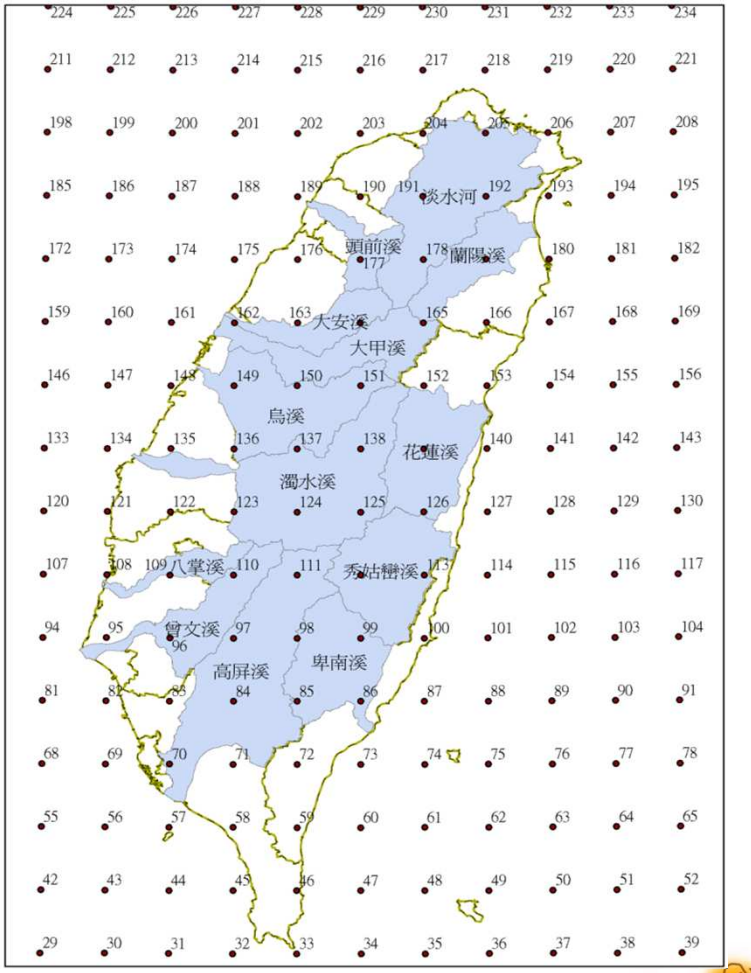
Impact Inoformation for Decision Making



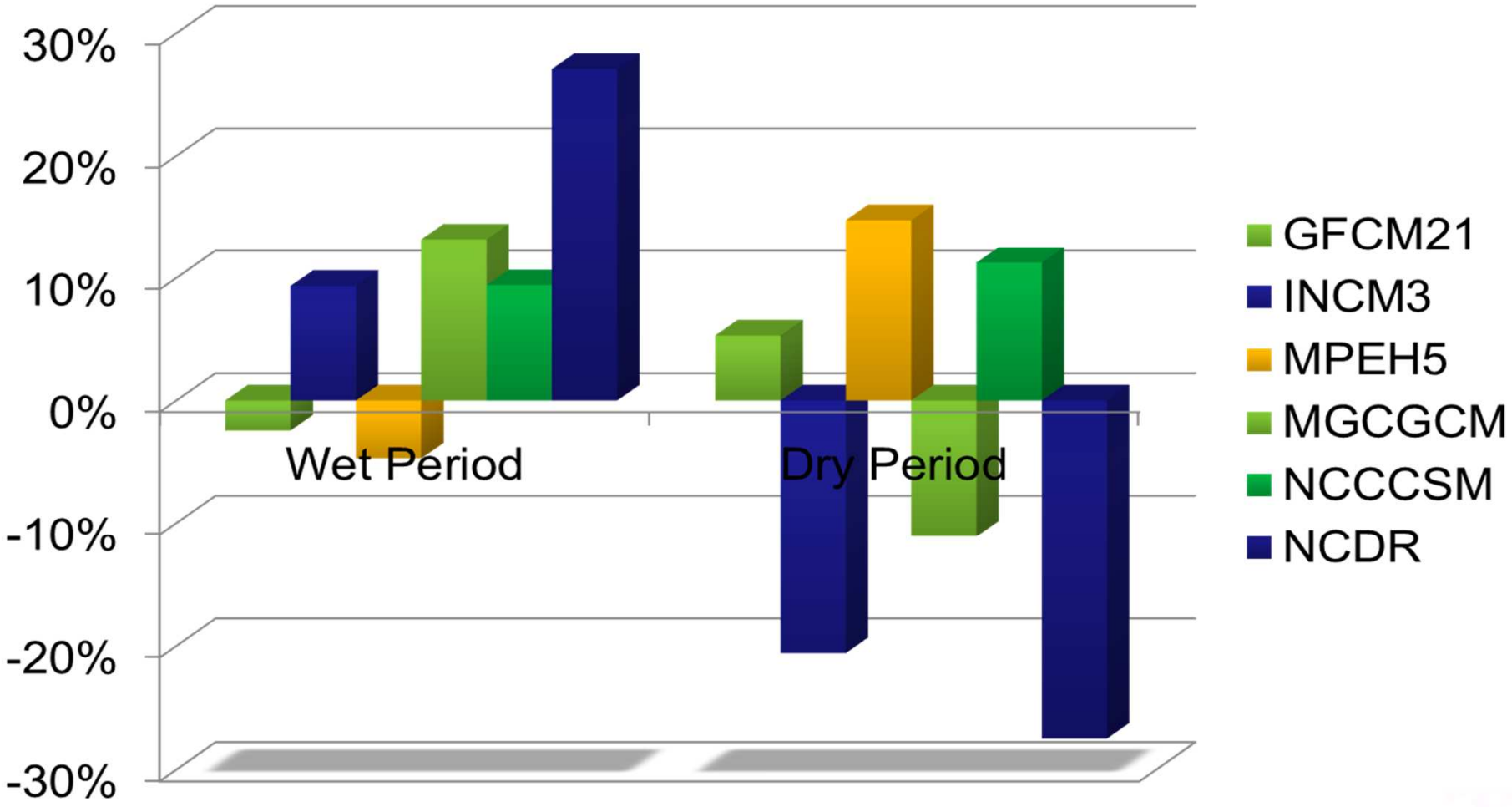


Downscaled GCMs ensmeble

- Downscaled by the **N**ational Science and Technology **C**enter for **D**isaster **R**eduction (NCDR) in Taiwan.



Projections of GCM and ensemble result (A1B scenario)



Tool for assessment

Taiwan Water Resources Assessment Program to Climate Change (TaiWAP)

http://groups.google.com.tw/group/taiwap2

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Google 網上論壇

氣候變遷對水資源衝擊評估模式 TaiWAP

首頁 上次之後的更新： 3 則留言

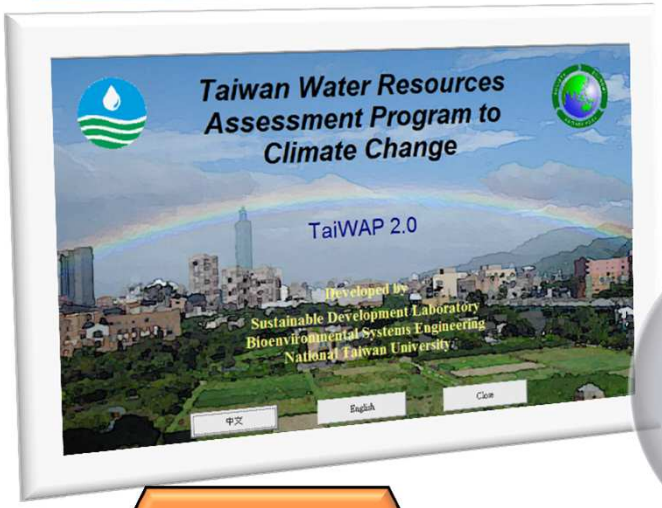
Taiwan Water Resources Assessment Program to Climate Change

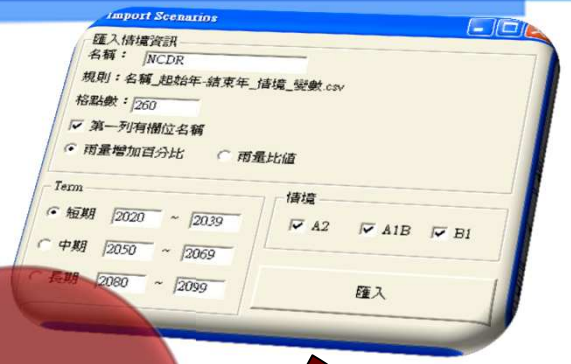
有關TaiWAP的問題討論與解答以及版本更新均會在此發布。
Welcome! Here is the board for the announcement and discussion of TaiWAP.
如果你對TaiWAP有興趣，請加入此群組。
If you are interested in TaiWAP, please join this group.
任何討論內容或版本更新通知都會自動傳送至您的 email。
All the discussion and announcement will be sent to your email.

Download TaiWAP

TaiWAP與氣候變遷評估說明請點此下載(ppt)
TaiWAP and Climate Change Download(ppt in Chinese)
GWLF參數資料請點此下載(MS Word)
Parameters of GWLF in Taiwan Download(MS Word in Chinese)
氣象資料合成模式說明請點此下載
About weather generator in TaiWAP Download (MS Word in Chinese)

Components of TaiWAP





GCMs
NCDR

Trend Analysis

AHP Tool

Downscaling & Weather Generation

Assessment Tool

System Dynamics Model

Uncertainty Analysis

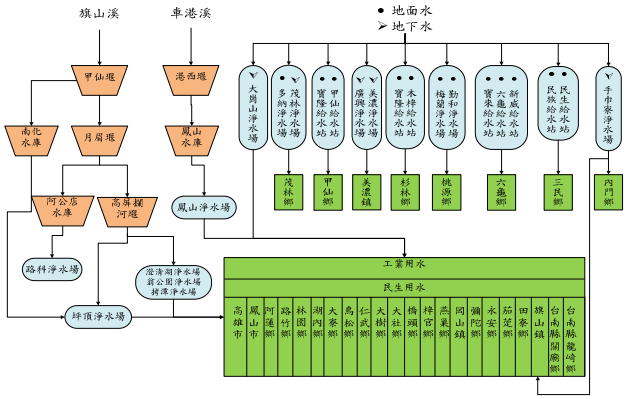
Hydrological Model & Water Demand

Study area-Kaohsiung

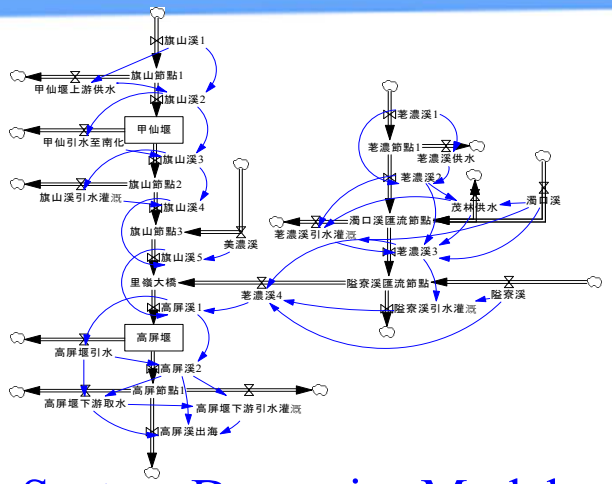
- The second largest city in Taiwan
- Population around 2.9 million
- Total area : 2,946km^2

Sustainable Developmen

Flowchart of making water resources vulnerability map

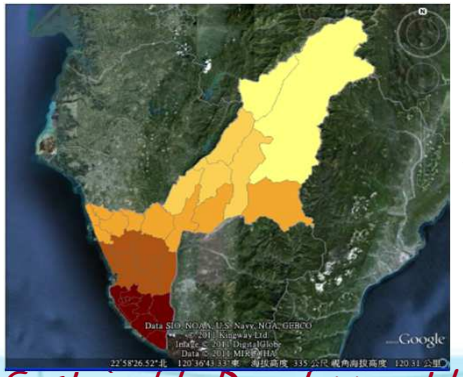


Water Supply System

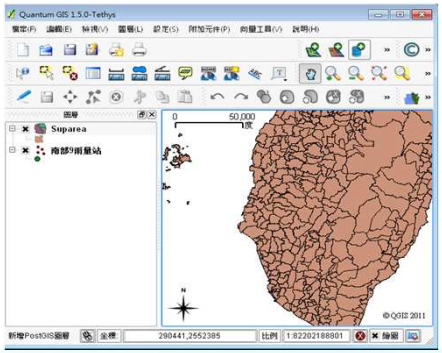


System Dynamics Model

Google Map



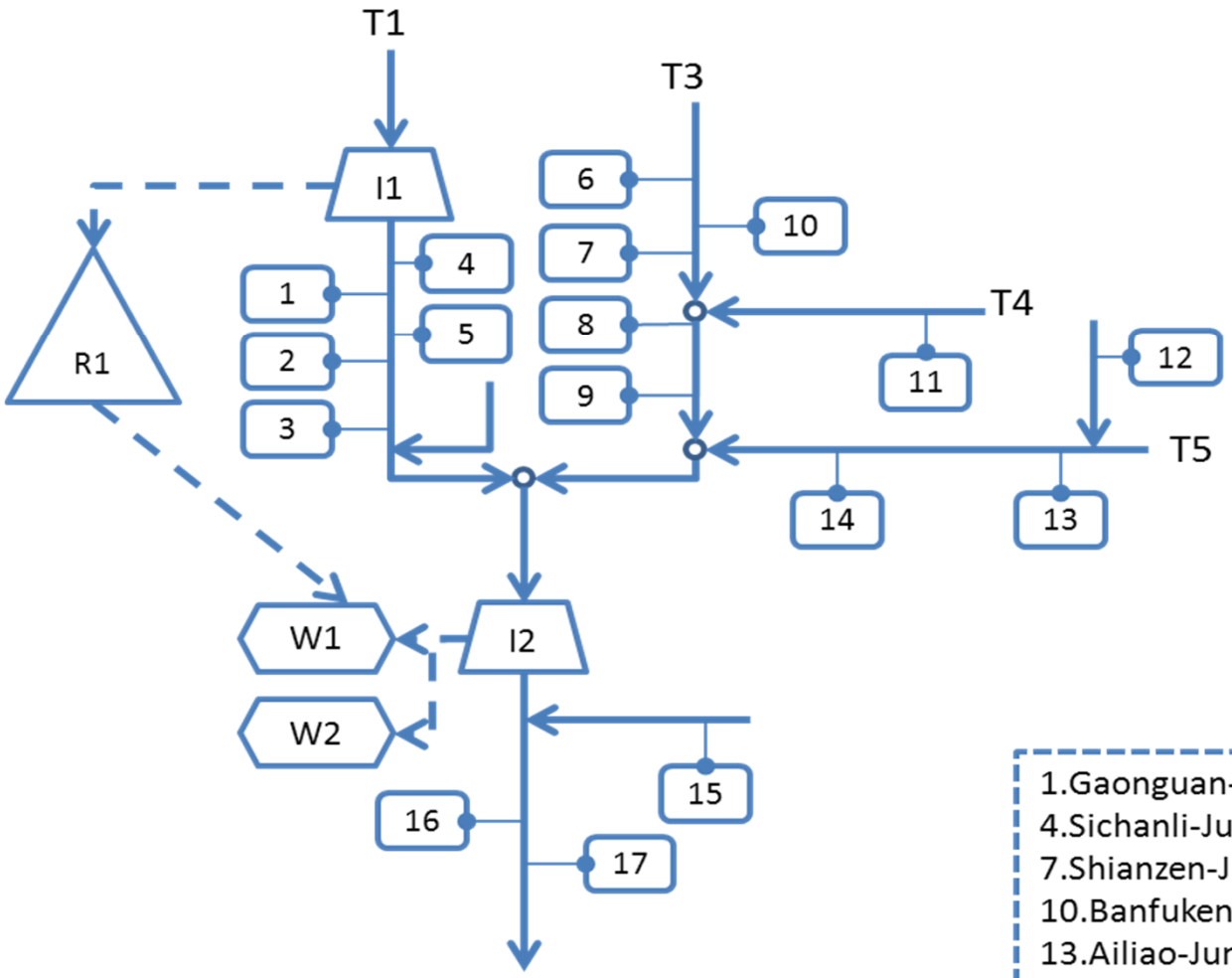
GIS



Data Sheet Output

供水分區	缺水風險	人口
高雄市	0.7	######
鳳山市	0.3	######
路竹區	0.3	######
林園區	0.1	######

Water supply system



Pipe

Tributary

T1 : Cishan River
T2 : Meinong River
T3 : Laonong River
T4 : Jhuokou River
T5 : Ailiao River

Reservoir

R1 : Nan-hua reservoir

Intercept Weir

I1 : Chiahsien weir
I2 : Gaoping weir

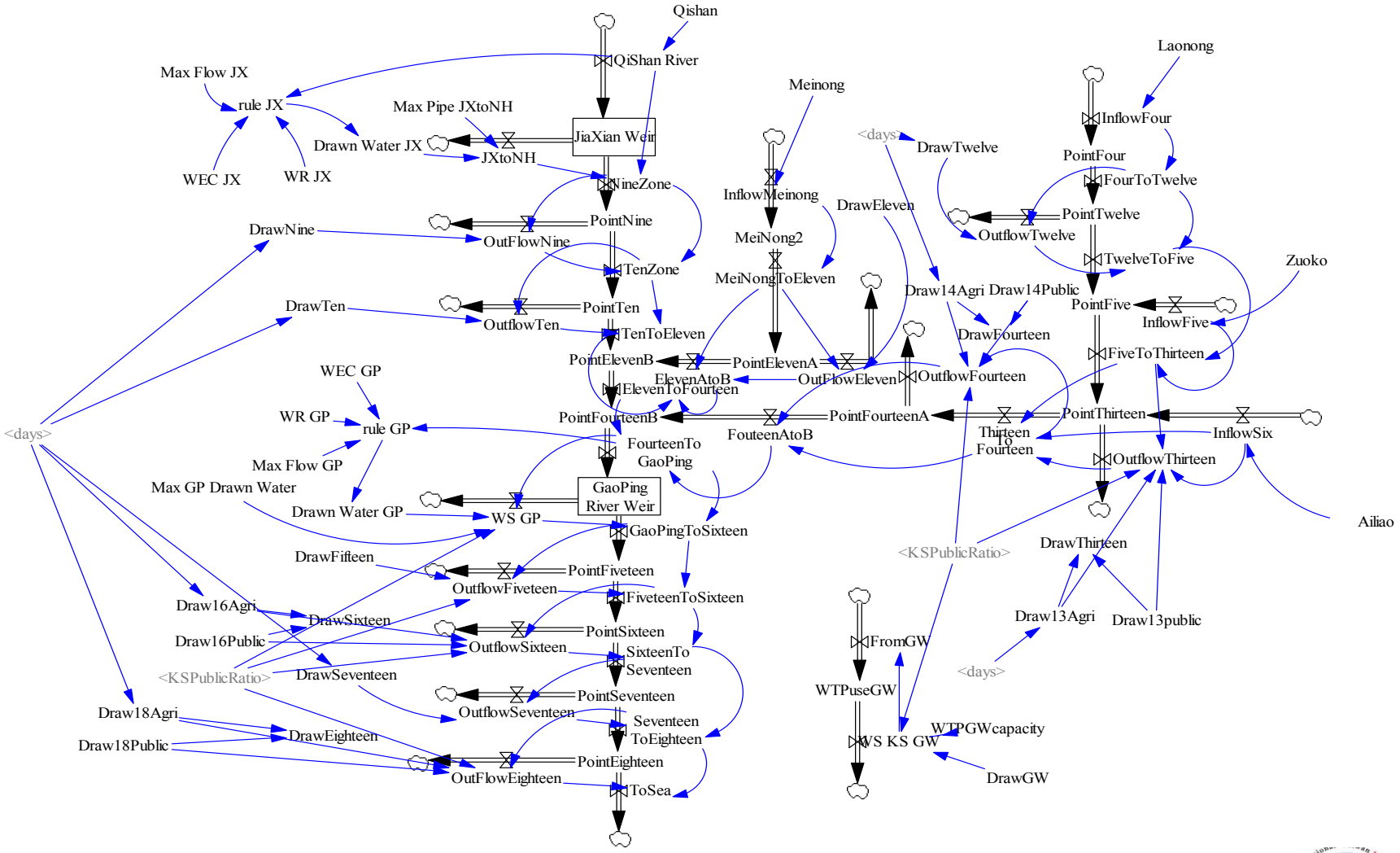
Water purification plant

W1 : Pinding
W2 : KS series

Irrigation area

1.Gaonguan-Jun, 2.Banchihu-Jun, 3.Cishan-Jun,
4.Sichanli-Jun, 5.Banwupo-Jun, 6.Shanjensi-Jun,
7.Shianzen-Jun, 8.Shiztou-Jun, 9.Gueyshan-Jun,
10.Banfuken-Jun, 11.Joulioa-Jun, 12.Taishan-Jun,
13.Ailiao-Jun, 14.Ligan-Jun, 15.Conlan-Jun,
16.Tsaogong-Jun, 17.Wandan-Jun

System dynamic modeling water supply system (VENSIM)

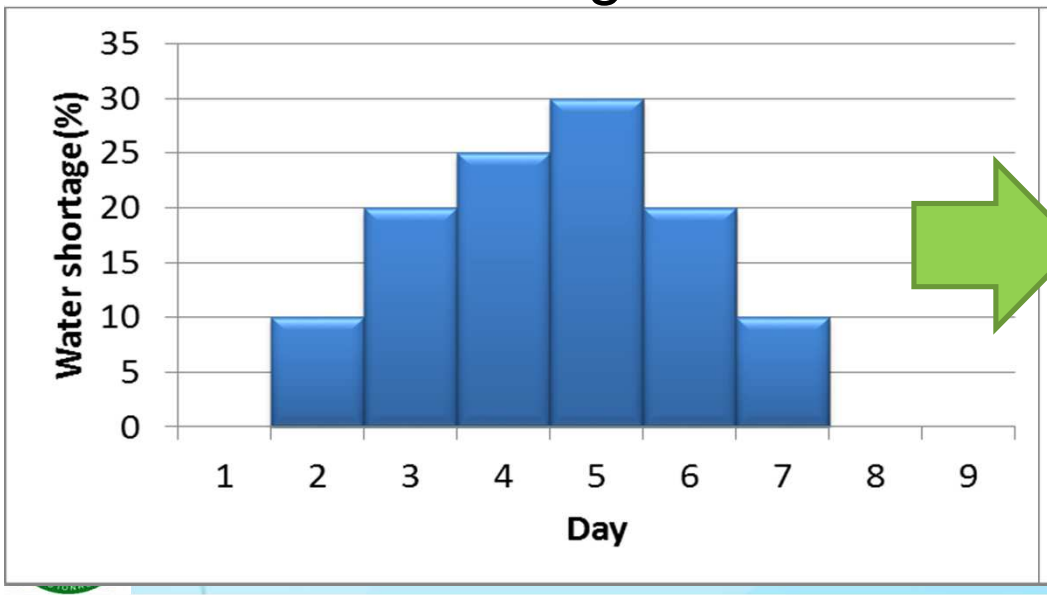


Deficit Percent Day Index-DPD

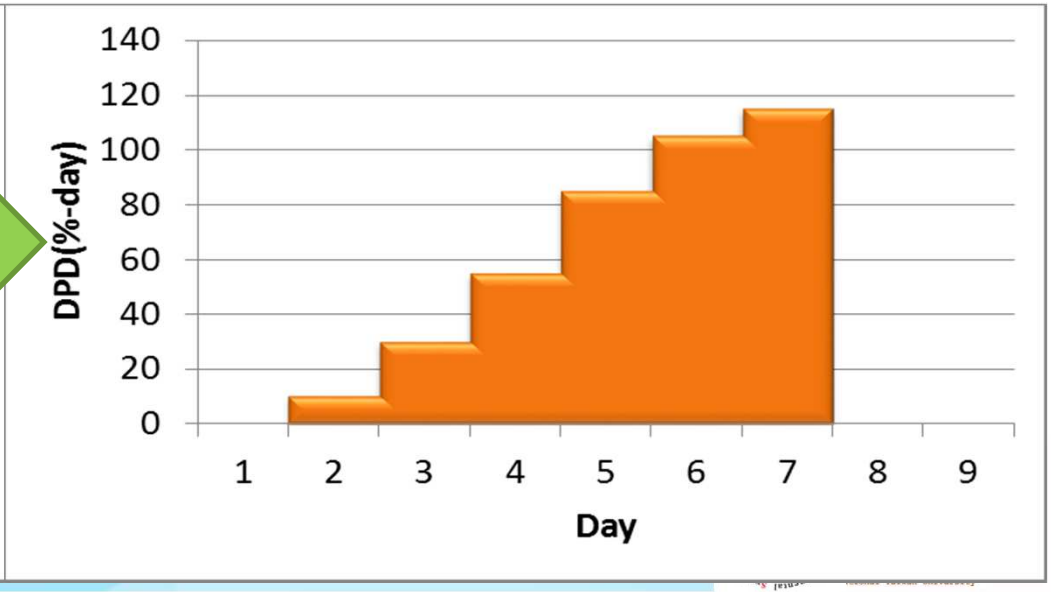
- Japan Water Resources Agency(1977), Hsu(1988)

$$DPD\ (\%-day) = \sum_{i=1}^{N} \frac{D_i - S_i}{D_i} \times 100(\%)$$

Water shortage event

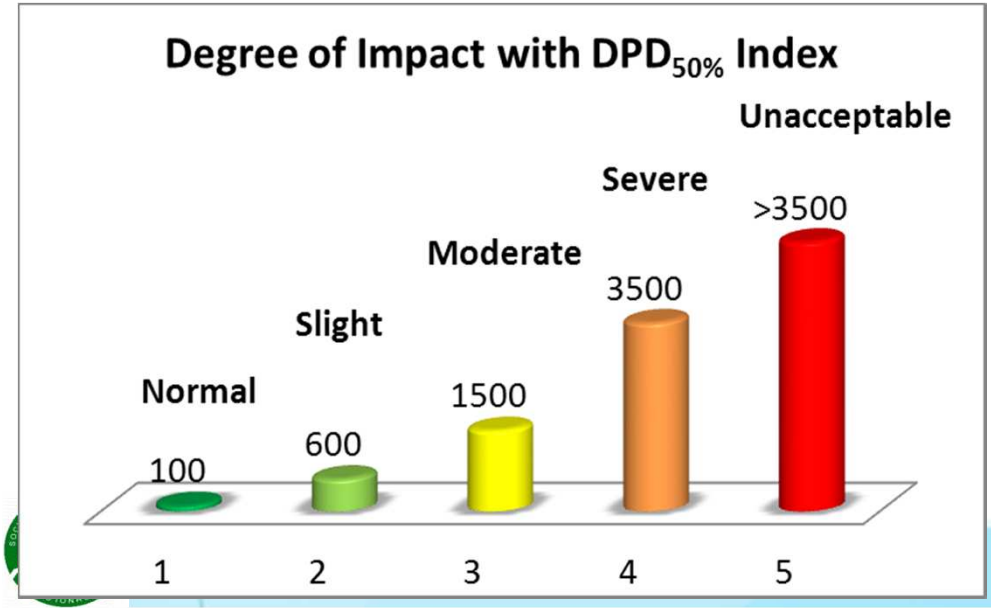


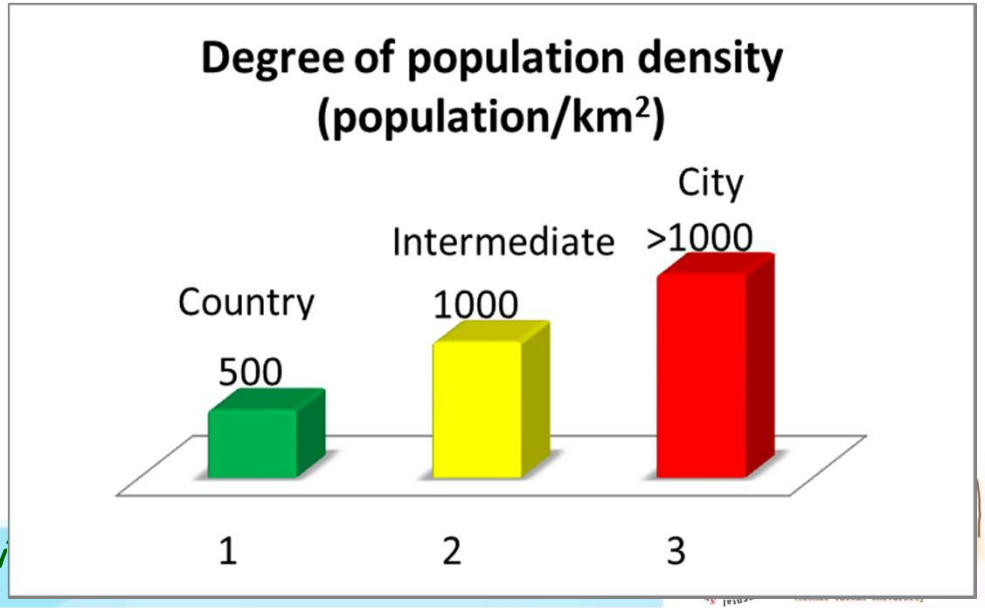
DPD



Degrees of impact and sensitiviity

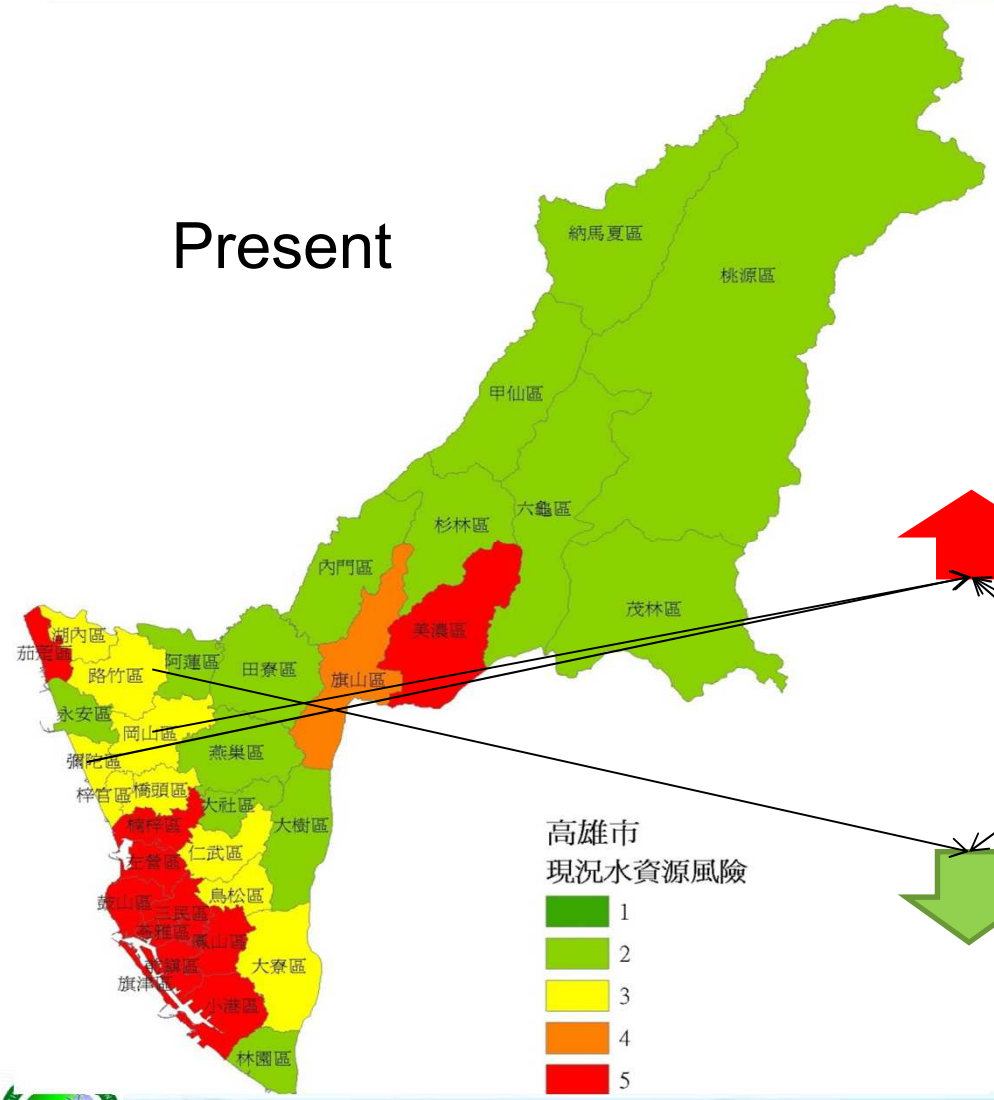
- Use Exceedance Probability=50% of DPD as the Impact Index of water deficit
- Population density as Sensitivity of domestic water
- Industry value of output as Sensitivity of industry water
    - Vulnerability=Impact×Sensitivity



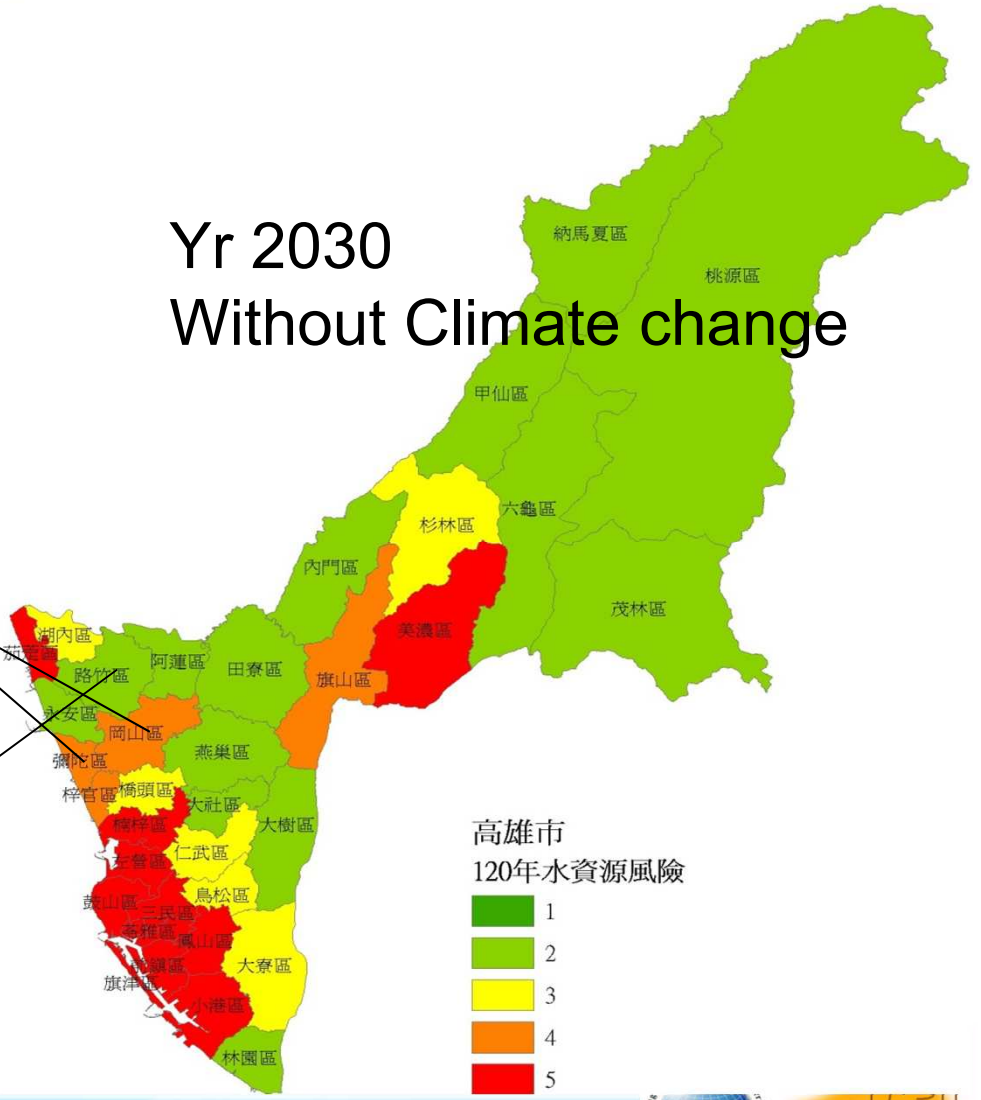


Vulnerability Map without Climate Change

Present

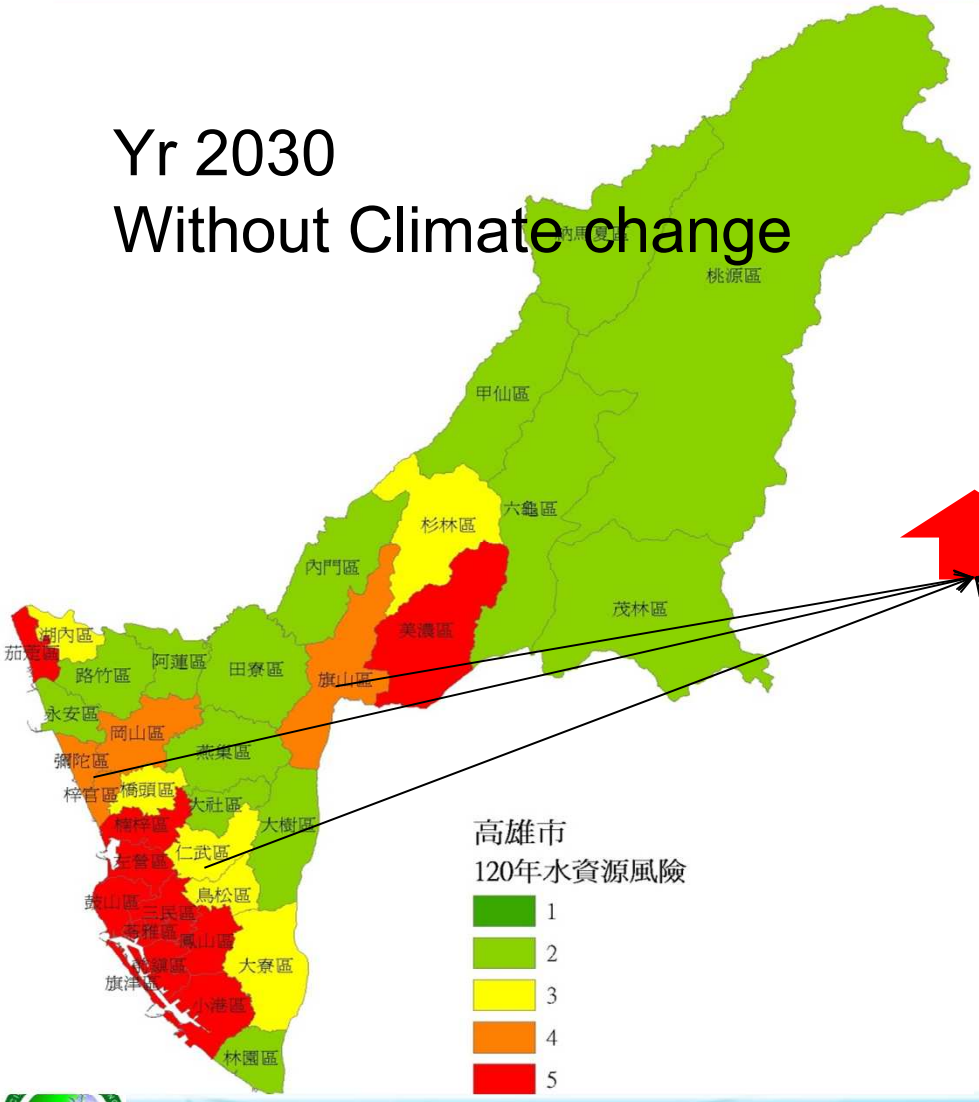


Yr 2030
Without Climate change

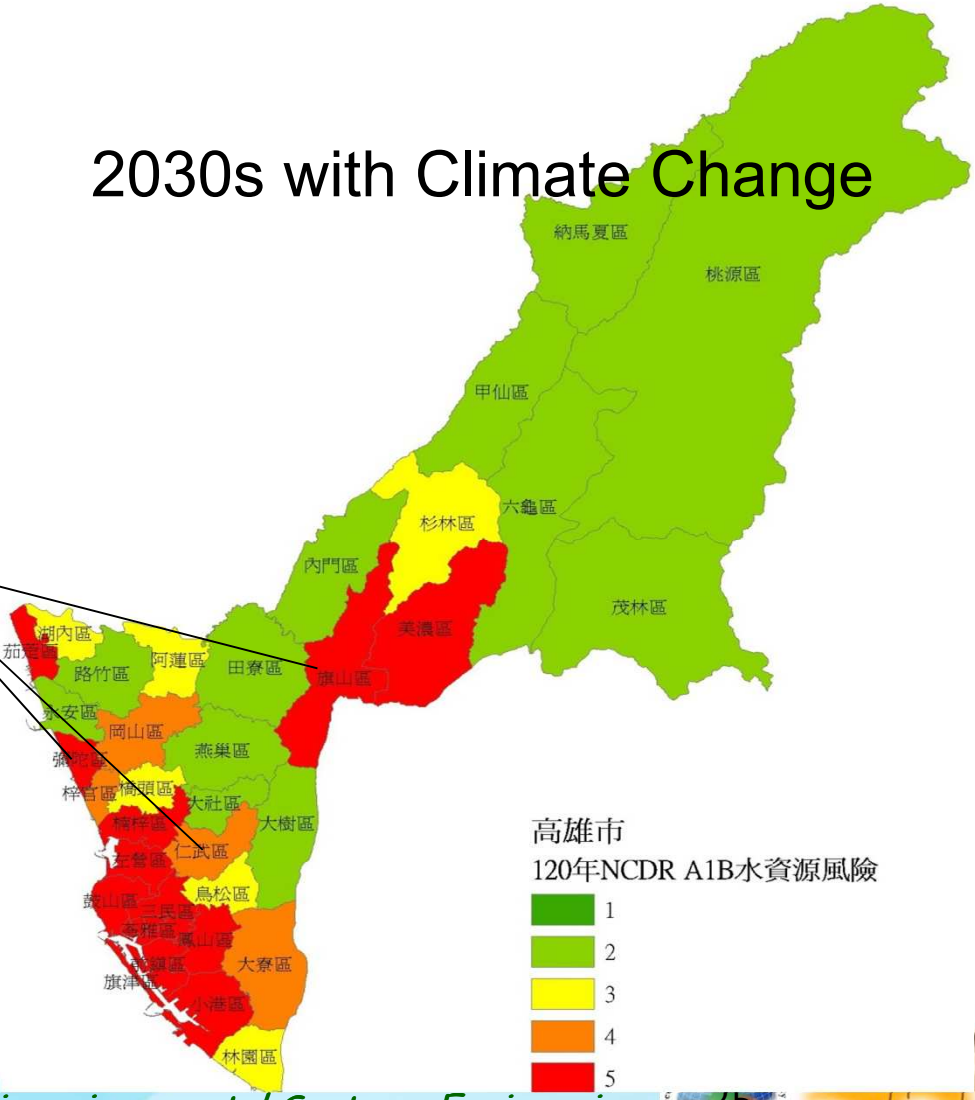


Vulnerability Map for 2030s

Yr 2030
Without Climate change



2030s with Climate Change



Adaptive capacity building

- Reservoir?
  - Huge cost
  - High Impact to ecology
  - Not flexible
  - Not easy to promote
  - Need long time to plan and build
- Distributed response system
  - Low cost
  - Low impact development
  - Flexible
  - Easy to plan
  - Short time for planning

Distributed response facilities

Pumping Well

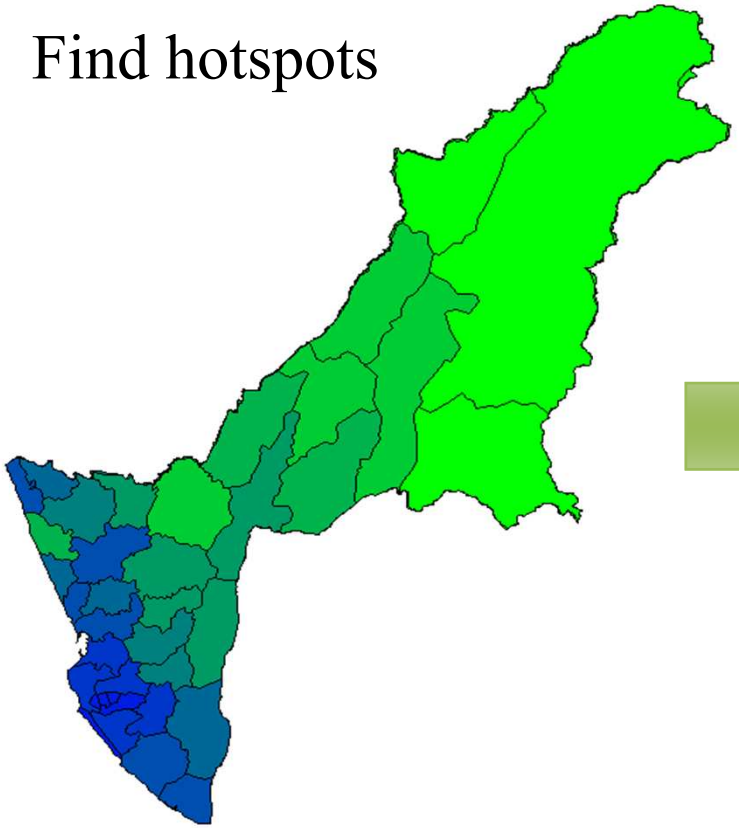
Rainfall Harvesting

Artificial Lake

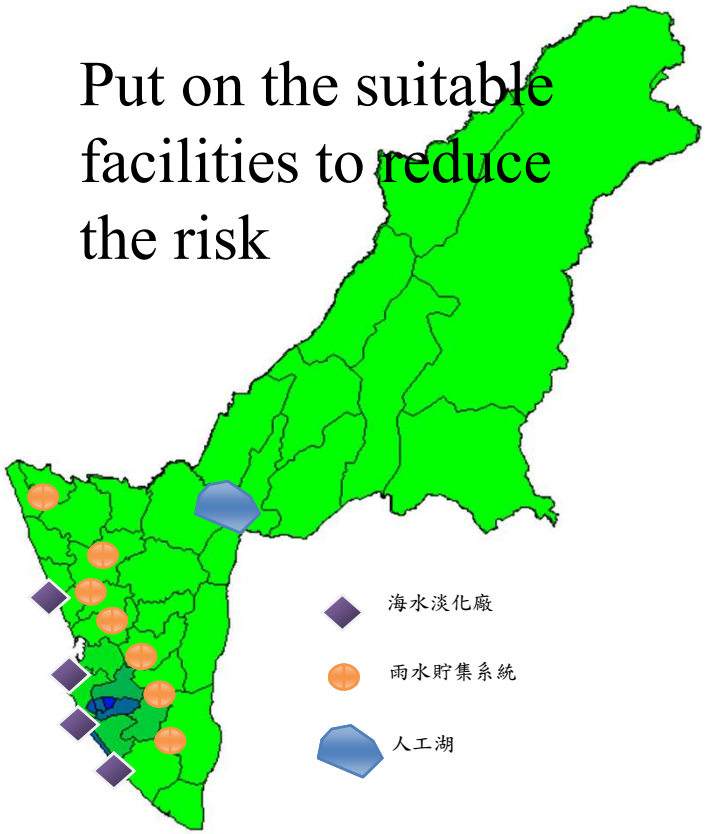
Sea water desalinization

Distributed response system

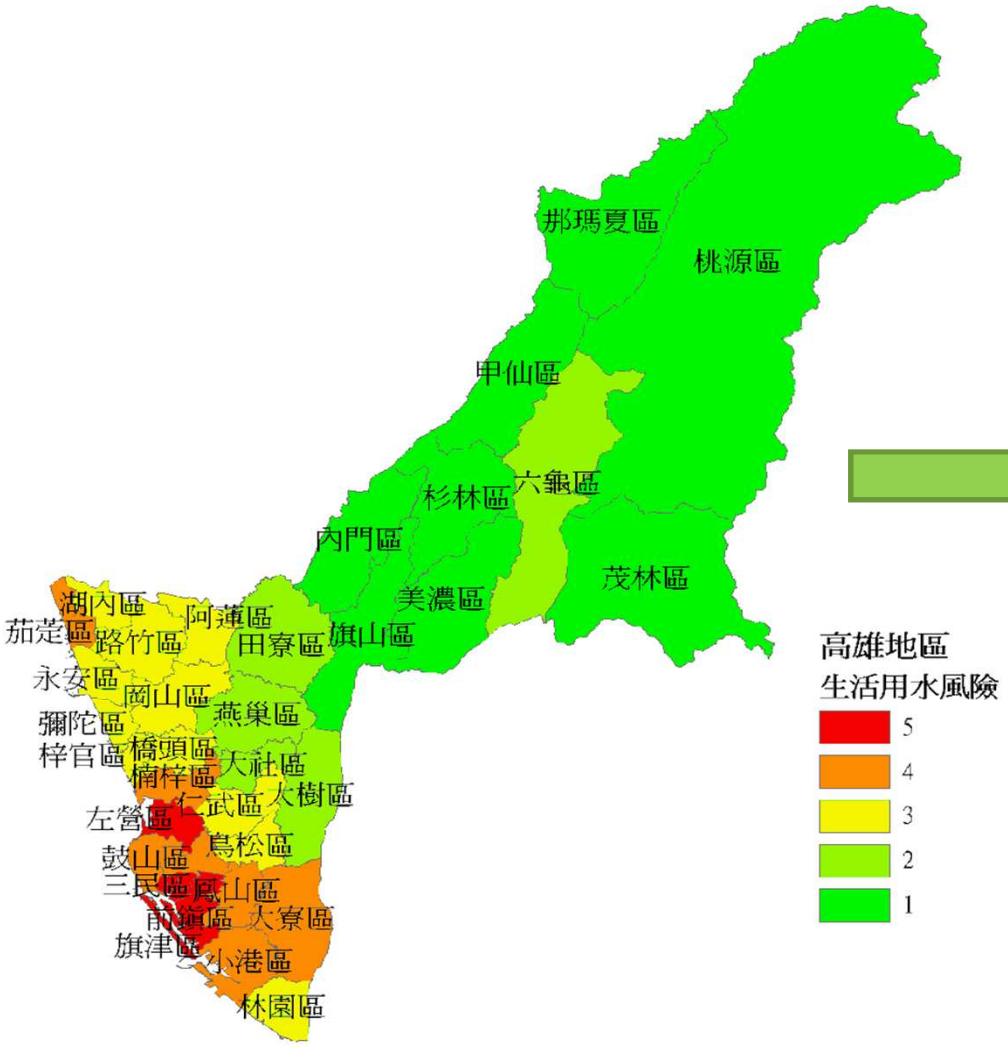
Find hotspots



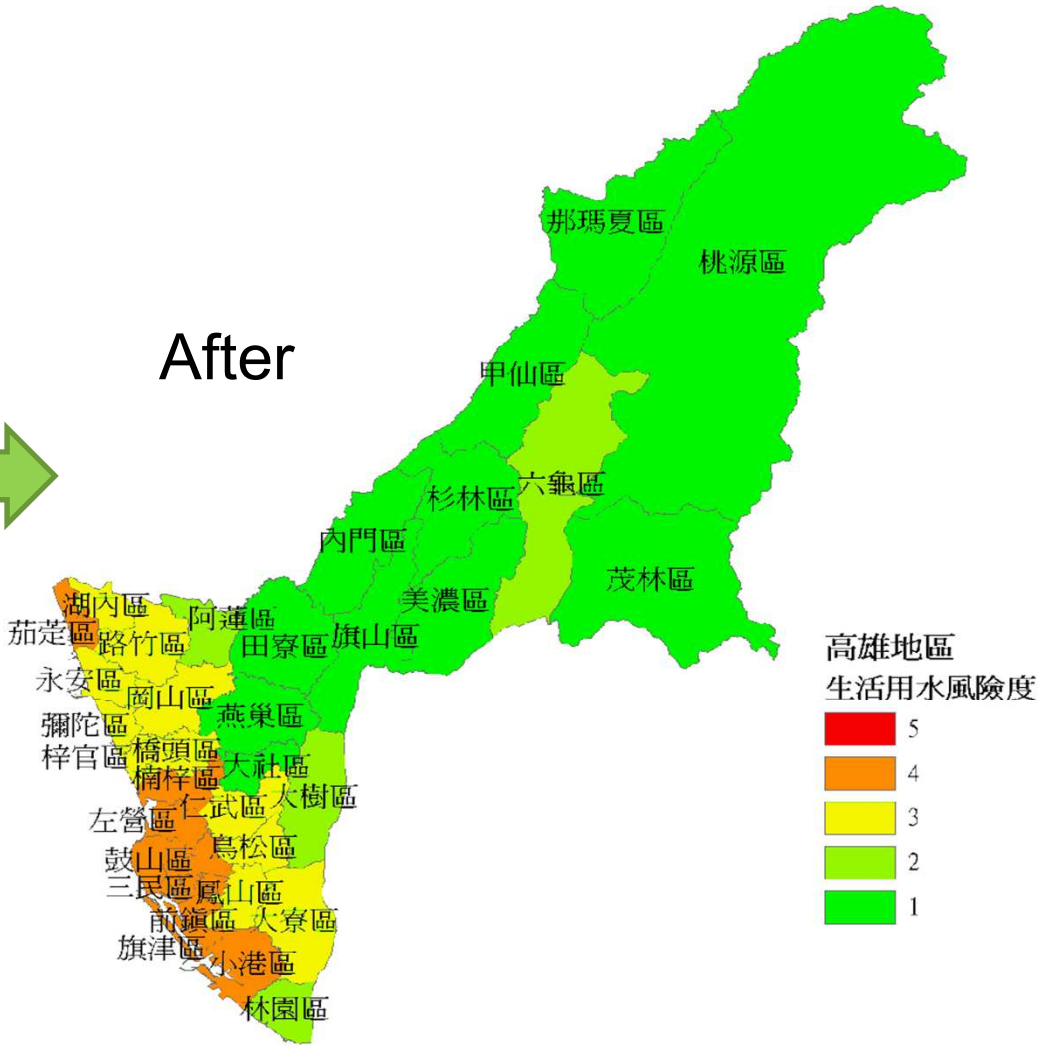
Put on the suitable facilities to reduce the risk



Distributed response system result



After



Conclusion

- Under climate change uncertainty, flexible strategies are needed.
- Distributed response system can help to reduce the water shortage in a system by rising up the flexibility of hotspots.
- Cost and energy usage need to be considered


THANK YOU