Adaptation Strategies for Climate Change in the TAIWAN

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Presentation Outline

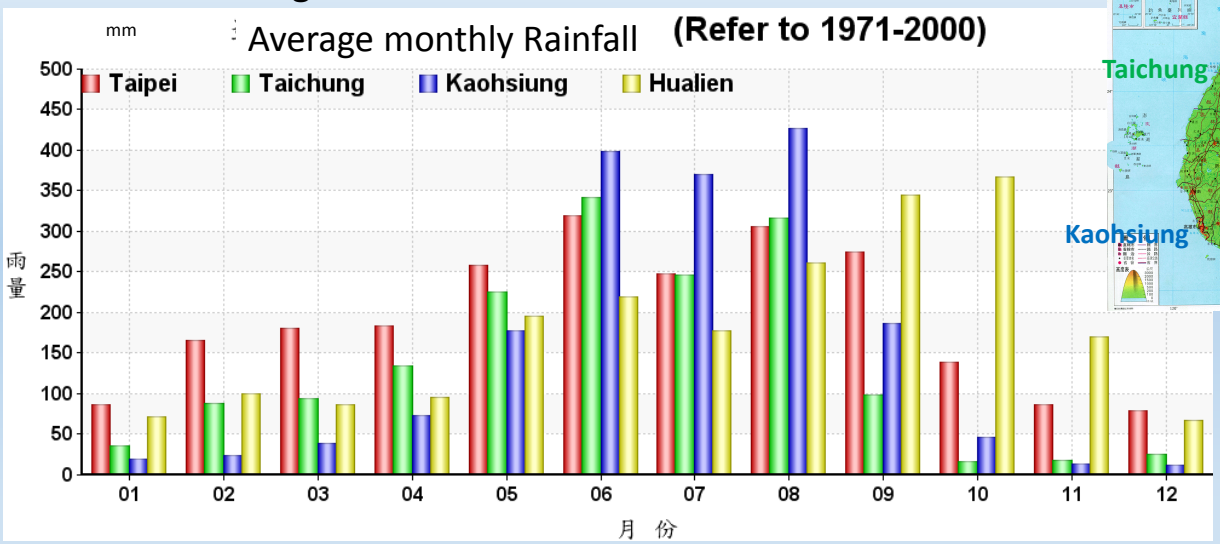
- Water Resource Situation in the Taiwan
- Impacts of Climate Change in Water Resource of Taiwan
- Adaptation Strategy for Climate Change in the Taiwan
- Conclusion

Water Resource Situation in the Taiwan (1)

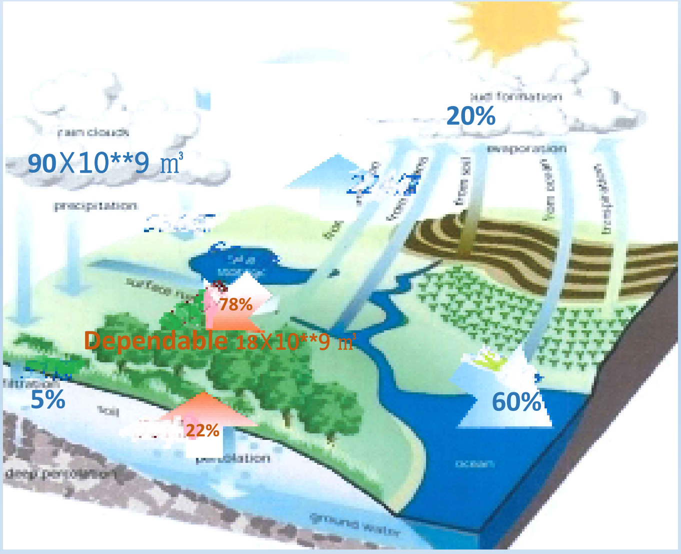
Land Area：35,873 Km^2

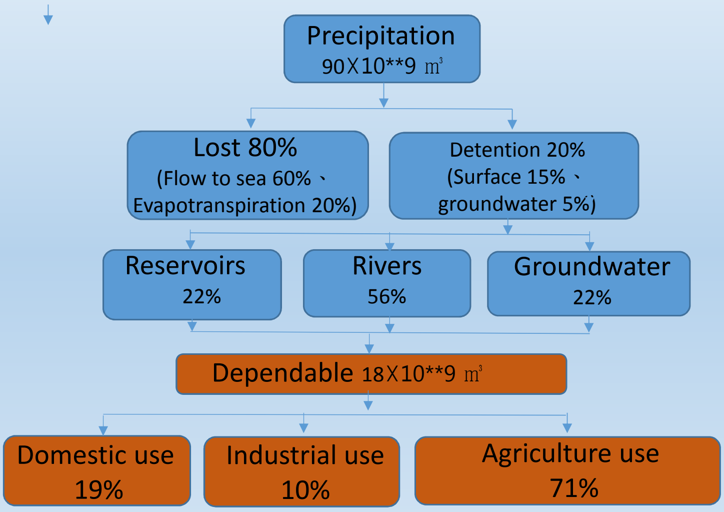
Water Resource Situation in the Taiwan (2)

Annual Average Rainfall：2500mm



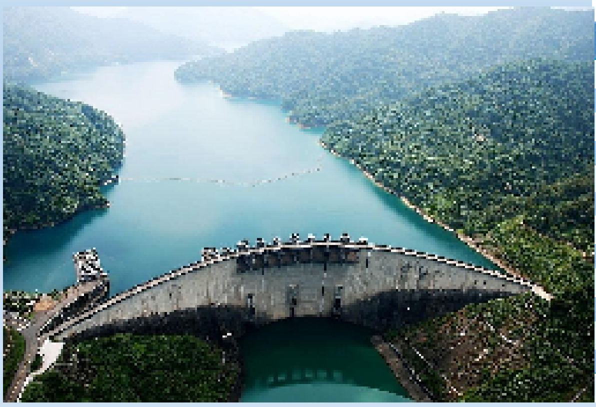
Water Resource Situation in the Taiwan (3)





Water Resource Situation in the Taiwan (Reservoirs) (4)

- 95 reservoirs and 2.4 billions M^3
- $100M^3$/p.(Taiwan) < $236M^3$/p.(Japan) < $45649M^3$/p.(USA)
- Average Sediment rate:~30%



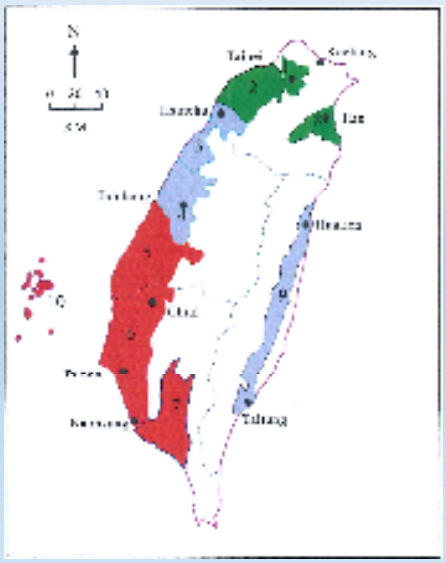
10000 M^3

Reservoir Name	Design Storage	Real Storage	Sediment Rate
石門水庫	30912	21714	30%
曾文水庫	74840	47330	36%
南化水庫	15805	9793	37%
烏山頭水庫	15415	7987	48%
霧社水庫	14860	4727	68%
白河水庫	2509	970	61%
[illegible]	7	5	30%
[illegible]	65	41	37%
明德水庫	1770	1285	27%
澄清湖水庫	530	393	26%
德基水庫	26221	19662	25%
鳳山水庫	920	761	17%
日月潭水庫	17162	14359	16%

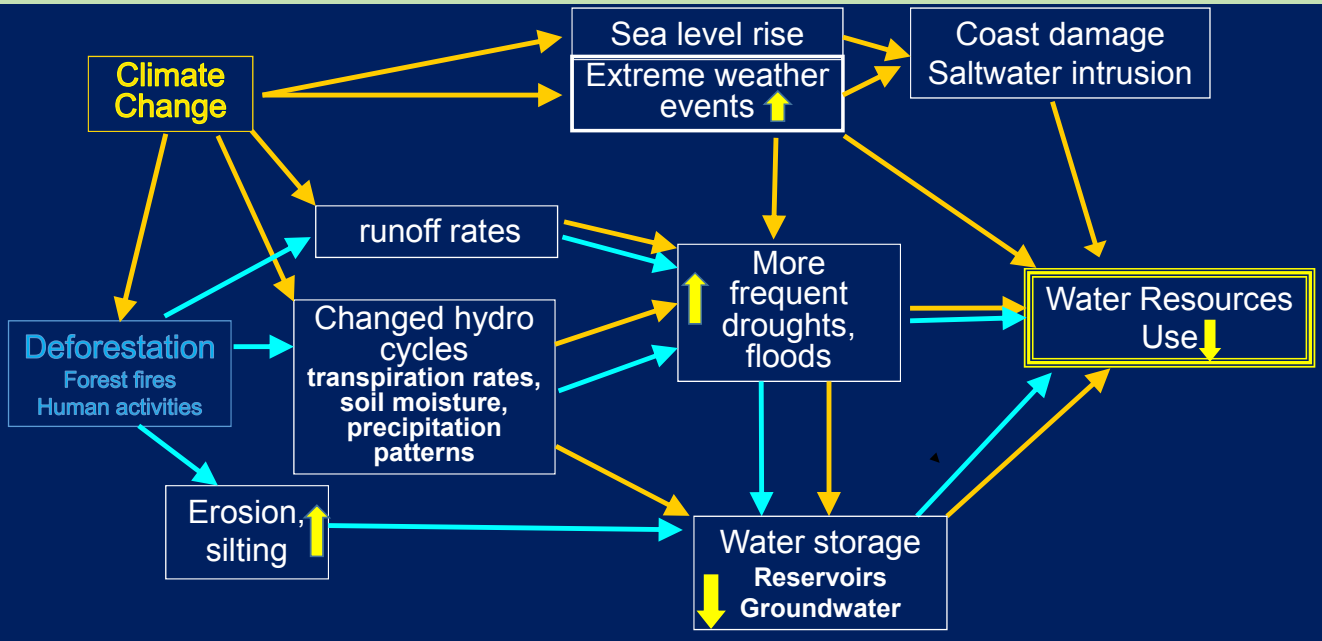
Reservoir Name	Design Storage	Real Storage	Sediment Rate
牡丹水庫	3118	2679	13%
明湖水庫	976	845	13%
明潭水庫	1440	1291	10%
阿公店水庫	1837	1669	9%
鏡面水庫	115	107	7%
翡翠水庫	40600	38136	6%
新山水庫	1000	999	0.1%
寶山水庫	547	550	0.1%
永和山水庫	2958	2925	1%
仁義潭水庫	2911	2712	7%
[illegible]	978	978	0.1%
寶二水庫	3134	3212	1%
鯉魚潭水庫	12607	11905	6%

Water Resource Situation in the Taiwan (Groundwater)(5)

- Infiltration: ~ 4.5 billion M^3 /yr.
- Extract Groundwater: ~ 3.96 billions M^3 /yr.
- Recharge = extraction : north regions of Taiwan.
- Recharge > extraction : central regions of Taiwan
- Recharge < extraction : south regions of Taiwan
  - Ultra pumping groundwater in the coastal area for aquacultures
  - The saltwater intrusion into freshwater aquifers and stratum subsidence.
  - The severest stratum subsidence depth: ~ 2 M.

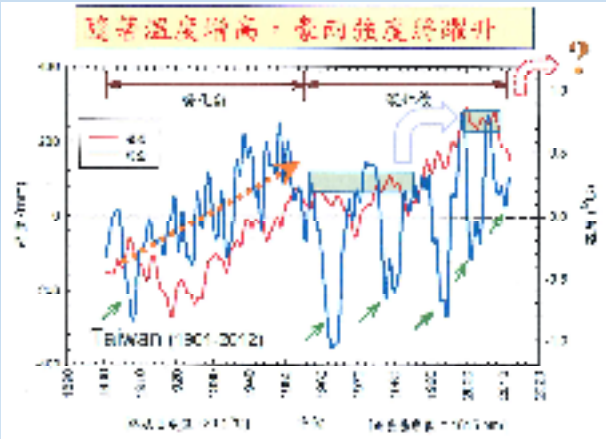


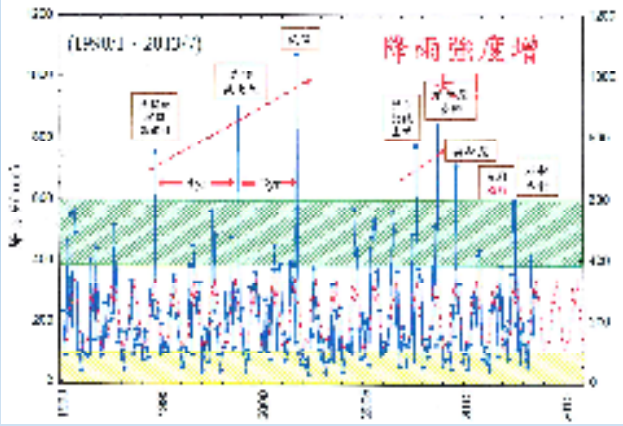
Impacts of Climate change in Water Resource (1)



Impacts of Climate change in Water Resource (2)

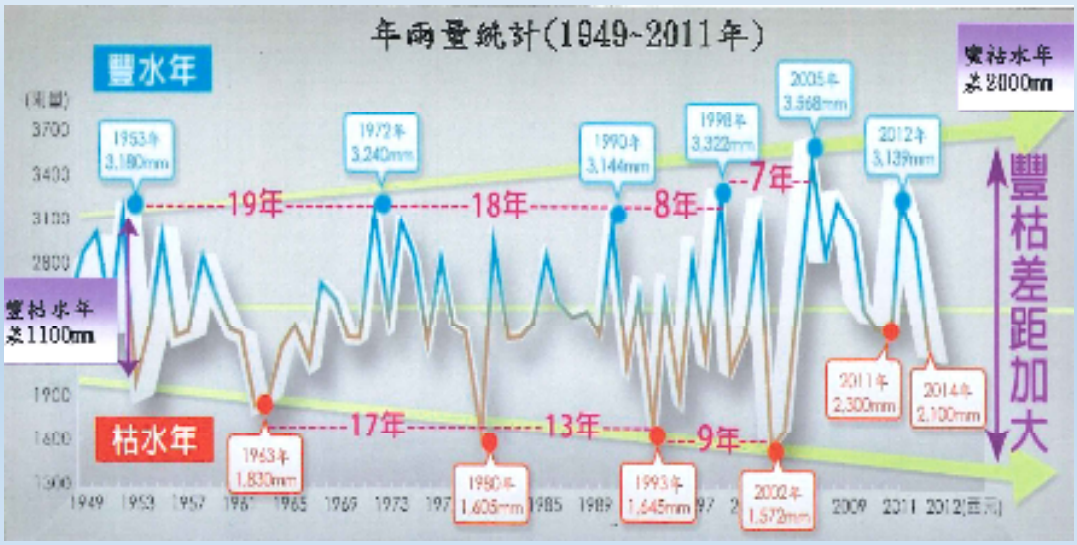
- Increased Temperatures (red line)
- Changing Rainfall Patterns (blue line)





Impacts of Climate change in Water Resource (3)

- Changing Rainfall Patterns



Impacts of Climate change in Water Resource (4)

- Water quality
  - Flooding increased sediment and turbidity and non-point source pollution loading increased in rivers
  - Decline in streamflow and lake levels make nutrients and contaminants become more concentrated in reduces volumes with longer water residence times -- Making eutrophication and algae growth.
  - Increase water temperature reduce dissolved oxygen concentrations, making lake stratification and down the mixing rate and increase biota development.
  - Sea-level rise increased saline intrusion and reduction in freshwater availability.

Adaptation Strategy for Climate Change

- Government budgets (2017-2024) : US$80 billions on mitigation and adaptation strategy for climate change.
- The Projects includes:
  1. Water policy reforms e.g. Pricing mechanisms
  2. Building smart water supply systems
  3. Efficient water use and water conservation
  4. Rainwater harvesting
  5. Integrated river management
  6. Construction of storage
  7. Recycling of wastewater
  8. Building desalination plants
  9. Etc..

1. Water policy reforms

- Increasing water rate of Taipei Water Department from Mar. 2016
- Charging water to discourage wasteful practices
- Penalizing illegal use of water – need strictly enforced

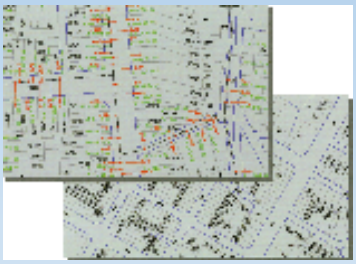
Water rate of Taipei Water Department

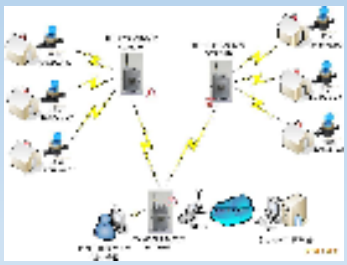
Water consumption level	0-20	21-60	61-200	201-1,000	1,001以上
Number of household 10^3	941	516	54	7.9	1.8
Old price (NT$/$m^3$)	5	5.2	5.7	6.5	7.6
New price (NT$/$m^3$)	5	6.7	8.5	14	20
Difference (NT$/$m^3$)	-	34	142	1,242	7,242

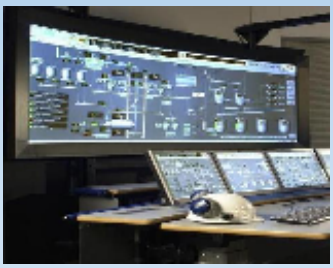
1 NT$≈0.03 US$

2. Building smart water supply systems

1. Grasping the situation of water resource activities from reservoirs to customers.
2. The water supply utilities to built and improve their management system. Such as GI System、SCADA system、DMA system、AMR system, monitoring system, etc.
3. Improved management and maintenance of water supply system







3. Efficient water use and water conservation

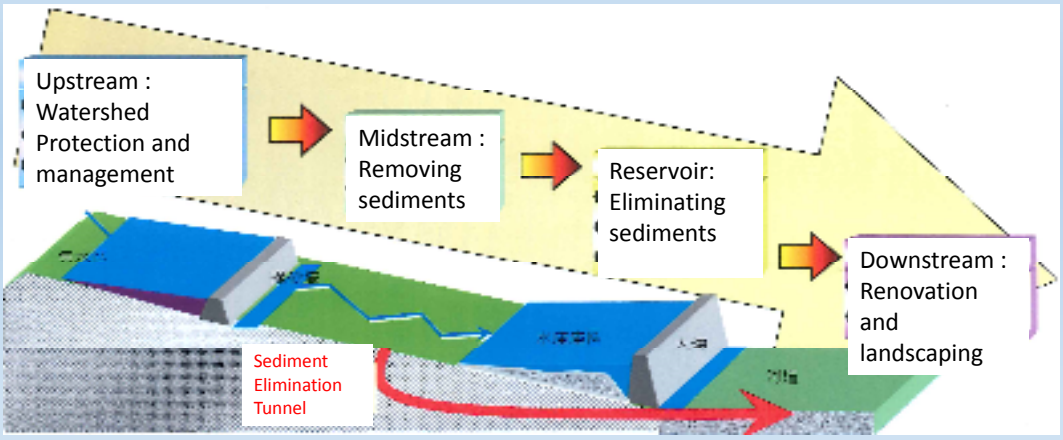
Items	2003	2016	2021
daily water consumption	291 lpcd	268 lpcd	250 lpcd
Water - saving toilet Water – saving wash machine	68.5% 14.5%	86.8% 72.5%	100% 100%
Industrial water recycling rate	47.7%	69.8%	80%
Water leakage rate	24.3%	16.8%	12%

4. Rainwater harvesting

- Funded to Schools and public parks building the rainwater harvesting system.
- New buildings and communities should built graywater system on new building regulations for using on toilet flushing, landscape or crop irrigation, and other non-potable uses.

5. Integrated river management

- River and Watersheds: 131
- To forest and limit land use on watershed
- Eliminated the sediments for holding reservoir storage with sediment elimination tunnel and removing and elimination sediments from reservoirs



6. Construction of storage

- Off stream reservoirs
- Artificial lakes
- Groundwater recharge lakes

- Increase normal water supply : 1 million CMD
- Supporting water supply : 2 millions CMD

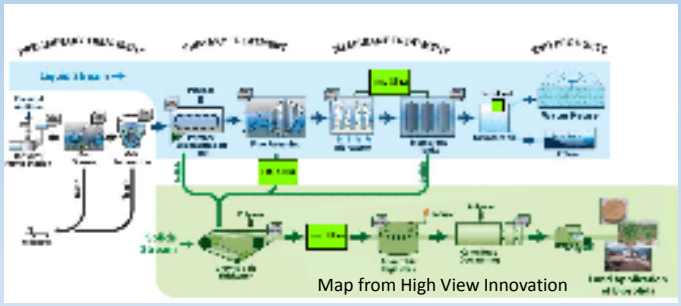
Hushan Reservoir

Chungzhung artificial lake

Pingtung G.R. lake

7. Recycling of wastewater

- 42 wastewater plants in Taiwan, design capacities is 4.18 millions m^3/day.
- Promote safe reuse of treated wastewater for irrigation, industry and secondary domestic purposes



Map from High View Innovation

8. Building desalination plants

- New desalination plant plans: 300,000 CMD
  - in small islands for lack of water resource
  - in coastal industry regions for in response dry season
  - High energy consumption, high cost

Water source	Cost (NT$/m³)
Drinking water	10.5-20.0
groundwater	3.o-5.0
Irrigation water	5.0-10.0
Reuse of wastewater	17.2-21.6
Reservoir	30.0-40.0
Desalination water	35.2-39.3

Conclusion

- Climate change will be serious year after year, it influence the water resource will also be serious year after year.
- Governments and the people should promote awareness on impact of climate change and must be continued do something, from individual household to local communities and watershed to catchment, to reduce the influences of climate change.
- Building “resilience” water resource system, conjunctive use of surface water and groundwater and reuse of waste water and desalination water.
- Protection and use with caution of water resource toward sustainable water supply systems.

Thanks for your listening