International Water Forum

2017 in Takamatsu

Adaptation Strategy for Climate Change
-Toward Sustainable Water Resource Management-

Thursday, 26 October, 2017
Kagawa International Conference Hall,
Sunport Takamatsu Symbol Tower 6F

Organized by:

JAPAN WATER WORKS ASSOCIATION

ひと、くらし、みらいのために 厚生労働省 Ministry of Health Labour and Welfare

IWA International Water Association Japan YWP Japan National Young Water Professionals

Program Overview

Opening Address 14:00-14:05

Speaker	**Ei YOSHIDA** Executive Director, Japan Water Works Association

Keynote Speech 14:05-14:25

14:05-14:25	Adaptation to the Climate Change in the Japanese Water Supply System	**Junichi HIOKI** Director, Water Supply Planning and Guidance Office, Water Supply Division, Ministry of Health, Labour and Welfare

Case Study [Part 1] 14:25-15:25

14:25-14:45	The Effect of Drought and the Efforts to Secure Water Resources in Takamatsu City	**Masatsugu HOSOKAWA** Director General, Takamatsu City Waterworks And Sewerage Bureau
14:45-15:05	Creation of Manual for Supplying Minimum Quantity of Water in Emergency (drought, etc.)	**Tae-Yong CHOI** Korea Water and Wastewater Works Association (KWWA)
15:05-15:25	Adaptation Strategy for Climate Change in the Taiwan	**Yang-Long WU** Chinese Taiwan Water Works Association (CTWWA)

Short Break 15:25-15:35

Case Study [Part 2] 15:35-16:35

15:35-15:55	Adaptation Strategy for Climate Change - Towards Sustainable Water Resource Management	**Krishan Murari Lal MATHUR** Indian Water Works Association (IWWA)
15:55-16:15	Climate Change Adaptation and the Australian Urban Water Industry	**Carl RADFORD** Water Services Association of Australia (WSAA)
16:15-16:35		International Water Association (IWA)

Coffee Break 16:35-16:50

Panel Session 16:50-17:30

Facilitator	**Takahiro SEKI and Yasuhiro ASADA** Japan-YWP

Wrap-up 17:30-17:40

Presenter	**Takahiro SEKI and Yasuhiro ASADA** Japan-YWP

Closing

Keynote Speech

Adaptation to the climate change in the Japanese water supply system

Junichi HIOKI

Head of Water Supply Planning and Guidance Office

Water Supply Division

Pharmaceutical Safety and Environmental Health Bureau

Ministry of Health, Labour and Welfare

Topics

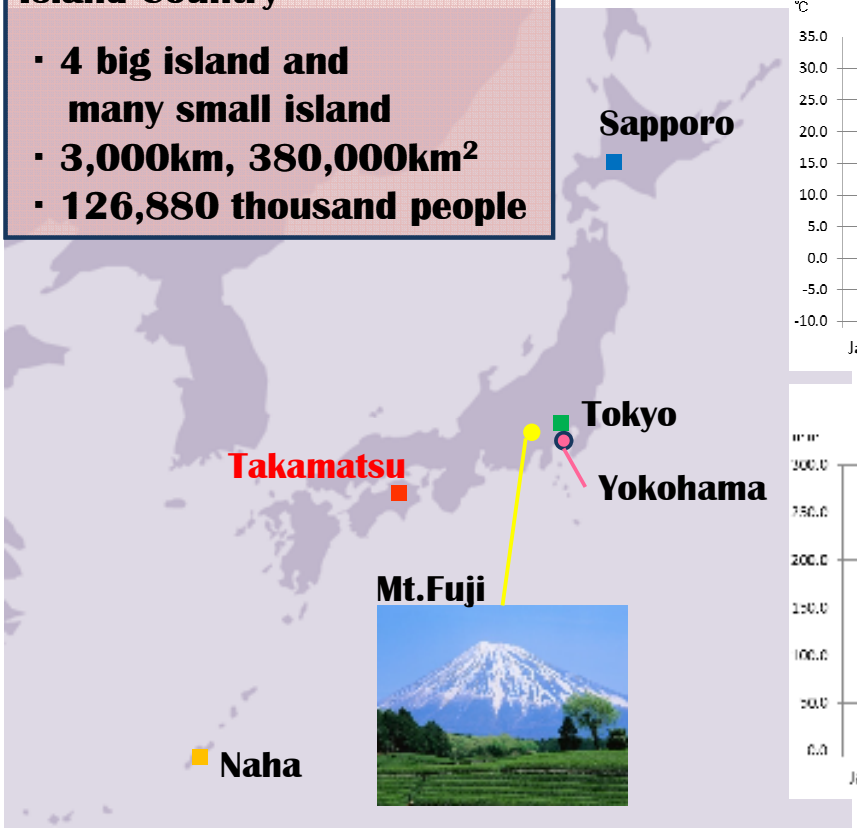
1. Outline of water supply in Japan
2. Influence of the climate change in the water supply
3. Action for the climate change in Japan

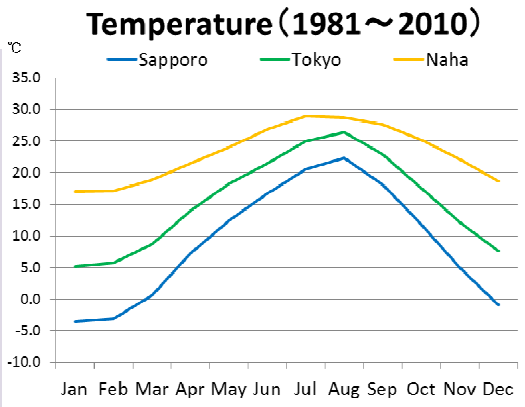
1. Outline of Water Supply in Japan

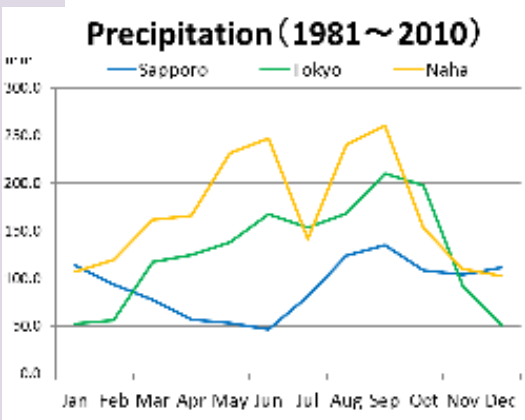
General Information of Japan

Island Country

- 4 big island and many small island
- 3,000km, 380,000km²
- 126,880 thousand people





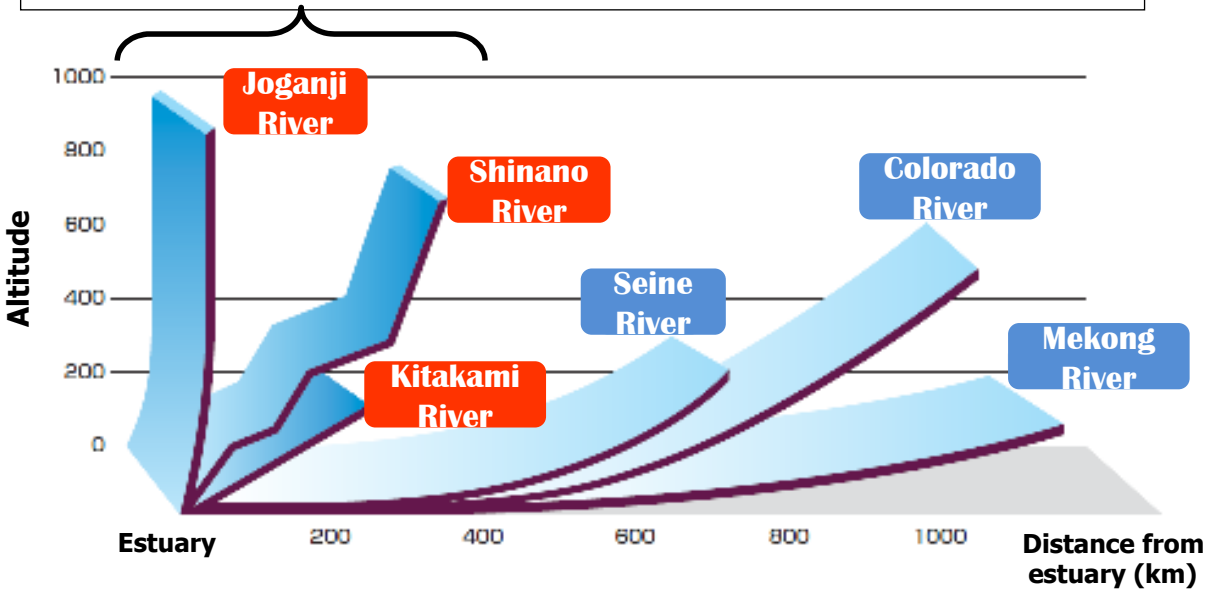


General Information of Japan

○ River gradients of Japan and the World

【Characteristic of Rivers in Japan】

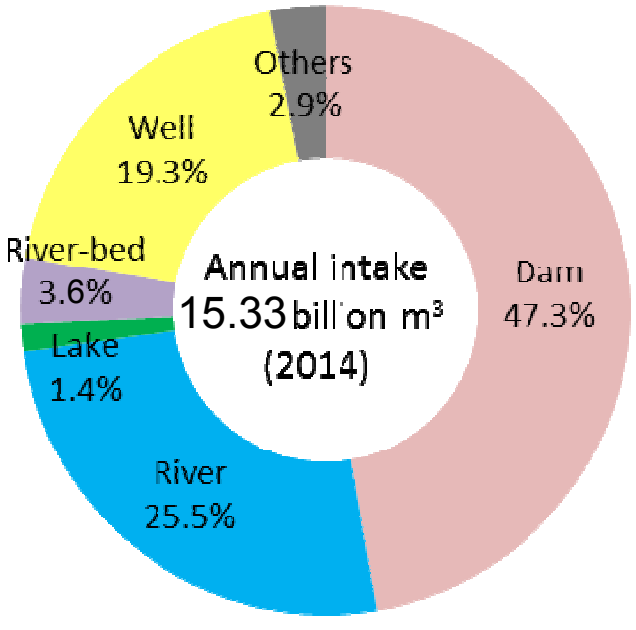
The length is short, the inclination is steep. So, the water of the river flows out to the sea.

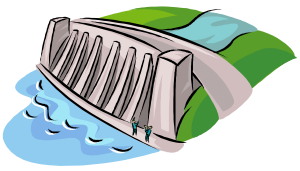


http://www.mlit.go.jp/river/pamphlet_jirei/kasen/gaiyou/panf/gaiyou2005/pdf/c1.pdf

Water sources of water supplies

In Japan, we have secured to the water necessary for National Consumer Affairs and economic activities, by the dam.





Administration

○ In Japan, the administration of the water supply is carried out based on laws and ordinances.

【Laws and ordinances related to water supply】

The Waterworks Law, The Cabinet Order, The Ordinance of the Ministry

○ Japanese administration has 3 layers.

【National Government】 Ministries related to water (5 Ministries)

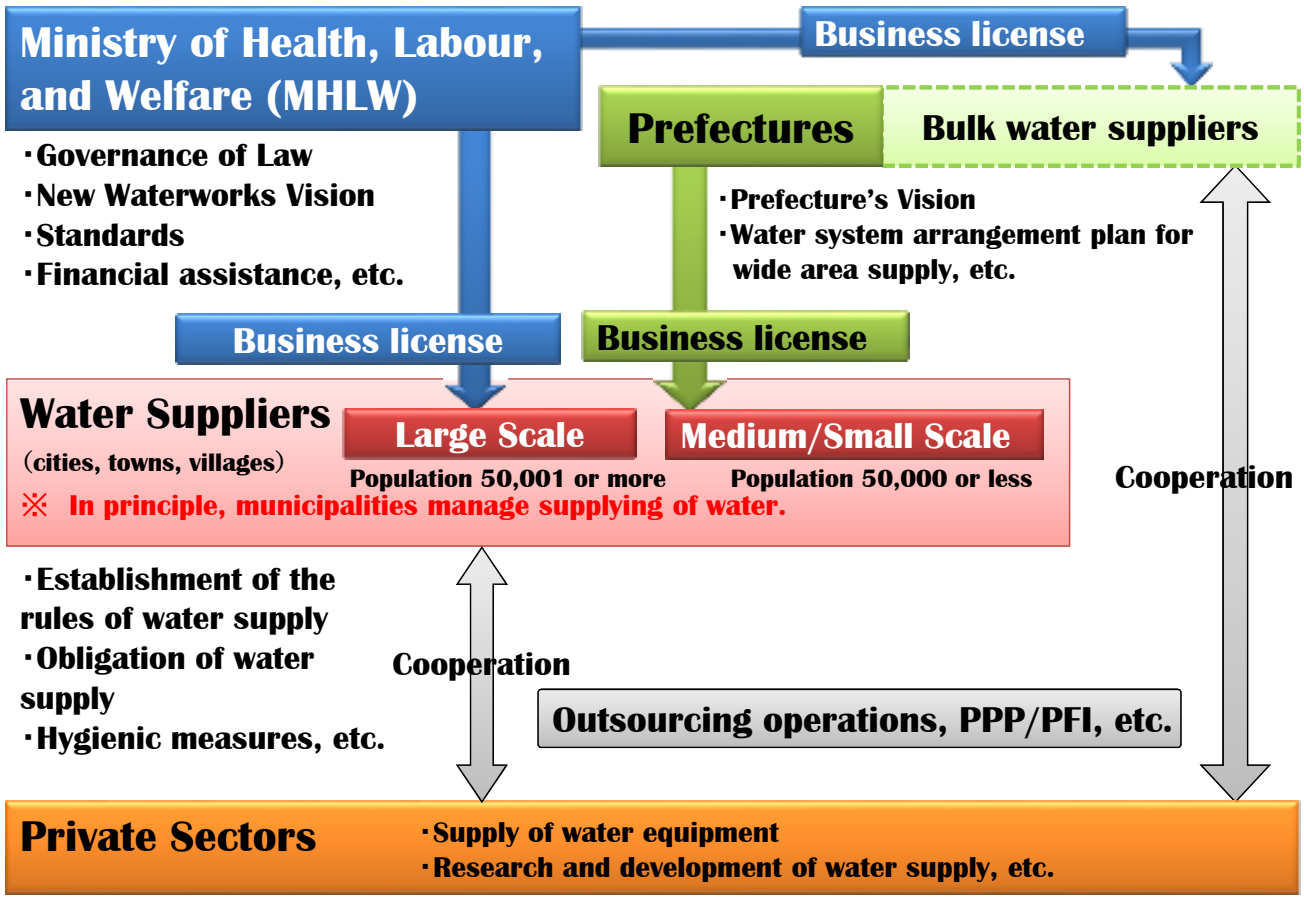
1	Ministry of Health, Labour and Welfare	Water supply
2	Ministry of Environment	Water Environment
3	Ministry of Land, Infrastructure and Transport	River Control Water Resource Sewerage system
4	Ministry of Economy, Trade and Industry	Industrial water
5	Ministry of Agriculture, Forestry and Fishery	Agricultural water

【Prefecture】 47 prefectures

【Cities, Towns and Villages】 1,718 communities （As of October 10, 2016）

*Prefecture, cities, town and village is the Local Government.

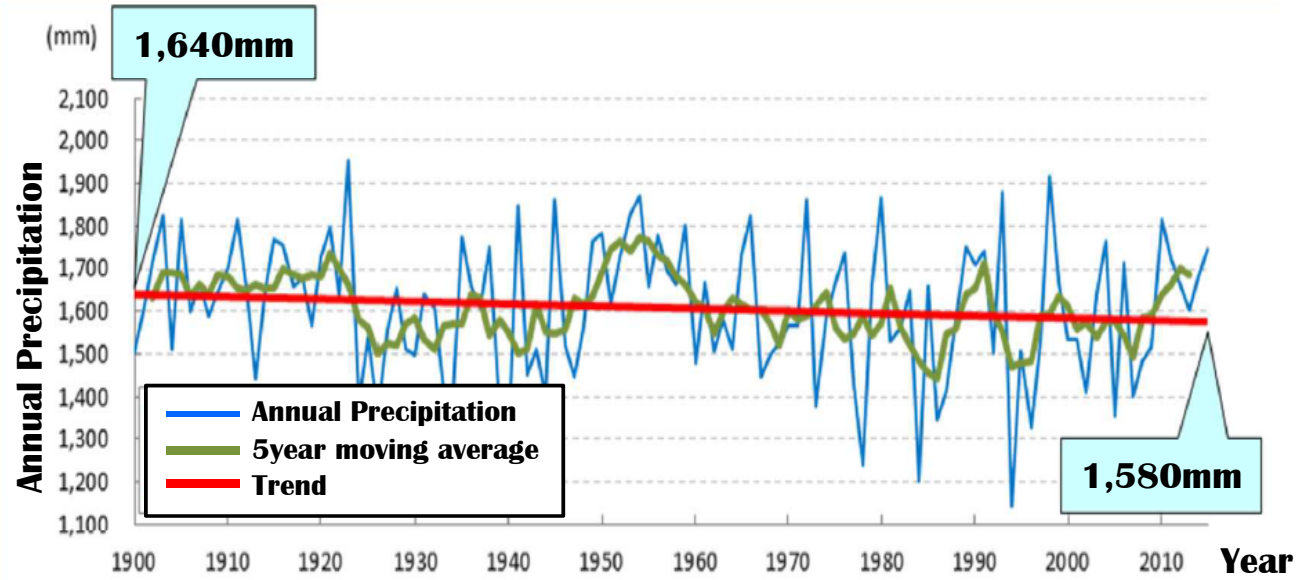
Stakeholders in Water Supply Sector



2. Influence of the climate change in the water supply

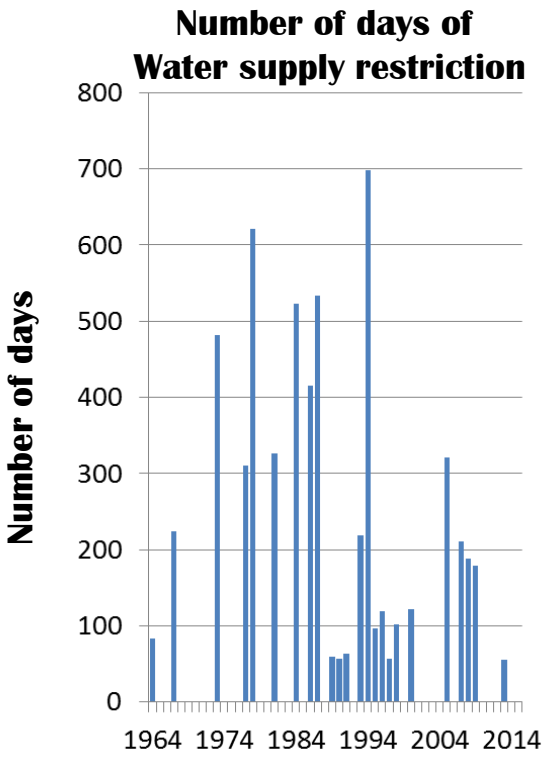
Increase of the Water shortage risk

- Year of low rainfall increase from about 1965
- Difference of precipitation between low rainfall year and high rainfall year is increasing in recent 20-30 years

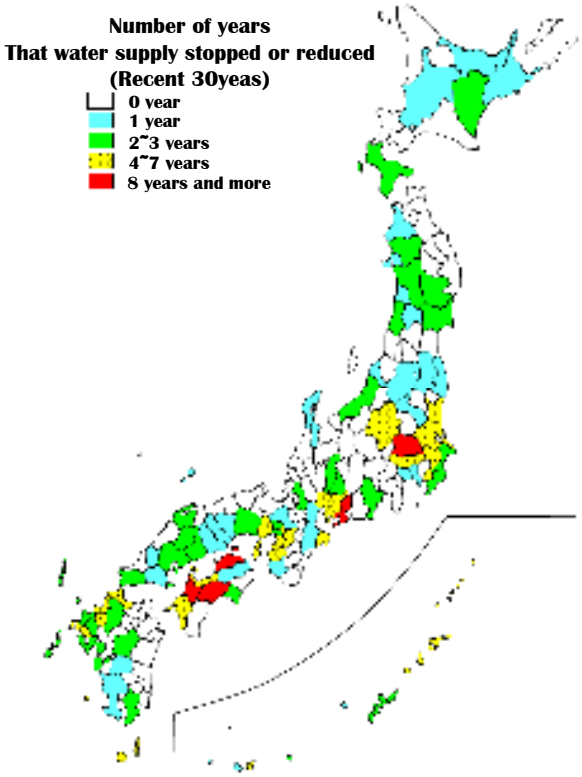


The current state of Japanese water resources in 2016(Ministry of Land, Infrastructure and Transport)

Total number of days of Water supply restriction



Made by MHLW based on
The current state of Japanese water resources in 2016
(Ministry of Land, Infrastructure and Transport)



The current state of Japanese water resources in 2016
(Ministry of Land, Infrastructure and Transport)

Countermeasures to water shortage

●Set up the network of water shortage

Ministry of Health, Labour and Welfare established “The network of water shortage" constructed in MHLW, JWWA and the local government and carried out communalization of the shortage of water information.

●Each local government called for saving water through various mediums

Government office

Appeal to passing traffic and the visitor to the Government office for saving water


(Saitama city)


(Tokorozawa city)

Website, Twitter

Provide information using website and Twitter

(Tokyo)


(Saitama Prefecture)

Road

Appeal for saving water with a public car and electric light pole

(Saitama city)

Poster, Digital Signage

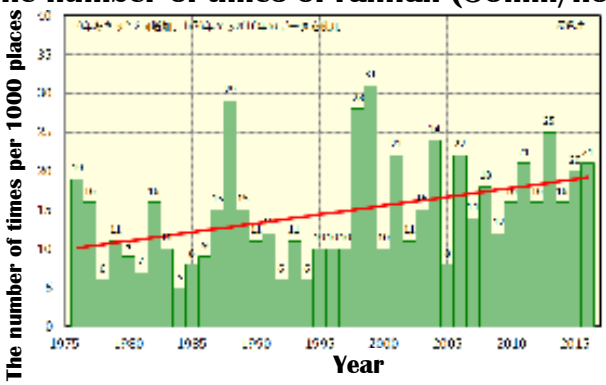
Appeal for saving water using poster and Digital Signage


(Saitama Prefecture)


(Kawagoe city)

Rise in turbidity of the river

The number of times of rainfall (80mm/hour)



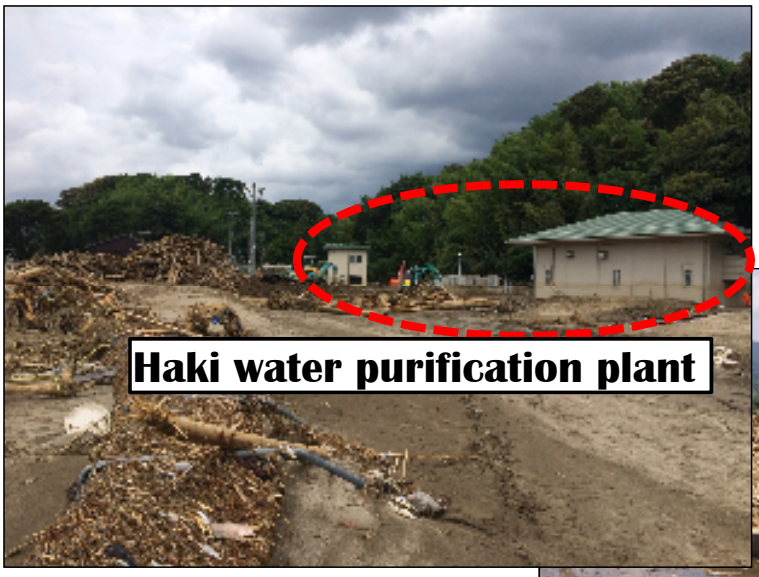
(Japan Meteorological Agency)

Typhoon, heavy rain and Damage of the large-scale suspension of water supply

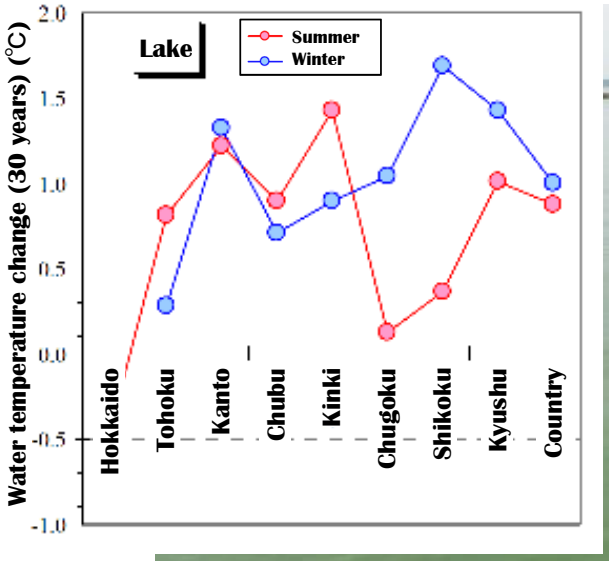
Timing of the appearance	Area	The number of houses that cut off water supply	The maximum days that cut off water supply
2010.6~7	Yamaguchi, Akita, Hiroshima, etc	About 17,000	6
2011.7	Niigata, Fukushima	About 50,000	68
2011.8~9	Wakayama, Mie, Nara, etc	About 54,000	26
2012.7	Fukuoka, Oita, Kumamoto	About 12,000	About 1 month
2013.7	Yamagata, Yamaguchi, Shimane, etc	About 64,000	17
2014.7~8	Kochi, Nagano, Hiroshima, Hokkaido, etc	About 55,000	36
2015.7	Kagawa, Kagoshima, etc	About 2,000	10
2015.9	Ibaraki, Tochigi, Fukushima, Miyagi	About 9,300	11

damage by the flood

2017.7 Heavy rain at North-Kyushu



Declining quality of water with increase in temperature



H23.7 Kasumigaura
(Kasumigaura river office, Ministry of Land, Infrastructure and Transport)

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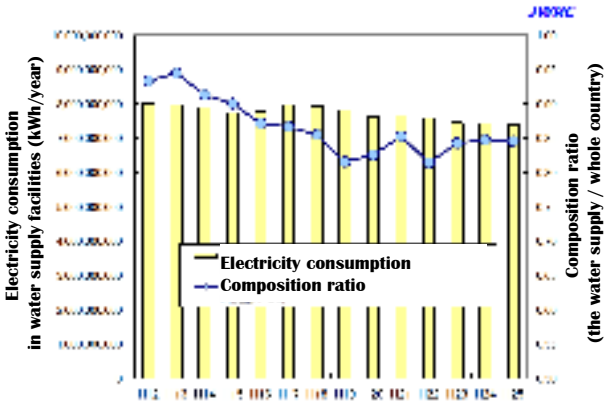
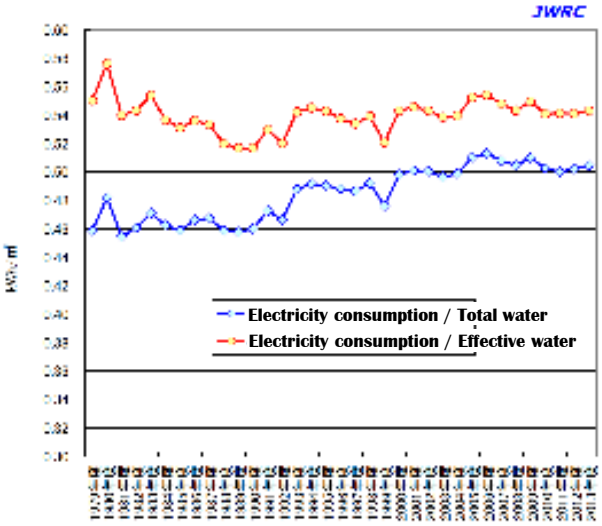
Energy saving and Clean energy

Electricity consumption in water supply facilities



Water hot news #496(Japan Water Research Center)

Electricity consumption per unit quantity of water in the water supply



Water hot news #496(Japan Water Research Center)

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3. Action for the climate change in Japan

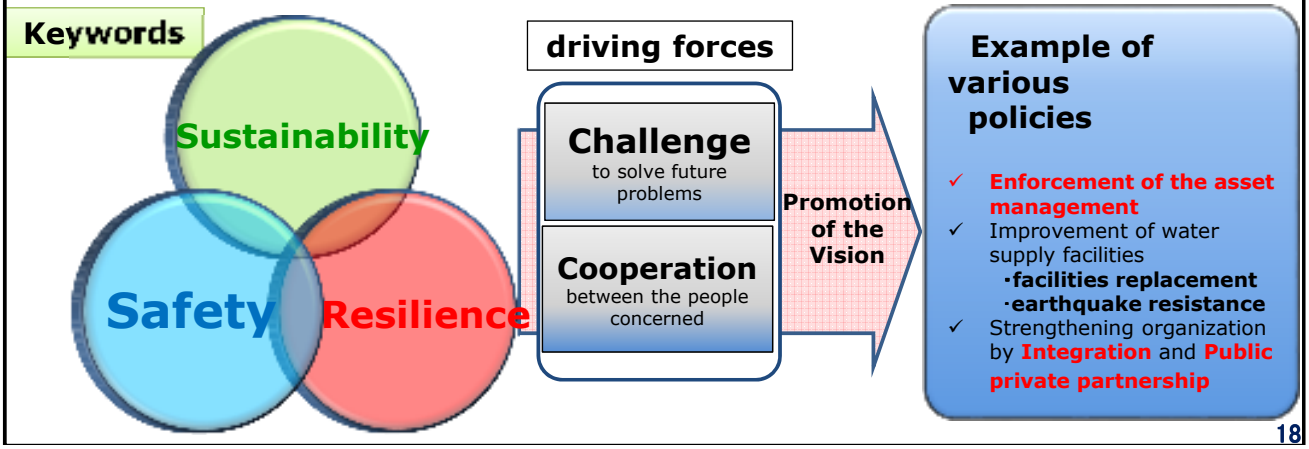
Release of the New Waterworks Vision

(Former) Waterworks Vision was published (June, 2004)

- Experience of large-scale damage of the water supply facilities by the Great East Japan Earthquake (March, 2011)
- The concern that business management becomes much severer by the arrival of the population decline society.

New Waterworks Vision (March, 2013)

【Concept】Succession of reliable water supply to the future alongside communities



Adaptation to the climate change

Risk management

- Promotion effective measures for various risk factor
- Hardware measures (Advancement of water purification, The use of plural water resources, Reorganization of water intake system, etc)
- Software measures (Formulate the manual for a crisis, training, Establish a method to share information in the people concerned of the basin, etc)
- Promote a water security plan by integrated approach
- Formulate the BCP

Environment

- Carry out the water source maintenance that cooperated by a basin unit
- Saving energy (High efficiency apparatus, Inverter control a pump, etc)
- Renewable energy (Small hydroelectric generation, Photovoltaic power generation, Biomass generation, Geothermal power generation)

Human resources and Organization

- Secure human resources, Succeed to technology

Communication with inhabitants

- Cooperate with inhabitants at the time of a disaster
- Develop effective reporting and strategic publicity work

Thank you for your kind attention.

Safety

Idealized image of water supply	・Water supply to be able to drink in peace ・Appropriate water quality management system ・Measures by integrated approaches
Immediate goals	Maintaining continuous safe water supply of all water supply system in collaboration with stakeholders
Direction of the action	○ Preserving and securing good water source ○ Maintenance of the water supply facilities according to water source ○ Water quality management in the clean water processing ○ Establishment of public information, well-known system to distribute the information of water quality

Resilience

Idealized image of water supply	・Crisis management ・Appropriate facilities replacement, earthquake resistance ・Flexibility against disaster
Immediate goals	All water utilities complete earthquake resistance of pipelines, distributing reservoirs and water purification plants, concerned with the prime water supply bases
Direction of the action	○ Carrying out earthquake resistance of all the water supply facilities stepwisely ○ Reinforcement of the facilities which become the water supply base to enable essential water supply at the time of disaster ○ Securing of water supply means that emergency restoration activity and emergency water supply can be carried out by cooperation with the person concerned at the time of disaster

Sustainability

Idealized image of water supply	· **Trust by the nation** · **Stability of business base for the long-term future** · **Measures based on population decline society**
Immediate goals	**All water utilities carry out the asset management**
Direction of the action	○ **Careful management and operation of all the water supply facilities** ○ **Replacement of aging facilities** ○ **Reinforcement of the financial base for sustainable management** ○ **Securing the staffs having specialty to be engaged in essential duties**

Case Study

2017 International Water Forum

Adaptation Plans for the Impact of Climate Change on Water Supply

The Effect of Drought and the Efforts to Secure Water Resources in Takamatsu City

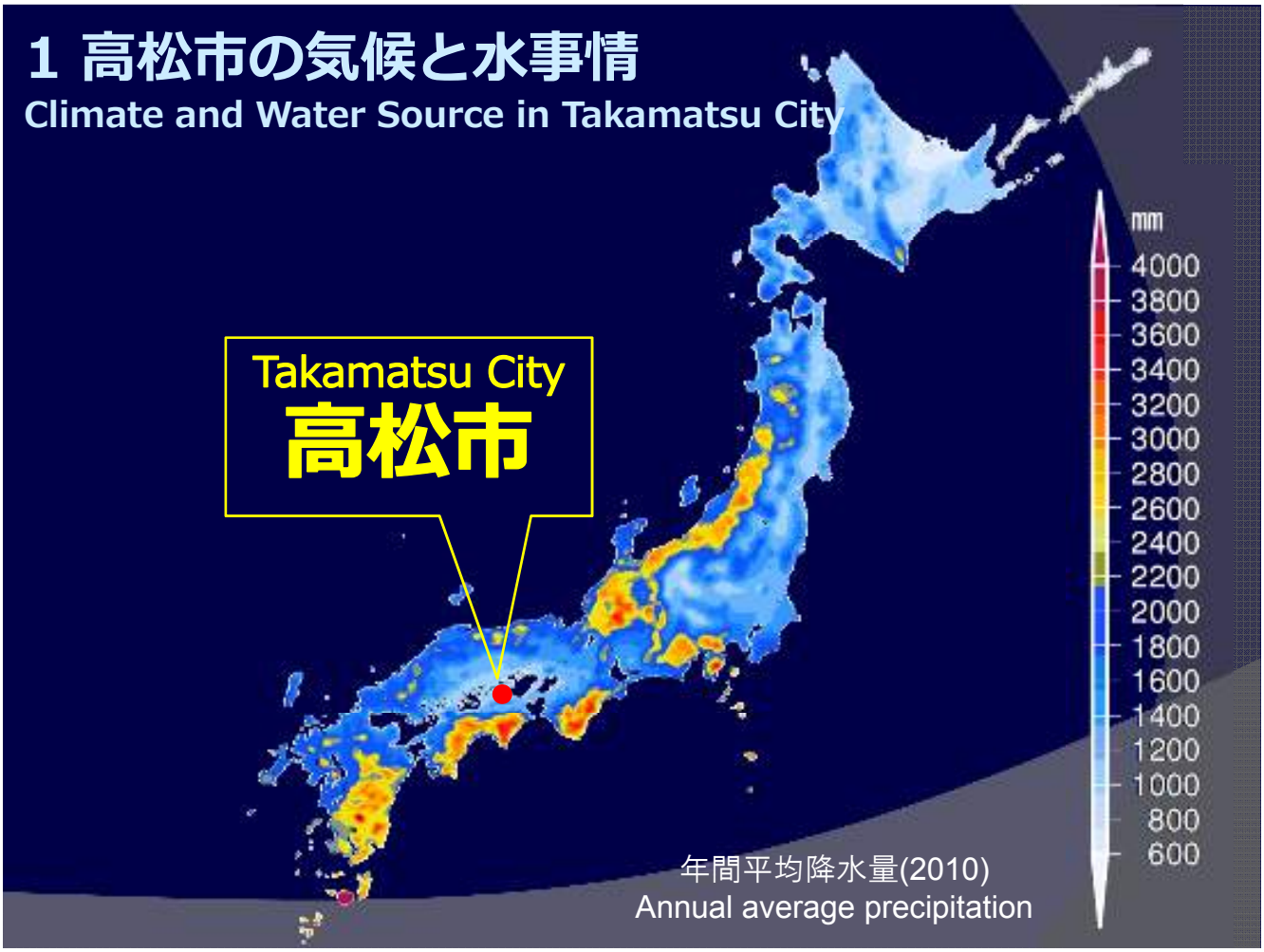
高松市における渇水の現状と水資源確保の取組

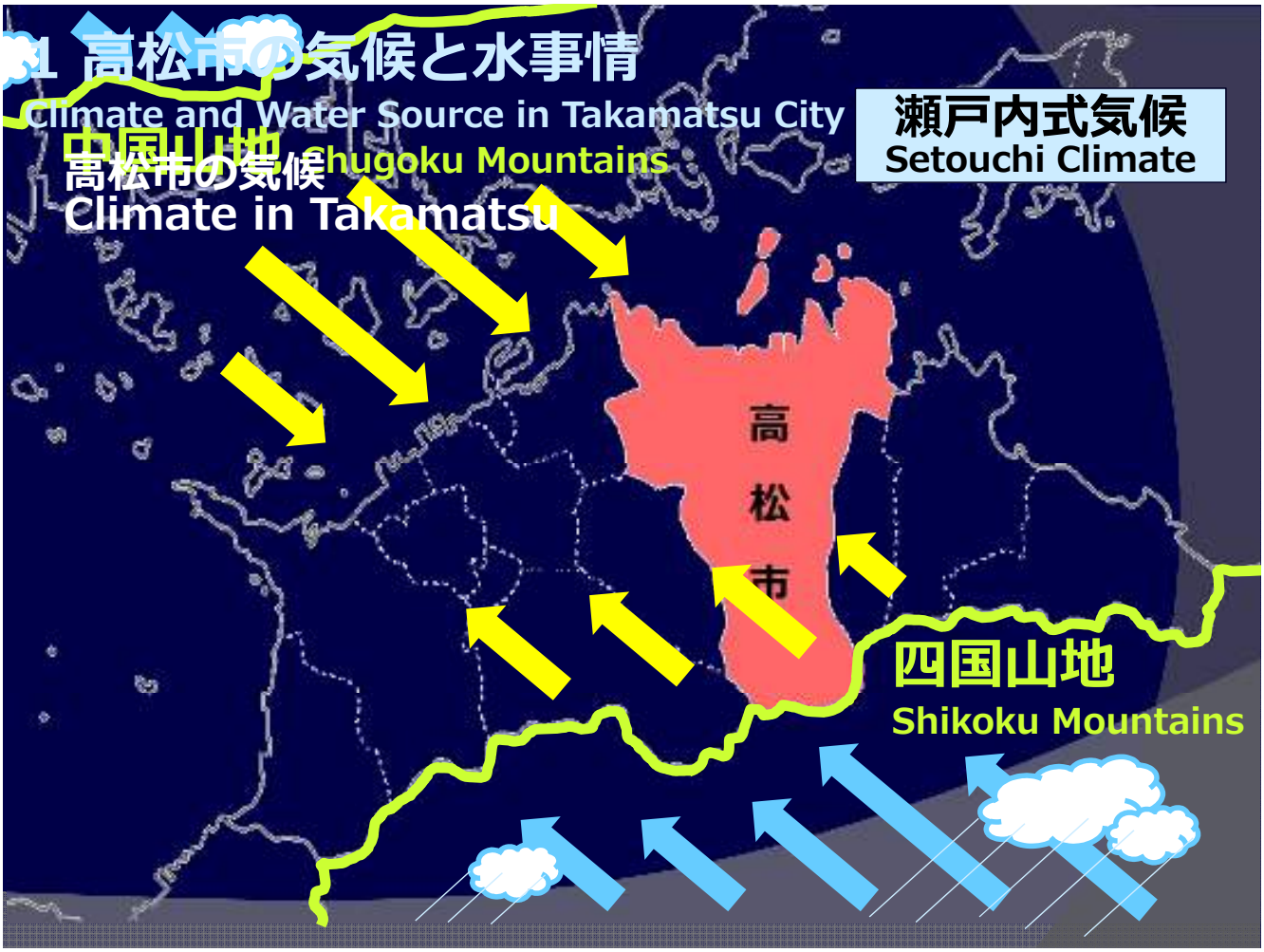
26 October 2017

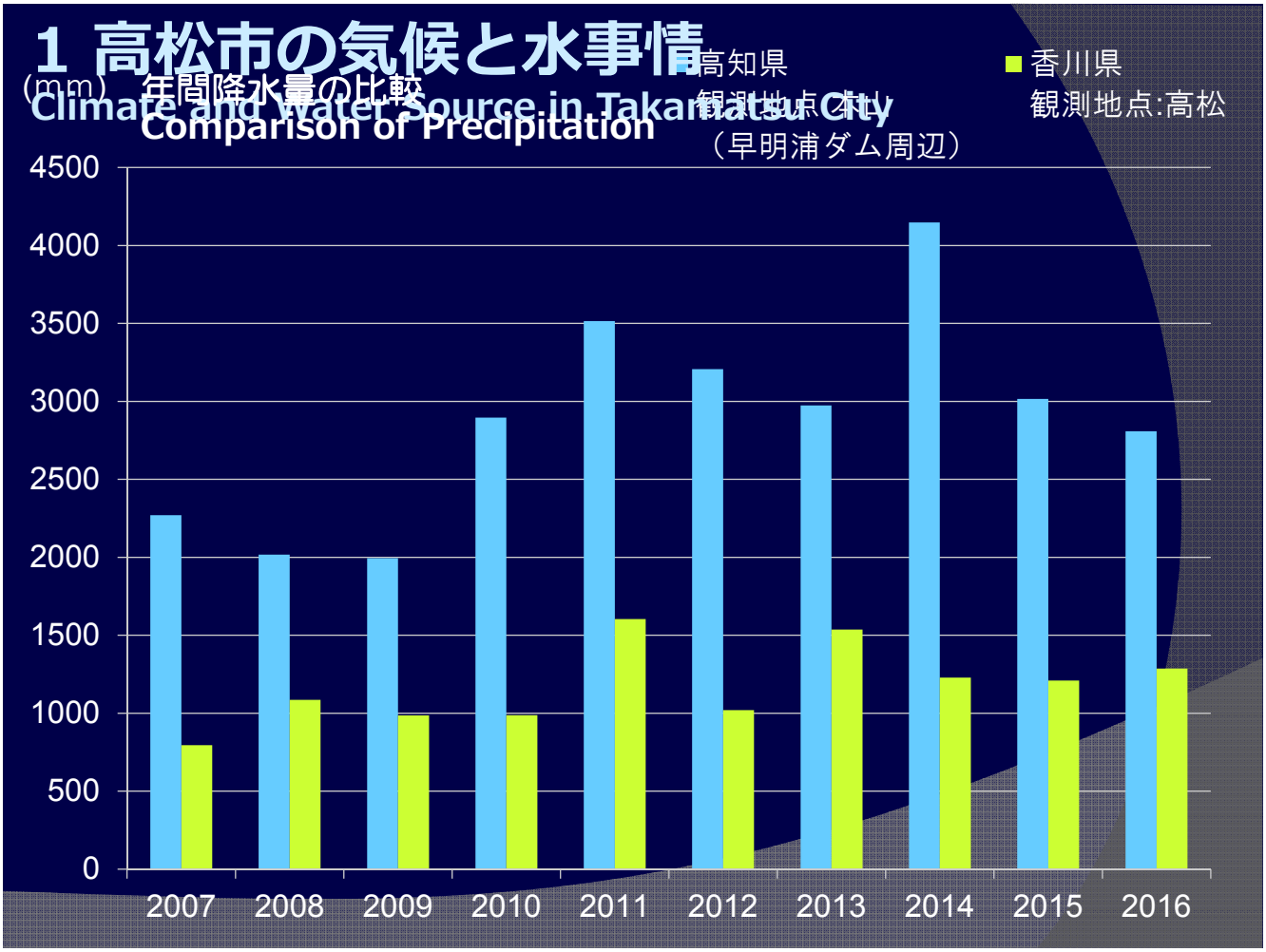
Masatsugu HOSOKAWA
Director General,
Takamatsu City Waterworks and Sewerage Bureau

1 高松市の気候と水事情

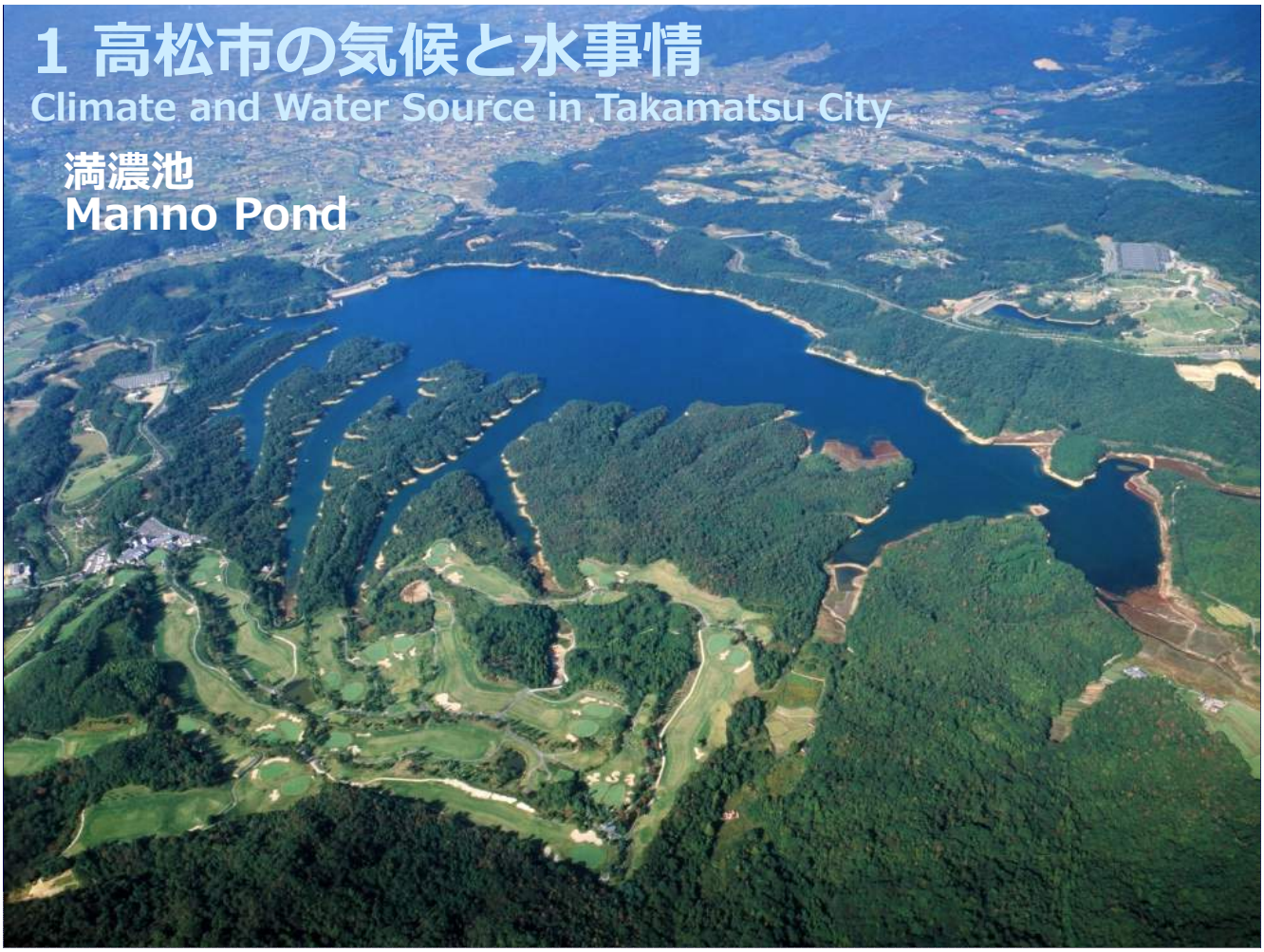
Climate and Water Source in Takamatsu City




1 高松市の気候と水事情
Climate and Water Source in Takamatsu City
瀬戸内式気候
Setouchi Climate
中国山地 Chugoku Mountains
高松市の気候
Climate in Takamatsu
高松市
四国山地
Shikoku Mountains


1 高松市の気候と水事情
Climate and Water Source in Takamatsu City
(mm)
年間降水量の比較
Comparison of Precipitation
高知県
観測地点:本山
（早明浦ダム周辺）
香川県
観測地点:高松
4500
4000
3500
3000
2500
2000
1500
1000
500
0
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016

1 高松市の気候と水事情
Climate and Water Source in Takamatsu City



満濃池
Manno Pond

1 高松市の気候と水事情
Climate and Water Source in Takamatsu City

早明浦ダム
Sameura Dam

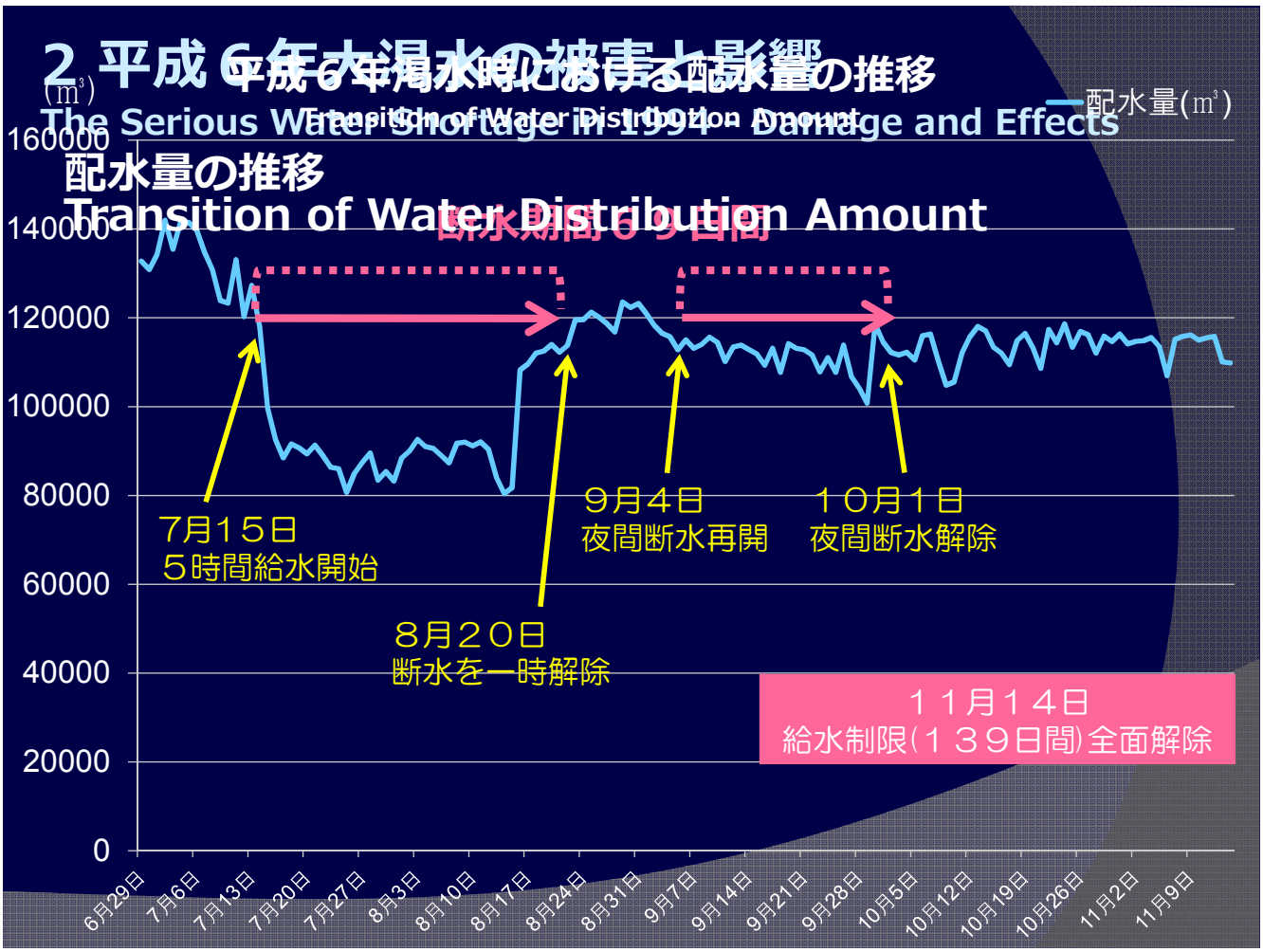
2 平成６年大渇水の被害と影響

The Serious Water Shortage in 1994 - Damage and Effects

2 平成６年大渇水の被害と影響

The Serious Water Shortage in 1994 - Damage and Effects

配水量の推移
Transition of Water Distribution Amount

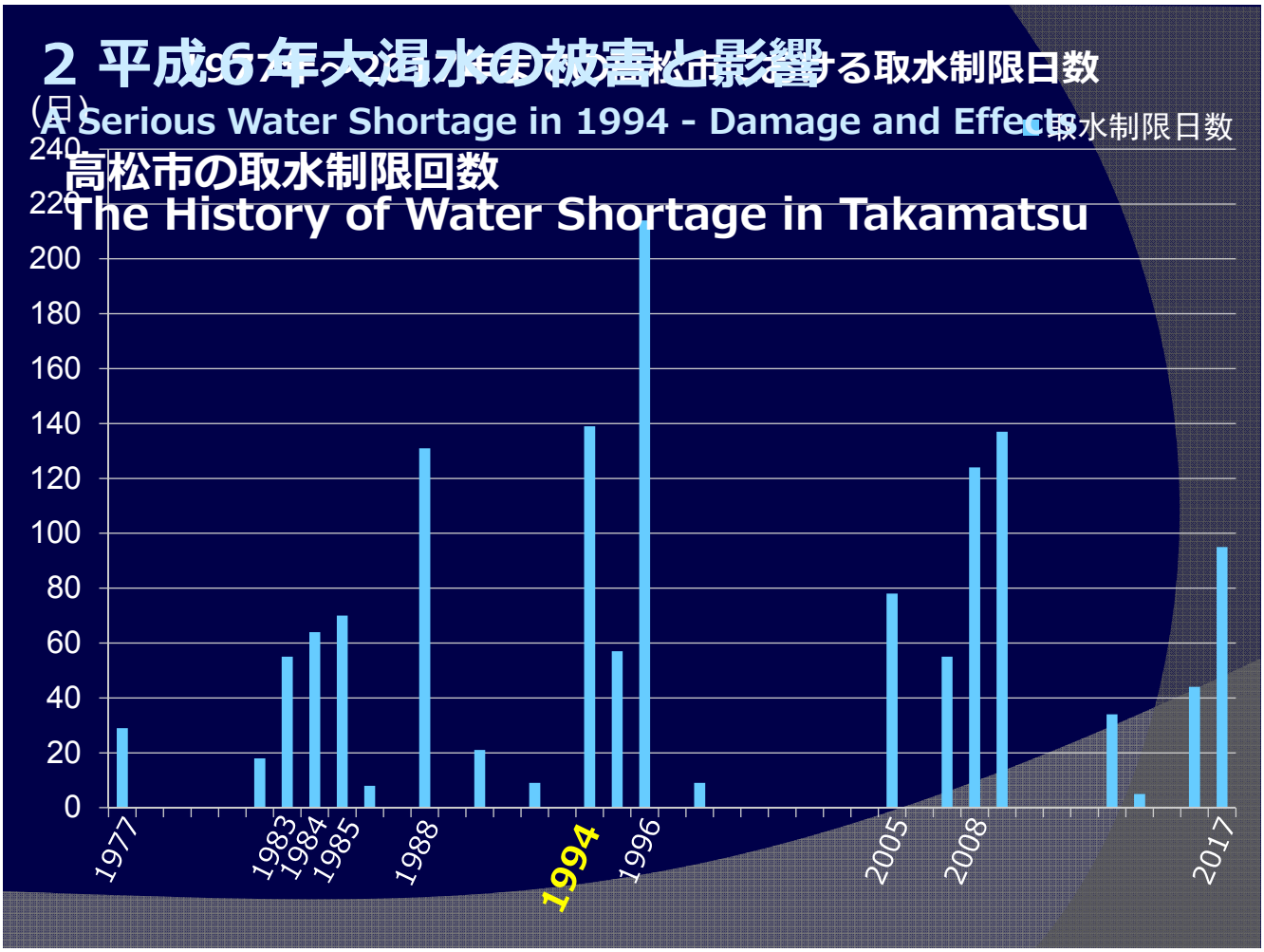


2 平成6年大渇水の被害と影響

A Serious Water Shortage in 1994 - Damage and Effects

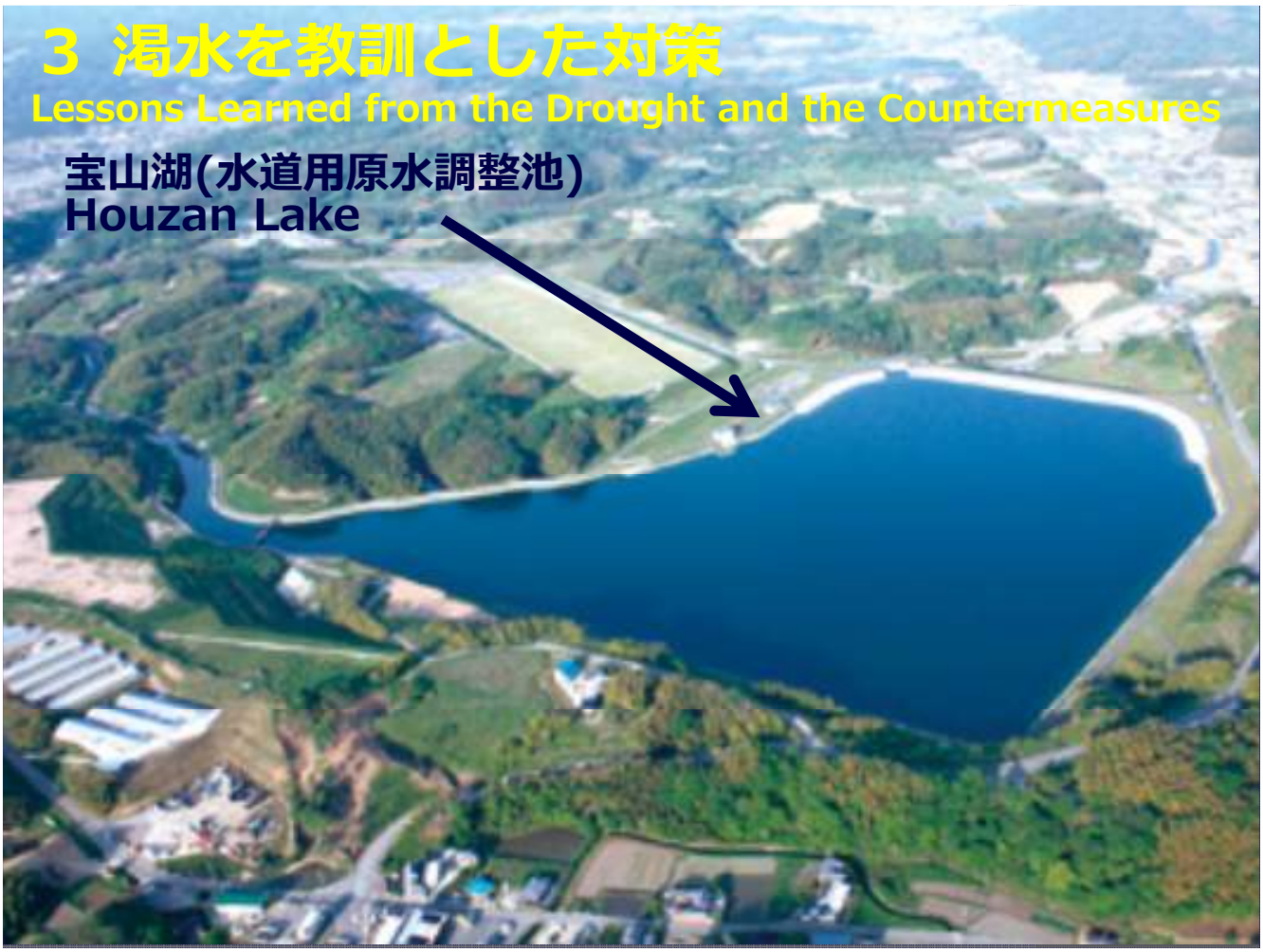
高松市の取水制限回数

The History of Water Shortage in Takamatsu



3 渇水を教訓とした対策

Lessons Learned from the Drought and the Countermeasures

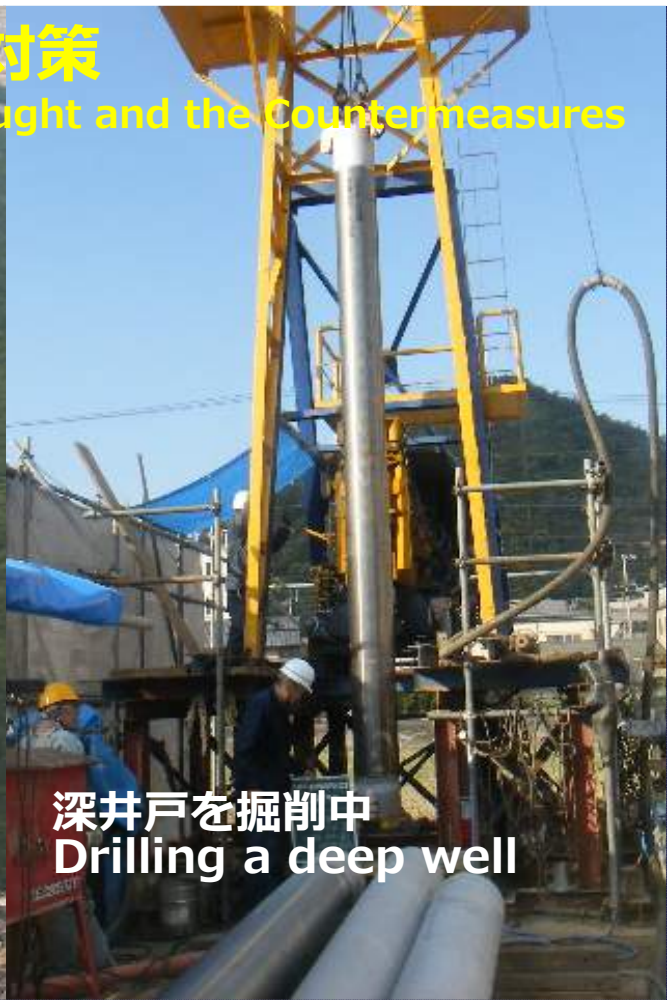


3 渇水を教訓とした対策
Lessons Learned from the Drought and the Countermeasures

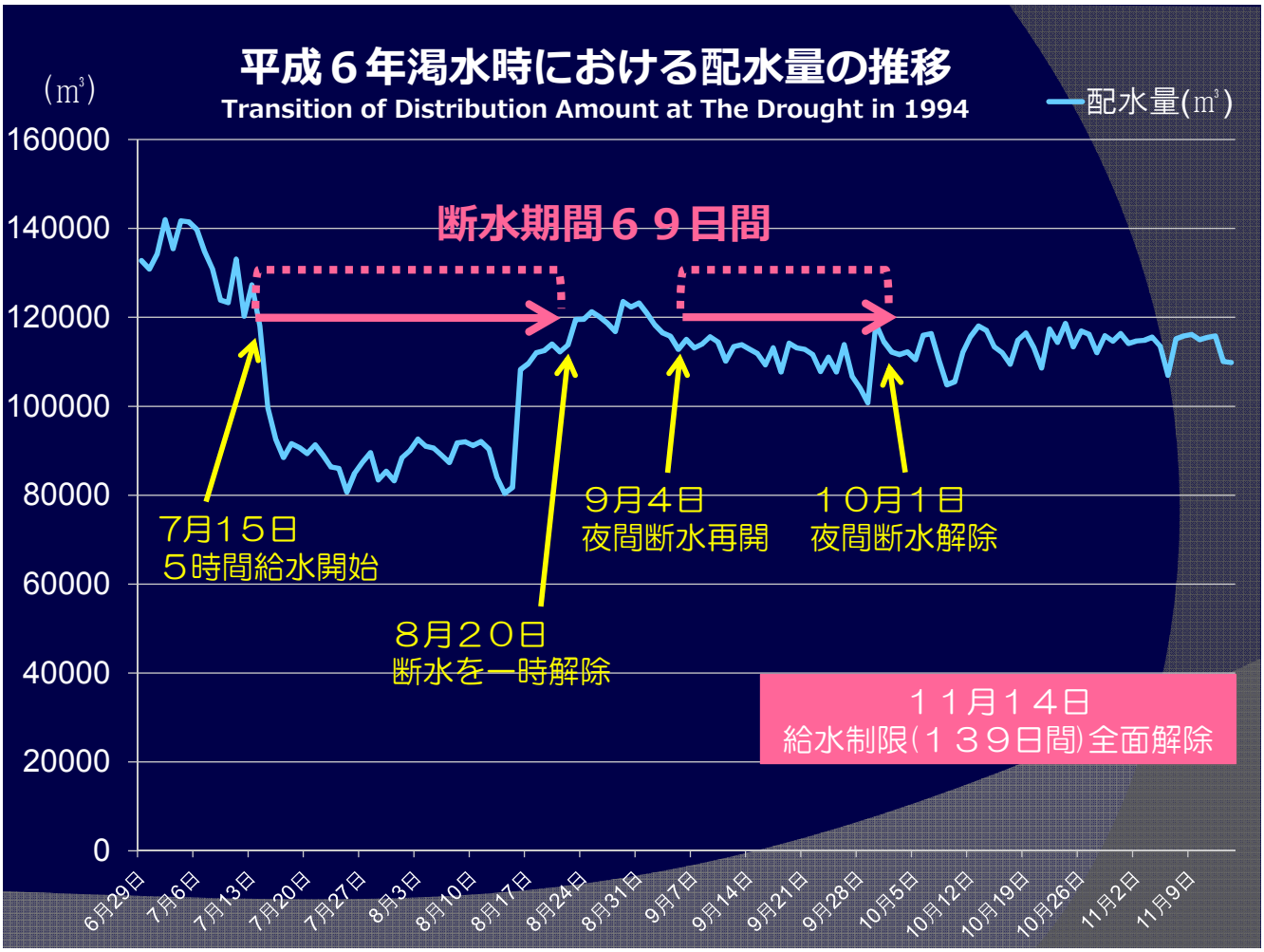
椛川ダム（建設中）
Kabakawa Dam (Under Construction)

3 渇水を教訓とした対策
Lessons Learned from the Drought and the Countermeasures

元農業用のため池「奥の池」
Okuno Pond



深井戸を掘削中
Drilling a deep well

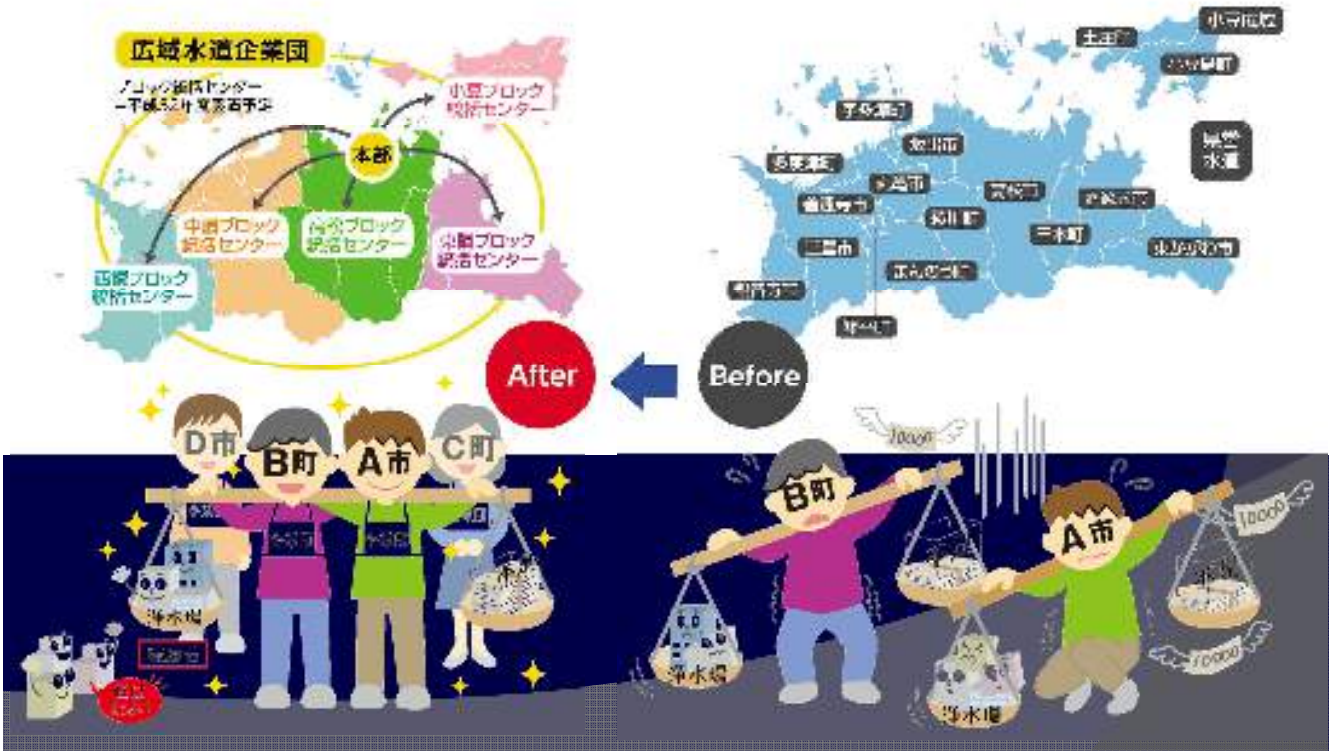


３ 渇水を教訓とした対策

Lessons Learned from the Drought and the Countermeasures

節水啓発チラシ
The Flyer ask for Water Conservation

4 水道広域化
Integrate Waterworks to Expand Supply Area
統合イメージ Future organization



御清聴
ありがとうございました
Thank you for your kind attention

END

Creation of Manual for Supplying Minimum Quantity of Water in Emergency (drought, etc.)

Choi Tae-Yong, Ph.D
Korea Water & Wastewater Works Association

KWWA
KOREA WATER AND WASTEWATER WORKS ASSOCIATION

CONTENTS

01. Overview

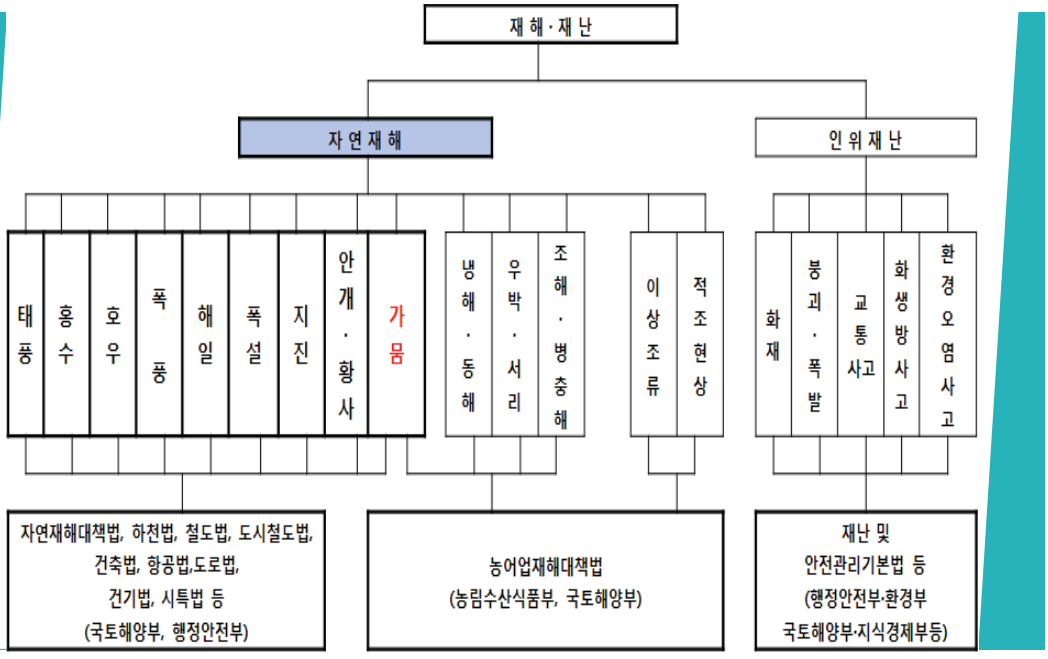
01. Overview / Definition and Scope of Emergency

What is an Emergency

The period when impossible to supply basic necessities due to disasters and extreme weather events

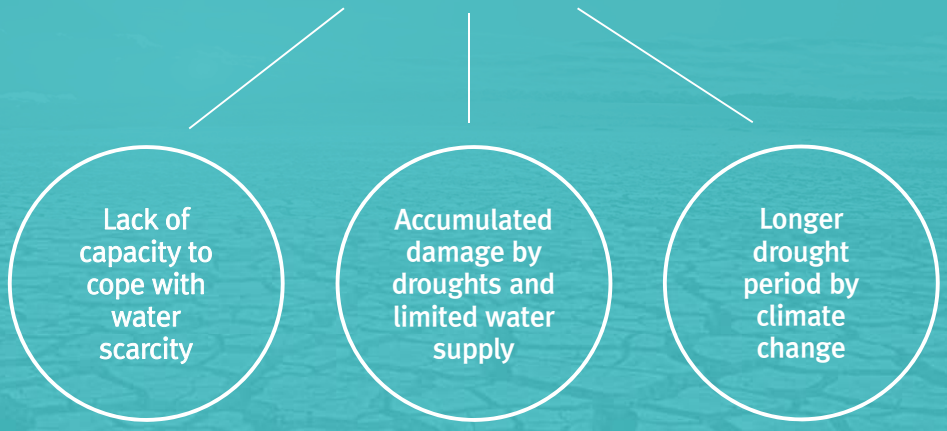
Scope of Emergency

Strategy for supply minimum quantity of water in droughts



Source : Disasters by Structure and Vehicles and Strategy for Coping with Disasters , 2003

Current Droughts in Korea



Damages by droughts in Korea

M = million

Year of droughts		Damages
1967 to 1968	1967	Drought area 420,547ha / damage 551 M USD
	1968	Drought area 470,422ha / damage 616 M USD
1981 to 1982	1981	Drought area 145,457ha / damage 191 M USD
	1982	Drought area 231,244ha / damage 303 M USD
1994 to 1995		Drought area 173,269ha (86 cities)
2001 to 2002	2001	Limited water supply to 304,815 people (86 cities)
	2002	Limited water supply to 92,838 people (23 cities)
2008 to 2009		Limited water supply to 228,068 people (77 cities)

Drought Report (1995, 2002), 2008 to 2009 Adaptation to Drought Progress Report (2009)

02. Prior Study Review

02. Prior Study Review / Adaptation to Drought in Water Supply for Everyday Life, Ministry of Environment (2007)

Stage 1-1
10% less water supply

- Supply water by transportation to highlands and areas of poor water supply
- Conduct public relations for water saving public by broadcasting and campaigns
- Strengthened management of drinking water quality

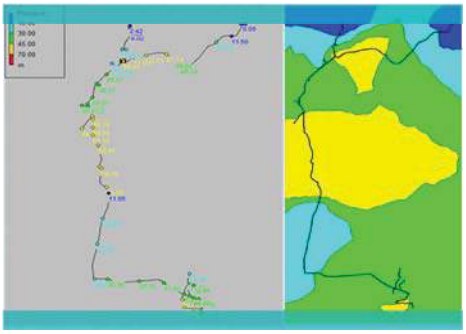
Stage 1-2
10 to 30% less water supply

- Operate emergency water supply team for each local government
- Reduce business hours or conduct temporary closure of businesses using a large quantity of water
- Strengthen drinking water quality management
- Encourage people to save water at home and in large buildings and further expand water saving campaign
- Further encourage people to save public water and recycle water

02. Prior Study Review / Adaptation to Drought in Water Supply for Everyday Life, Ministry of Environment (2007)

Stage 2 30 to 50% less water supply	• Neighboring local governments support each other for emergency water supply • Businesses using a large quantity of water close their business voluntarily
Stage 3-1 50 60% less water supply	• Supply water for 3 to 5 days depending on situations • Shorten and stop industrial water supply
Stage 3-2 At least 60% less water supply	• Supply a minimum quantity of water for everyday life
Stage 4 Suspended water supply	• Provide bottled drinking water, and execute drinking water supply system for supplying minimum quantity of water • Share private wells

02. Prior Study Review / Assessment of Vulnerability to Drought and Creation of Guideline for Limited Water Supply , Ministry of Environment (2016)



- Estimate the volume to be reduced in each drainage zone for each local government in limited water supply
- Examine poor water flow and suggest action plan in limited water supply
- Calculate peak load rate based on drainage runoff
- Control valve opening to simulate limited water supply (use US EPAnet)
- Control valve opening with the drainage location as a starting point to control overall water pressure

03.
Manual for Limited Water Supply System for Each Stage

03. Manual for Creating Limited Water Supply System in Each Stage/ Regulation Improvement Planning

Suggest improvement plan for effective limited water supply

STEP 01 Awareness (Blue)

Existing Action Guideline	Proposal
	▶ Check and correct drought strategies in area where droughts are predicted and take water saving measures.
• Inspect and repair drought-fighting equipment in area where droughts are predicted	• **Limit use of water in gardens (trees, shrubs, flowering plants)** – Recommend water cans and water sprinklers to water plants in gardens for voluntary water saving
• Promote water saving strategy	• **Limit other use of water than at home (fountains, water features, etc.)** – Permit for fountains and water features for decoration : Promote voluntary water saving. – Permit for use of water for dust control in construction sites and commercial car wash : recommend voluntary water saving.
• Take measures to prevent water contamination incidents in water shortage	• **Limit use of water in commercial districts and public authorities (parks, shops, public institution, etc.)** – Encourage people to save water voluntarily.
• More water supply facilities constructed in islands, rural districts and fishing villages	• **Use of water in facilities in urban areas and public facilities (parks, public swimming pools)** – Park : Plan management and recommend 5% of water saving during drought period. – Public swimming pool: Recommend covers in leak repair or when not used
	• **Use of water indoors and for other purposes (humidifier, air conditioning outdoor unit, etc.)** – Encourage people to save 5% of water usage.

03. Manual for Creating Limited Water Supply System in Each Stage/ Regulation Improvement Planning

Suggest improvement plan for effective limited water supply

STEP02 Alert (Yellow)

Existing Action Guideline	Proposal
	▶ Water saving campaign through local media
• Water saving campaign through local media	• Limit use of water for landscaping(trees, shrubs. flowering plants) – Grass : Recommend watering once or twice/week. – Recommend no transplanting or new planting,
• Continue to check areas where droughts are predicted to occur	• Limit other use of water than at home(fountains, water features, etc.) – Permit for fountain and water features for decoration : Permit use of water for small fountains and ponds, Limit use of water for big fountains with no water recirculation. – Permit for use of water for dust control in construction sites and car wash : Recommend best management practice for specific industry to reduce 14% of annual usage of water, Recommend car wash once per month.
• Continue to examine regional rainfalls, and water storage of reservoirs for farming	• Limit use of water in commercial districts and public institutions (factories, shops, public institutions, etc.) – Recommend best management practice to reduce water usage – Restaurant : Recommend to reduce the number of dishes to be washed

03. Manual for Creating Limited Water Supply System in Each Stage/ Plan Regulation Improvement

Regulation Improvement Planning

STEP03 Warning (Orange)

Existing Action Guideline	Proposal
• Operate disaster control headquarter in concerned area	▶ Operate disaster control headquarters in concerned area.
• Conduct step-by-step limited water supply in concerned area (transportation) and report situation	• Limit use of water for landscaping (trees, shrubs, flowering plants, etc.) – Recommend regular watering grass once or twice per week, trees and shrubs at least once/month. – Recommend no transplanting or new planting.
• Utilize alternative water resources, e.g., rainwater using facilities installed before	• Limit other use of water than at home (fountains, water features, etc.) – Prohibit use of fountains and water features for decoration. – Permit for use of water for dust control in construction site and commercial car wash : Recommend best management practice for specific industry to reduce 22% of annual water usage, Use water not more than 150L for car wash and limit car wash once per 6 weeks by manager's approval.
• Perform limited water supply strategies in farming, water supply service and industry	• Limit use of water in commercial districts and public institutions (factories, shops, public institutions, etc.) – Recommend best management practice for reducing water usage – Restaurant : Recommend to reduce the number of dishes to be washed
• Water saving campaign through local media	

03. Manual for Creating Limited Water Supply System in Each Stage/ Plan Regulation Improvement

Regulation Improvement Planning

STEP04 Severe Level (Red)

Existing Action Guideline	Proposal
• Operate disaster control headquarters in concerned area	▶ Operate disaster control headquarters in concerned area
• Conduct step-by-step limited water supply in concerned area (transportation) and report situation	• Limit watering for landscaping(trees, shrubs, flowering plants, etc.) – Prohibit watering grass, and specify official days for watering trees and shrubs – Prohibit all new planting for landscaping
• Utilize alternative water resources, e.g., rainwater using facilities installed before	• Limit other use of water than at home(fountains, water features, etc.) – Prohibit use of fountains and water features for decoration. – Permit for use of water for dust control in construction site and commercial car wash : Recommend best management practice for specific industry to reduce 40% of annual water usage, Limit use of water not more than 55L for car wash and permit car wash by manager's approval.
• Perform limited water supply strategies in farming, water supply service and industry	• Limit use of water in commercial districts and public institutions (factories, shops, public institutions, etc.) – Recommend best management practice for reducing water usage – Restaurant : Recommend to reduce the number of dishes to be washed
• Expand water saving campaign through local media	

03. Manual for Creating Limited Water Supply System in Each Stage/ Suggest plan for reducing water demand

1) Public Relations for Water Saving and Limited Water Supply

▶ **Master plan for drinking water supply for longer drought period by Seoul City (2015)**

〈 Water saving Campaign 〉

- Drought damages
- Public relations for drinking water saving

〈 Public relations for limited water supply 〉

- Build emergency contact network for businesses using a large volume of water

Master plan for self water supply required

It is necessary for local governments to create their own water saving campaign and action guidelines about public relations in limited water supply

03. Manual for Creating Limited Water Supply System in Each Stage/ Suggest Method for Reducing Water Demand

2) Review self-regulated water supply scheme

Forced water supply control
Control branching valves to reduce the volume of supplied water

Self-regulated water supply control
Active water saving campaign in which residents participate voluntarily

Thank you

Adaptation Strategies for Climate Change in the TAIWAN

Yang-Long Wu
Secretary General
Chinese Taiwan Water Works Association

Presentation Outline

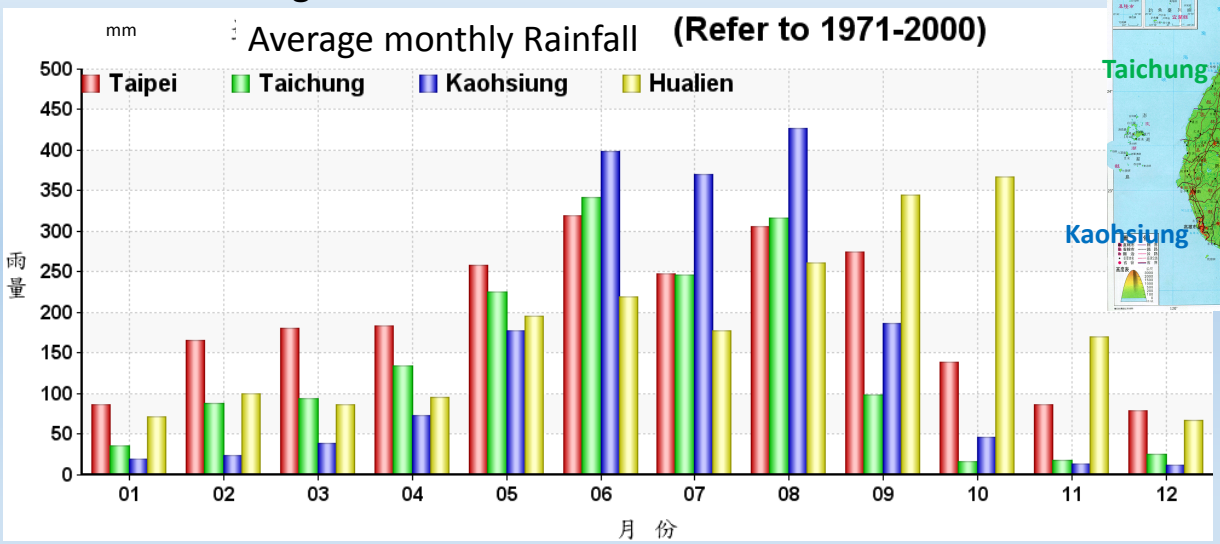
- Water Resource Situation in the Taiwan
- Impacts of Climate Change in Water Resource of Taiwan
- Adaptation Strategy for Climate Change in the Taiwan
- Conclusion

Water Resource Situation in the Taiwan (1)

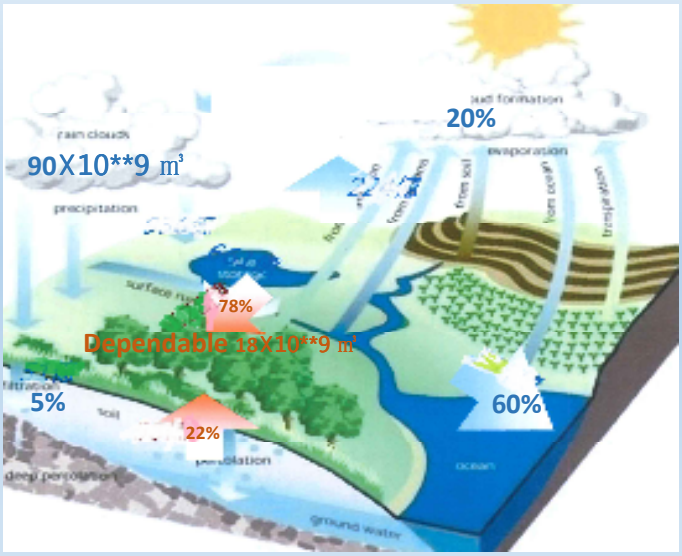
Land Area：35,873 Km^2

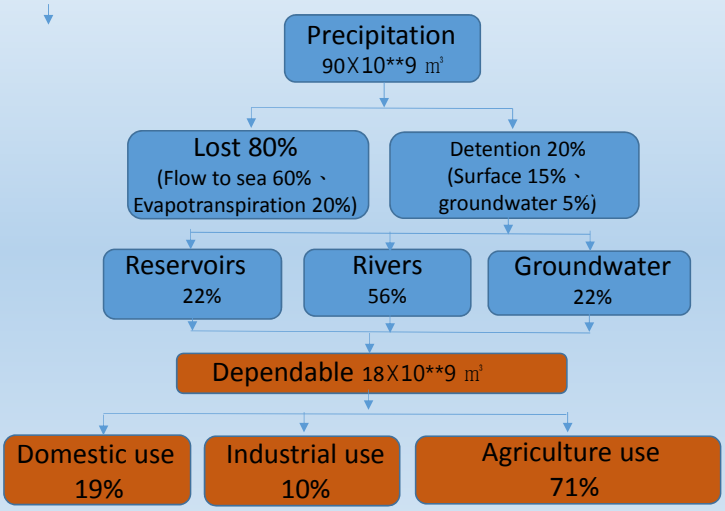
Water Resource Situation in the Taiwan (2)

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%

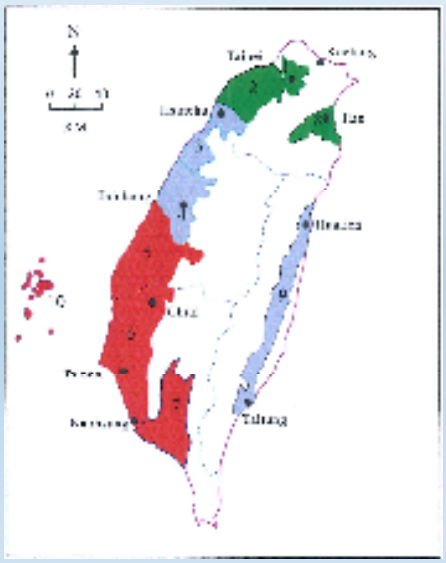
10000 M^3

Reservoir Name	Design Storage	Real Storage	Sediment Rate
石門水庫	30912	21714	30%
翡翠水庫	74800	47330	36%
曾文水庫	15605	9793	37%
南化水庫	16415	7982	48%
烏山頭水庫	14860	4727	68%
白河水庫	2509	970	61%
阿公店水庫	7	5	30%
仁義潭水庫	65	41	37%
鯉魚潭水庫	1770	1285	27%
德基水庫	26221	19662	25%
霧社水庫	920	761	17%
日月潭水庫	17102	14359	16%

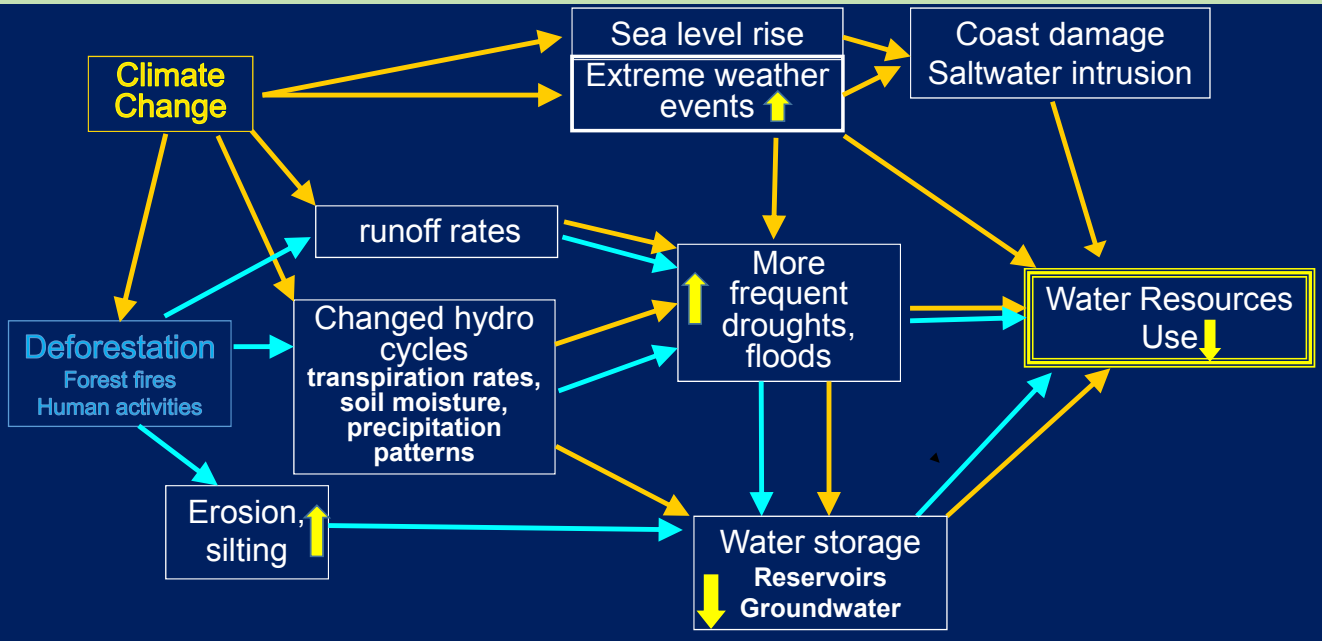
Reservoir Name	Design Storage	Real Storage	Sediment Rate
牡丹水庫	3118	2679	13%
明德水庫	976	845	13%
木屐寮水庫	1440	1291	10%
阿公店水庫	1837	1669	9%
蘇澳水庫	215	197	7%
翡翠水庫	40600	38136	6%
石岡水庫	1000	999	0.1%
鹿寮水庫	547	550	0.1%
永和山水庫	2958	2925	1%
仁義潭水庫	2911	2712	7%
鯉魚潭水庫	978	976	0.1%
翡翠水庫	3134	3212	1%
鯉魚潭水庫	17607	17805	6%

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.

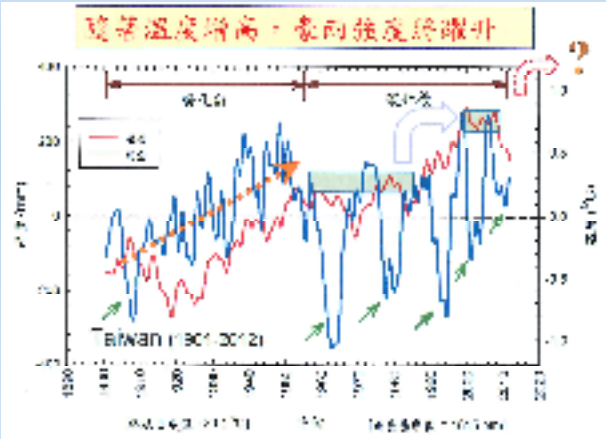


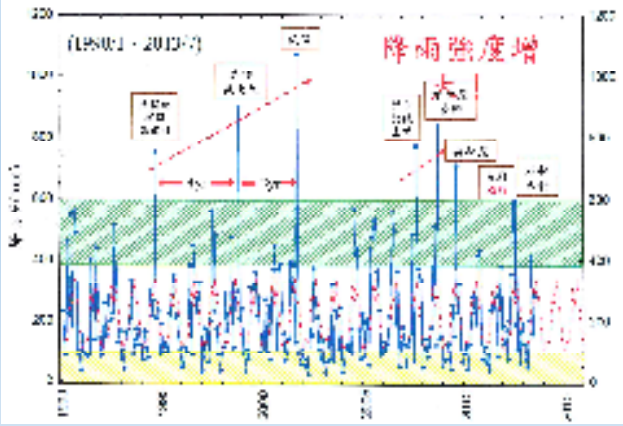
Impacts of Climate change in Water Resource (1)



Impacts of Climate change in Water Resource (2)

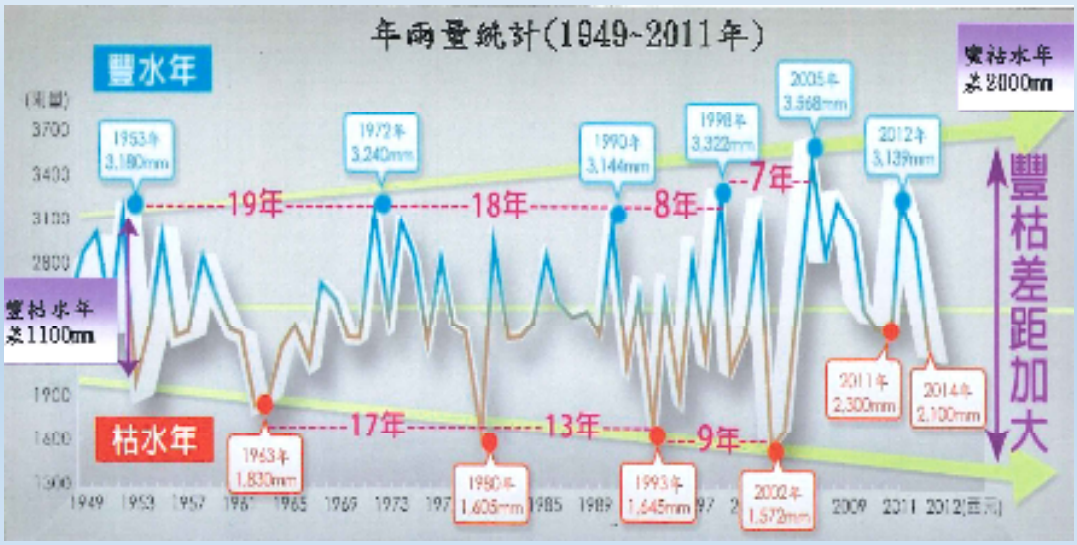
- Increased Temperatures (red line)
- Changing Rainfall Patterns (blue line)





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

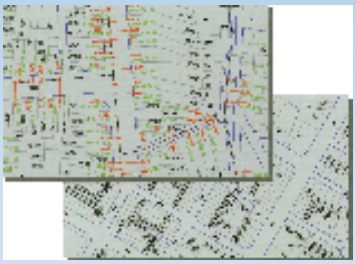
Water rate of Taipei Water Department

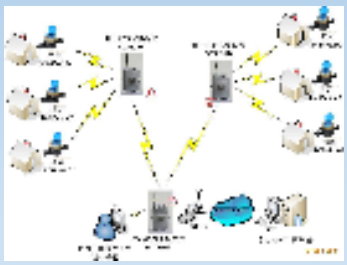
Water consumption level	0-20	21-60	61-200	201-1,000	1,001以上
Number of household 10^3	941	516	54	7.9	1.8
Old price (NT$/$m^3$)	5	5.2	5.7	6.5	7.6
New price (NT$/$m^3$)	5	6.7	8.5	14	20
Difference (NT$/$m^3$)	-	34	142	1,242	7,242

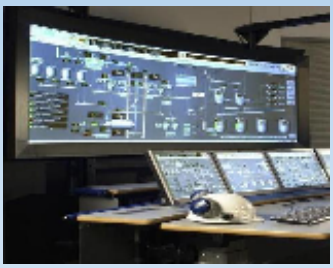
1 NT$≈0.03 US$

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

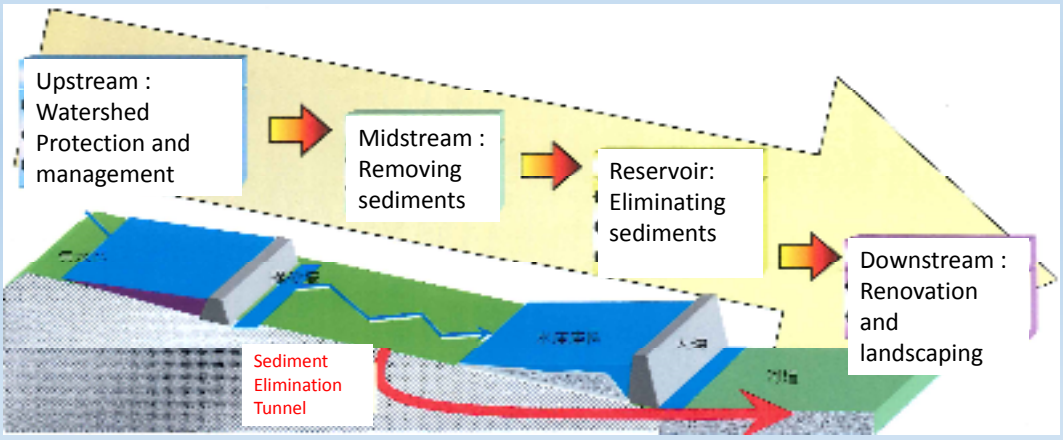
Items	2003	2016	2021
daily water consumption	291 lpcd	268 lpcd	250 lpcd
Water - saving toilet Water – saving wash machine	68.5% 14.5%	86.8% 72.5%	100% 100%
Industrial water recycling rate	47.7%	69.8%	80%
Water leakage rate	24.3%	16.8%	12%

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

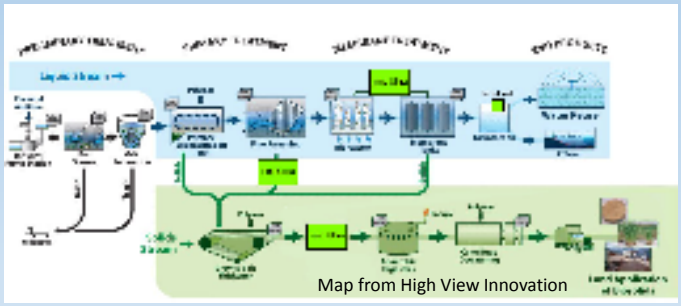
Hushan Reservoir

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

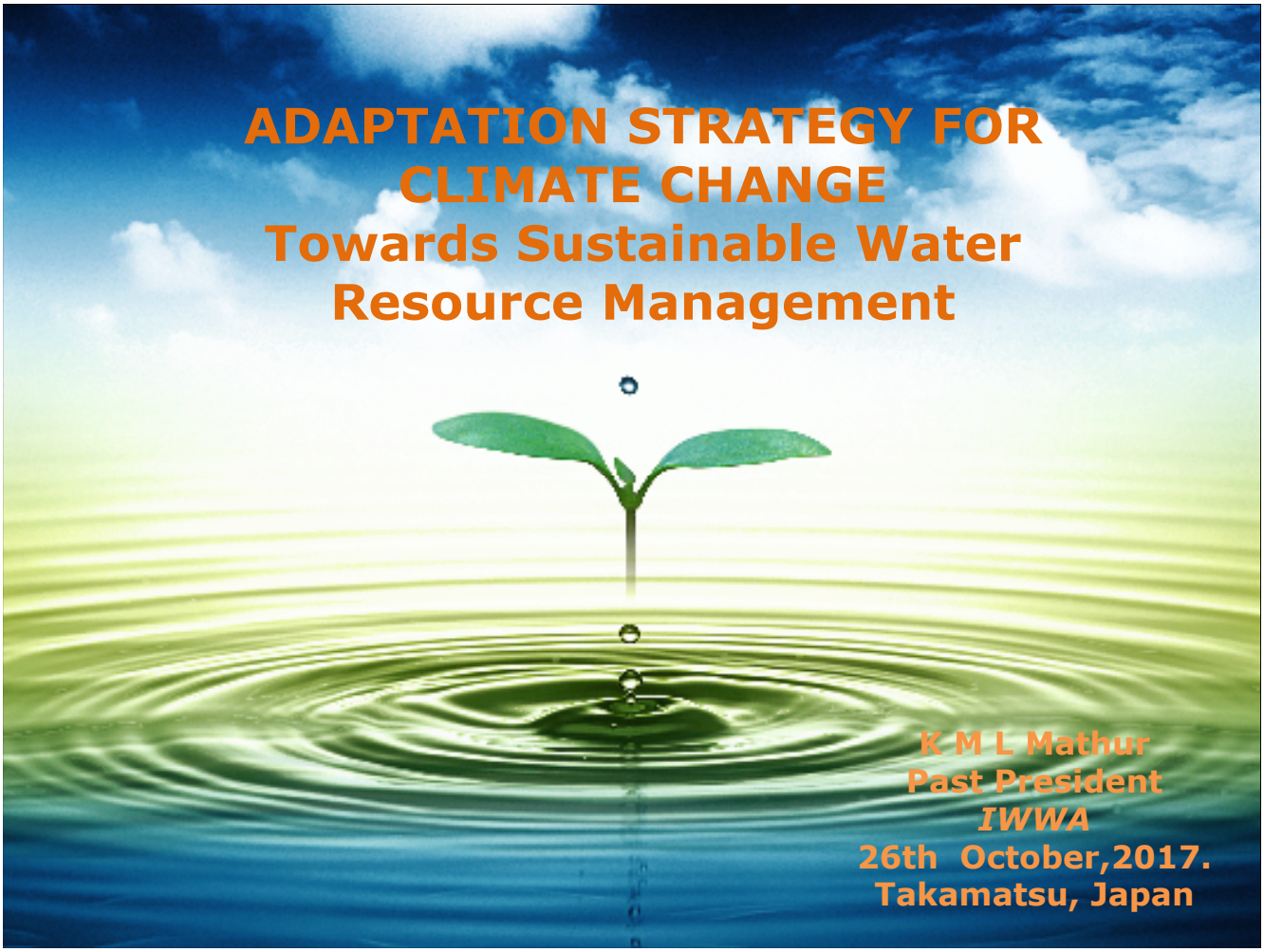
Water source	Cost (NT$/m³)
Drinking water	10.5-20.0
groundwater	3.o-5.0
Irrigation water	5.0-10.0
Reuse of wastewater	17.2-21.6
Reservoir	30.0-40.0
Desalination water	35.2-39.3

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

ADAPTATION STRATEGY FOR CLIMATE CHANGE
Towards Sustainable Water Resource Management



K M L Mathur
Past President
IWWA
26th October,2017.
Takamatsu, Japan

HISTORY OF INDIA

- Prime importance on water since ancient times
  - ◦Ancient civilizations developed near rivers
  - ◦Rivers considered as deities in Indian culture
- Evidences of water and wastewater management practices since 3000BC in Indus Valley Civilizations
  - ◦Drainage channels with covers for maintenance
  - ◦Retention structures for sludge collection
  - ◦Rain water harvesting measures in the form of reservoirs

Source: http://www.shunya.net/Pictures/WesternIndia/Gujarat/Dholavira/Dholavira03.jpg

Source: http://www.sewerhistory.org/images/w/wam/loth_wam10.jpg

HISTORY OF WATER IN INDIA

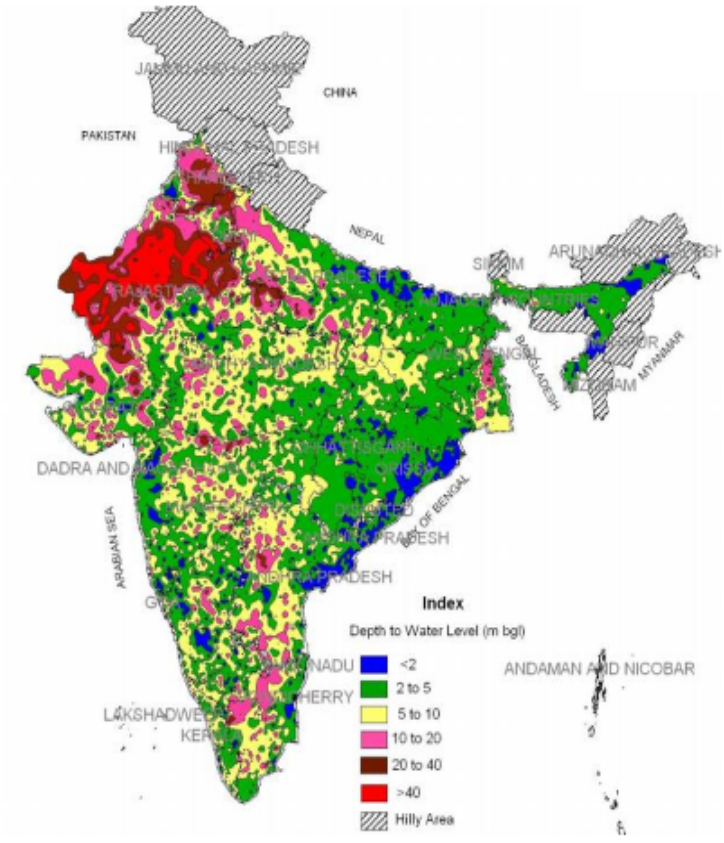
- Community approach also evident in many areas for conservation of water
  - Structures like Paar, Johads, Kund, Ahar and Bhandaras from Himalayas to arid deserts of Rajasthan

Source: http://socks-studio.com/2014/03/13/inhabiting-infrastructures-indian-stepwells/

- Water supply infrastructure
  - Example: Katraj Lake near Pune which still functional after 250 years

Source: http://www.thebetterindia.com/17159/jethu-singh-reviving-traditional-methods-rain-water-harvesting/

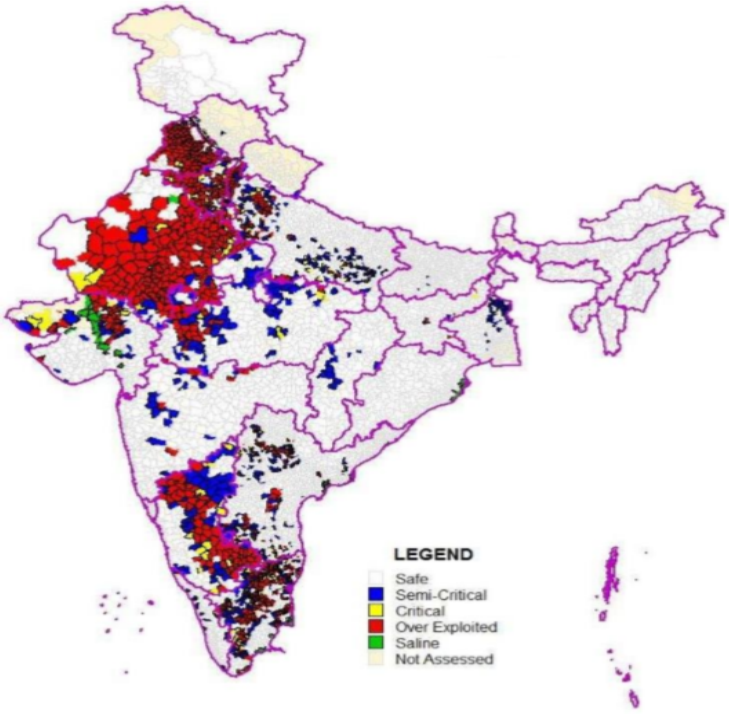
Figure 2: Depth to water level (pre-monsoon, 2014)



Note: m bgl denotes meters below ground level.
Sources: Central Ground Water Board; PRS.

- Availability of groundwater in the northwestern region of the country is at very low levels
- Significant pockets across the country where the depth of the water level is more than 10 meters.
- In areas where water level is below 10 meters, sophisticated equipment is required to extract it

Figure 3: Categorization of ground water assessment units



Note: Data as of 2011.
Sources: Ground water scenario in India, November 2014, Central Ground Water Board; PRS.

State	Ground water development in 2011 (%)
Andhra Pradesh	37
Arunachal Pradesh	0
Assam	14
Bihar	44
Chhattisgarh	35
Delhi	137
Goa	28
Gujarat	67
Haryana	133
Himachal Pradesh	71
Jammu & Kashmir	21
Jharkhand	32
Karnataka	64
Kerala	47
Madhya Pradesh	57
Maharashtra	53
Manipur	1
Meghalaya	0
Mizoram	3
Nagaland	6
Odisha	28
Puducherry	90
Punjab	172
Rajasthan	137
Sikkim	26
Tamil Nadu	77
Telangana	55
Tripura	7
Uttar Pradesh	74
Uttarakhand	57
West Bengal	40
Total *	62

Note: *Total includes union territories.

Water Availability In India

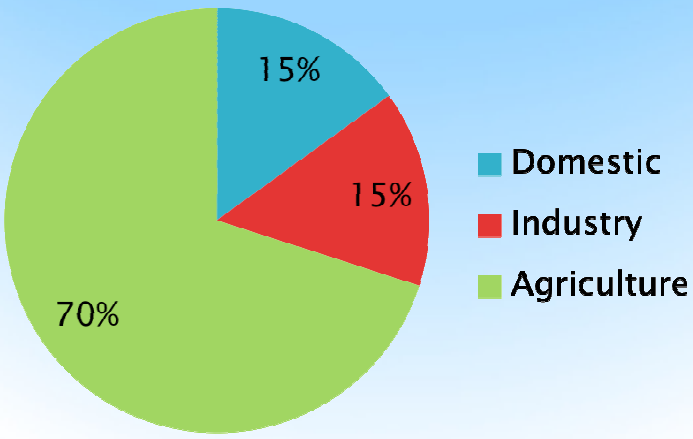
Parameters	Unit(Billion Cubic Meter/Year)
Annual Percipitation	4000
Average Annual Availability	1869
Estimated Utilizable Water Resources	1123
(i)Surface Water Resources	690
(ii)Ground Water Resources	433

Top fifteen river basins in India: Average water flow and utilizable water				
River basins	Average annual water flow (in Km3/year)	Utilizable flow (in Km3/year)	% of total average annual water flow in India	% of total utilizable wa flow in Ind
Ganga–Brahmaputra–Meghna Basin	1202	274	61.6	40
West flowing rivers south of Tapi	201	36	10.3	5.2
Godavari	111	76	5.7	11
Indus	73	46	3.8	6.7
Krishna	70	58	3.6	8.4
Mahanadi	67	50	3.4	7.2
Narmada	46	35	2.3	5.0
Brahmni–Baitarani	28	18	1.5	2.7
East-flowing rivers between Mahanadi and Godavari	17	Un-assessed	0.9	Un-assesse
West-flowing rivers of Kachchh and Saurashtra including Luni	15	15	0.8	2.2
Tapi	15	15	0.8	2.1
Subarnarekha	12	6.8	0.6	1.0
Mahi	11	3.1	0.6	0.4
East-flowing rivers between Pennar and Cauvery	10	17	0.5	2.4
Rivers draining into Bangladesh	8.6	NA	0.4	NA
Total	**1887**	**649.42**	**96.62**	**94.12**
Total average annual water flow in all river basins (in Km3/year):				**1953**
Total utilizable water flow in all river basins (in Km3/year):				**690**

WATER STATISTICS

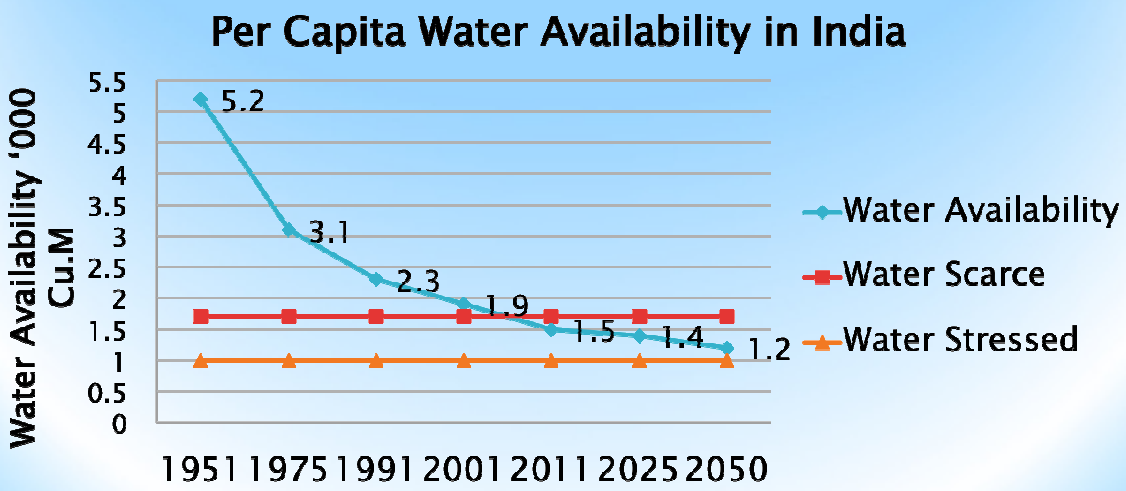
16% of world population and 4% of water resources usage of water in India.

Usage of water in India



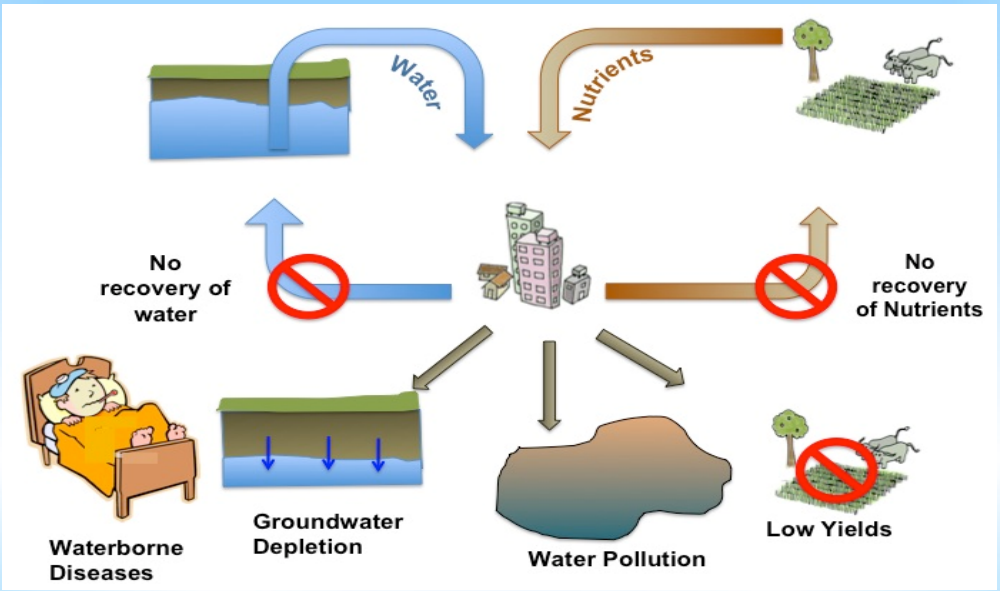
WATER STATISTICS

- Per capita water availability in India has dropped and is expected to further reduce in the future
- Increasing demand and population



CURRENT WATER ISSUES

- Over exploitation of ground water resources
- End of the Pipe solutions
- Lack of sewage and effluent treatment



CURRENT WATER ISSUES

- Inefficient operation and maintenance of wastewater treatment facilities by Municipal Bodies and SMEs at many places
- Water use productivity in India is very low (UNESCO, WWAP)
- Many SMEs can't afford ETPs. CETPs employed in few cases
- Distribution losses due to lack of maintenance and repair
- Service Level benchmark for NRW is fixed at 20%
- "In a study by Andey and Kelkar (2007), in four cities across India, to evaluate the influence of intermittent and continuous water service on NRW, it was showed that NRW increased from 19.5% to 35.8% under IWS, whereas it increased from 31 to 47.8% under continuous supply system" (Jayaramu and Kumar 2014)

DROUGHT IN INDIA

- Scanty rainfall due to climate change.
- Total 1.7 million rural habitation.
- About 25%, 4,41,390 faces drinking water scarcity every year.

SHORT TERM MEASURES TO COMBAT DROUGHT

- Repair and restoration of hand pumps on priority.
- Addition of riser pipe to bore holes to access deeper ground water.
- Laying temporary pipe lines.
- Feeding through water tankers.
- Hiring of private bore wells to augment water supply.
- Drilling and commissioning of additional bore wells for power pumps.

LONG TERM MEASURES

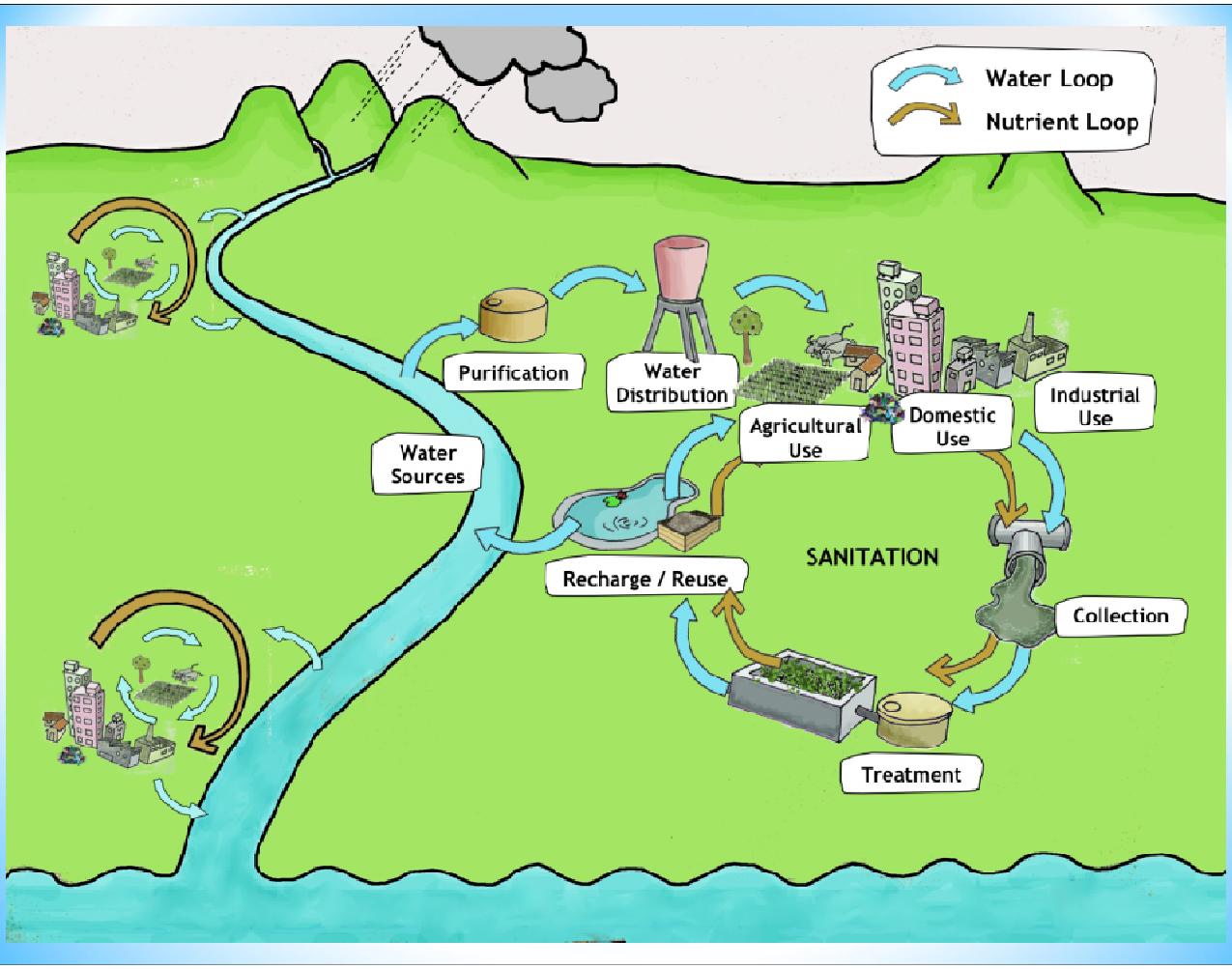
- Construction of check dams/ sub surface barrier.
- Rain water harvesting structures.
- Interlinking of rivers.
- Use of recirculated sewage water for drinking use.
- Transforming flood irrigation to drip/ sprinkle irrigation.

EQUITABLE DISTRIBUTION

- National Water Policy recognizes the need for equitable distribution
- It also recommends judicious use of water including recycle and reuse
- Focus on subsidizing basic services for urban poor with schemes like JNNURM
- Issues like high NRW, lack of metering

LAW AND LEGISLATION

- Environment Protection Act (1986)
- Water recognized as a basic need and a part of right to life
- Water Act (1974)
  - Prevention, Control and Abatement of Pollution
  - Ensure safe supply of water to people
  - Responsibility on State and ULBs to enact and enforce
- Rules and regulations at local level, written and unwritten
- Most control of water utilization with states rather than centre
- Pollution Control Boards at State and Central level
- National Water Policy, National Sanitation Policy, Municipality Act etc. all recognize the need of access, treatment and regulation of water sources



FUTURE OF WATER IN INDIA

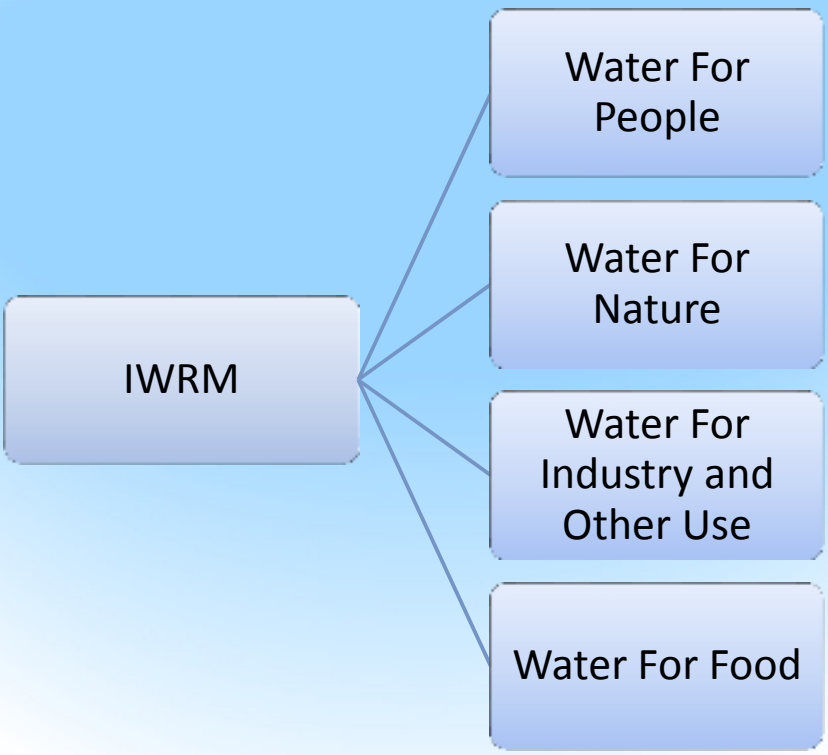
- Risk of being a water scarce country owing to increasing demand and population
- Contamination of water resources and climate change can further aggravate the problem
- 55% of all water is sourced from groundwater sources which are fast depleting

SECURING INDIA'S WATER FOR FUTURE

- Data Management and Dissemination for local adaptation and behavioral change
- Integrated watershed management to mitigate climate change
- Sustainable development
  - Adoption of unconventional and decentralized options along with centralized solutions
  - Maintaining environmental flow requirements
  - Encouraging water recycle and reuse
- More financing for water management with the help of private sector

SECURING INDIA'S WATER FOR FUTURE

- Incentive for treatment and reuse coupled with punishment for defaulters with strict implementation
- Efficient water use by using low flow equipment's, increasing water productivity
- Technical skill development for better management of water resources
- Encouraging research and development in the water sector including research on traditional methods



Piplantri Village District RajSamand, Rajasthan

SUCCESS STORY – Village Piplantri Distt. Rajsamand, Rajasthan

Basic Information Piplantri Village

- **Total Habitation – 7 nos.**
- **Total population – 5138 souls.**
- **Total families – 1100 nos.**
- **Total area – 2207.52 hectare**
  - **Cultivable area – 15 to 20 %**
  - **Water table – 15 to 20 meter**
- **No water supply facility in the village.**
- **No sanitation facility in the village.**

WORKS TAKEN UNDER IWRM

- 4 nos anicuts .
- Rain water harvesting structure.
- Water shed development.

FUNDING AGENCY

- NEGRA.
- Swajal Jhara.
- Nirmal Gram Programme.
- NGO under community development program.

RESULTS

- Water table increased by 10 to 12 meters. Now it is only 1.5 to 2 meters.
- Pipe water supply in village.
- Sanitation facility developed.
- Water sheds in 805 hectare out of which –
  - 216.83 hectare arable
  - 588.17 non arable
  - Hilly area converted to green by forestry
  - Horticulture plantation
  - Medical plants
  - Alovera plantation
- Enhancement in crop protection.
- Due to increase in water table crop area increased. Thus more production , more income.
- Due to employment in village migration stopped.
- No drought in future.

Water Table After IWRM work.

Rain Water Harvesting Structure

Anicuts Constructed under IWRM.

Anicuts constructed under IWRM.

Afforestation work done in non arable area.

Save Water

For Future

THANKS


MAP OF RAJASTHAN
PUNJAB
Ganganagar
Hanumangarh
PAKISTAN
HARYANA
UTTAR PRADESH
Churu
Jhunjhunun
Bikaner
Sikar
Alwar
Nagaur
Bharatpur
Jaisalmer
JAIPUR
Dausa
Jodhpur
Ajmer
Tonk
Sawai Madhopur
Barmer
Pali
Bhilwara
Bundi
Jalor
Baran
Rajasmand
Kota
Sirohi
Chittorgarh
Udaipur
Jhalawar
MAP LEGEND
State Boundary
International Boundary
District Boundary
State Capital
District Headquarters
Dungarpur
GUJARAT
Banswara
MADHYA PRADESH
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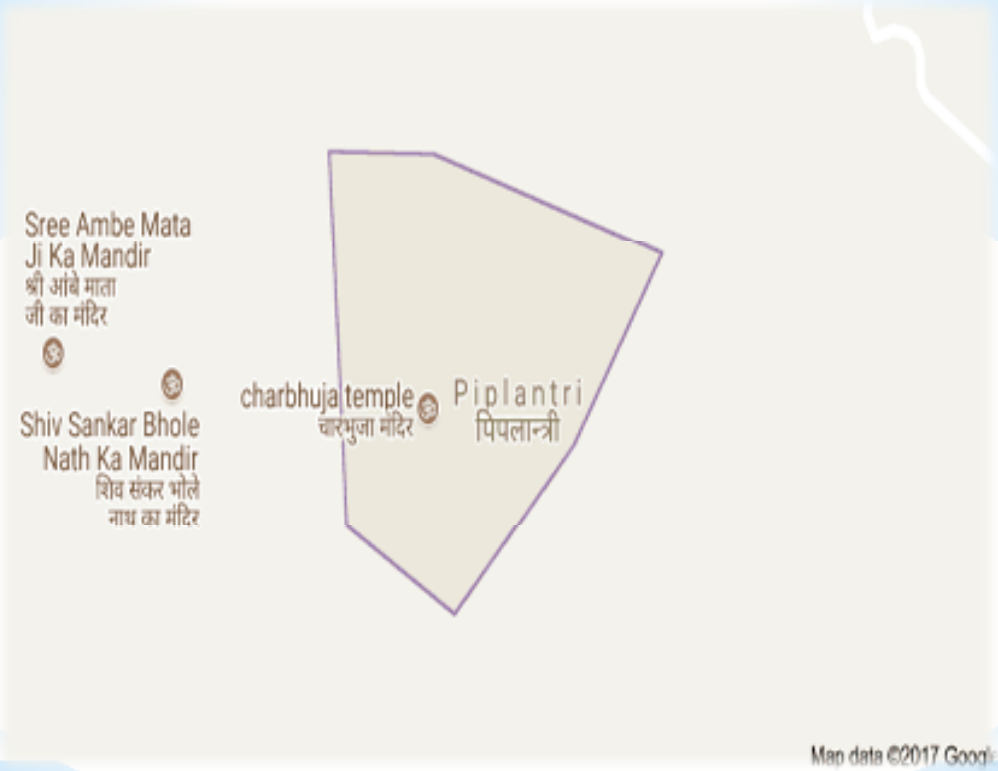
Travel Corporation (India) Ltd.
Map not to scale


RAJSAMAND DISTRICT
RAJSAMAND


Sree Ambe Mata
Ji Ka Mandir
श्री अंबे माता
जी का मंदिर
Shiv Sankar Bhole
Nath Ka Mandir
शिव संकर भोले
नाथ का मंदिर
charbhuja temple
चारभुजा मंदिर
Piplantri
पिपलान्त्री
Map data ©2017 Google

To slide 22

WATER SERVICES ASSOCIATION OF AUSTRALIA

International Water Forum

Carl Radford, Water Services Association of Australia

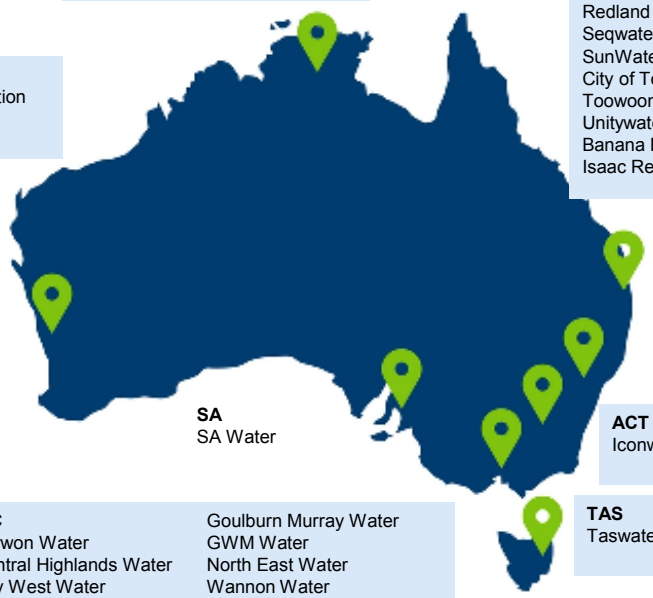
October 2017

Climate Change Adaptation and the Australian Urban Water Industry

What is WSAA?

- Peak body for water utilities
- Members provide services to over 20 million Australians (around 80-90% of population)
- Members have annual revenue over $15 billion
- Members manage over $150 billion in assets

WSAA Utility Members



NT
Power and Water Corporation

WA
Water Corporation
Aqwest

SA
SA Water

QLD
Queensland Urban Utilities
City of Gold Coast
Gladstone Area Board
Logan City Council
Redland City Council
Seqwater
SunWater
City of Townsville
Toowoomba Regional Council
Unitywater
Banana Regional Council
Isaac Regional Council
Mackay Regional Council
Mount Isa Water Board
Southern Downs Regional Council
Wide Bay Water
Whitsunday Regional Council
Cairns Water
Western Downs Regional Council

NSW
Gosford City Council
Goldenfields Water
Hunter Water
Shoalhaven Water
Sydney Water
WaterNSW
Queanbeyan Regional Council
Byron Shire Council
Lithgow City Council
Eurobodalla Shire Council
Lismore City Council
MidCoast Water
Port Maquarie-Hastings Council
Tweed Shire Council

ACT
Iconwater

TAS
Taswater

VIC
Barwon Water
Central Highlands Water
City West Water
Coliban Water
Gippsland Water
Goulburn Valley Water
Melbourne Water
South East Water
Western Water
Yarra Valley Water
Goulburn Murray Water
GWM Water
North East Water
Wannon Water
Lower Murray Water
South Gippsland Water

NZ
Watercare Services
Wellington Water

WSAA'S central functions

1. Collaboration

- Between members information sharing and problem solving
- On projects that are too big or expensive to do alone

2. Advocacy

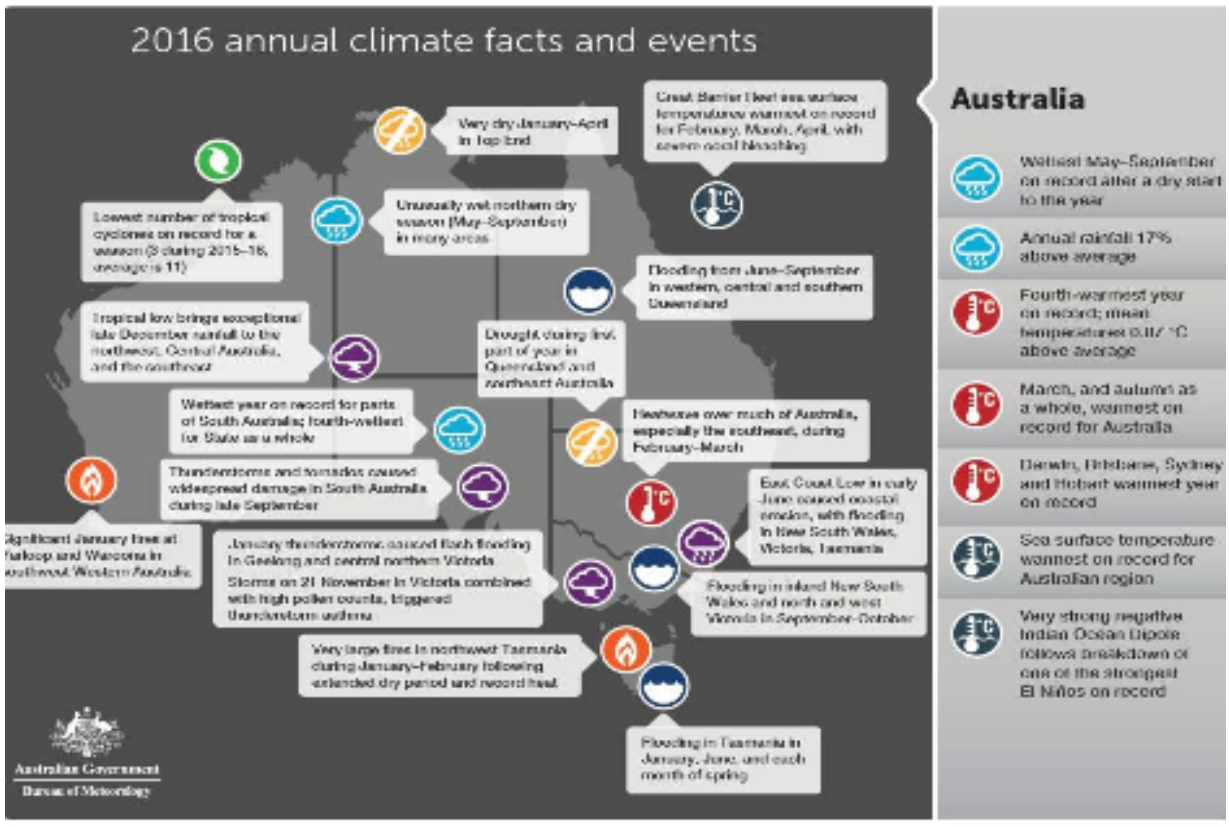
- Representing industry interests in Canberra
- Influencing policy
- International representation

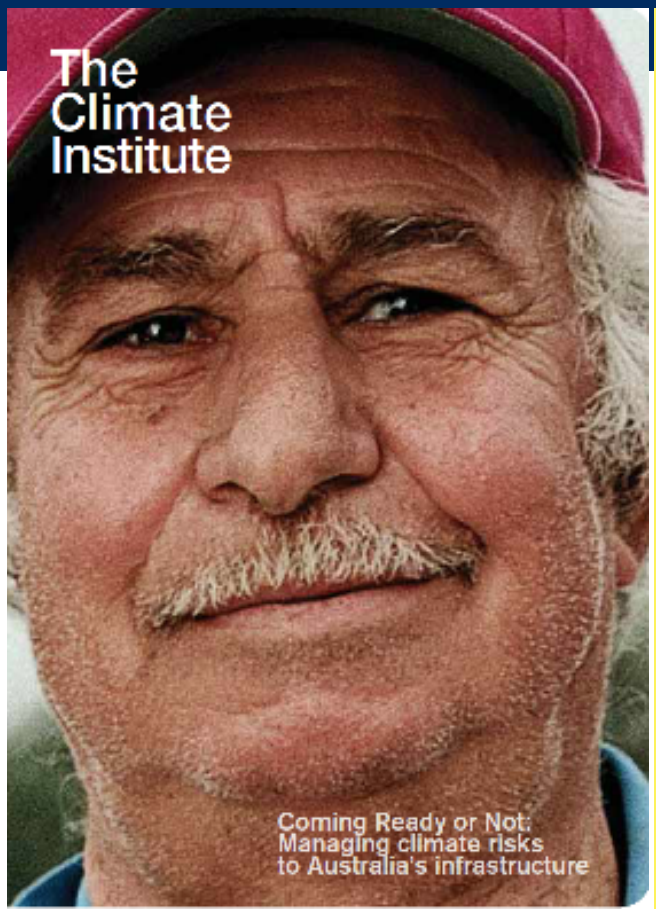
3. Innovation

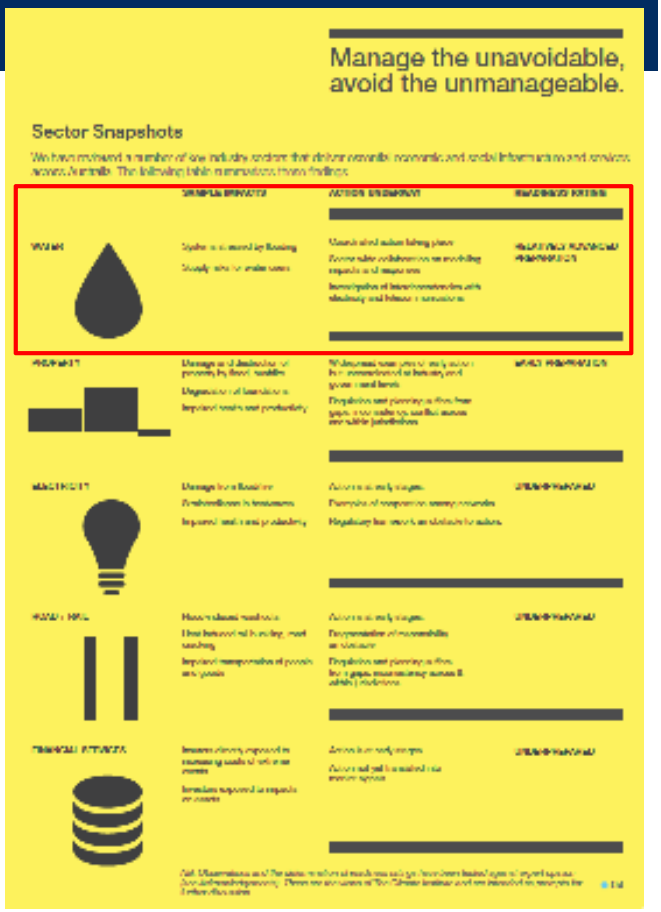
- A filtering point for latest technology
- Introducing new ideas from Australia and overseas
- Benchmarking

Risks & challenges for urban water utilities

Australia's climate in 2016







Setting the Scene

At a National level

CSIRO

Australian Government
Bureau of Meteorology

- Latest projections released 2016
- State of Climate Reports with BoM

NCCARF
National Climate Change Adaptation Research Facility

Australian Government
Department of the Environment

- Phase 2 – focus on coastal impacts
- Funding of $8.8 Million
- End User Reference Grp involvement

WATER SERVICES ASSOCIATION OF AUSTRALIA

WITNESS KING TIDES
A PROJECT BY GREEN CROSS AUSTRALIA

- Developed National Adaptation Guidelines
- Building resilient communities

National Adaptation Guidelines

Objective

- incorporate ‘best practice’ consideration of climate change risks and responses into business as usual using a straightforward, logical approach

Addresses

- broad range of climate change - related hazards including damage to infrastructure, disruption of services from power failure, telecom disruption etc.

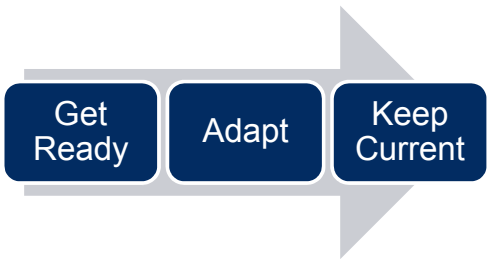
Outcomes

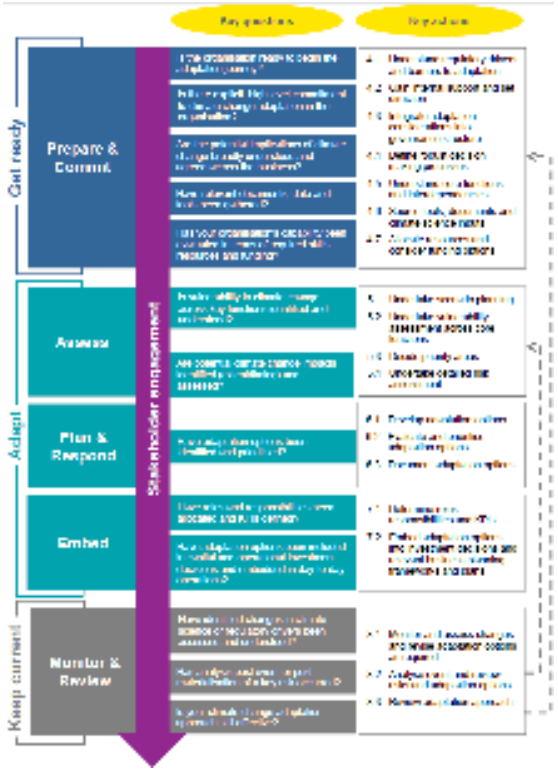
- National effort
- A way forward for integrating within business as usual
- Consistent Approach
- Industry leadership
- Assurance for Regulators
- expand awareness and approach to planning (Rethinking Adaptation for a 4 degree world)

Climate change adaptation decision framework

Five main ‘steps’

1. **Prepare and Commit**
2. **Assess**
3. **Plan & Respond**
4. **Embed**
5. **Monitor and Review**

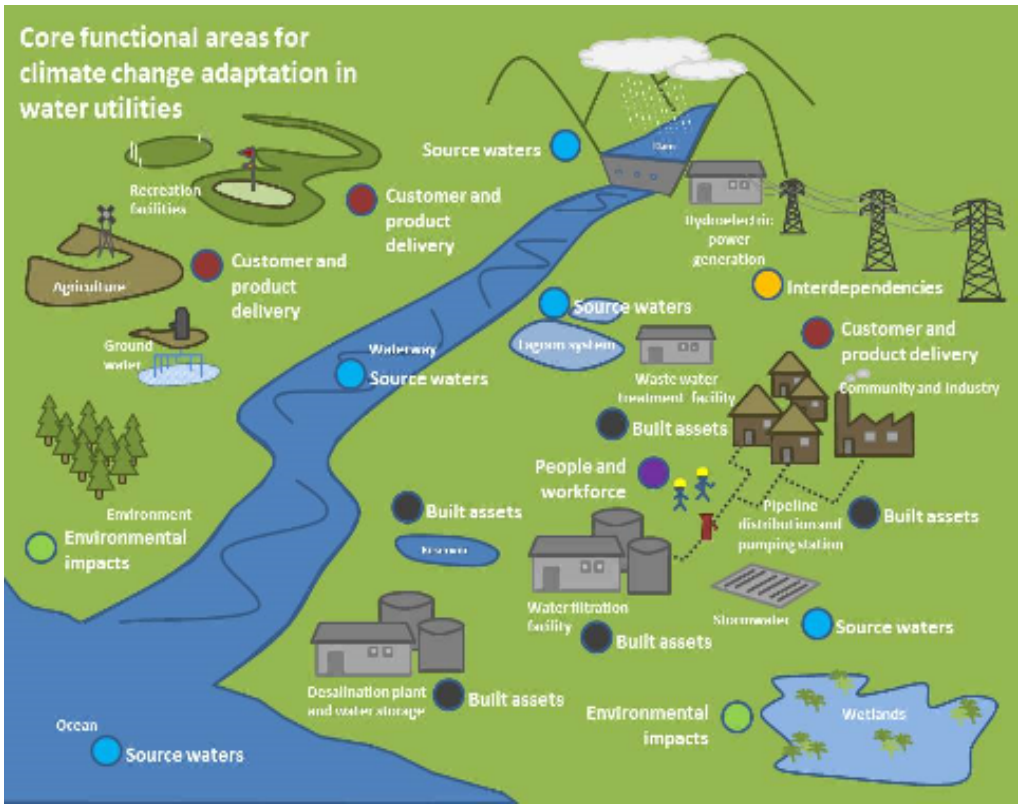




The appendices also link to useful sources, tools and references

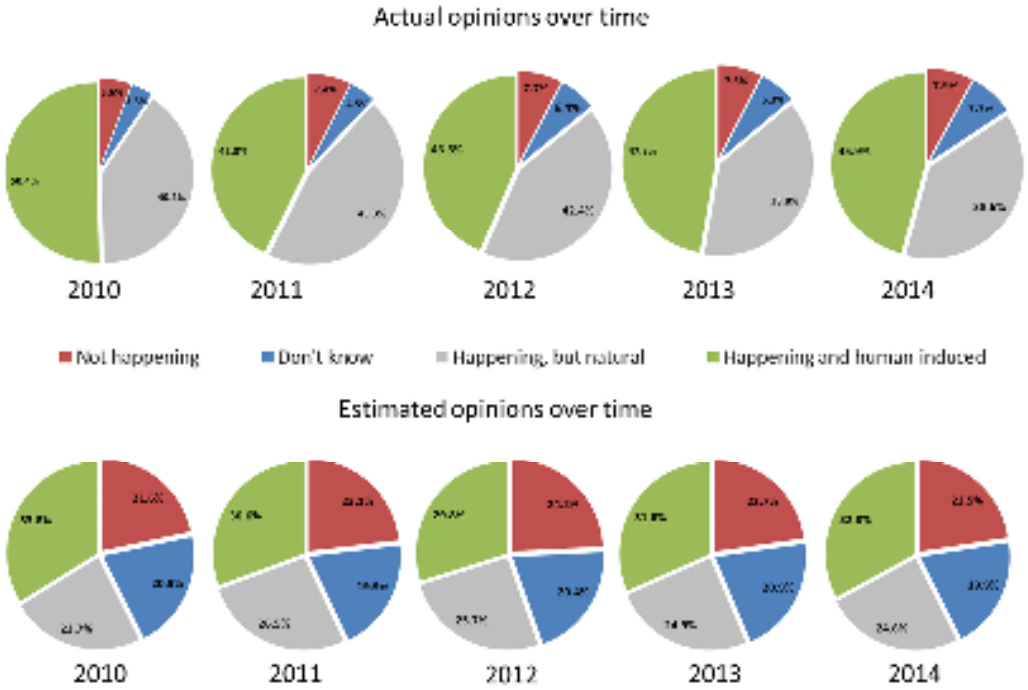
- Climate data
- Tools for adaptation planning
- Examples of adaptation planning documents and Australian case studies
- Stakeholder consultation
- Scenario planning
- Vulnerability and risk assessments
- Adaptation options and maladaptation

The technical appendices provide additional guidance for core functions



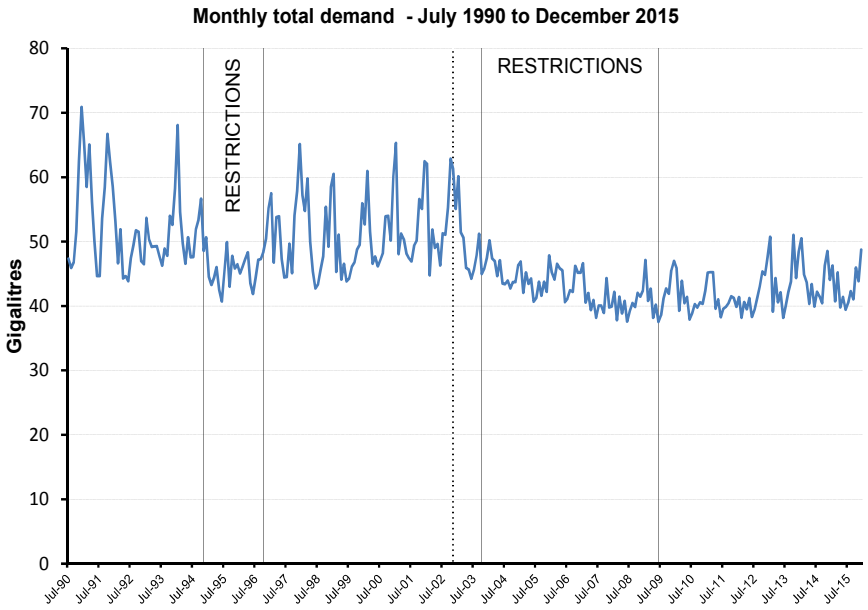
Community attitudes

The majority of Australians (78%) accept that the climate is changing. Regardless of their age, gender or level of education.



Customer Demand

Source: Sydney Water

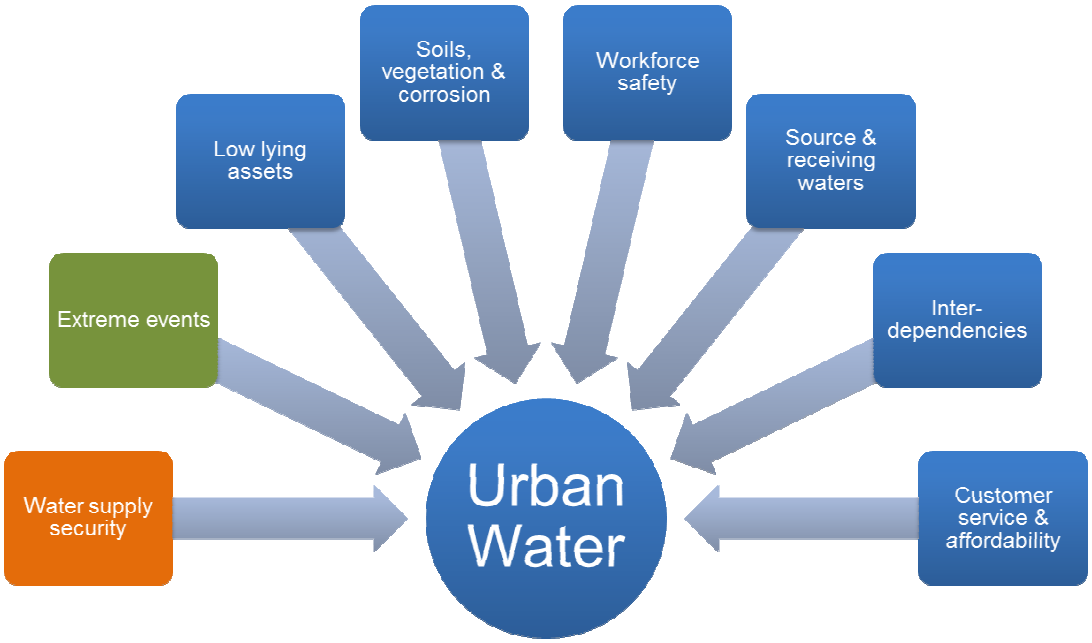


Challenges for urban water

- Climate change viewed as a strategic risk, but ‘best science’ isn’t easily useable
- Perception that it’s essentially about urban water supply security where variability is a key driver
- Distractions caused by a focus on ‘mitigation’ and carbon pricing, with ‘adaptation’ playing second fiddle
- There are complex interdependencies at play but only patchy collaboration
- Quantifying risk, costs, benefits and timeframes has been challenging

15

Critical longer-term issues



Climate risks

Brisbane floods 2011

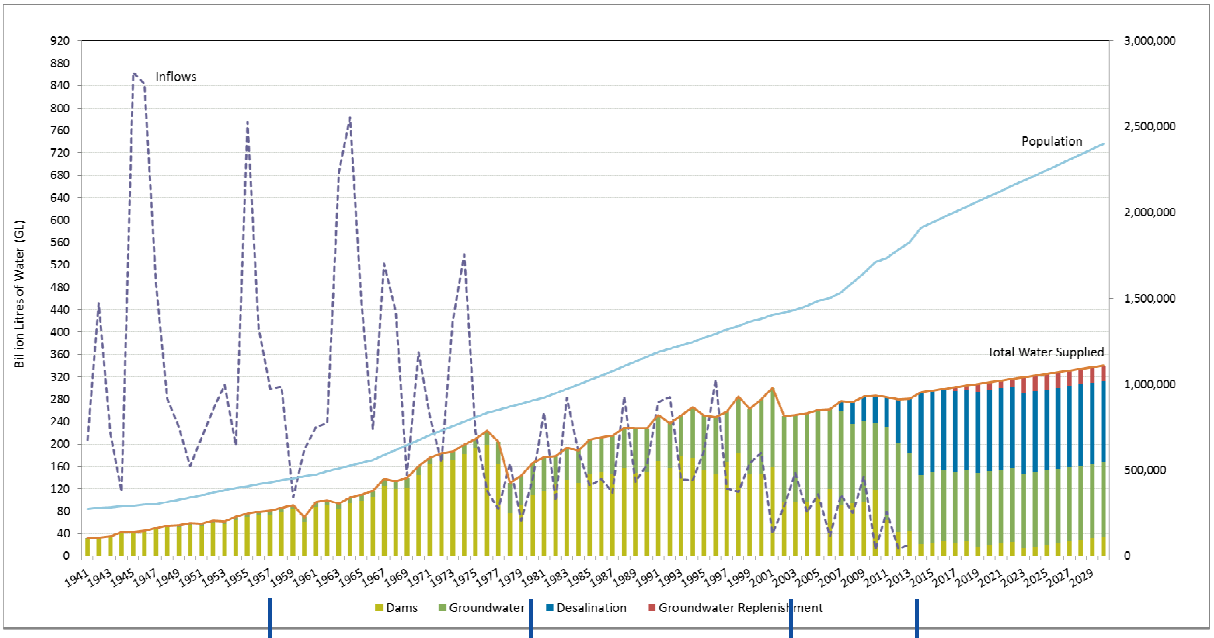
Blue Mountains bushfire 2013

Victoria heatwave 2014

Water supply security

- Always top of mind:
- Securing supplies in response to drought
- Climate variability a key driver
- $30 billion urban water investment
- Ensuring quality as well as quantity

Perth metropolitan water supply



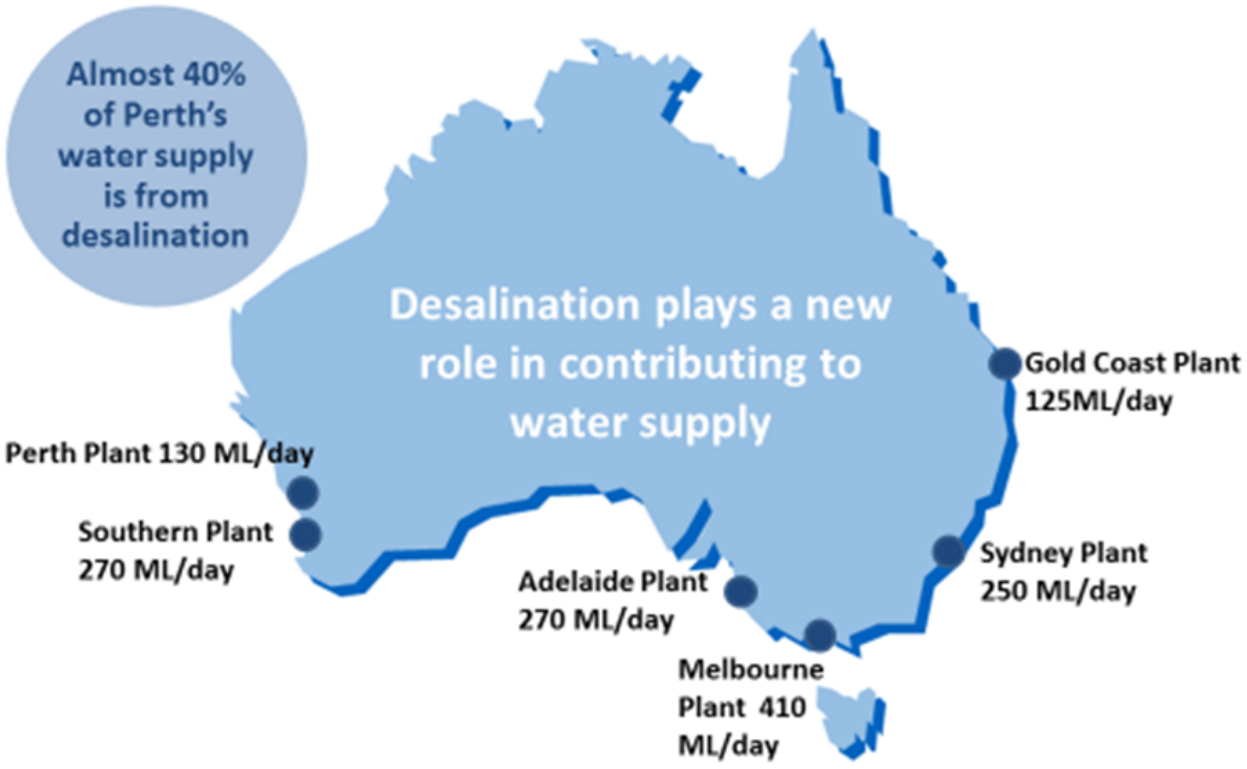
1958
92% Dams
8% G/water

1980
65% Dams
35% G/water

2004
38% Dams
62% G/water

2014
7% Dams 50% Desal
42% G/water
1% GWR

Desalination plants



Bushfires

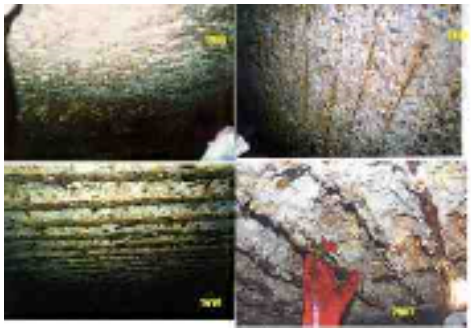
- Multiple impacts:
- Catchments & supplies
- Exposed infrastructure
- Worker health & customer impacts

Flooding of low lying assets

- Extent of exposure being determined:
- Sewers & stormwater channels
- Inundation & capacity, corrosion
- Implications for energy, chemicals & treatment

Buried infrastructure

- Research underway:
- Accelerated corrosion & odour
- Predicting pipe failure in critical water mains
- Episodic drought & wetting
- Vegetative impacts



Customers

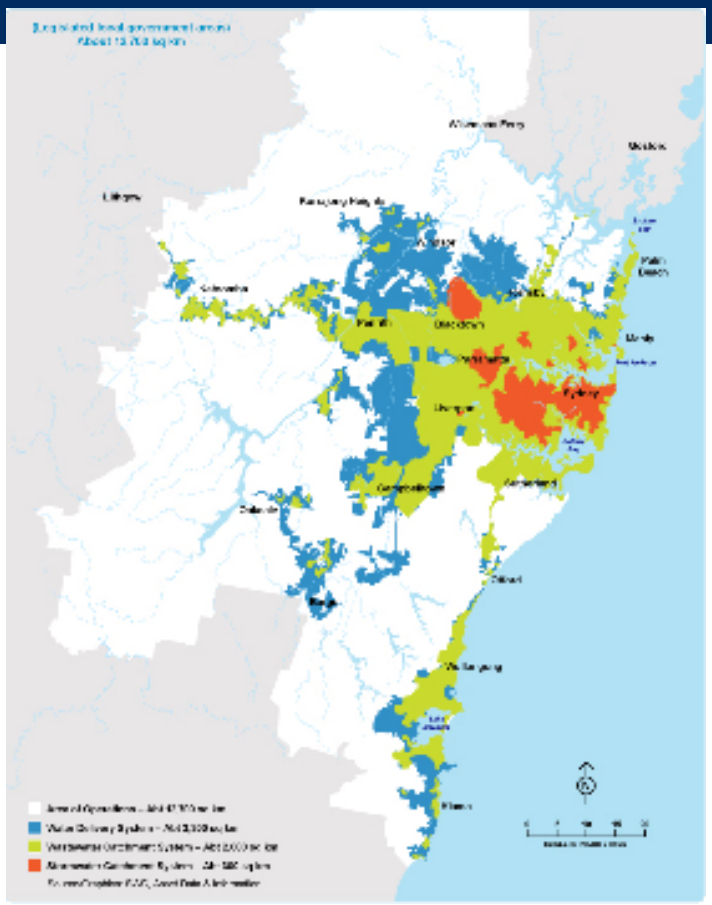
- Consider implications for:
  - Supply disruptions (black/brown-outs, fire)
  - Main breaks (ground wetting and drying)
  - Response times (emergency resourcing)
  - Taste & odour (algal)
  - Water pressure (fire)
  - Increased cost

Sydney Water

- Serves 4.3 million customers daily
- 12,700 km2 operational area
- Water, waste water & recycled water services
- $36 billion existing assets
- $1.6 billion annual turnover

Our systems

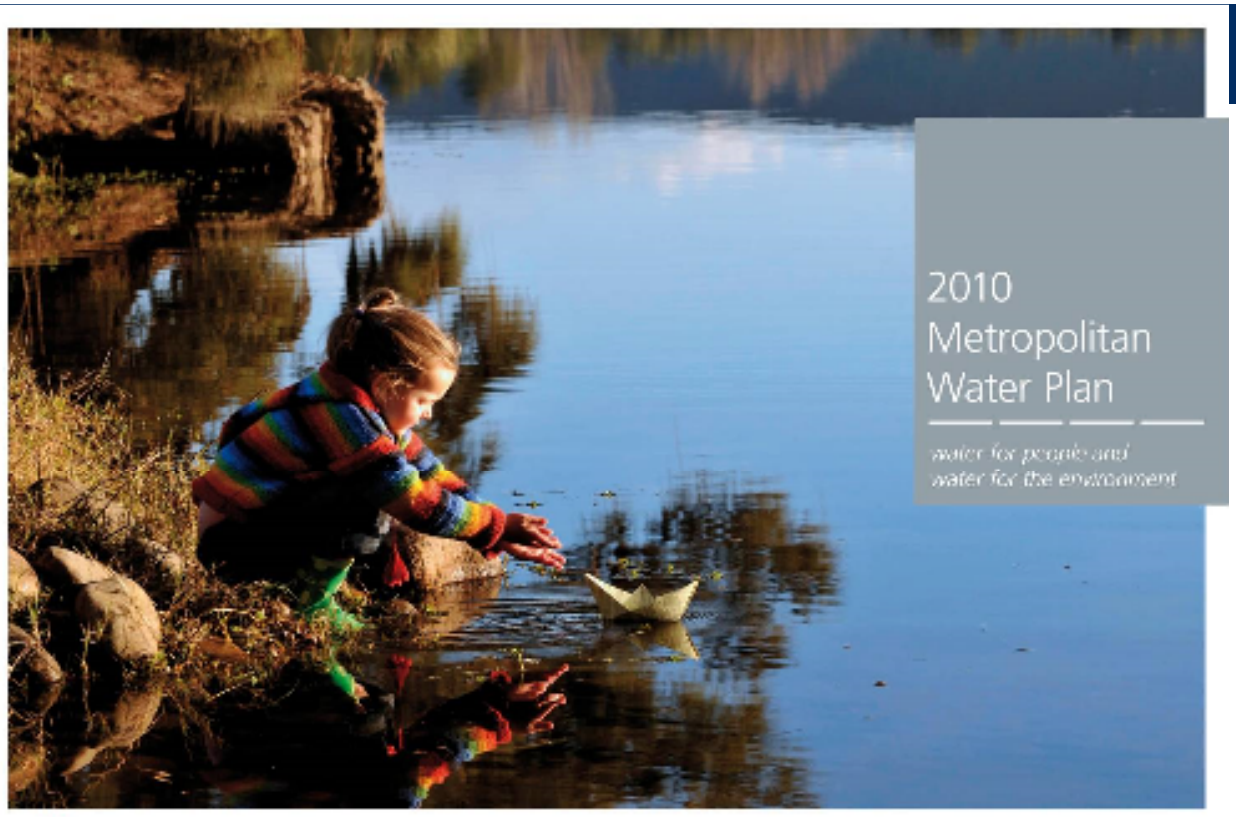
- 1.4 billion litres of water/day
- Water supplied via 21,000 km of water pipes, 251 reservoirs and 164 pumping stations
- Wastewater managed via 24,000 km of wastewater pipes, 680 pumping stations, 14 water recycling plants and 16 treatment plants.
- ~ 400km of stormwater channels



Sydney Water's Journey

- Modelling climate change impacts from 2000
- Supply/Demand planning initial focus
- Involvement in NARCLiM – from 2011
- Shift in focus to infrastructure impacts through Climate Change Adaptation Program – 2009 to 2013
- Development of AdaptWater tool
- Ongoing implementation, monitoring & engagement
- New projects incl. National Guidelines

2000 → 2016 →



NSW GOVERNMENT

Water4life

Where Can I Get a Copy of the WSAA Guidelines?

The new WSAA Climate Change Adaptation Guideline is available free of charge from the WSAA website:

www.wsaa.asn.au

How to find us

Twitter
@admlovell
@wsaa_water

LinkedIn
Water Services Association of Australia (WSAA)

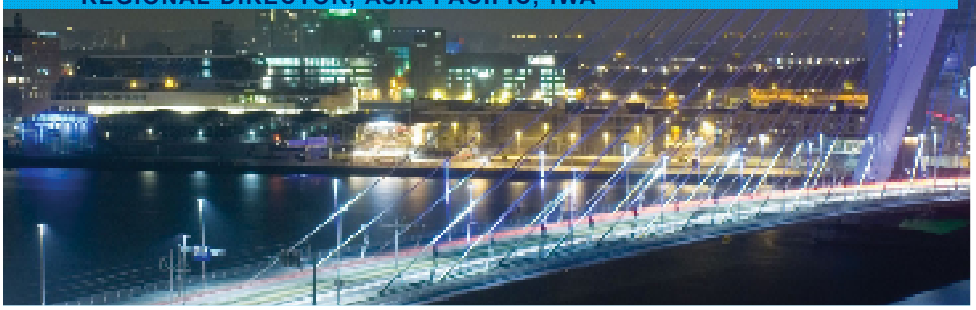
Web
www.wsaa.asn.au

Questions

Any QUESTIONS???

Resilient Water Management Strategies for a Climate Changing Society

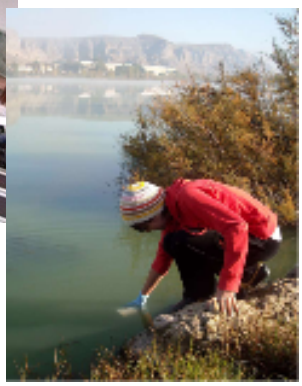
GANESH PANGARE
REGIONAL DIRECTOR, ASIA-PACIFIC, IWA



inspiring change

INTERNATIONAL WATER ASSOCIATION

Global network for water professionals spanning the continuum of research and practice, and covering all facets of the water cycle

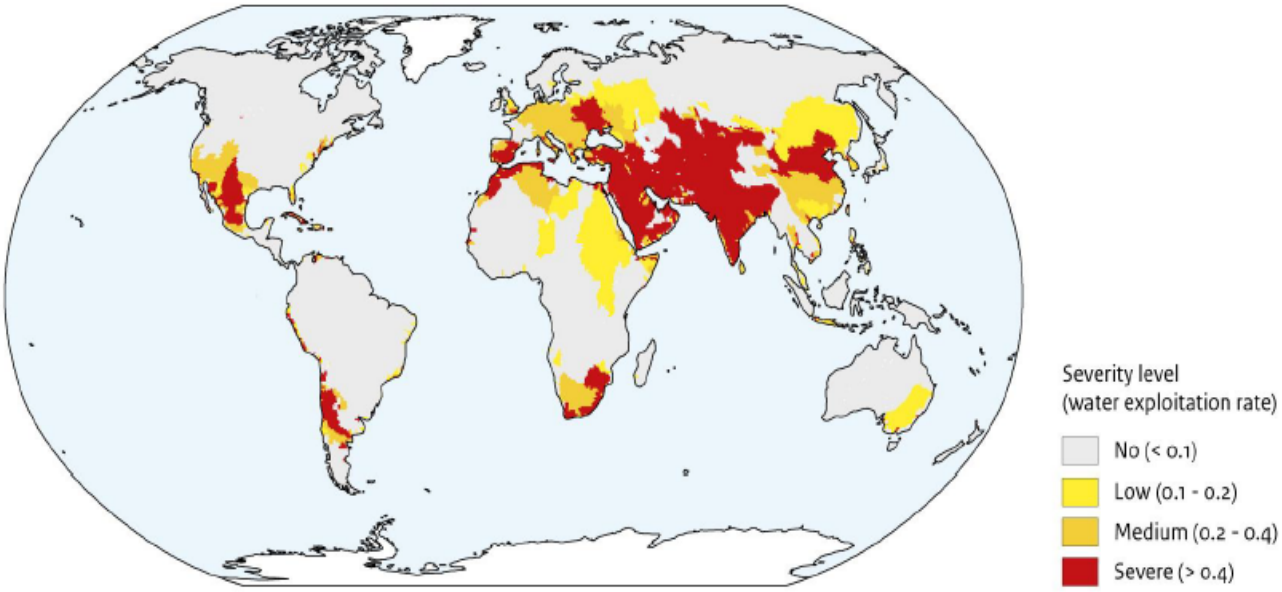


CLIMATE CHANGE IS A REALITY

An abandoned ship in the former Aral Sea, near Aral, Kazakhstan.

Unprecedented Challenges

3.9 Billion People in Severe Water Stress Basins

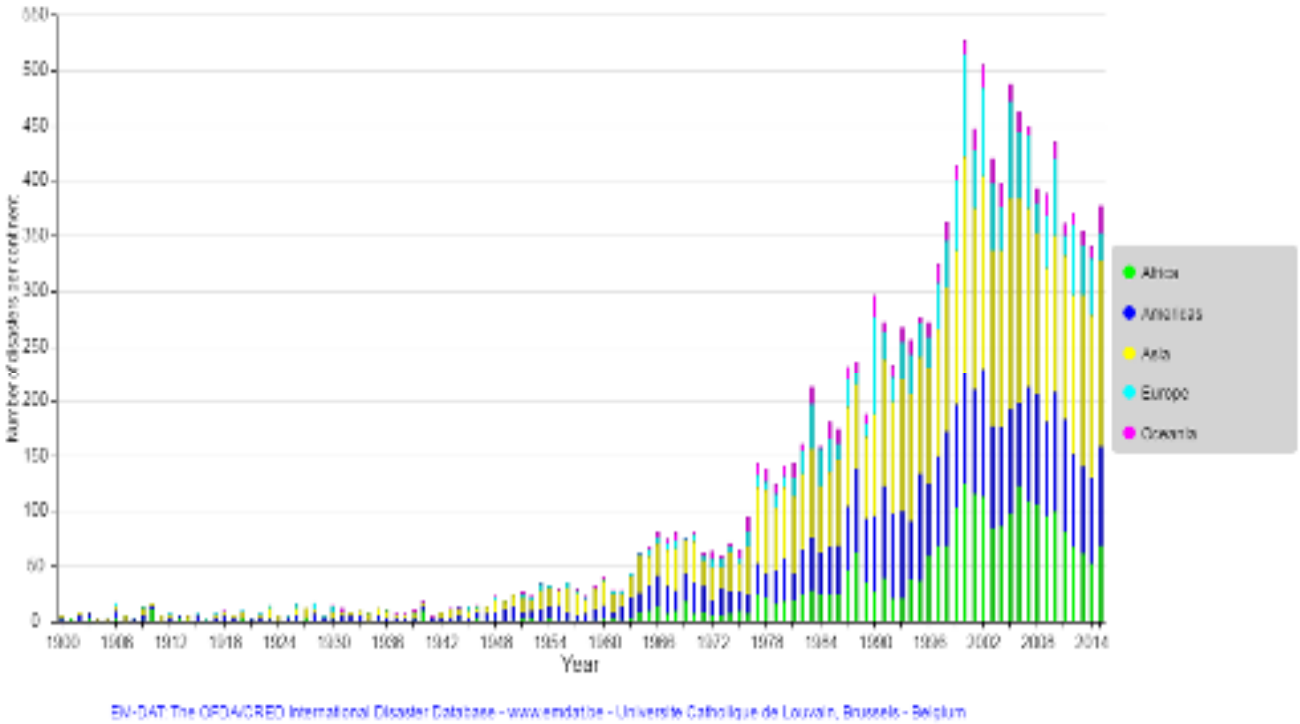


5

CLIMATE CHANGE IS A GROWING REALITY

NB OF DISASTERS BY CONTINENT

the international water association



EM-DAT The OFDA/CRED International Disaster Database - www.emdat.be - Université Catholique de Louvain, Brussels - Belgium

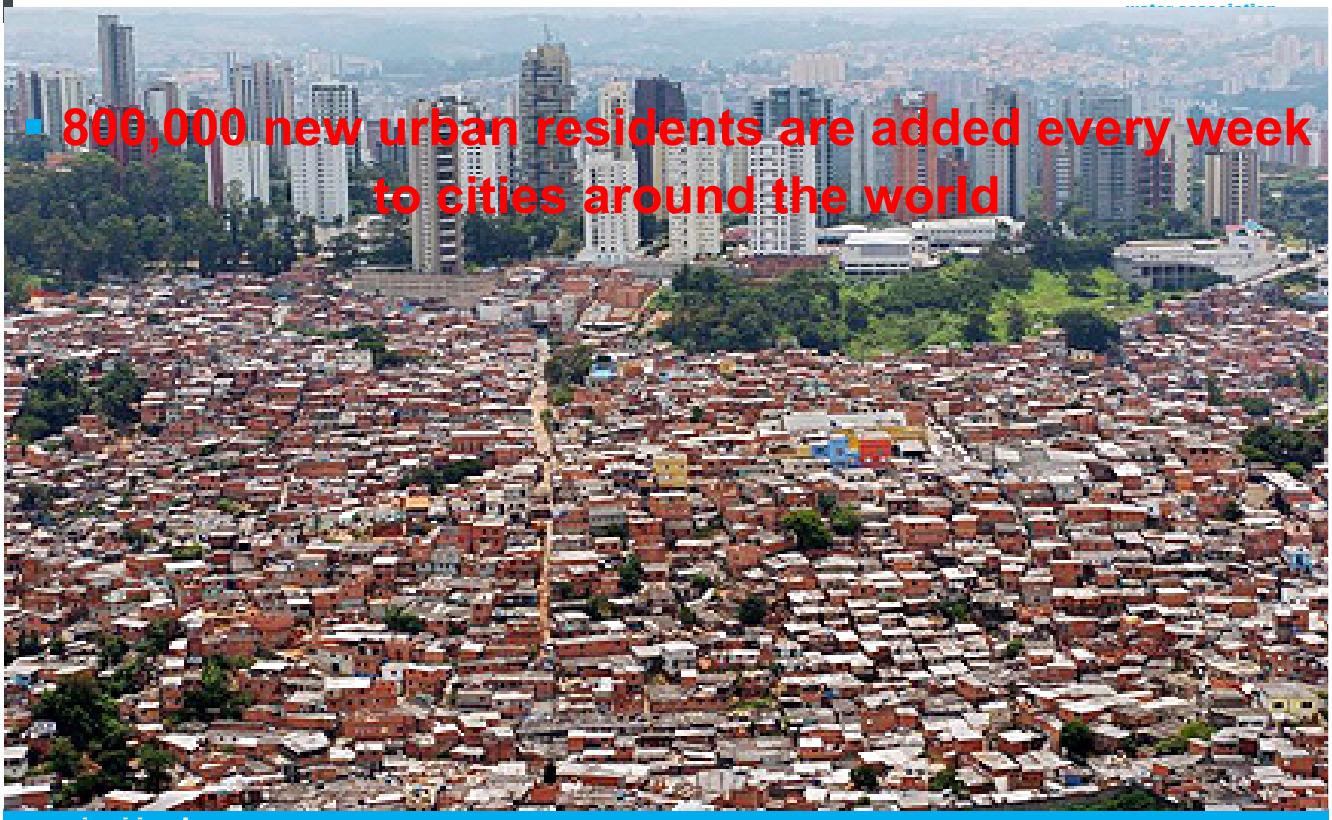
MEETING HIGH LEVEL TARGETS

… to adress Global Challenges by 2030

Climate	Access	Environment
2°C	100%	50%
Cap on Temperature rise	Safe drinking and adequate sanitation	Reduction in untreated wastewater

RESILIENCE OF UTILITIES TO NATURAL DISASTERS

PRINCIPLES FOR WATER WISE CITIES



- 800,000 new urban residents are added every week to cities around the world

The Plan of Taipei Water to Battle against Natural Hazards

Strategy – Five layers of protection

Invest $USD 1.4 billion from 2006 to 2025 to set up five protection layers.

Increasing efficiency of water resource.

Enhance water supply system

Drought

Storm rain

Accident

Earthquake

Level 1

Decrease leakage under 10%

Level 2

Implement household water Conservation

Decrease 16% of using water

Level 3

Increase efficiency of water purification

Back-up rate to 50%

Level 4

Build back-up system for 11 supply zones

Dual system for water supply

Level 5

Establish emergency water supply system and take aseismic measure

2. Establishing 46 Emergency Water Supporting Stations

Goal: Provide each citizen 3 liter of life-supporting water daily for 28 days

Reason: To have enough time to repair the damaged facilities if needed.

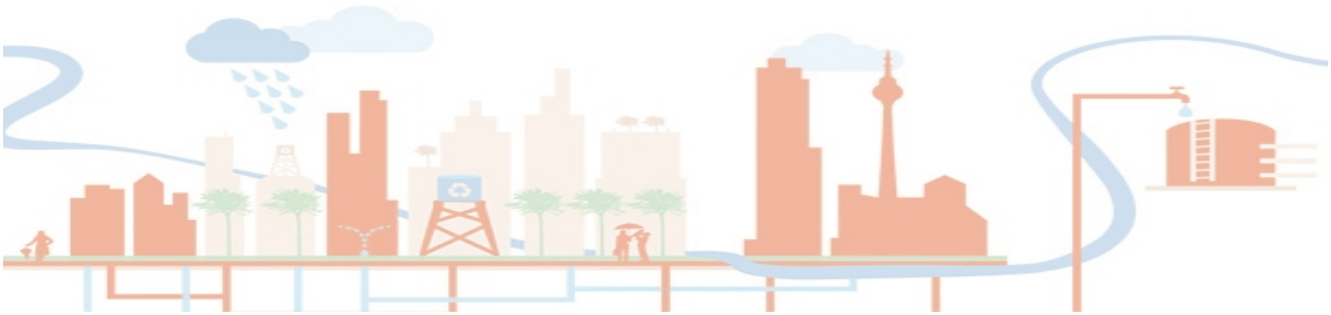
Budget: **US$ 4.94 million**

Period: **2007~ 2013**

Distribution of Water Supporting Stations

Water and Wastewater Companies for Climate Mitigation (WaCCliM)

Closing the carbon loop: utilities as key-players



How can greenhouse gases be reduced in water supply and wastewater treatment?

Mitigation = efforts to reduce or prevent emission of greenhouse gases (e.g. carbon dioxide, methane, nitrous oxide) into the atmosphere

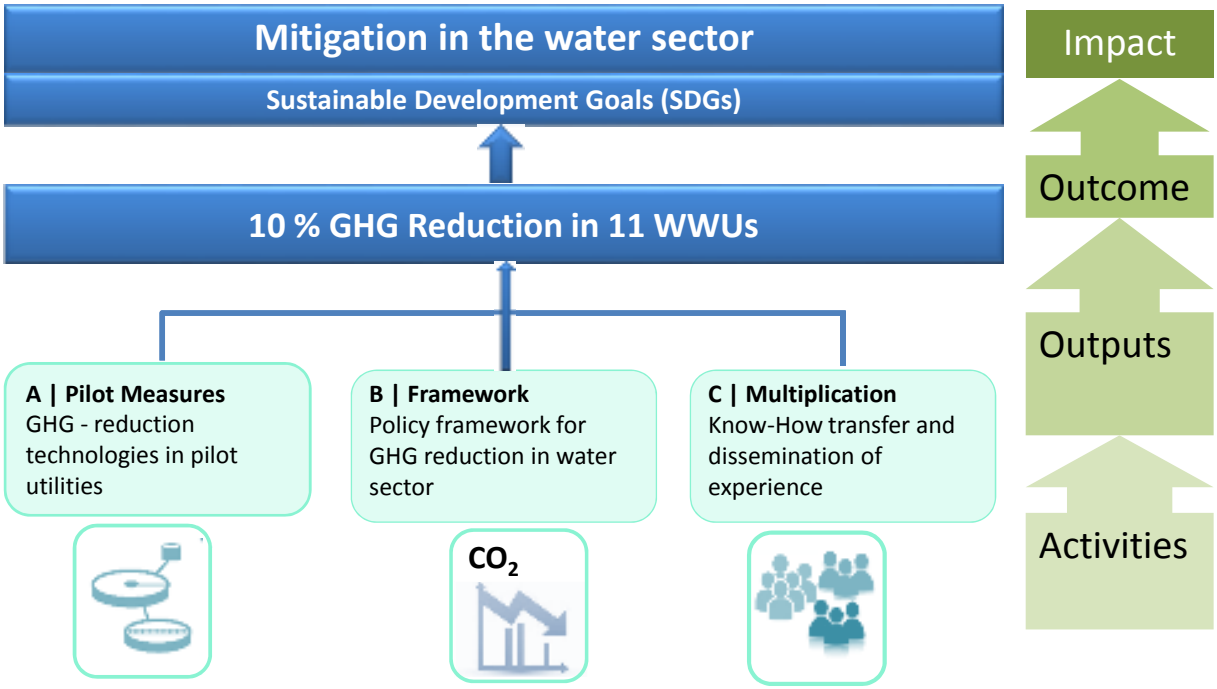
- Requiring less energy for the same service or product
  Reducing water losses, using energy efficient pumps
- Producing and using renewable energy
  Producing biogas from wastewater
- Reducing or preventing direct greenhouse gas emissions
  Reducing methane emissions from treatment tanks and sludge
- Substituting processes that would use energy elsewhere
  Recovering nutrients from wastewater instead of producing fertiliser

What is the water sector's benefit of reducing greenhouse gas emissions?

- Reduced operational costs of utilities
- Less dependency of the water sector on fluctuations of energy prices
- More efficient use of water resources
- Contribution to the country's climate mitigation goals

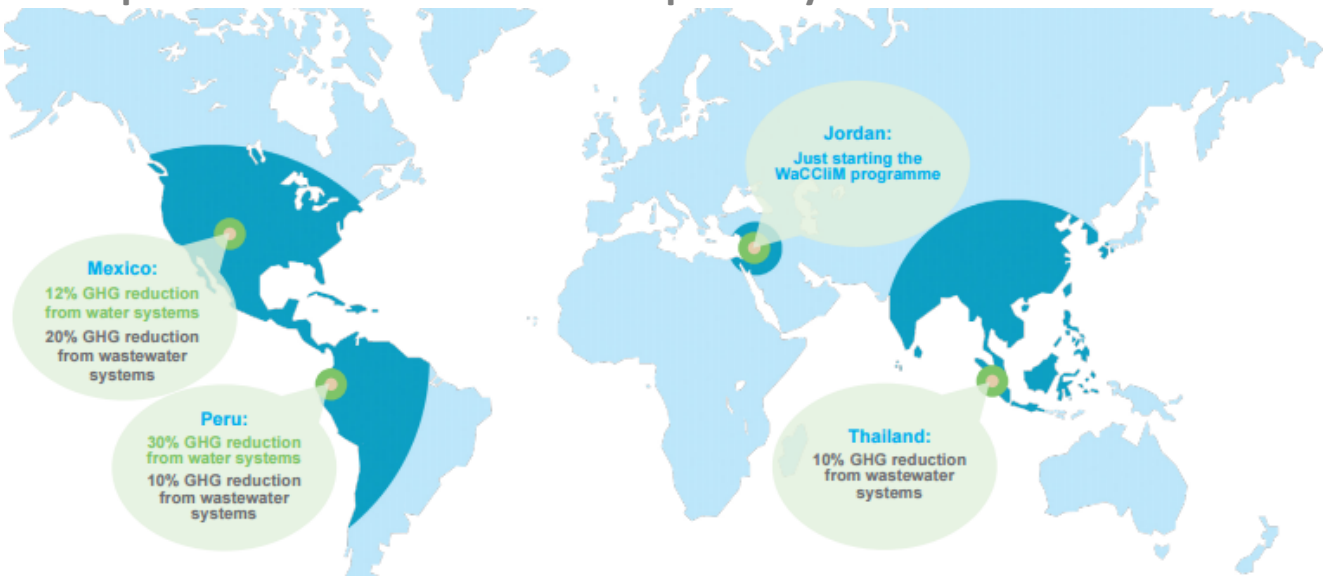
WACCLIM PROJECT APPROACH

Water and Wastewater Companies for Climate Mitigation (WaCCliM)



WACCLIM PILOT UTILITIES

Anticipated reductions at WaCCliM pilots by 2018:



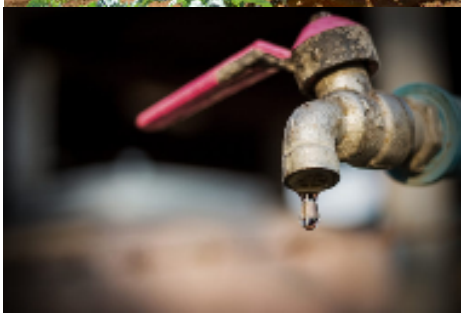
MEXICO	PERU	JORDAN	THAILAND
San Francisco del Rincón	***Cusco***	***Madaba***	***Chiang Mai***
Water Supply and Wastewater Treatment System	**Water Supply System and Wastewater Treatment System**	**Water Supply System and Wastewater Treatment System**	**Wastewater System**
128 000 pop.	415 000 pop.	190 000 pop.	150 000 pop.

Water and Wastewater Companies for Climate Mitigation (WaCCliM)

Tackling Water Scarcity – HOW?

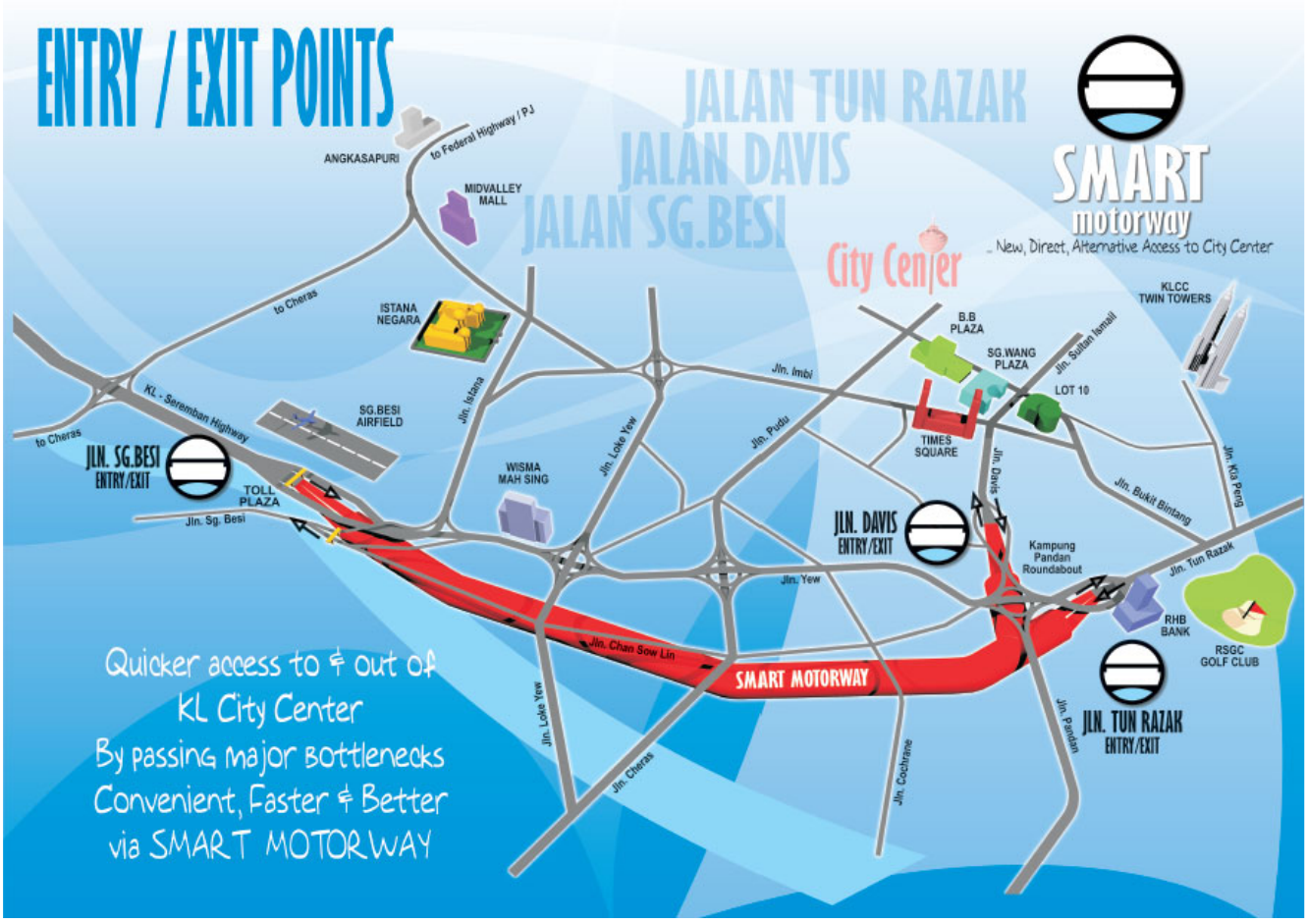
Principles

- Building resilient water systems – able to coping with long term scarcity and shorter extreme situations
- Pro-active management – beyond responding to extreme conditions and focus on long term preparedness

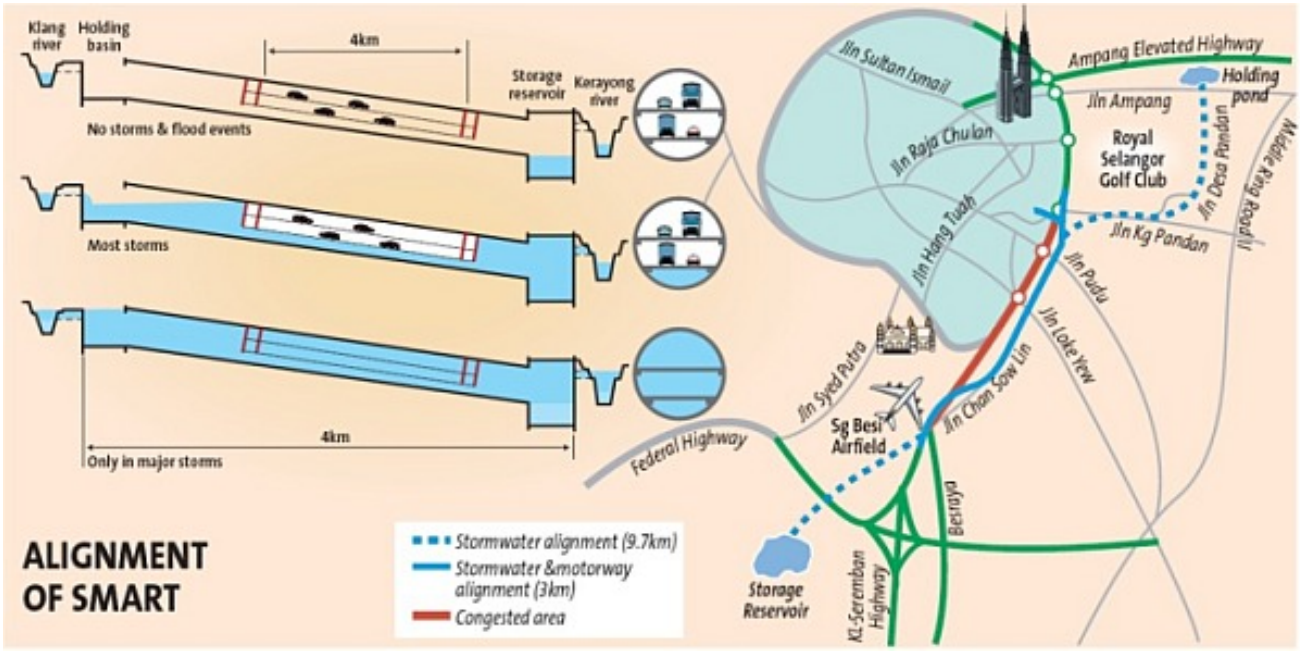


Focusing on, for example:

- Demand management while augmenting supply
- Efficient and effective water allocation amongst users
- Cascading water from one user to other
- Efficiency in use



SMART (Storm water Management And Road Tunnel), Kuala Lumpur (since May 2007)



Solving two problems the Smart way

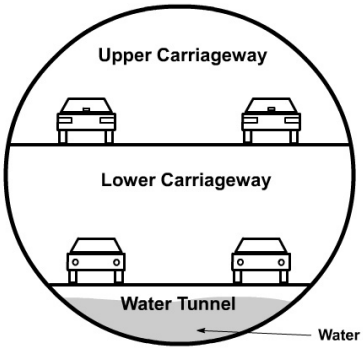
By PRAKASH DANIEL
prakash@thestar.com.my

MALAYSIA has many highways and expressways. But imagine if one built underground could double up as a flood diversion channel during seasonal monsoon rains? Can a tunnel big enough in diameter and long enough be built to house such an engineering feat in Kuala Lumpur?

The answer is 'Yes'. What started out as a vision in 2003 became a reality when the Stormwater Management And Road Tunnel (Smart), an engineering marvel built by MMC-Gamuda Joint Venture was completed in 2007. Since then, the first-in-

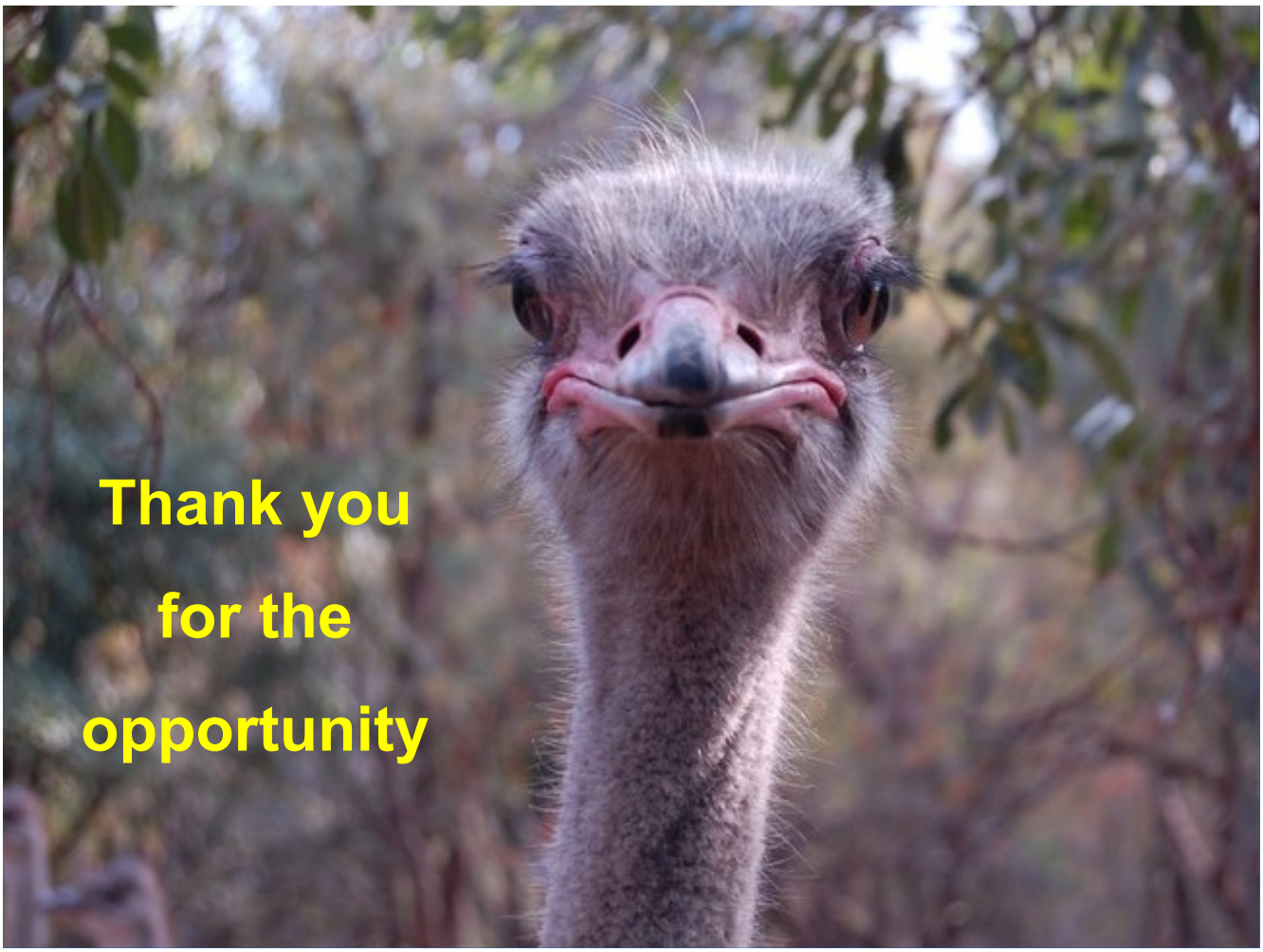
venience of having Smart as a flood prevention solution and as an alternative route to the city centre. Now when the motorway is closed for maintenance works or during a flood operation, commuters feel the inconvenience but realise how Smart has once more helped keep Kuala Lumpur streets dry.

Smart, a project by two Government agencies namely the Department of Irrigation and Drainage and Works Ministry, was designed and built by local contractors with a local workforce who



Tsurumi river basin, Japan

A win-win situation creating multipurpose facilities and land use including flood retention.



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