IX SYMPOSIUM PAPERS

Ⅸ-1 Program

The 16th International Symposium on National Land Development and Civil Engineering in Asia

"Integrated Water Resource Management
Adapting to the Global Climate Change in Asia"

Monday December 3, 2007
13:00-17:10

Hotel Shiragiku

National Institute of Land and Infrastructure Management (NILIM)
Ministry of Land, Infrastructure and Transport(MLIT)

[Contents]

13:00-13:15	Opening Address	Mr. Shin TSUBOKA Director General, NILIM
	Address	Mr. Hiroaki TANIGUCHI Vice Minister for Engineering Affairs, Ministry of Land, Infrastructure and Transport (MLIT)
	Address	Representative of Overseas Participants

13:15- 14:15 Lecture

"Integrated Water Management under the Global Warming Scenario
–Case Study of Northern Kyusyu with Scarce Water Resources–"

Dr. Kenji JINNO
Professor, Faculty of Engineering, Kyushu University

Global warming is believed to be the one of the major causes of the abnormal climate at present. Beside the regulation of the emission of warming gas, the countermeasures against the threat of flood and drought need to be taken simultaneously. The role of central and local governments which are responsible for the infrastructure management is increasing than before. It is expected for them to take practical and appropriate counteractions.

On the other hand, the water environment in megacities where a half of the world people live is also another concern. Frequent flooding, inappropriate waste water management, and insufficient water resources are mostly related to the negative impact of rapid urbanization. In order to conquer the above subjects caused by both abnormal climate and urbanization, the concrete measures need to be initiated in a river basin or regional scale integrating various water users and residents living there.

In the present speech, the state of art for the relationship between the

potential threat of global warming and the impact of rapid urbanization will be discussed.

14:15-17:00 Presentation and Discussion
（Chair : Mr. Kazunori ODAIRA, Director, River Dept., NILIM）

14:15-15:45 Presentation of Case Study

(14:15-14:25) Mr. Shin TSUBOKA
Director General, NILIM

(14:25-14:35) Mr. Yoshinori ASHIDA
Director, Planning Dept., Kyusyu Regional Bureau, MLIT

(14:35-14:45) Mr. Dhinadhayalan MURUGESAN
Assiatant Adviser of Public Health and Environmental Engineering, Central Public Health and Environmental Engineering Organization, Ministry of Urban Development
India

(14:45-14:55) Dr. Seok-Young YOON
Director, Policy research Division , Korea Institute of Construction Technology, Republic of Korea

(14:55-15:05) Mr. Wan Abd Rahim Bin WAN ABDULLAH
Director, Sewerage Services Dept.,
Ministry of Energy, Water & Communication, Malaysia

(15:05-15:15) Dr. Judy Famoso SESE
Director III, Bureau of Research & Standards,
Dept. of Public Works and Highways,
Republic of the Philippines

(15:15-15:25) Ms. Paniyanduwage Nalanie Sriyalatha YAPA
Deputy General Manager,
National Water Supply & Drainage Board
Democratic Socialist Republic of Sri Lanka

(15:25-15:35) Ms. DANG Anh Thu
Expert (environmental management and urban planning),
Department of Urban Technical Infrastructure,
Ministry of Construction, Socialist Republic of Vietnam

15:35-15:50 Break

15:50-17:00 Question and Answer Session / Panel Discussion

(PANELISTS)

1. Dr. Kenji JINNO, Professor, Faculty of Engineering, Kyushu University
2. Mr. Shin TSUBOKA, Director General, NILIM
3. Mr. Yoshinori ASHIDA, Director, Planning Dept.,
   Kyusyu Regional Bureau, MLIT

4. Mr. Dhinadhayalan MURUGESAN, India

5. Dr. Seok-Young YOON, Republic of Korea

6. Mr. Wan Abd Rahim Bin WAN ABDULLAH, Malaysia

7. Dr. Judy Famoso SESE , Republic of the Philippines

8. Ms. Paniyanduwage Nalanie Sriyalatha YAPA,
Democratic Socialist Republic of Sri Lanka

9. Ms. DANG Anh Thu, Socialist Republic of Vietnam

17:00-17:10 Closing Address
Mr. Katsumune SUZUKI
Director General, Kyusyu Regional Bureau, MLIT

17:30-19:00 Reception
(Venue : Banquet room, Hotel Shiragiku)

Host Vice Minister for Engineering Affairs, MLIT
Guests Director General, Kyusyu Regional Bureau, MLIT

Accommodations: Hotel Shiragiku
16-36, Kamitanoyu-machi, Beppu, Oita 874-0908, Japan
TEL. +81-97-721-2111, FAX: 81-97-721-5633

Integrated Water Management under the Global Warming Scenario

- Case Study of Northern Kyushu with Scarce Water Resources -

Kyushu University, Fukuoka, Japan
Kenji Jinno

1. Introduction
2. Global warming scenario and required tasks
3. Effect of urbanization on water
4. Integrated water management at a basin scale
5. Cooperation of government and residents
6. Evaluation
7. Conclusion

keywords ; flood, water resources, environment, IPCC, monthly precipitation, drought, surface water, groundwater, land subsidence, multiple water resources, spring, change of water source, roles of government, participation of expertise and local people, competition amongst municipalities, · · · · ·

1 . Introduction

Climate change ! , ?

***Normal Probability Level* :**
Strategic planning
Expectable outcomes
Investable cost, etc.

There are many text books to learn from the experienced regions.

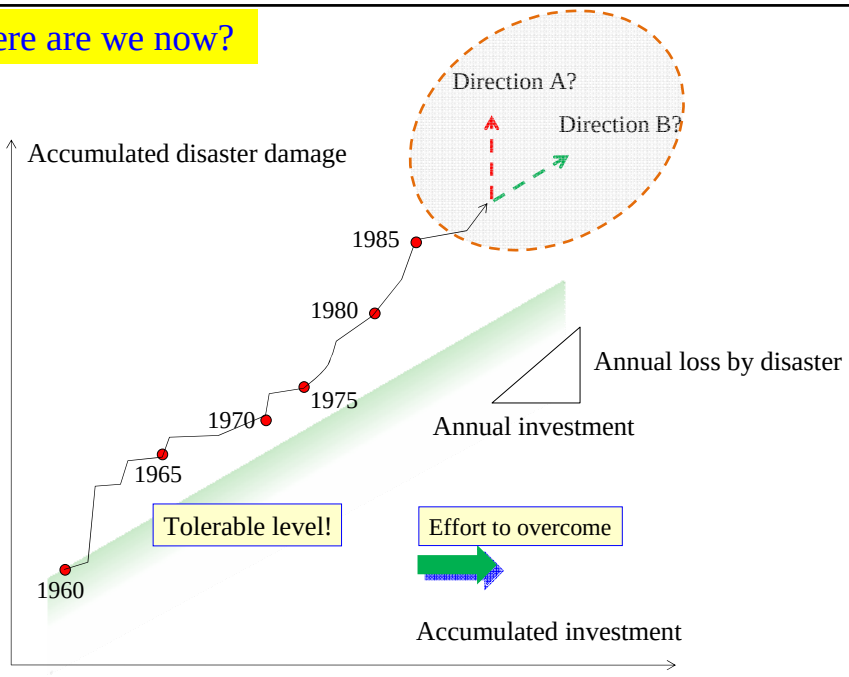
Flood prevention, Stable water resources development, Safe water supply, Environment conservation and Restoration

Bewildering situation?

Are there any experiences to overcome ?

Is the global warming "Out of the Normal Probability Level ?":
Attackable planning ?
How long will it take time ?
Are there any text books, etc. ?

Where are we now?




西日本新聞 2003年(平成15年)7月20日 日曜日

九州北部豪雨、混乱続く

地下鉄一部は終日運休

強い積乱雲頻発 局地的にドカ雨

温暖化進み亜熱

Flooded water in the subway, Fukuoka City

- Northern Kyushu, Japan July 20, 2003, 99mm/hr
- Subway stopped all day long

It is written in this article:

- **Changes to the subtropical climatic regime caused by global warming**

Very frequent news from the world!

Remarks ;

1-1. It is necessary to identify *where we are now in water problems under the scenario of global warming*, in order to shift to the new stage of water issues.

2. Global warming scenario and required tasks

Introduction to the AR4

The Working Group III contribution to the IPCC Fourth **Assessment Report (AR4)** focuses on new literature on the **scientific, technological, environmental, economic and social aspects** of mitigation of climate change, published since the IPCC Third Assessment Report (TAR) and other various reports.

OHP presentation by Dr. R. K. Pachauri, Chairman, IPCC
26th Session of the SBSTA, Bonn, Germany, 12th May 2007

How does IPCC predict the effect of global warming on water?

Fresh water resources and their management;
Drought-affected areas are likely to increase in extent.
Heavy precipitation events, which are very likely to increase in frequency, will augment flood risk.

Will these changes take place in your regions?

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

Climate Change 2007: The Physical Science Basis

Summary for Policymakers

Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change

This Summary for Policymakers was formally approved at the 10th Session of Working Group I of the IPCC, Paris, February 2007.

Note:
Text, tables and figures given here are final but subject to copy-editing.

Corrections made as of February 5th, 2007

Climate Change 2007: The Physical Science Basis, Summary for Policymakers
Contribution of **Working group I** to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change http://www.ipcc.ch/SPM2feb07.pdf

Table SPM-2. Recent trends, assessment of human influence on the trend, and projections for extreme weather events for which there is an observed late 20th century trend.{Tables 3.7, 3.8, 9.4, Sections 3.8, 5.5, 9.7, 11.2-11.9}

Phenomenon [a] and direction of trend	Likelihood that trend occurred in late 20th century(typically post 1960)	Likelihood of human contribution to observed trend [b]	Likelihood of future trends based on projections for 21st century using SRES scenarios
Warmer and fewer cold days and nights over most land areas	*Very likely* [c]	*Very likely* [d]	*Virtually certain* [d]
Warmer and more frequent hot days and nights over most land areas	*Very likely* [e]	*Likely* (nights) [d]	*Virtually certain* [d]
Warm spells/heat waves. Frequency increases over most land areas	*Likely*	*More likely than not* [f]	*Very likely*
Heavy precipitation events. Frequency (or proportion of total rainfalls) increase over most areas	*Likely*	*More likely than not* [f]	*Very likely*
Areas affected by droughts increases	*Likely* in many regions since 1970s	*More likely than not*	*Likely*
Intense tropical cyclone activity increases	*Likely* in some regions since 1970s	*More likely than not* [f]	*Likely*
Intense incidence of extreme high sea level (excludes tsunamis) [g]	*Likely*	*More likely than not* [f, h]	*Likely* [i]

When should we take actions?

Do we need the complete and accurate evidence?
Or, should we take the actions now?

Suspecting global warming!

Believing global warming!

Table SPM E.1: *Qualitative definition of uncertainty*[*)]

high ↑ Level of agreement (on a particular finding)	High agreement, limited evidence	High agreement, medium evidence	High agreement, much evidence
	Medium agreement, limited evidence	Medium agreement, medium evidence	Medium agreement, much evidence
	Low agreement, limited evidence	Low agreement, medium evidence	Low agreement, much evidence
	Amount of evidence[50] (number and quality of independent sources) → **much**		

[50] "Evidence" in this report is defined as: Information or signs indicating whether a belief or proposition is true or valid. See Glossary.

*) Source: INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, Working Group III contribution to the Intergovernmental Panel on Climate Change, Fourth Assessment Report, Climate Change 2007: Mitigation of Climate Change; *Summary for Policymakers*. p.36

I found several significant opinions;

Climate Change 2007: Observations and Drivers of Climate Change

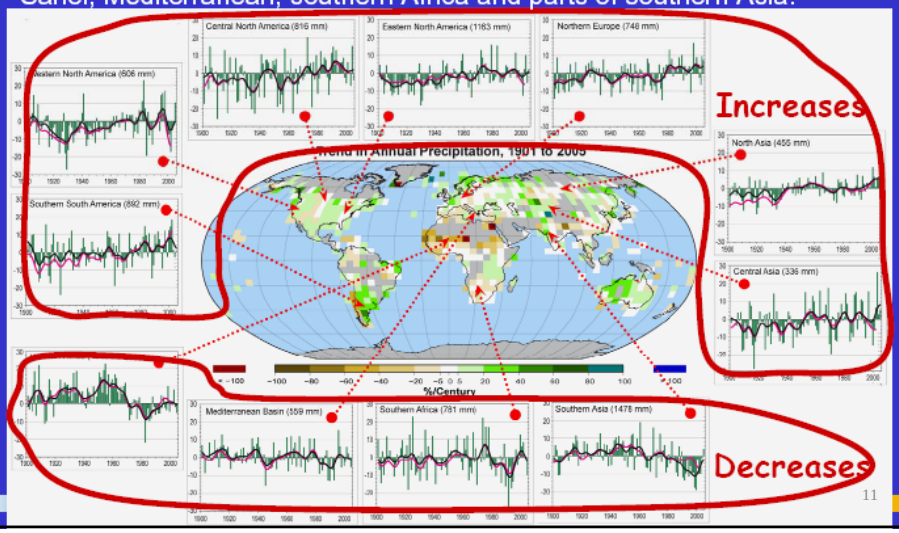
WG 1

Martin Manning
Director, IPCC Working Group I Support Unit

1. Observed climate change
2. Paleoclimatic perspective
3. Drivers of climate change

Precipitation (rain & snow) is variable – but there is evidence for systematic change

Precipitation has increased in eastern parts of North and South America, northern Europe and northern and central Asia – and decreased in the Sahel, Mediterranean, southern Africa and parts of southern Asia.



WG-2

Adaptation to Climate Change and its Inter-Relationships with Mitigation

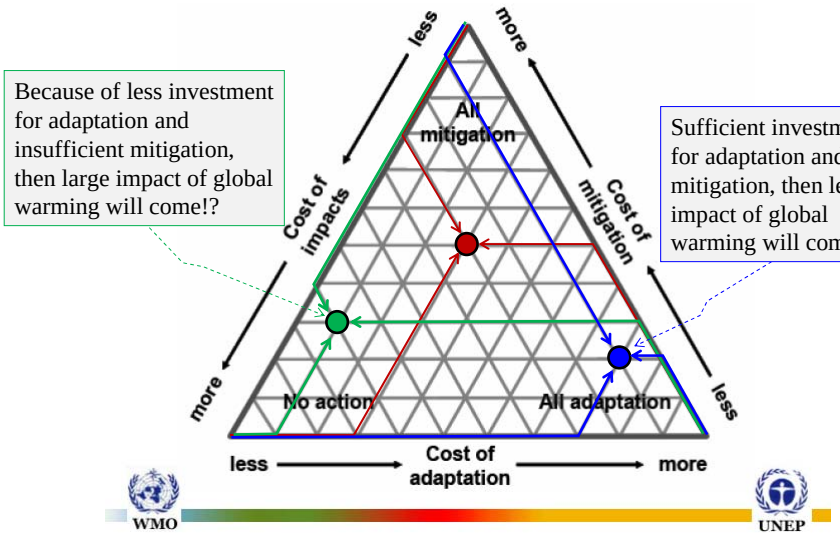
Richard J.T. Klein
Stockholm Environment Institute

Contributing Author of Chapter WGII-17
Coordinating Lead Author of Chapter WGII-18

WMO UNEP

Schematic diagram for the political decision:

Where are we now and which scenarios are going to take?



Because of less investment for adaptation and insufficient mitigation, then large impact of global warming will come!?

Sufficient investment for adaptation and small mitigation, then less impact of global warming will come!?

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It is not yet possible to say whether or not adaptation buys time for mitigation

- Integrated assessment models provide approximate estimates of relative costs and benefits at highly aggregated levels, but only a few models include feedbacks from impacts
- Challenges to making trade-offs beyond the local scale include the different spatial, temporal and institutional scales of options and the different interests, beliefs, value systems and property rights of actors
- An "optimal mix" would reconcile welfare impacts on people living in different places and at different points in time into a global aggregate measure of well-being

MO UNEP

I think we have similar subjects like the effect of urbanization.

Also, I think local people and government should initiate.

Yes, common information and understanding based on the scientific analyses need to be shared both at a local and global scale.

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Social and economic development enhances capacity to adapt and mitigate

We need the people who know their region sufficiently and well organized working teams.

- Response capacity is often limited by a lack of resources, poor institutions and inadequate infrastructure
- People's vulnerability to climate change can therefore be reduced not only by adaptation and mitigation, but also by development aimed at improving the living conditions and access to resources of those experiencing the impacts

Yes, it is significant to participate in this kind forum it order to exchange ideas.

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Research needs

Yes, find the appropriate direction, based on the integrated expertise.

- Development of a consistent analytical framework to analyse inter-relationships between adaptation and mitigation, including their potential and limitations
- Empirical analysis of each of the four types of inter-relationships, in particular at the regional and sectoral levels, and for specific social and economic groups
- The effect of development pathways on adaptation and mitigation, and vice versa

Again, share the common understandings.

- Requirements on national and international policy in facilitating decisions on adaptation and mitigation at the relevant institutional levels

WMO UNEP

This statement suggests that one of the indispensable adaptations and mitigations is the counteraction for urbanization.

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Remarks ;

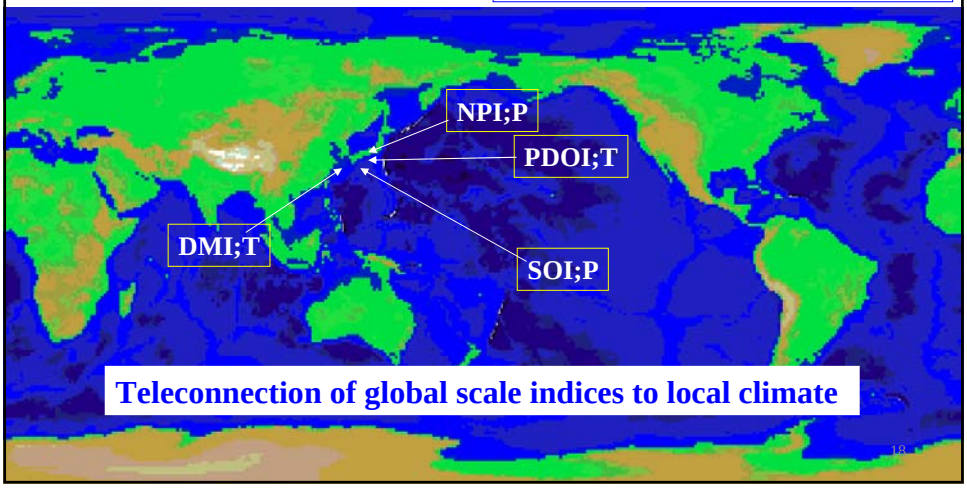
2-1. It seems that policymakers are urged to take necessary countermeasures although the alarm provided by IPCC is not completely finalized(for us, or to me).

2-2. More careful observation of water related indices seems to be necessary in order to take concrete measures *at a different scale.*

Examination of the indices of the global climate change which may affect Fukuoka, northern Kyushu, Japan

102 year record of **Precipitation** and **Temperature** measured at Fukuoka meteorological station

Monthly data of
NPI(*North Pacific Index*); P
PDOI(*Pacific Decadal Oscillation Index*); T
SOI(*Southern Oscillation Index*); P
DMI(*Dipole Mode Index*); T

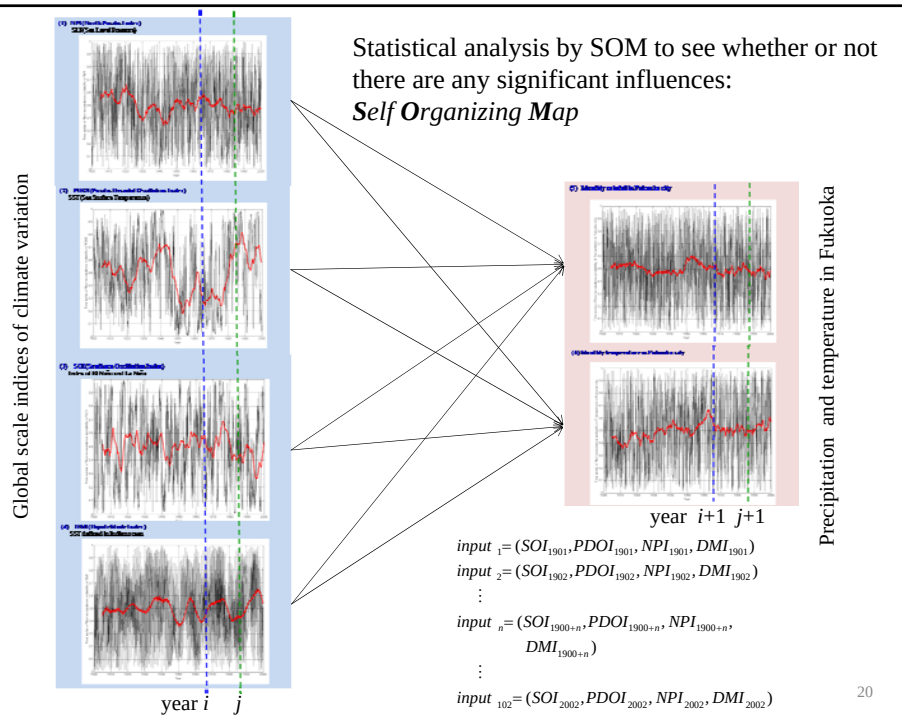


Teleconnection of global scale indices to local climate

Correlation between the global climatic indices and Fukuoka's climate;

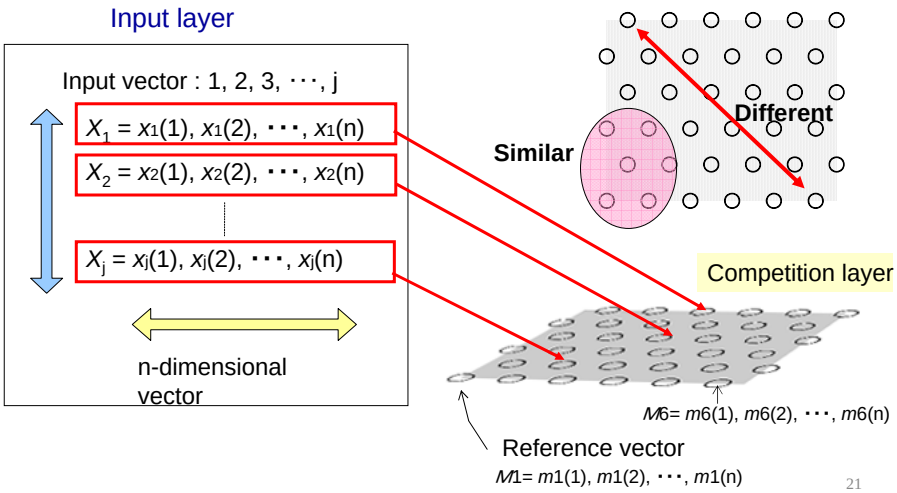
We need to be confident on the possibility of the climatic change caused by global warming.

Indices of global climatic variation(Scaled 0 to 1.0 from their original values)		
Index (Jan. 1900 - Dec. 1999)	High/ Low	Climatic means
NPI :P (North Pacific Index)	High	Weak Aleutian low pressure
	Low	**Strong Aleutian low pressure**
PDOI: T (Pacific Decadal Oscillation Index)	**High**	Low sea surface temperature(SST) anomalies in the central North Pacific Ocean, and **high in the equatorial Pacific Ocean and California coast of USA**
	Low	High SST anomaly in the central North Pacific Ocean, and low in the equatorial Pacific Ocean and California coast of USA
SOI: P (Southern Oscillation Index)	**High**	Strong trade wind=***La ñina***
	Low	Weak trade wind=*El ñino*
DMI: T (Dipole Mode Index)	**High**	High SST anomaly in the **equatorial West Indian Ocean**, low SST anormaly in the equatorial South Eastern Indian Ocean
	Low	Low SST anomalies in the equatorial West Indian Ocean, and high SST anomaly in the equatorial South Eastern Indian Ocean



About the Self Organizing Map (SOM)

SOM (Self-Organizing Map) is able to plot the multi-dimensional vector onto the 2-dimensional map called **SOM-map** depending on the vector properties.



Variation of annual precipitation in Japan

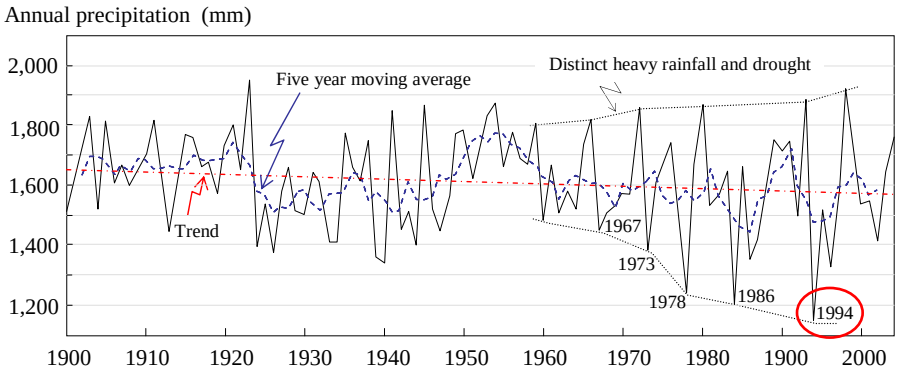


Figure Variation of annual precipitation in Japan. In recent 40 years, heavy rainfall and drought is becoming distinct.

SOM-map; blue numbers indicate the SOM-grid

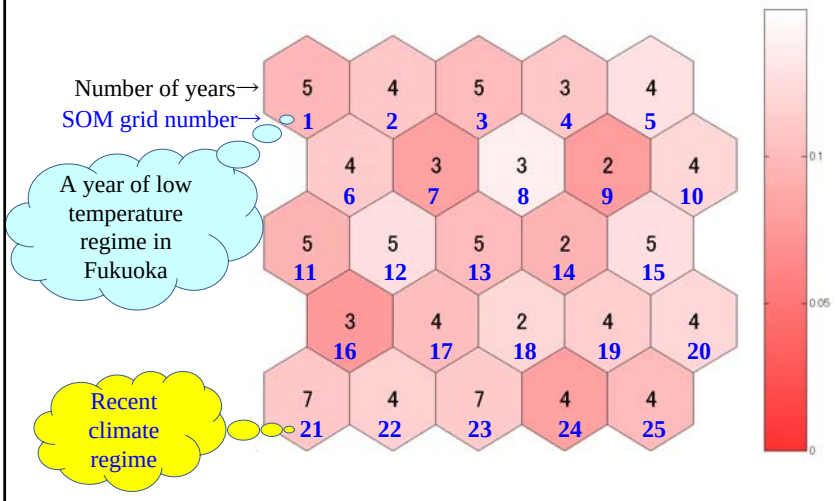


Figure The map obtained by applying SOM for the 102 inputs(years). The number written in each node indicates the number of data classified in the node. Red color bar indicates a low square of deviation(Very similar pattern).

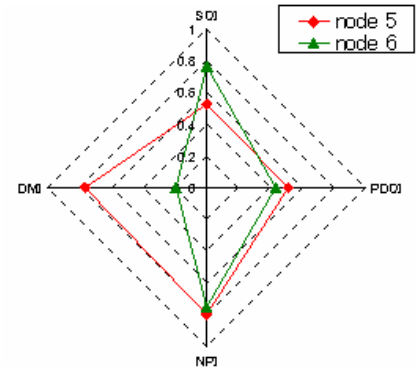
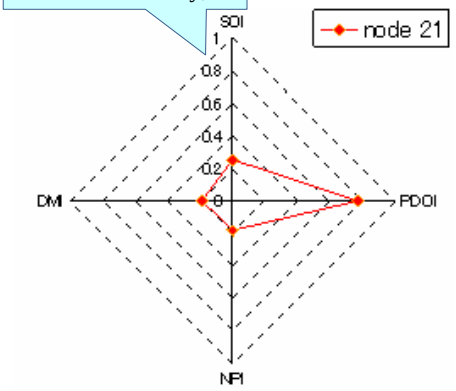


Figure Radar chart of reference vector for the SOM node 5 (red) and for the SOM node 6 (green). Each of the 4 axes shows non-exceedance probabilities of SOI (top), PDOI (right), NPI (bottom) and DMI (left)

Recent tendency;

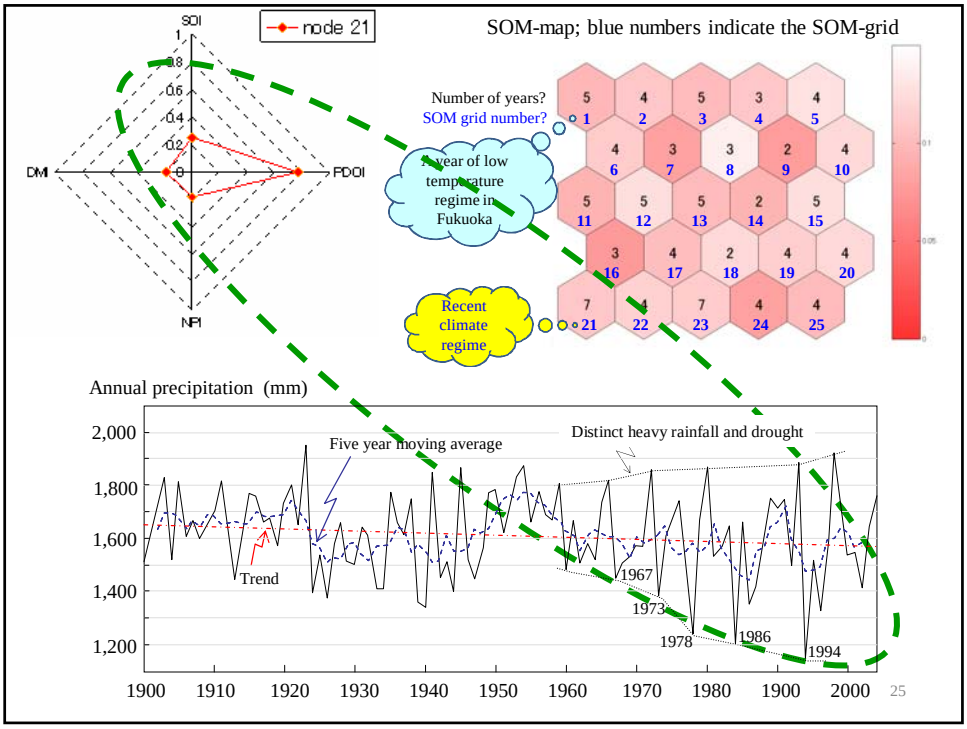


1. **Figure** Radar chart of reference vector for the

SOM node 21:

Low: **SOI** (*El ñino*),
DMI(Low SST anomaly in the equatorial Western Indian Ocean),
NPI(Strong Aleutian low pressure),

High: **PDOI**(High SST anomaly in the equatorial Pacific Ocean and California coast)



Summary of SOM analysis:

1) **The classification of climate indices by SOM** identified the distinct change of the climate patterns which have been observed **since 1960s**.

2) **Fukuoka's temperature from April to September is likely to be low when,**
   SOI is high when **La Niña** occurs,
   PDOI is high,
   NPI is high((Aleutian pressure is weak), and
   DMI is low.

3) **High and low precipitation tend to fluctuate alternately.**

How about is your region?
Won't you check your data whether they show clear correlation or not?

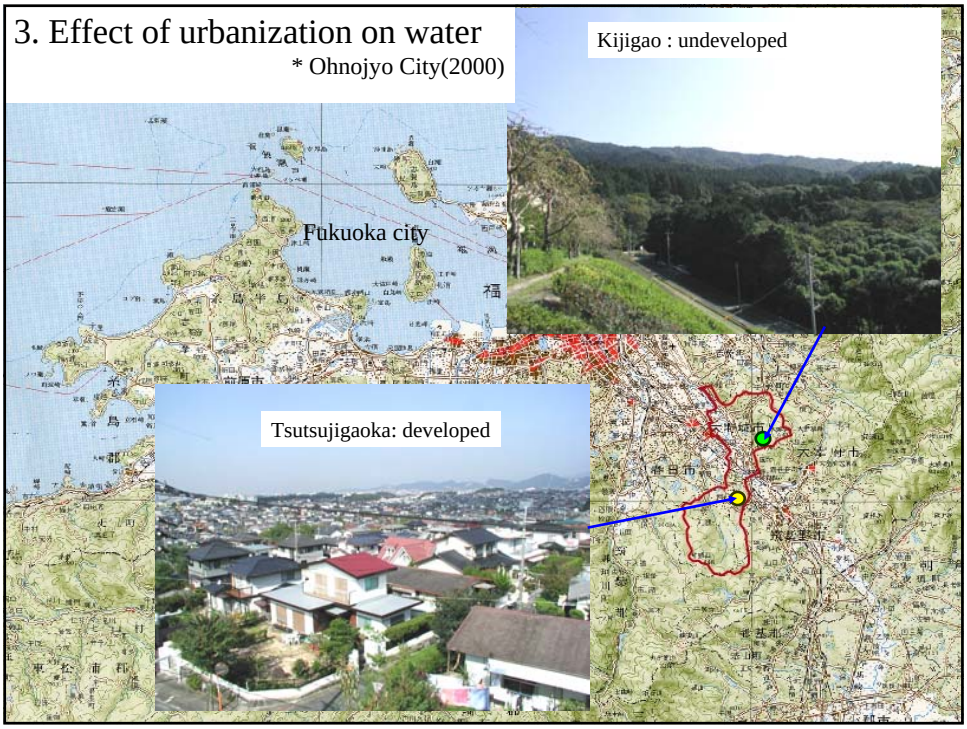
Remarks ;

2-3. The fluctuation of the annual precipitation in Fukuoka seems to be correlated with the employed four indices.

2-4. More direct signals may be necessary in Fukuoka region to clearly state the effect of global warming on the scientific level.

3. Effect of urbanization on water

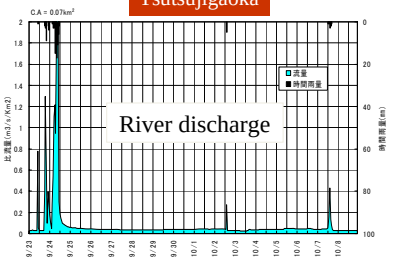
* Ohnojyo City(2000)

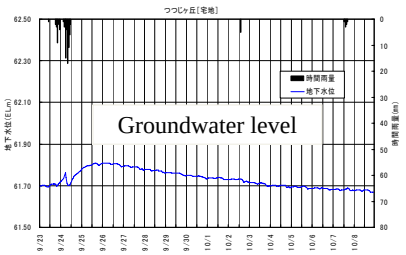


Difference in river discharge

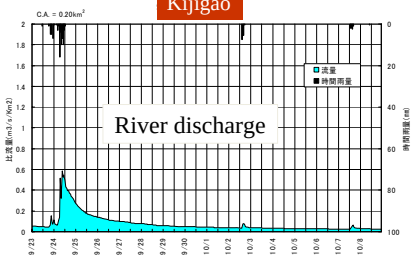
urbanization

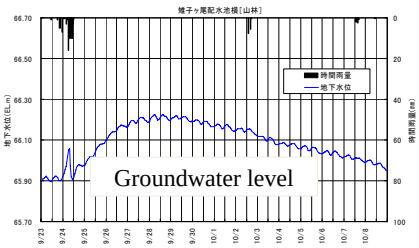
Tsutsujigaoka



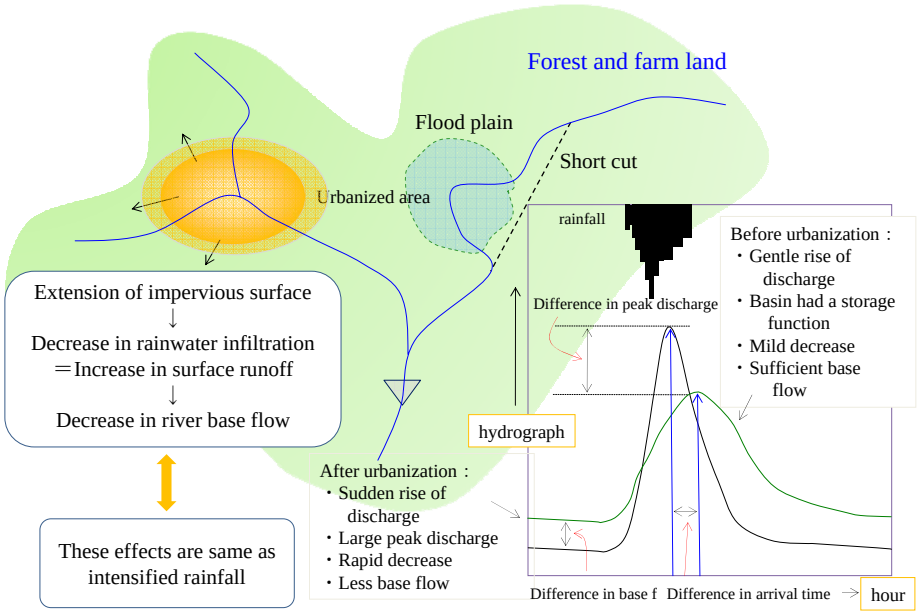


Kijigao





Will urbanization bring a same effect as global warming?



Extension of impervious surface
↓
Decrease in rainwater infiltration
＝Increase in surface runoff
↓
Decrease in river base flow

These effects are same as intensified rainfall

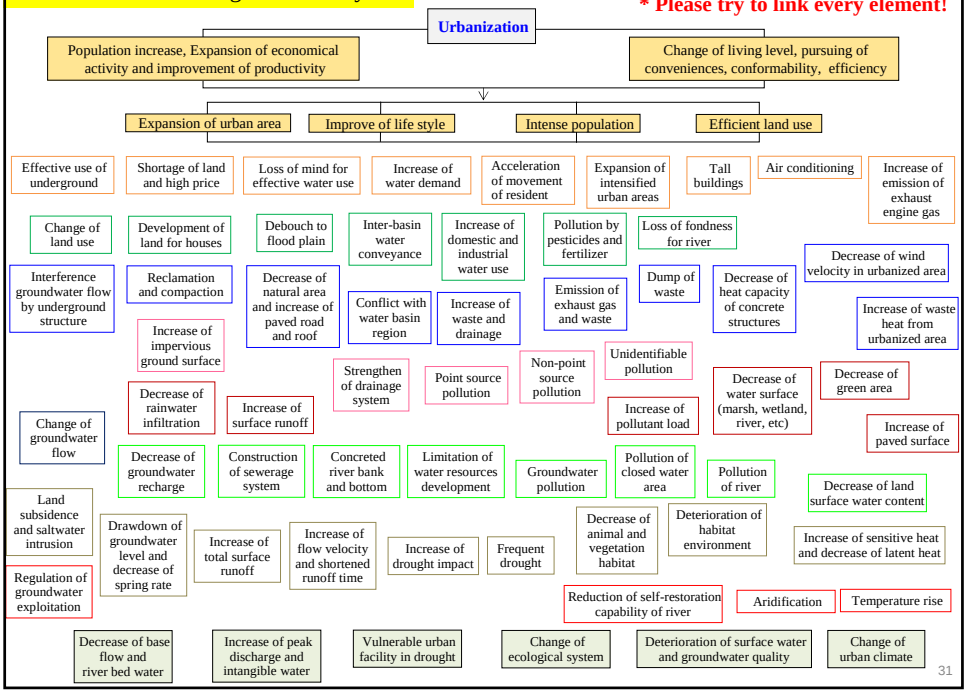
Before urbanization：
- Gentle rise of discharge
- Basin had a storage function
- Mild decrease
- Sufficient base flow

After urbanization：
- Sudden rise of discharge
- Large peak discharge
- Rapid decrease
- Less base flow

Urbanization and change of water cycle

Original picture by H. Niida (MLIT, 2005, PhD)

*** Please try to link every element!**



Mechanism of global warming : Emission of warming gas.

↓

Similar impact both global warming and urbanization.

Reduction of emission of warming gas and mitigation of urbanization needs to be simultaneously discussed

Urbanization without consideration of water cycle

Global warming

Deforestation, extension of impervious area

Distinct flood and drought
(Intensified rainfall and longer drought period)

Impact of global warming could be attenuated if urban environment is improved.

Essential effect of global warming and urbanization:

- Increase of surface discharge
- Decrease of river base flow
- Decrease of rainwater infiltration

Risk of flood and worsened water resources management

Remarks ;

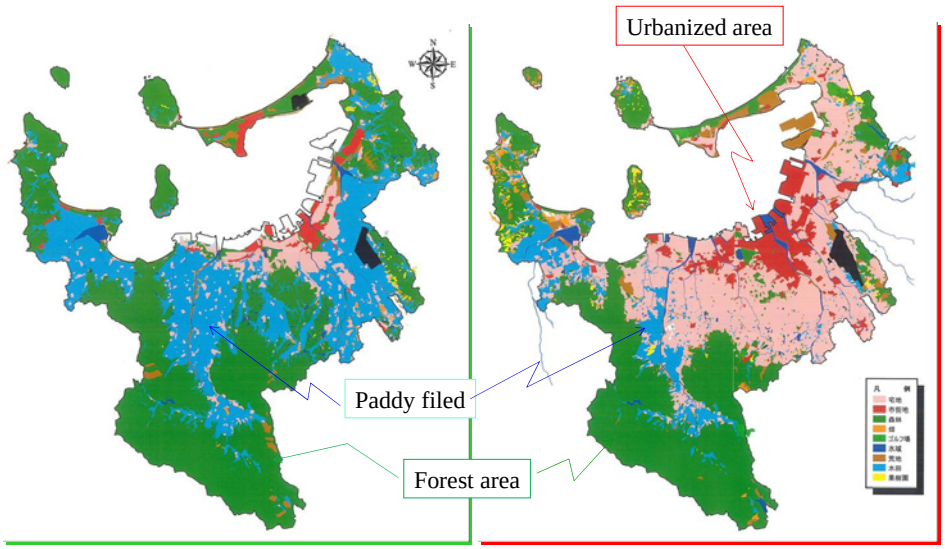
3-1. Urbanization without having proper measures for water management will result in worsened environment.

3-2. If global warming is likely to induce the distinct rainfall pattern, similar water problems which we observe in the urbanized areas at present, will occur.

3-3. Perhaps, both effects are already evident in many urbanized areas of the world.

Example of effect of urbanization of water environment

History of land use alteration of Fukuoka city (by Fukuoka city office)



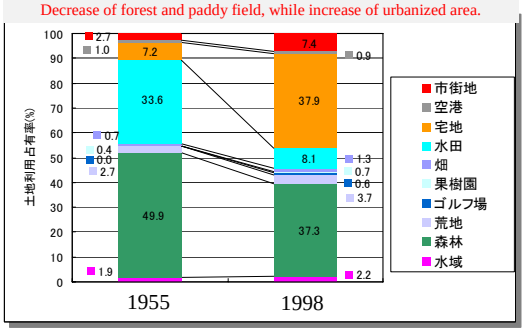
Year 1955 Year 1998

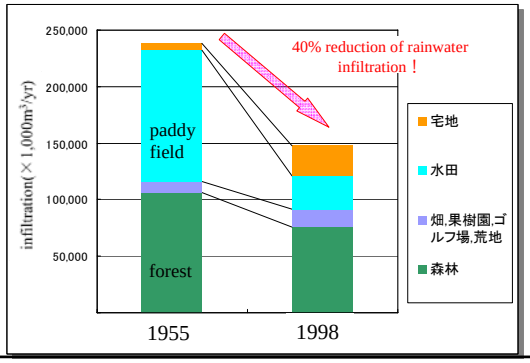
Action plan of *aesthetic water cycle* of Fukuoka city:

[purpose]
Rapid urbanization of Fukuoka metropolitan area has brought the decrease of river base flow and increase of flood peak resulting in deterioration of water quality during drought and heavy rainfall event.

In order to improve such subjects, Fukuoka City declares to take the necessary actions based on the aesthetic water cycle. This means all the water related administrations will cooperate each other.

Decrease of forest and paddy field, while increase of urbanized area.





Remarks ;

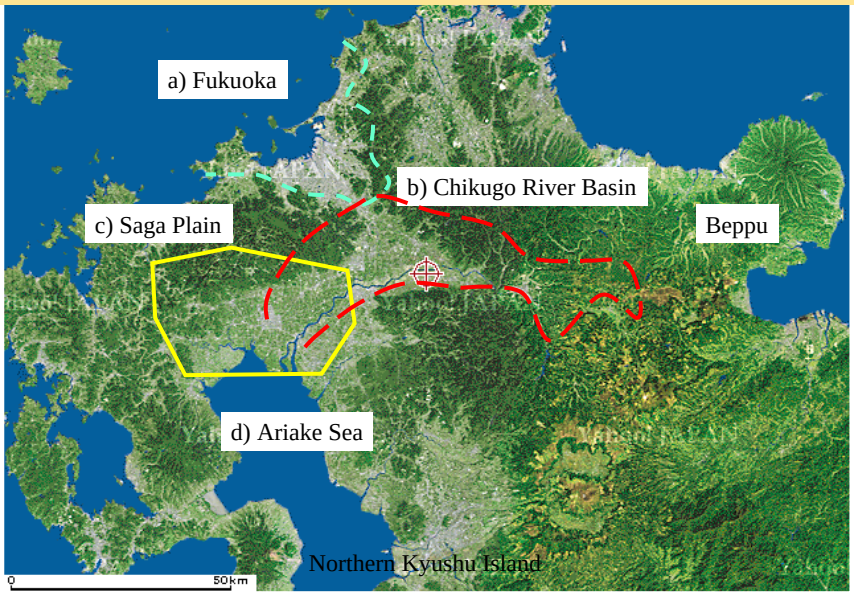
3-3. A concept of "***Aesthetic water cycle***" is not yet sufficiently known.

3-4. The people expect that rainwater infiltrates into ground and create tasty groundwater.

3-5. To achieve the "***Aesthetic water cycle***",
1) Estimate the amount and movement of surface and groundwater, and
2) Estimate the quality of surface and groundwater, in your region.

4. Integrated water management at a basin scale

Inter-basin subjects, especially when drought happens
- Case of Fukuoka metropolitan area and Chikugo River Basin -



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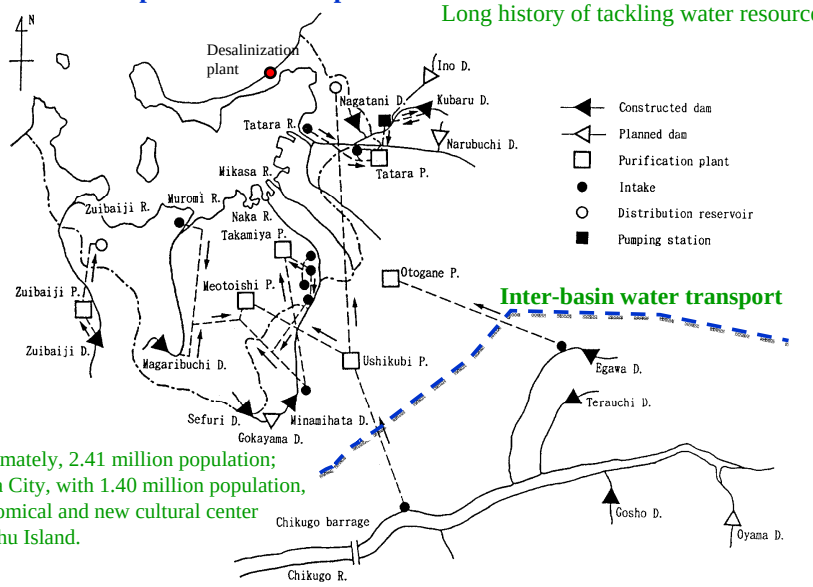
a) Fukuoka metropolitan areas→Water resources, aesthetic water cycle

→Department shop of water development

Small watersheds, highly populated area.
Long history of tackling water resources.

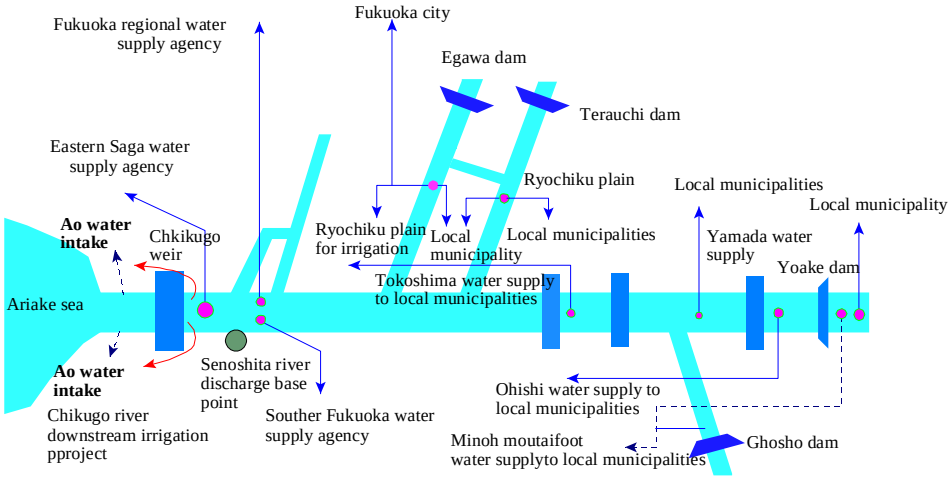


Approximately, 2.41 million population;
Fukuoka City, with 1.40 million population,
an economical and new cultural center
of Kyushu Island.

Waterworks facilities, water sources and conveyance system of Fukuoka City

b) Chikugo River Basin→Water resources, extension of sewerage system, and land subsidence

Irrigation, drinking water, river and sea fishery, river environment, flood control are all interrelated in Chikugo River Basin which covers the prefectures from the upstream to the downstream sea. Land subsidence, vulnerable for drought.



Ao: local word meaning of fresh water

Long history of water use of Chikugo River Basin

c) Saga-Chikugo Plain→Land subsidence, replace of groundwater by surface water

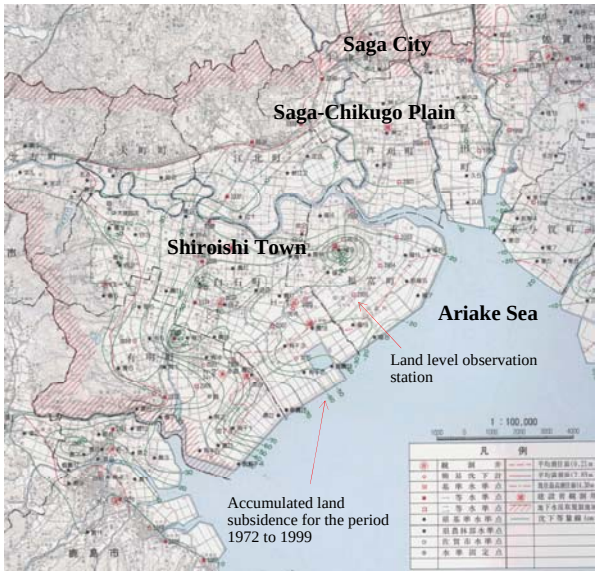


Figure * Total land subsidence for Feb.1942 – Feb. 1999. Lines are the contours of land subsidence, dots are the monitoring stations of groundwater level and ground level (By Saga Prefectural Office, 1999)

d) Ariake Sea→Recovery of the sea environment and basin

There are 8 major rivers which are directly managed by the central government(MLIT) in the Ariake Sea region. The catchment has been used in many ways more than 2,000 years. Recently, remarkable deterioration of sea environment are observed and fishery industries are getting worse. An integrated regional water management in the entire Ariake Sea region is becoming indispensable to improve the situation.

Drought of 1994!

vulnerable of the water resources in this region;

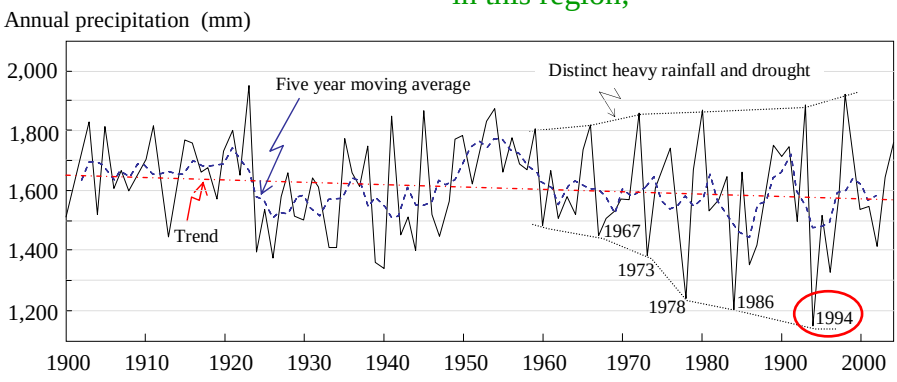


Figure: Variation of annual precipitation in Japan. In recent 40 years, heavy rainfall and drought is becoming distinct.

a) Influence of the 1994 drought in Fukuoka area

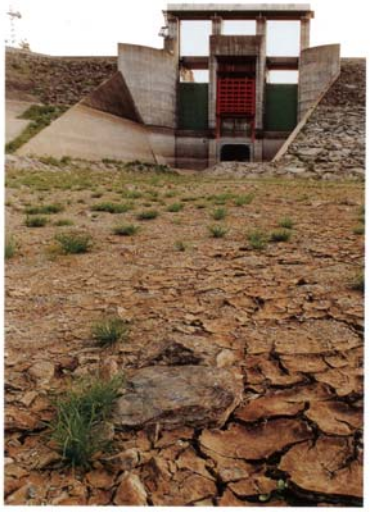
Preparation of drinking water at home,
(photo by Yomiuri News)

(平成６年９月２日掲載)

Street stall of Chinese noodles, "*We have to close when no water*",
(photo by Asahi News)

(平成６年８月５日掲載)

b) Influence of the drought in 1994 to the agricultural area in Chikugo-Saga plains



Dried up Terauchi dam,
(photo by Nishinihon News)

Wilted rice in Saga prefecture,
(photo by Mainichi News)

(平成６年８月21日掲載)

Emergency release of the water stored
in the weir reservoir for irrigation in downstream

筑後大堰から下流アオ地区へ緊急放流
平成６年７月 26 日撮影

大詫間、大野島地区のアオ緊急取水の状況
平成６年７月 26 日撮影

クリークの枯渇状況（筑後川流域大詫間地区にて）
平成６年９月２日撮影

田面がひび割れし枯死した稲（筑後川流域大詫間地区にて）
平成６年９月２日撮影

Dried up rice field with cracks
← Farmers pump up the river water to irrigate
(by Ministry of Land , Infrastructure and Transportation)

c) Influence of the drought in 1994 to the area of land subsidence, Shiroishi Plain, Saga

Weren't there any other scenarios?

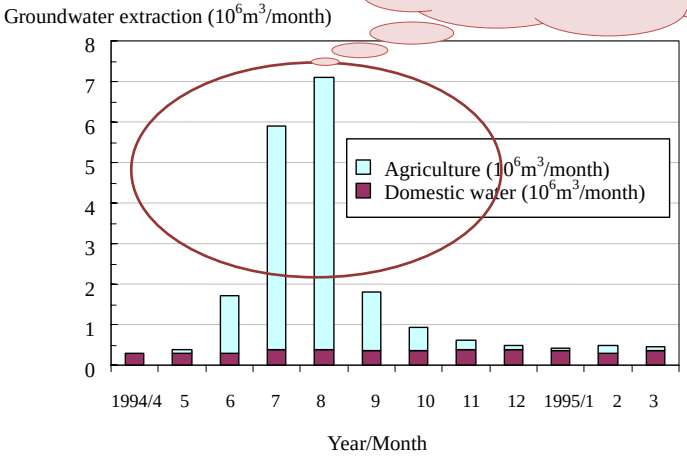


Figure Monthly groundwater extractions in Shiroishi Town
(By Saga Prefecture Office[5]).

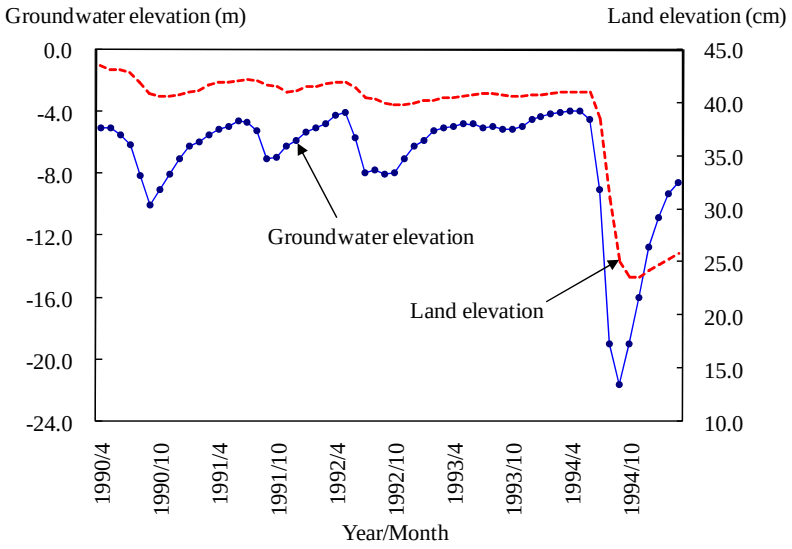
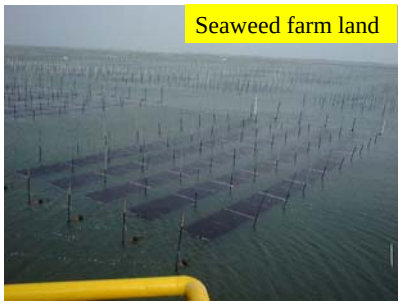


Figure Land subsidence and the variation of groundwater level.
(By Saga Prefecture Office, 1999[6]).

d) Fishery industry in Ariake Sea, its causes are often controversial.



http://contents.kids.yahoo.co.jp/shokuiku/zukan/seaweed/400.html

Remarks ;

4-1. Three regions belong to the different river basins. However, "*water*" has been their common subject.

4-2. Today, they are not independent.

4-3. Controversies arise with drought, low fishery product, and deteriorated sea environment .

5. Cooperation of governments and residents

Region	Subject
Fukuoka metropolitan	Drought, flood, **aesthetic water cycle**[*)], **+ global warming problem as urbanized regions**
Saga-Chikugo Plains	Land subsidence, drought, flood, sewerage system, population decrease in rural areas, forest management, **+ global warming as water source areas**
Ariake Sea	Recovery of fishery products industry, drought, land subsidence, sewerage system, **+ global warming as fishery**

How? Are there any rational strategies?

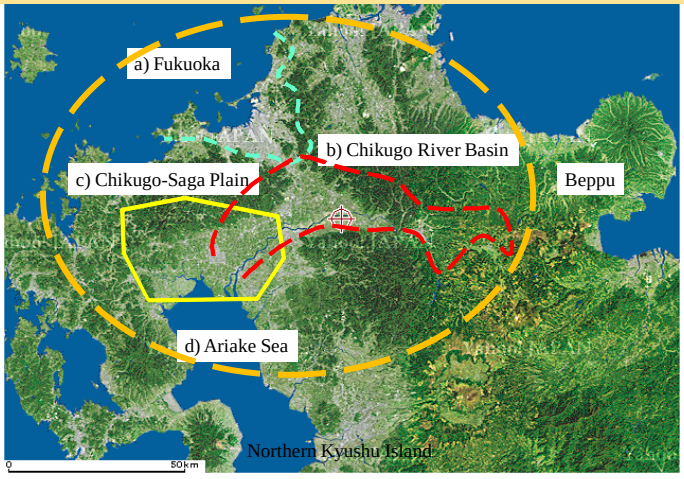
A view point for an integrated water management is indispensable in order to tackle negative effect of **urbanization** and **global warming**.

[*)] Theoretically, an aesthetic water cycle needs to be considered over the water-dependent region, estimating water balance and quality behaviors.

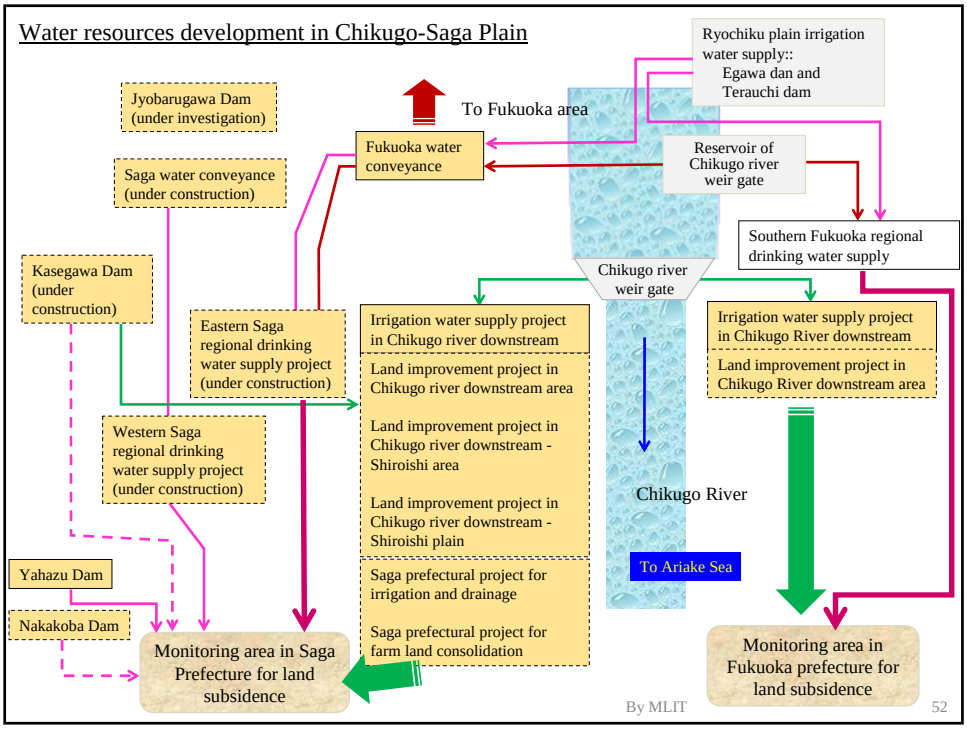
Are there any good examples in this region which can be good lessons?

→ Not yet sufficiently, but an integrated view point is likely to be created in this regions, because they can neither be independent on water nor human activities.

Inter-basin subjects, especially when drought happens
- Case of Fukuoka metropolitan area and Chikugo River Basin-



Water resources development in Chikugo-Saga Plain



By MLIT

Recovered spring; "*Nui-no-ike*" in Shiroishi Town, Saga.
When it was dried up.

Western Saga regional drinking water supply project replaced groundwater by surface water.

http://shinwa-techno.co.jp/wakimizu/pdf/wakimizu1.pdf

Various view points

Central government:
- policies
- technologies
- fund

Global warming

Urbanization

Municipalities
→direct communications with local residents and stakeholders

Urbanized areas

Rural areas

Water management for
- surface water
- groundwater
- waste water
- downstream water areas

Local government
- policies
- technologies
- fund

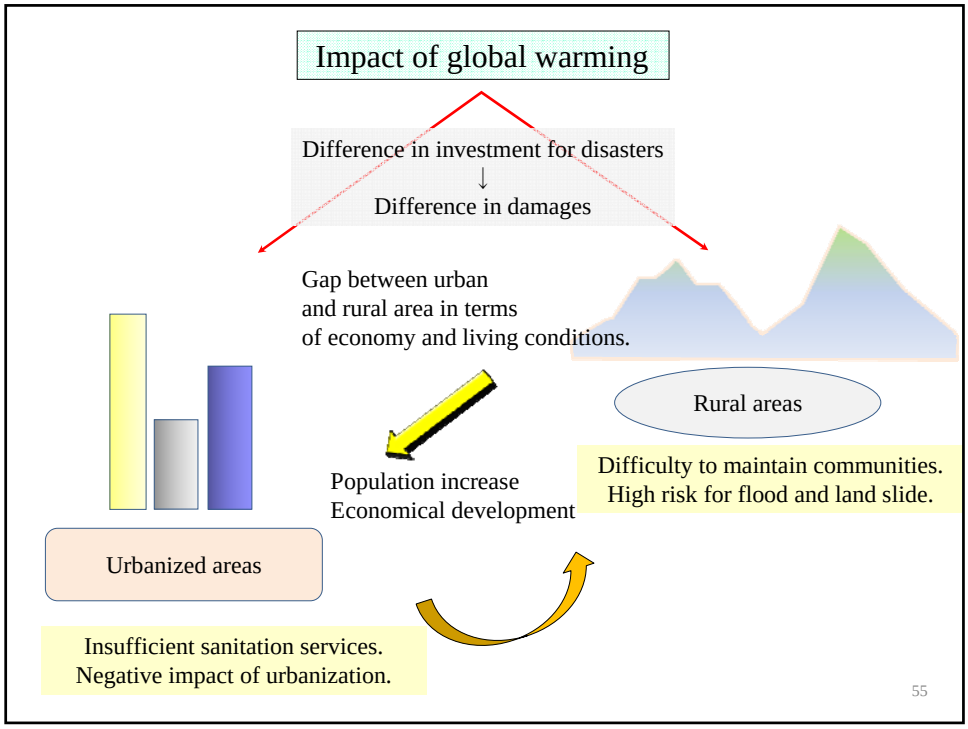
Various opinions

flood

environment

drought

Evaluation method



Remarks ;

5-1. The present areas needs to cooperate in the field of water, because the areas can not be free from the water subjects.

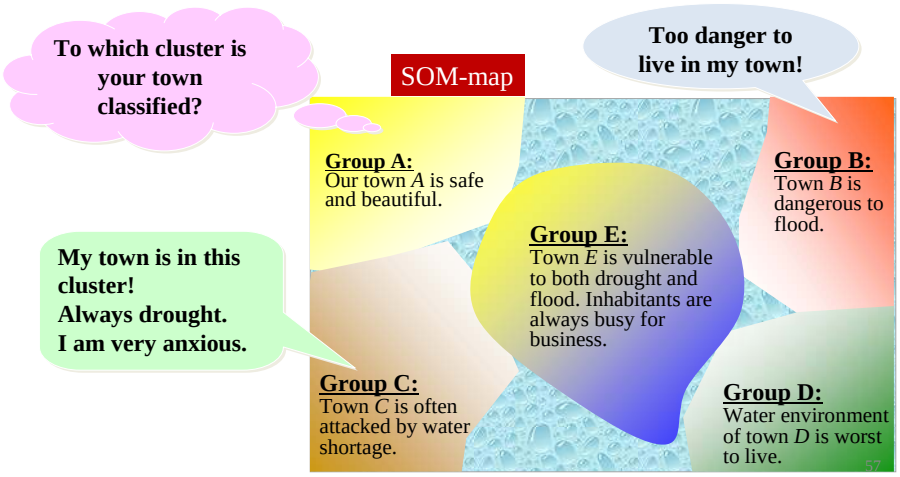
5-2. Movement of people and economical activity can not be stopped; They should cooperate so that both can get benefits from each.

6. Evaluation

To have a competitive spirit

→A driving force to improve situations

Regional campaign : Moderate scale which lead the residents to have a competitive spirit with other regions.



Competitive spirit amongst municipalities

- Do our residents have high awareness for water environment?
- Residents are often motivated by external stimulation!

16 questionnaires;

1. **Does your municipality plan any water related projects?**
2. **Occurrences of inundation, debris flow**
3. **Water use(sufficient or drought?)**
4. **Water environment**

+

Basic statistics of municipality

1. **Population density**
2. **Forest area size per capita**
3. **Farm land area size per capita**
4. **Rate of water supply propagation**
5. **Rate of sewerage system propagation**
6. **Elevation of municipality**
7. **Available water resources**
8. **Annual precipitation**

These questionnaires were distributed to approximately 300 municipalities in Kyushu Island.

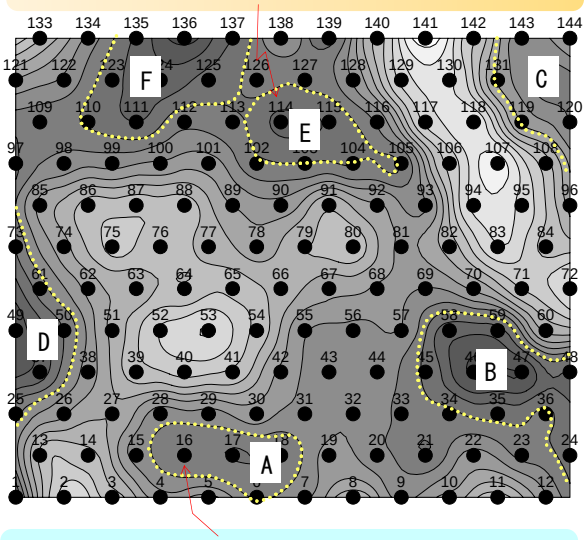
Self Organizing Map-method was applied in order to classify into several clusters of their aesthetic water environment.

Questionnaires

1. Water related subjects of your municipality
   - ① Rapid urbanization: 1. Continuing at present 2. Before but not now 3. No urbanization
   - ② Reduction of forest and farmland: 1. Rapidly decreasing at present 2. Before but not now 3. No
   - ③ Water related problems: 1. Continuing still now 2. Before but not now 3. No
   - ④ Measures for water problems: 1. We take actions at present 2. Before but not now 3. Nothing particular
   - ⑤ Important subject for water issues (multiples replies)
     1. Stable drinking supply 2. Flood control 3. Improve of drinking water quality 4. Creation of water amenity front 5. Conservation of eco-system 6. Others
   - ⑥Activities for aesthetic water cycles: 1. We take action at present 2. Not yet started although it is important 3. Concept of aesthetic water cycle is not clear
   - ⑦ Group or organization for water problems: 1. There are many 2. Some groups and organizations 3. Nothing 4. We do not get any information
   - ⑧ Symposium for water: 1. Frequently held 2. Sometimes 3. Not held
2. Flood, debris flows
   - ① Frequency of river flooding
     1. Every year 2. Once in five years 3 . Once in 10 years 4. Once in 30 years 5. No flood for the last 30 years
   - ② Frequency of inundation
     1. Every year 2. Once in five years 3. Once in 10 years 4. Once in 30 years 5. No inundation for the last 30 years
   - ③ Frequency of debris flow
     1. Every year 2. Once in five years 3. Once in 10 years 4. Once in 30 years 5. No inundation for the last 30 years
3. Water use
   - ①Frequency of water cut
     1. Every year 2. Once in five years 3. Once in 10 years 4. Once in 30 years 5. No inundation for the last 30 years
   - ② Ratio of water use in your municipality
     1. Domestic water>Industrial water>Agricultural water 2. Domestic water>Agricultural water>Industrial water
     3. Industrial water>Domestic water>Agricultural water 4. Industrial water>Agricultural water>Domestic water
     5. Agricultural water>Domestic water>Industrial water 6. Agricultural water>Industrial water>Domestic water
   - ③ Ration of self supply capability: 1. More than 80% 2. 60%-80% 3. 40%-60% 4. 20%-40% 5. Less than 20%
   - ④ Ratio of self water supply between surface water and groundwater
     1. River water more 80% 2. River water 60%-80% 3. River water 40%-60 4.River water 20%-40% 5. River water less than 20%
4. Environmental problems of river water in your municipality
   - ① River discharge
     1. Always plenty except for the drought year 2. Sometimes insufficient discharge
     3. Always less during irrigation period of rice 4. Only sufficient except for the flood period
   - ② River and lake water quality 1. Always good 2. Favorable 3. Normal 4. Unfavorable 5. Wrong
   - ③ Accident of water pollution 1. Frequently happens 2. Sometime 3. Never happened
   - ④ Animals and plants in river, waterways, and lake 1. Many species 2. Normal numbers 3. Seldom observed
   - ⑤ Land subsidence 1. Observed still now 2. In the past 3. Never happened
   - ⑥ Salt water intrusion 1. Observed still now 2. Observed in the past 3. No evidences
5. Water amenity conservation, cultures related to the local water
   - ① Quality of the water amenity front 1. Good 2. So far, good 3. Normal 4. Unfavorable 5. Wrong
   - ② Are there good water amenity fronts? 1. Many 2. So far, we have 3. Normal 4. A bit less 5. No places
   - ③ Cultures related to water 1. Well known water cultures in Japan 2. Locally known cultures 3. Nothing

Result of questionnaires plotted on SOM-map;

My town belongs to this group. Very unhappy, because we are in the same group to which very well known dark town belongs.



My town belongs to this group. Very happy, because we are in the same group to which a famous beautiful town belongs.

Characteristics of group	
A	Flood control, water resources, and environment are favorably maintained in good condition
B	Sufficient water resources but poor for flood control and water amenity
C	Flood control is good, but water resources and environment are very worse. Specifically, ratio of self water supply is extremely low.
D	Almost in good condition for flood control, water resources, and environment. Prevention of land slide needs to be enhanced.
E	Self water supply is very poor and no cooperative water supplying system amongst local municipalities is established. Because of this, water shortage often happens. Both flood control and water amenity are insufficient.
F	Flood control, water resources, and environment are in good condition. However, activity to conserve water culture is low.

Remarks ;

6-1. A competitive spirit could be a driving force which leads the people to be more concerned.

6-2. The people's participation will bring a good result for both the people and governments.

7. Conclusion

Reduce the impacts of global warming and urbanization by integrating surface water and subsurface water systems at a basin scale.

Restoration of urban environment is at least one of the solutions for the global warming impact on water.

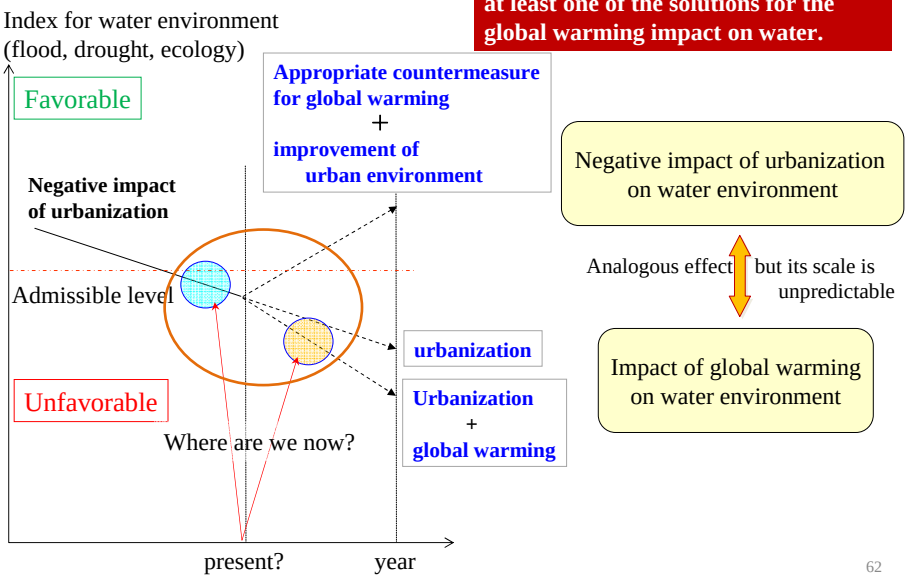


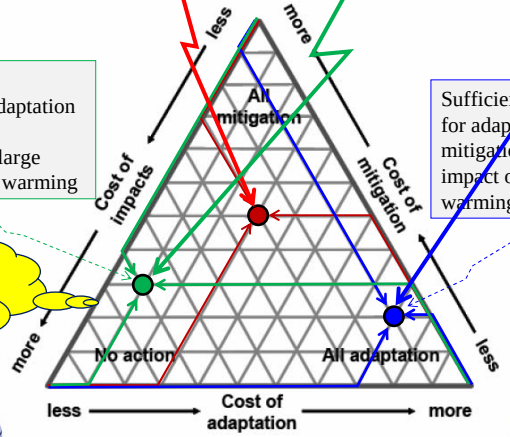
Table SPM E.1: *Qualitative definition of uncertainty*[*])

high ↑ Level of agreement (on a particular finding)	High agreement, limited evidence	High agreement, medium evidence	High agreement, much evidence
	Medium agreement, limited evidence	Medium agreement, medium evidence	Medium agreement much evidence
	Low agreement, limited evidence	Low agreement, medium evidence	Low agreement, much evidence
	Amount of evidence[50] (number and quality of independent sources) → much		

Because of less investment for adaptation and insufficient mitigation, then large impact of global warming

Sufficient investment for adaptation and small mitigation, then less impact of global warming

What strategy will you take?



WMO UNEP

Summary of the presentation

Global warming

Urbanization

Urbanization and change of water cycle

Evaluation

Various view points

Diverse opinions

The following remarks can be shared by us;

1) We need to pay attention on what is discussed amongst the scientists, specifically the discussions on the impact of the regional scale water environment,

2) At least, negative impact of urbanization on our living condition needs to be improved,

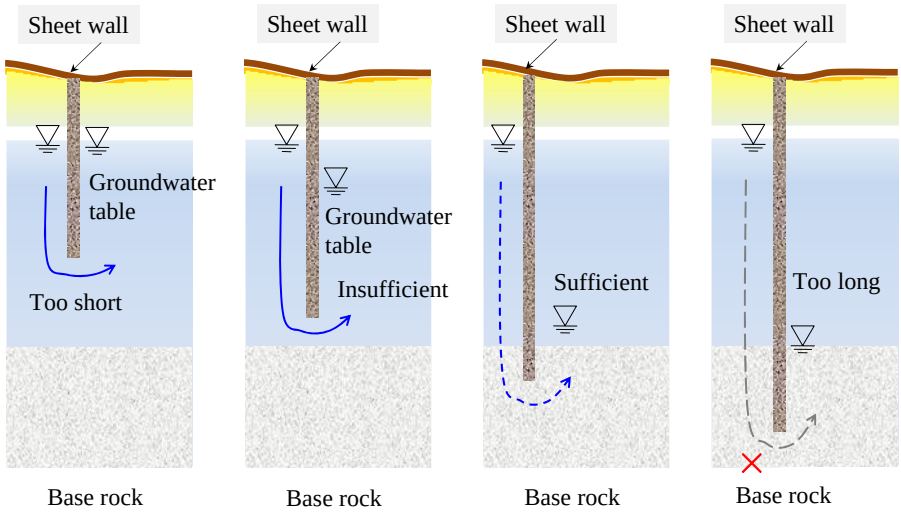
3) Facilities which are owned at present need to be effectively utilized with an integrated manner,

4) Combined water use of surface water, groundwater, rainwater, and recycled water needs to be taken into consideration, and

5) Forums of water environment joined by politicians, engineers, residents, and scientists are necessary at a regional level.

Finally, an appropriate length needs to be designed.

The wall does not need to be constructed using high quality material, but idea of design needs to be optimal for the region.



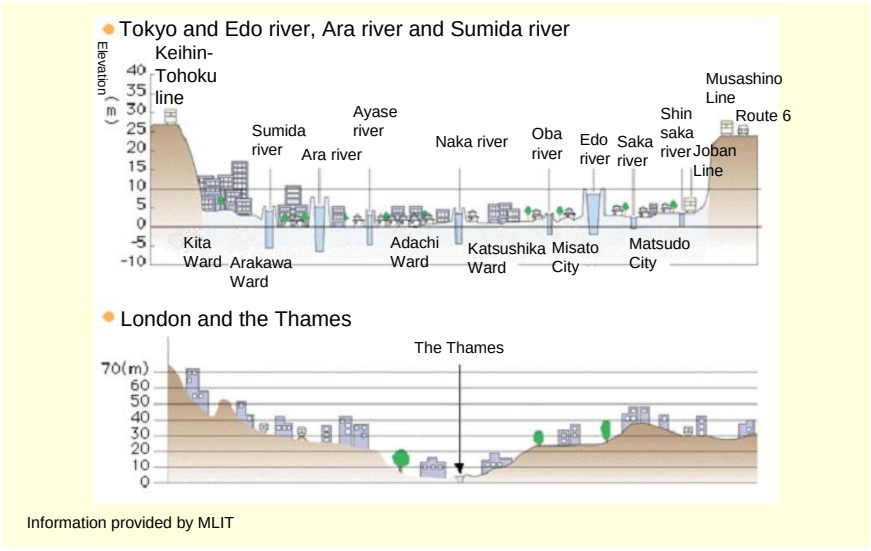
Thank you for your attention!

Adaptation to Flood Change Due to Warming in Japan

Shin TSUBOKA
Director General

National Institute for Land and Infrastructure Management

Flood Vulnerability

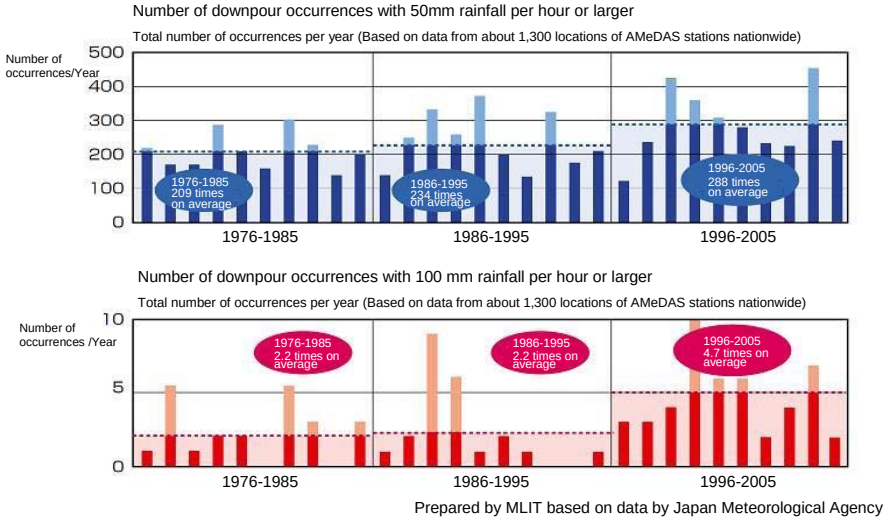


Information provided by MLIT

The relation of grounds and rivers level in Tokyo and London

1

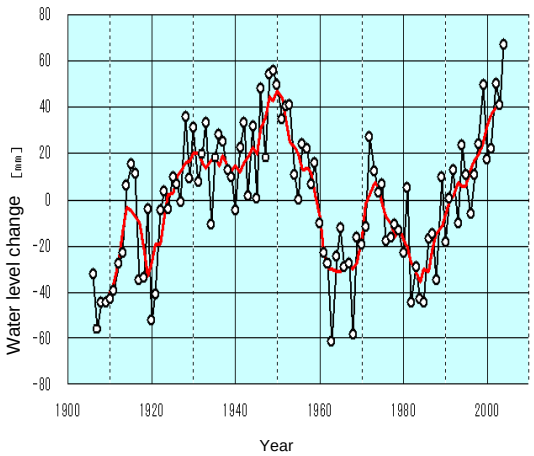
Precipitation change



Recent changes in heavy rain frequency based on AMeDAS data by Japan Meteorological Agency

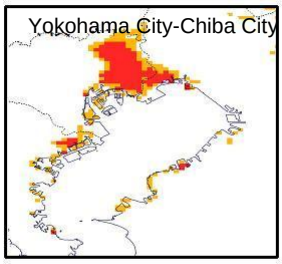
2

Changes in Sea Surface Level and their influences



Changes in sea surface in Japan's coastal areas

Tokyo Bay



1.76 million people ⇨ 2.7 million people

(Currently) (After sea level rise)

Change in the under sea surface area in Tokyo Bay in the case of rise of 0.59m

3

Storm Surge Information System

Japan Meteorological Agency

Typhoon Prediction

Wave Model for Shallow Water
(prediction：1-24 hours later)
(revision: every 6 hours)

Storm Surge Model
(prediction：1-33 hours later)
(revision: every 6 hours)

Predicted Tide Level and Wave

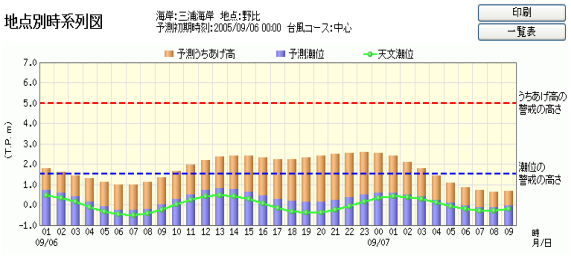
Wave Runup Forecast System

Beach Profile

Wave Runup Model

Forecasted Wave Runup

Editing Output Screen



web

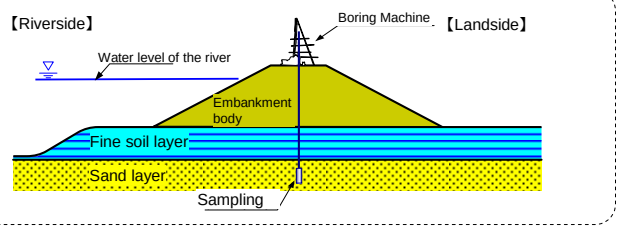
Regional Bureaus and Prefectures

Flood Fighting Warning

4

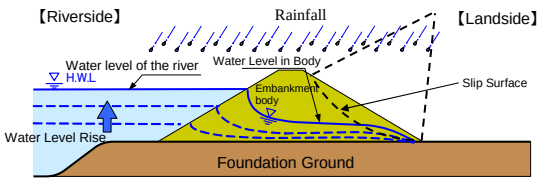
Safety Inspection of River Embankment for Infiltration

Understanding of soil mechanics of embankment body by boring



Inspection of infiltration safety

Seepage flow analysis, Circular arc method → Evaluation of safety



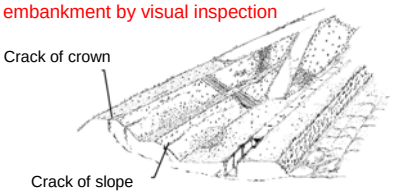
Inspection section 10,117km (Finished, 6,476km, As of the end of 2006)

5

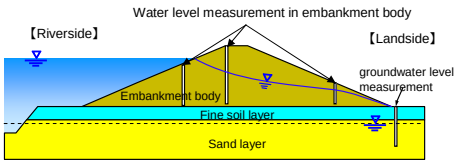
Monitoring and Reliability Evaluation of River Embankment

Monitoring of river embankment

Understanding of deformation of embankment by visual inspection



Observation by measuring equipment



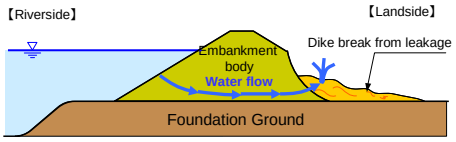
Result of monitoring

Reliability evaluation of river embankment

Accuracy improvement of the safety evaluation method such as Seepage flow analysis / Circular arc method

Dike break mechanism by the piping

Build the analysis model that can reproduce cavitation / flowage of the sandy embankment body by the piping



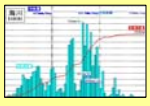
Establishment of reliability evaluation technique based on the dike break mechanism

6

Support system for drawing up flood hazard map

Input Data

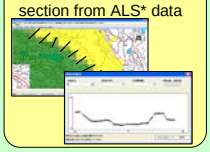
Rainfall data
・text data
・observational data



Topographical data
・Digital Map (elevation)

Sub-basin boundary
・GIS data（shp-file）

River cross section
・Coordinate of river cross section from ALS* data

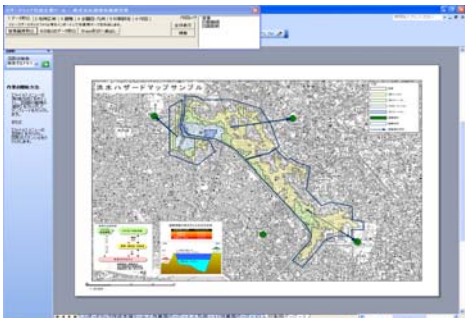


・In this system, it is able to import various data, and to make or correct subset of input data using the interface of this system.

Support system for drawing up flood hazard map

Runoff analysis | Inundation analysis

Water level analysis | Drawing-up hazard map



* ALS data: Airborne Laser Scanning data

7

Conclusion

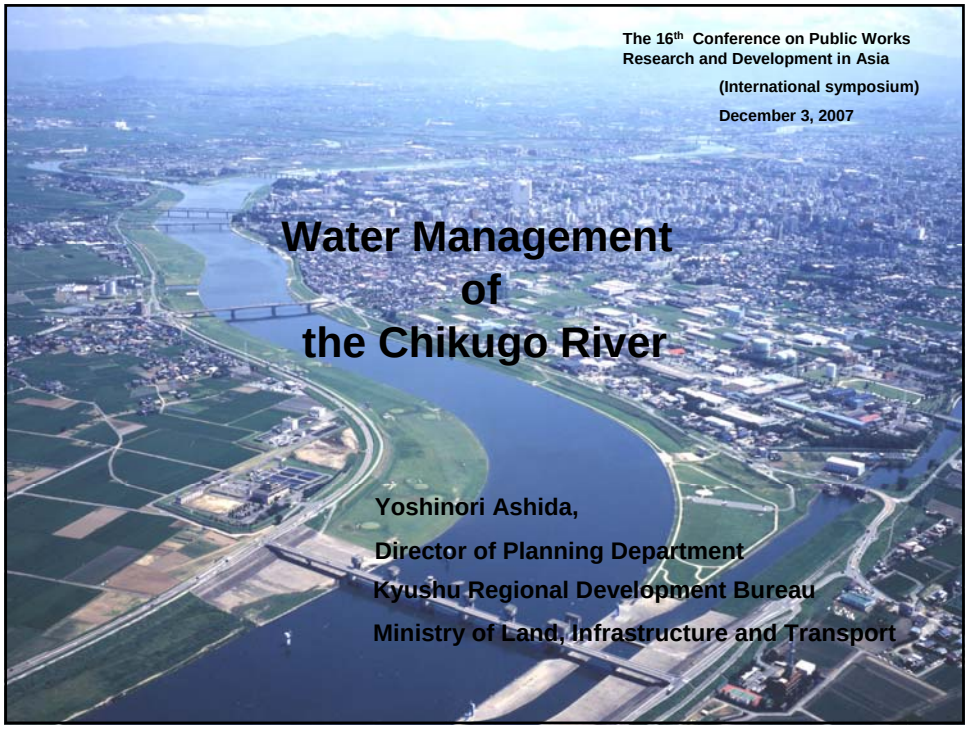
1) Japan has many cities over alluvial plains and vulnerable structure to flooding.

2) Because of climate change, the difference of the heavy rainfall area and the light rainfall area spreads greatly.

3) As adaptation measures, the followings are necessary.
   - To improve disaster prevention facilities based on vulnerability assessment of the facilities against external forces.
   - To improve residents' power for disaster mitigation by providing and sharing disaster information such as hazard maps.

4) National Institute for Land and Infrastructure Management has the preparation which confronts the threatening of the climate change in promoting the researches for various technical tasks and proceeding with the technology sharing to build a cooperation system with each participating nation.

8



The 16th Conference on Public Works Research and Development in Asia

(International symposium)

December 3, 2007

Water Management of the Chikugo River

Yoshinori Ashida,

Director of Planning Department

Kyushu Regional Development Bureau

Ministry of Land, Infrastructure and Transport

Brief overview of Kyushu

●Kyushu can be called the window to Asia as it is relatively close to the Korean Peninsula, Shanghai etc.

●Geographically, it is surrounded by sea and has many remote islands and peninsulas. It is also divided east and west by the Kyushu Mountains, which form a large volcanic zone of Aso and Kirishima.

●The natural environment in Kyushu is rich, varied and beautiful. But the region frequently suffers from frequent typhoons and natural disasters such as concentrated heavy rain, earthquakes and volcanic disasters.

●In recent years, as a background of well-developed traffic networks, rich nature and a warm climate, it has been designed to develop the region, and IC, automobile and some other industries have been shifting production to Kyushu. Especially, the North Kyushu centered around the Fukuoka Metropolitan Area has become the central hub of the economy in Kyushu.

Fukuoka Metropolitan Area with a population over 2.4 million.

Recently, Kyushu has frequently experienced abnormal weather.

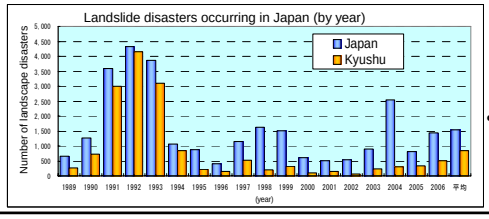
The mean annual rainfall in Japan is approx. 1800mm, twice as much as the world average. In Kyushu, the mean annual rainfall is over 2000mm, even higher than the national average. However, the rivers in the region are fairly small and the water volume is not stable because of concentrated heavy rain in the rainy season and the typhoon season. Moreover, the complex and precipitous topography and the conditions of the rivers make the region most prone to flooding and landslide disasters in Japan. Especially in recent years, large-scale disasters have occurred due to localized torrential rains.

■8 large-scale disasters have occurred in the last 10 years! (1997-2006)

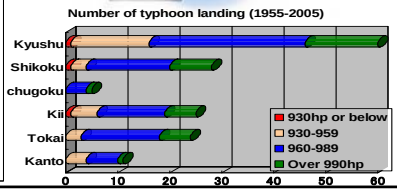
1. Mudflow in Harihara, Izumi city, July 1997
2. Typhoon No. 19 (Kita River, Gokase River System), July 1997
3. Fukuoka flooding (Mikasa River), June 1999
4. Typhoon No. 18 (high tide), September 1999
5. Fukuoka flooding (Mikasa River & Onga River), July 2003
6. Mudflow in Minamata, July 2003
7. Typhoon No. 14 (Gokase River & Ooyodo River), September 2005
8. Sendai River flooding, July 2006

Locations of large-scale disasters that have occurred in the last 10 years

■Most of landslide disasters in Japan occur in Kyushu.



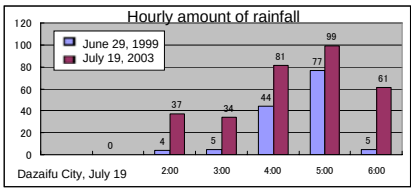
■Kyushu is constantly hit by a typhoon!



Kyushu has been frequently hit by a disaster.

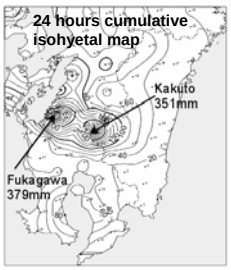
July 2003, Fukuoka flooding (Mikasa River)

In 1999, floods spread to the Hakata Station vicinities and underground malls. The city functions were severely damaged and became paralyzed.



5 hours cumulative amount of rainfall
1999: 147mm, 2003: 312mm

July 2003, mudflow in the city of Minamata

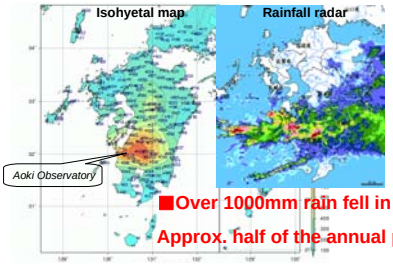


Map of 24 hours cumulative amount of rainfall from 16:00 July 19 to 15:00 July 20, 2003

Approx. 400mm rainfall poured in 24 hours!

Kyushu has been frequently hit by a disaster.

July 2007, Sendai River flooding (Kagoshima Pref.)

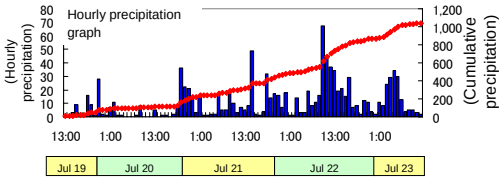


■Over 1000mm rain fell in 4 days!

Approx. half of the annual precipitation!

【Aoki Observatory (Sendai River)】

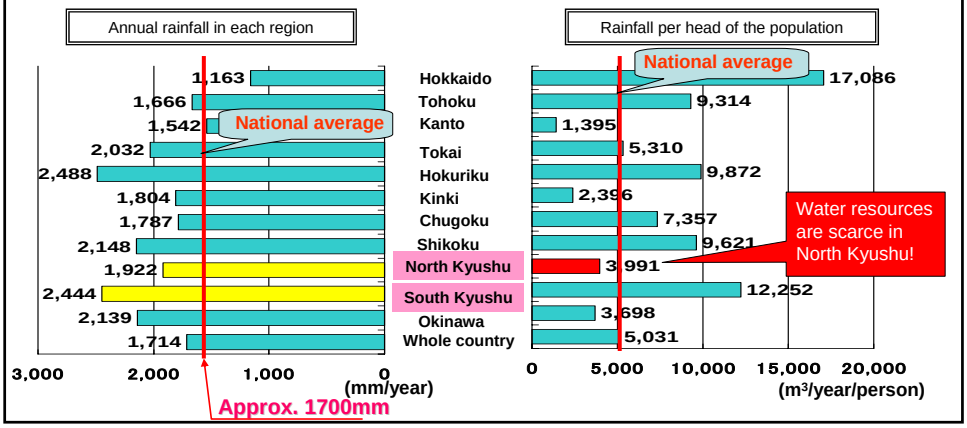
Ookuchi City,Kagaoshima



In Kyushu, due to frequent concentrated downpours and expansion of the urban district, the risk of flood disasters is increasing. Therefore, river improvements and other physical improvements are not enough to prevent natural disasters, and, in order to reduce disasters damage, it is necessary to set up non-structured measures such as provision of river information to the residents and establishment of evacuation procedures.

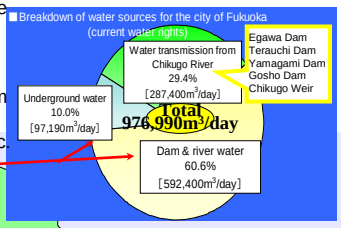
North Kyushu is prone to droughts.

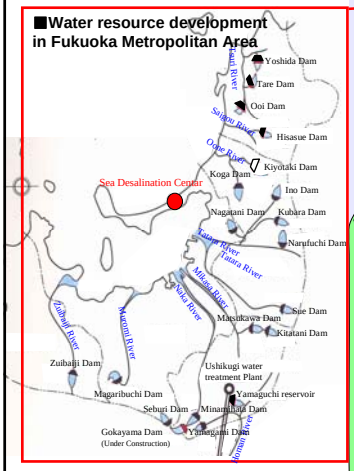
The annual rainfall in the Kyushu Region is over 2000mm. However, the rainfall per head of the population in the North Kyushu falls much below the national average, which makes the area prone to droughts.

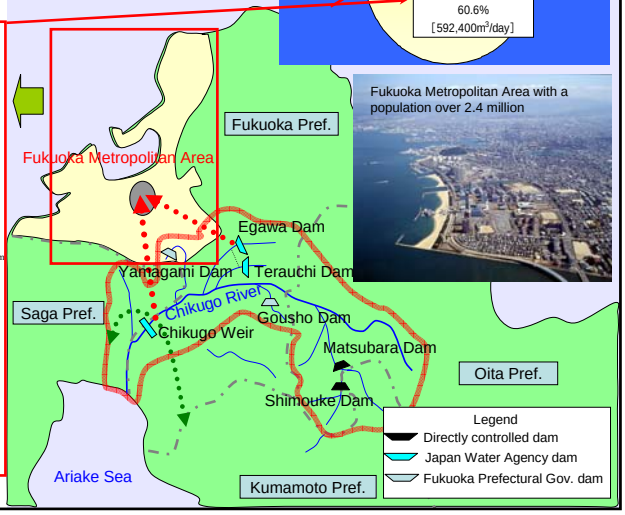


Current status of water use in Fukuoka Metropolitan Area

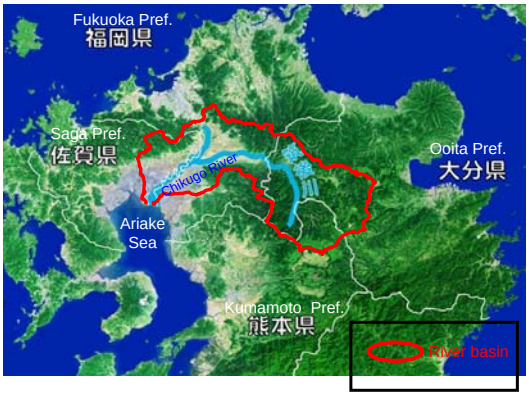
Regarding the water sources for the Fukuoka Metropolitan Area whose population is approx. 2.4 million, about 60% is secured from its own sources including existing dams, and about 10% is secured from the groundwater. However, the rest has to be obtained from the Chikugo River, which is located outside the area. About 30% is transmitted from the Chikugo River through the Egawa Dam, the Terauchi Dam, the Chikugo Weir, the Gousho Dam, the Fukuoka Water Transmission etc.







Brief overview of Chikugo River basin



The Chikugo River is the biggest first-class river in Kyushu, whose channel is 143km long and basin area is 2,860km^2.

The basin area extends across 4 prefectures (Kumamoto, Ooita, Fukuoka and Saga), and there is a rich natural environment along the river. The Chikugo River and the surrounding mountains, blending with each other, create a beautiful green landscape, and the downriver basin presents a unique brackish environment. The special beauty of the river landscape also plays a role as a tourism resource.
Moreover, the Chikugo River is an important water source for the economic growth in North Kyushu.

Hot-spring resort in Suikyo Hita

Waterside open space

Rich natural environment

Use of water in the Chikugo River (irrigation and city water)

【Irrigation】

Water in the Chikugo River is used for irrigation about 53,000ha in area, for the largest-scale agricultural production in Kyushu.

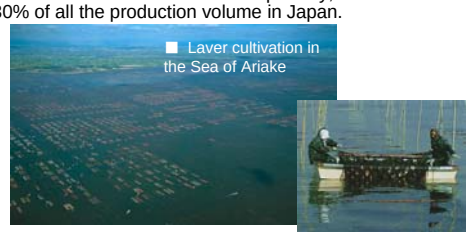
【City Water】

Water in the Chikugo River is currently supplied as daily life water in a large area, for a total of about 3.4million people living in the river basin and the Fukuoka Metropolitan Area.

Use of water in the Chikugo River (fisheries)

The Chikugo River has a rich natural environment and fisheries is a major industry in the area. Ayu (sweetfish) fishing is done in the upper- and mid-stream area and etsu (anchovy) fishing is actively done in the downstream brackish area after the Chikugo Weir. The Sea of Ariake, with the biggest tidal variation in Japan, is famous for various fishery products and laver cultivation. Especially, the laver production in the area accounts for as much as 30% of all the production volume in Japan.

Small fishing boats pulling in a net on the river is a common sight of the Chikugo River from May to July.



In winter ,the Sea of Ariake becomes a vast laver farm with laver supports regularly installed.

Every year many people visit the Chikugo River in June when the ayu season opens.

■Various creatures in the Sea of Ariake

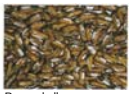
Goggle-eyed goby (overall length: 13cm) Specialty of the Sea of Ariake. Crawls around the tideland and goby) eats Bacillariophyceaes on the mud surface, shaking its head from side to side. Tasty when broiled or dried.

Tridentiger obscurus (overall length: 10cm) Called "tobihaze (jumping goby)" because it "jumps" on the water when the tide comes in. Often crawls up to the surface at full tide.

Calling crab (shell: 3.5cm) Living in a hole dug into a mud flat where the salt content is rather low. One of the two pairs of forceps of male calling crabs is much larger than the other. "Ganzuke", a specialty of Saga, is made of fermented calling crabs.

Odontamblyopus lacepedii (overall length: 30cm) Specialty of the Sea of Ariake. With rudimentary eyes, living in a hole dug into a tideland. Tasty when used for miso soup or dried.

Red tongue sole (overall length: 30cm) Also called "kutsuzoko (shoe sole)" as it looks like a shoe sole. Tasty for meuniere or when deep fried.



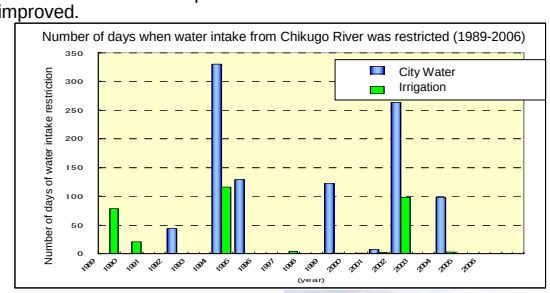
Razor-shell (overall length: 9cm) Living in a hole vertically dug into a tideland. Can be picked with a curved end of wire. Tasty when sauteed with butter or for soup.

Barnea (Umitakea) dilatata (overall length: 8cm) Living in soft mud. Can be caught from a boat by entangling its aqueduct with a cross-shaped end of a long stick. Dried or pickled in sake lees.

Green lingual (overall length: 4cm) Called "mekaia" in the region. Living in sandy mud at the bottom of sea. Also called a living fossil. Used for miso soup and other cooked dishes.

Chronic water shortage (drought status)

There is chronic water shortage around the Chikugo River as the flow condition becomes worse due to the recent dry weathers. Water intake from the river for city water and irrigation is restricted roughly every two years. Especially in summer, water shortage frequently occurs because of river flow depletion. The flow condition needs to be improved.




Depletion of the Terauchi dam reservoir (1994)

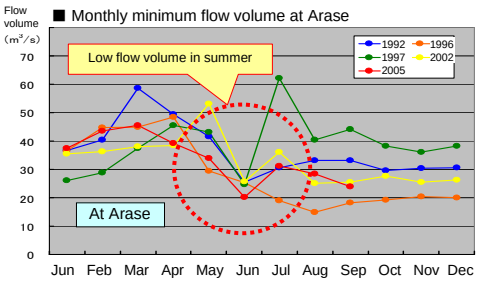

June 28, 2005(at the Ooishi Weir)

【The Mainichi Newspapers June 28, 2005】

River water volume becomes low in summer.

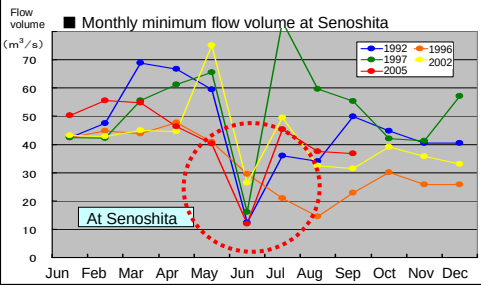
● Recently, there has often been little rain in the irrigation season when river water for agriculture is taken. In such years, the flow volume became extremely low.

■ Monthly minimum flow volume at Arase

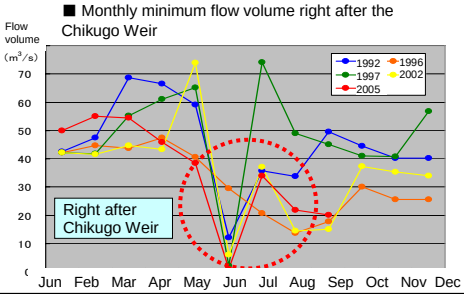


■ Locations of observation points

■ Monthly minimum flow volume at Senoshita



■ Monthly minimum flow volume right after the Chikugo Weir

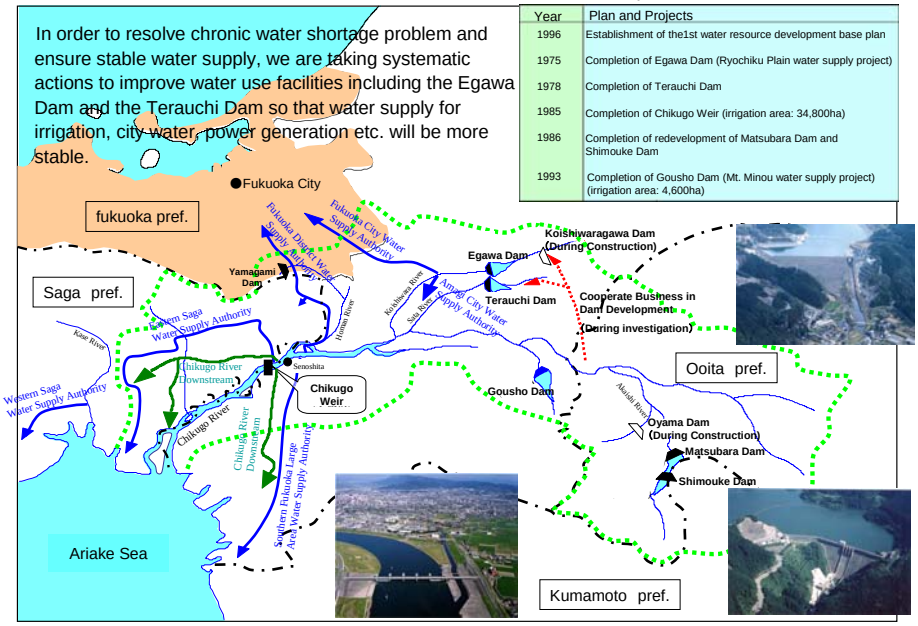


To ensure stable water supply

■Recent major actions for water utilization

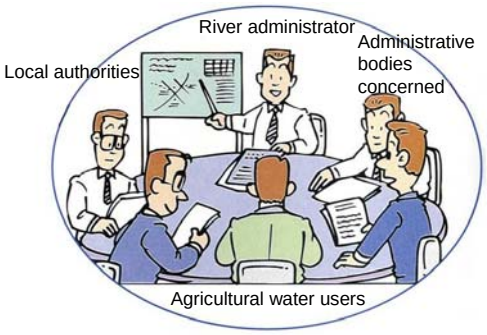
Year	Plan and Projects
1996	Establishment of the1st water resource development base plan
1975	Completion of Egawa Dam (Ryochiku Plain water supply project)
1978	Completion of Terauchi Dam
1985	Completion of Chikugo Weir (irrigation area: 34,800ha)
1986	Completion of redevelopment of Matsubara Dam and Shimouke Dam
1993	Completion of Gousho Dam (Mt. Minou water supply project) (irrigation area: 4,600ha)

In order to resolve chronic water shortage problem and ensure stable water supply, we are taking systematic actions to improve water use facilities including the Egawa Dam and the Terauchi Dam so that water supply for irrigation, city water, power generation etc. will be more stable.



Water management in the future

We will give priority to healthy water circulation and take actions to improve the environment along the Chikugo River. We will also conduct proper water management by paying attention not to affect vested water rights in the downstream side or fisheries and by maintaining the appropriate river flow through use of the existing dams, etc. Thus we will make efforts to contribute to the conservation of the environment in the Sea of Ariake.



【Water management in the future】

- Improve water facilities in a planned way and effectively utilize the existing dams.
- Effectively utilize water resources by keeping track of such data as river flow and intake volume and by proper dam management.
- Coordinate water use in cooperation with bodies concerned and create opportunities for discussion among water users and other partied concerned including fishermen and farmers.
- Coordinate water intake restrictions at the time of a drought, conduct overall management of water resources development facilities and make other arrangements.

INTEGRATED WATER RESOURCE MANAGEMENT ADAPTING TO THE GLOBAL CLIMATE CHANGE IN INDIA

Presented by

M. DHINADHAYALAN
ASSISTANT ADVISER (PHE)

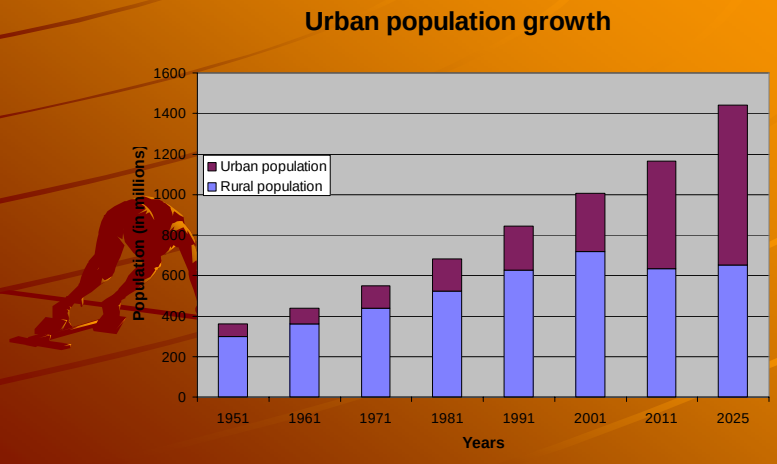
Central Public Health & Environmental Engineering Organization (CPHEEO), Ministry of Urban Development Government of India New Delhi

INTEGRATED WATER RESOURCE MANAGEMENT ADAPTING TO THE GLOBAL CLIMATE CHANGE IN INDIA

Population and Urbanization in India

- The total population of India was 1027 million as per 2001 census
- The urban population was about 285 million (27.8%), living in 5161 towns
- Population growth rate is about 3.1% per year
- The total land area is 3.29 Million sq. km
- India Accounts for about 4.5% of the World's fresh water resources and 16% of the World's Population.

Massive growth in urban population as India enters its "urban transition"



Literacy rate	-	64.84%
Life expectancy	-	64.35
Average per capita income	-	US $ 3,300

Climate

India experiences 3 main seasons

- Winter – December to March
- Summer – April to May
- Monsoon – June to November

Rainfall

- Most of the rainfall is from June to September
- Levels of precipitation vary from 100 mm a year to 9,000 mm a year (north-eastern state of Meghalaya).
- The average rainfall over the plain areas is about 1000 mm

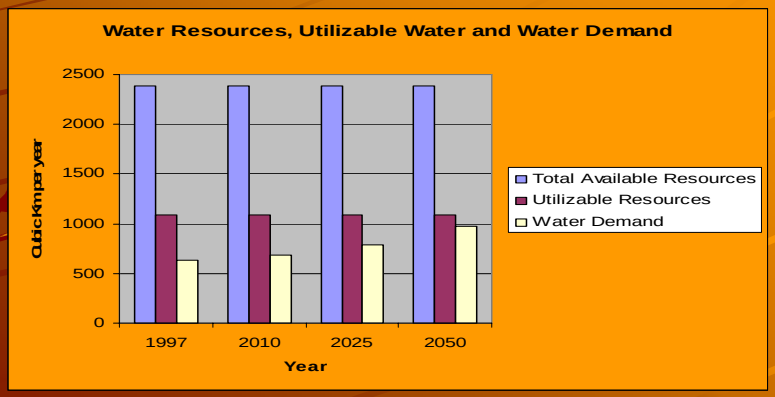
Water Availability and Demand in India

- India receive an average annual rainfall equivalent of about 4,000 billion cubic metres (BCM).
- With 3,000 BCM of rainfall concentrated over the four monsoon months, India's rivers carry 90 percent of water during the period from June-November.
- Thus, only 10 per cent of the river flow is available during the other eight months.

- The total water requirement of the country:
  - 694 BCM in the year 2010,
  - 973 BCM in the year 2050.
- Wide regional disparities in water availability exist.

India has enough utilizable water resources to meet this demand, but much of this is not effectively available

While total utilizable water covers growing demand, additional storage capacity is required to turn this into an effectively available source



Provision of Water Supply & Sanitation Facilities

- Urban Areas
  Water supply coverage -93%
  Sanitation Coverage - 63%
- Rural – 72% population take their drinking water from protected areas.
- The water supply is by and large intermittent (supply hours ranging from 3 hours to 10 hours)

National Water Policy, 2002

- The policy accords top priority to drinking water supply, followed by irrigation, hydropower, navigation and industrial and other uses.
- The policy also addresses issues such as planning of water resource development projects, maximizing water availability, water pricing, water quality, water zoning for proper management of resources and other issues.

IMPACT OF CLIMATE CHANGE ON WATER RESOURCES

- The most significant impact of climate change is expected in respect of availability of water. There are several regions that are already afflicted by water stress.
- Situation could worsen substantially due to changes in precipitation patterns, increasing salinity of ground-water due to increase in sea level and melting of glaciers.
- The IPCC estimates that in South Asia alone perhaps 500 million people would be affected by reduced river flows in the northern part of the subcontinent and about 250 million to China.

IMPACT IN INDIA

Availability of water in the river is expected to decrease

A rise in water level could inundate and erode coastal areas, increase flooding and salt water intrusion

Increase in temperature and seasonal variation in precipitation result rapid recession of Himalayan Glaciars

The Gangotri Glacier is already retreating at a rate of 30m per year

Flood Management

- Floods are the result of the peculiar rainfall pattern.
- The Ganga - Brahmaputra basin, which carries 60 percent of the total river flow in India, is most susceptible to floods.
- Every year, an average of 19 million hectares of land becomes flooded.

Flood Management

- The yearly average loss of life is reported to be 2590
- In order to mitigate the damage from flood, Structural schemes viz., reservoir construction, canal improvement, embankment construction etc are undertaken
- 173 flood forecasting & warning stations have been established in the different parts of the country.

INDIA'S INITIATIVES ON CLIMATE CHANGE

India has undertaken response measures that are contributing to the objective of the united nations frame work convention on climate change

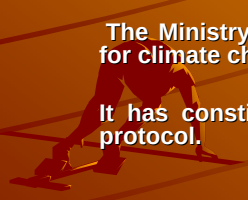
India signed the UNFCCC on 10 June 1992 and ratified it on 1 November 1993.

INDIA'S INITIATIVES

Under the UNFCCC, India do not have binding GHG mitigation commitments in recognition of their small contribution to the greenhouse problem as well as low financial and technical capacities.

The Ministry of Environment and Forests is the nodal agency for climate change issues in India.

It has constituted working groups on the UNFCC and kyoto protocol.



CONCLUSION

- There is going to be a very serious pressure on resources and problem of environmental degradation as the consequent large-scale transformation of the hydrological cycle.
- Reliable, timely and adequate water supply has to be provided for drinking and modernizing the agricultural activities.
- Rapid advances in all spheres have to take place, management of water being a prominent one.
- In India the planning process is guided by the principles of sustainable management

THANKS

16th Conference on Public Works Research and Development in Asia

Water Resources Management As a Response to Climate Change

Korea Institute of Construction Technology
Director of Policy Research
Seok-yeong Yoon

16th conference on PWRD

Contents

1. 1 Causes of Climate Change

❖ **Natural cause**: Changes in solar energy, changes in earth's orbit of revolution, volcanic activities, topographic activities and natural volatility of the climate system

❖ **Artificial cause**: Greenhouse gas, aerosol, weakened ozone, destruction of forests and changes in environment

1. 1 Causes of Climate Change

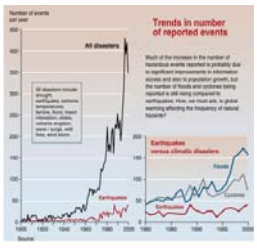
Contents

1. 1 Causes of Climate Change

Contents

❖ **Boiled frog syndrome**

- **Change does not occur overnight. It is rather gradual.**
- **The future of humanity can change according to the depth of understanding climate change and how fast the change is responded.**

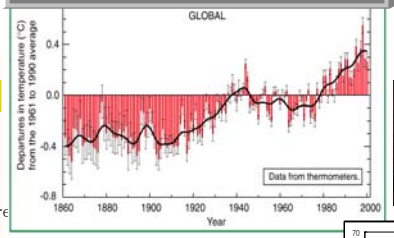


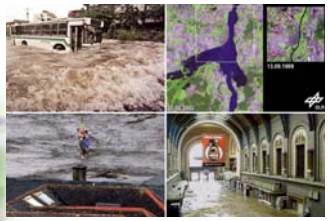
1. 2 Abnormal Climate Caused by Climate Changes

16th conference on PWRD

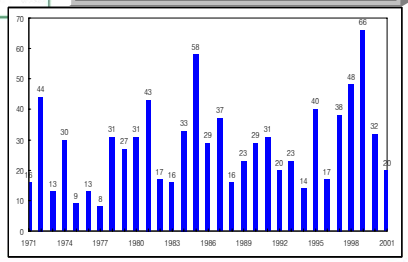
Contents

Temperature rise throughout the earth





Number of rainfalls over 100mm



1.2 Climate Change – A Global Issue

16th conference on PWRD

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War on Co_2

Lower carbon dioxide emission rates through development of new technologies

VS

Cut carbon dioxide 20% by 2020

1.2 Climate Change – A Global Issue

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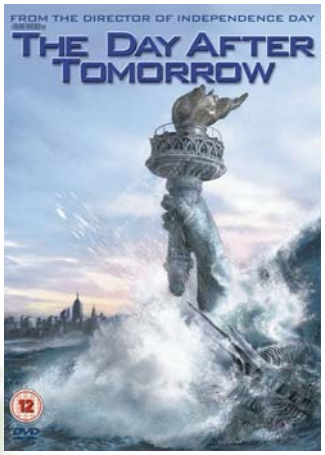

1.3 Climate Change in South Korea

Contents

- Global climate change is happening as proven by the indicators such as global warming and el nino.
- Climate change is not a controversial issue in South Korea anymore.
- Countries that are part of Kyoto Protocol must reduce greenhouse gas by 5.2% from that of 1990 in 4 years between 2008 and 2012.
- South Korea was recognized as a developing country in 1992 when UN Framework Convention on Climate Change was established therefore is not required to reduce greenhouse gas. However, South Korea is being strongly pressured for greenhouse gas reduction as it has joined OECD in 1996 and is ranked 9th in global carbon dioxide emission and 10th in global energy consumption.
- Climate change is increasing uncertainties associated with water resources plan for stable water supply and also imposing difficulties for preparing appropriate measure for severe natural disasters such as flood and drought.
- With small land and overpopulation, intensity of land and water resources in South Korea is much greater than other countries. Small changes in climate have potential to present significant water resources problem.
- Effect of climate change should no longer be ignored as it has been until now for the lack of scientific basis. It is an urgent subject that must be dealt with by establishing national water resources plan and water resources practice.

2. 1 Impacts of Climate Changes

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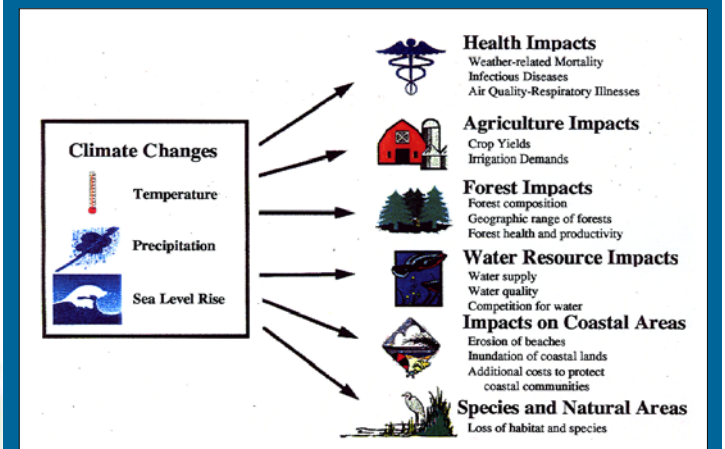
Impacts of Climate Changes



Water Resources Management As a Response to Climate Change

2. 1 Impacts of Climate Changes

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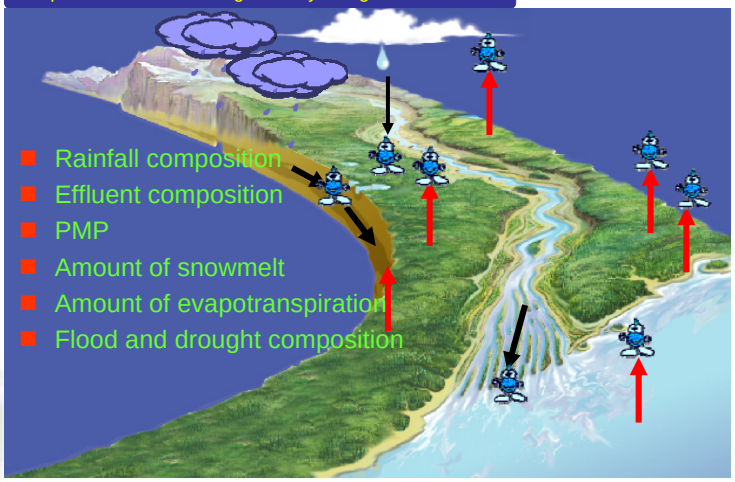
2. Impacts of Climate Changes
3. Studies on Climate Changes in South Korea
4. Response to Climate Changes
5. Conclusion

Impacts of Climate Changes on Hydrological Circulation



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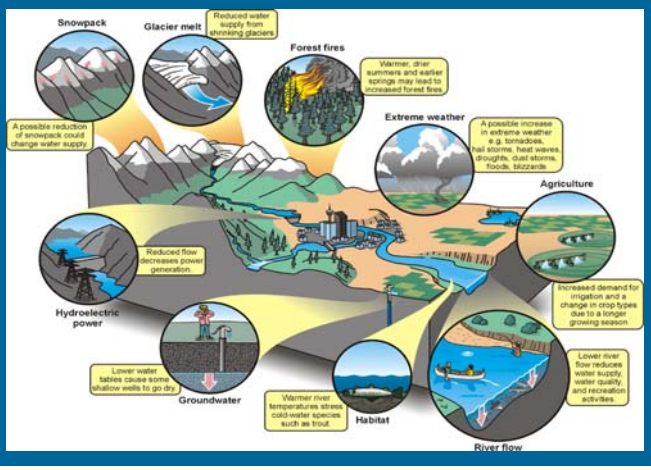
Impacts of Climate Changes on Water Resources



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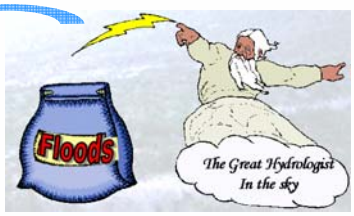

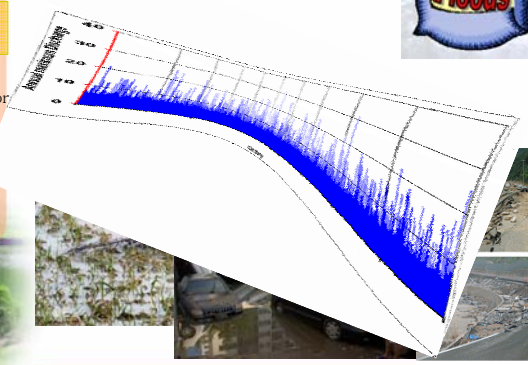

Flood in Gangwondo - 2006

2. 2 Damages Caused by Abnormal Floods in South Korea

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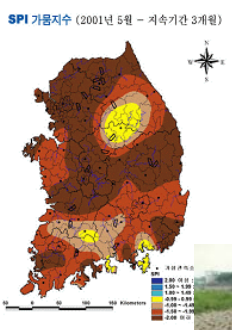
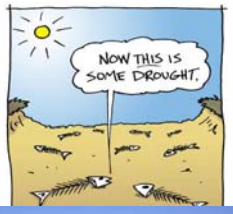
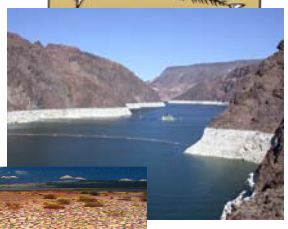
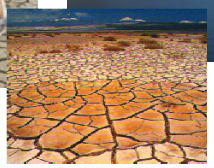


Drought distribution in 2001







2. 3 Abnormal Weather in Korean Peninsula Caused by Climate Change

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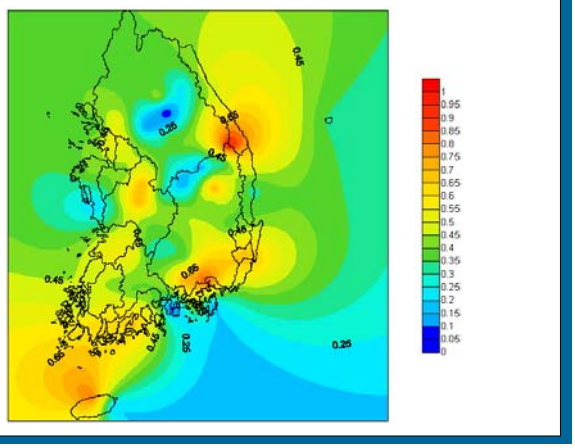
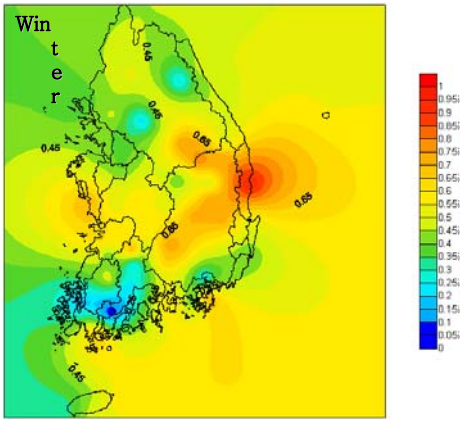
(Heavy Rainfall) - Summer



2. 3 Abnormal Weather in Korean Peninsula Caused by Climate Change

Hot-day



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3. 1 Studies on Climate Changes in South Korea

- **Studies on and impact evaluation of climate changes on water resources severely lack in quantitative terms compared to studies on hydrological factors.**
  - **Symposium on Impacts of Climate Changes on Korean Peninsula (Korea Institute of Science and Technology, 1994)**
  - **Study I, II, III on Impact Evaluation of Climate Changes and Digital Image Processing Technology (Ministry of Science and Technology, 1993, 1994b, 1995b)**
  - **Study on Asian Summer Monsoon between El Nino in 1987 and La Nina in 1988 using METRI / YONU GCM (Yonsei University,1999)**
  - **Forecasting on Changes in Drought and Flood Frequency in Korean Peninsula Caused by Global Environmental Changes (1998 IHP Report, Korea University)**
  - **Impact Evaluation of Water Resources Plan following Climate Changes (Korea Institute of Construction Technology, 2000)**
  - **Analysis Technique for Volatility of Water Circulation Structure Caused by Climate Changes (Korea Institute of Construction Technology, 2004)**
  - **Evaluation System for Impacts of Climate Changes on Water Resources (Ministry of Science and Technology, in progress)**

Unfortunately, there are no water resources plans or policies that reflect climate changes until today!

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Analysis Technique for Volatility of Water Circulation Structure Caused by Climate Changes (2004)

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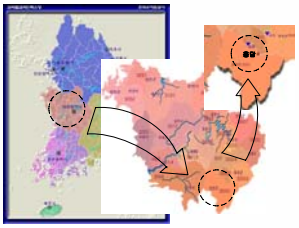

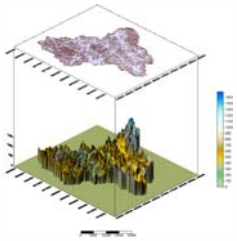

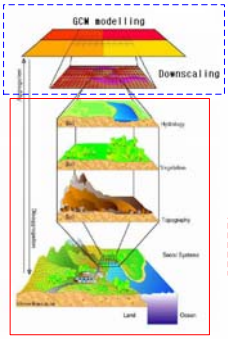

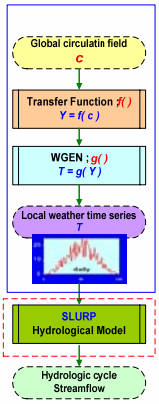

Analysis Technique for Volatility of Water Circulation Structure Caused by Climate Changes (2004)

Analysis on Volatility of Water Circulation Structure Caused by Climate Changes

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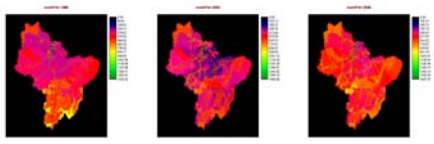
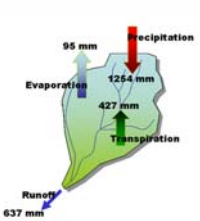
Contents

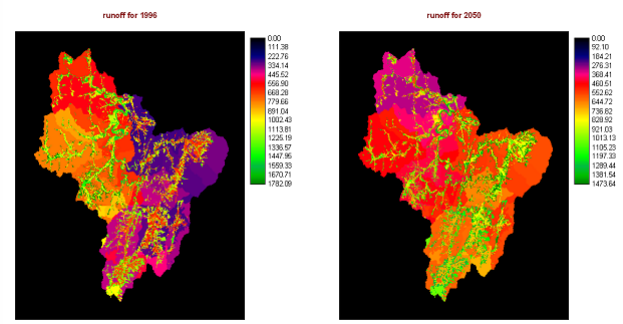
- *temperature*
- *precipitation*
- *storms*
- *evaporation*
- *soil moisture*
- *runoff*
- *floods*
- *snow cover*
- *glacier melting*





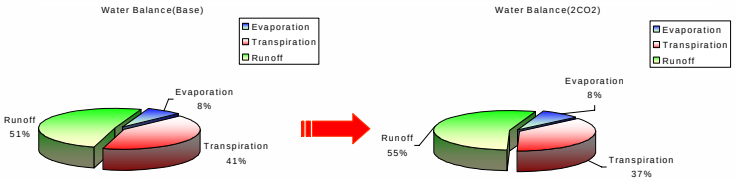
Analysis Technique for Volatility of Water Circulation Structure Caused by Climate Changes (2004)

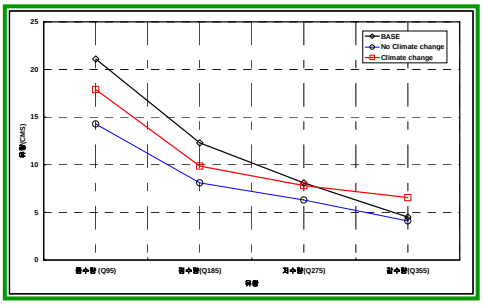
Distributional Change of Effluent Amounts in Basins



1996 2050

Analysis Technique for Volatility of Water Circulation Structure Caused by Climate Changes (2004)





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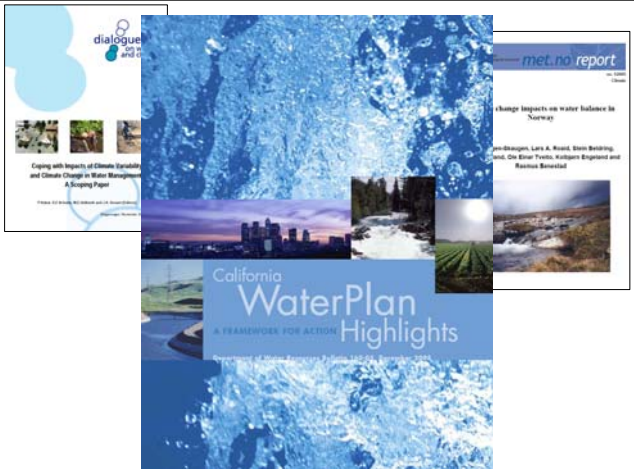
International Water Resources Reports that Reflect Climate Changes



4.1 Response to Climate Changes

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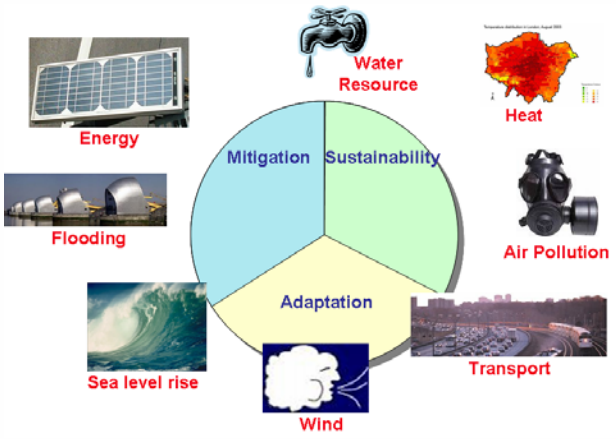

4.2 Importance of Response to Impacts of Climate Changes on Water Resou

Contents

- **Due to small land and overpopulation, intensity of land and water resources use in South Korea is much higher than that of other countries. Even a small climate change such as global warming can impose a serious problem to the water resources..**
- **Statistical characteristics of climate are constantly change due to climate change. Frequency analysis using past data is not a valid mean for establishing water resources plan today.**
- **Past records of climate and hydrological phenomena are no longer a valid guideline for the future. Both structural and non-structural design of water resources system must consider potential impacts of climate changes (1991, World Climate Conference).**
- **We strongly advise persons involved with water resources management to reform water demand management and system to effectively respond to uncertainties of climate changes and to systematically review the following aspects of water resources system: Design scope, operation rule, emergency plan and water distribution policy (1996, IPCC).**

4.3 Response to Climatic Impacts on Water Resources

Study on Design Standard Enhancement for Abnormal Climate (2005-2010)

4.3 Response to Climatic Impacts on Water Resources

Study on National Water Resources Security for Climate Changes (2007-2009)

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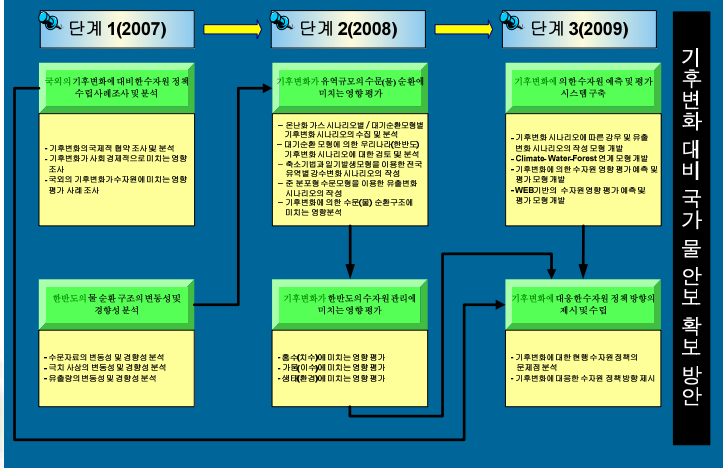

Study on National Water Resources Security for Climate Changes (2007-2009)

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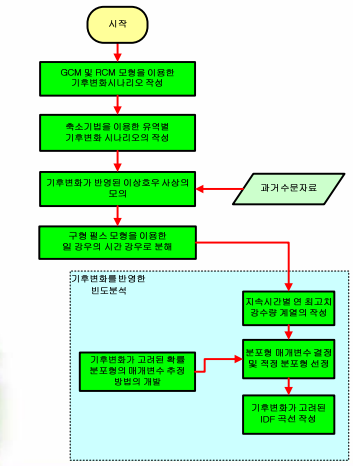
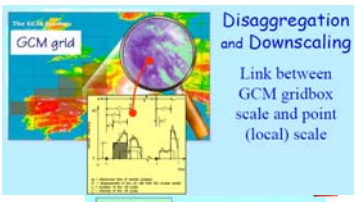
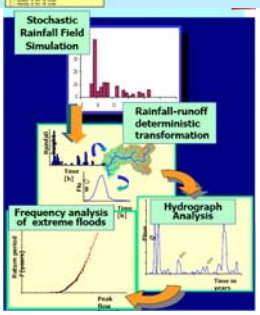
Climatic Impacts on Flood (Flood Control)







Study on National Water Resources Security for Climate Changes (2007-2009)

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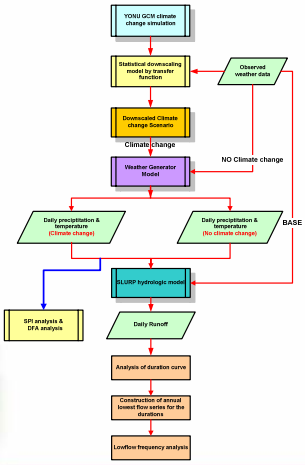
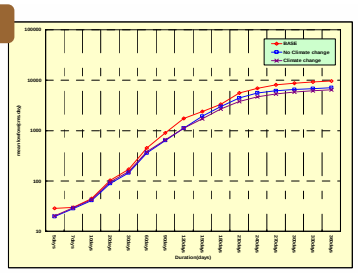
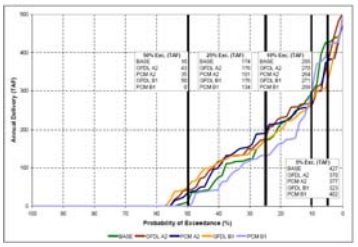
Climatic Impacts on Flood (Irrigation)







5. Conclusion

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(1) Nationwide flood control plan based on national capacity evaluation of flood defense in regard to abnormal flood caused by climate changes

- Evaluate flood defense capacity of existing facilities related to levees, dams, rivers and floods

(2) Selective flood control and IWRM designed for each individual basin

- Establish flood defense strategy and comprehensive basin irrigation plan that considers natural features; retention in upper stream, restraint in middle stream and drainage in lower stream

(3) Improvement of current flood forecasting system (flood forecasting system of a new paradigm)

- System that includes flood forecasting for tributaries
- Forecasting system for unexpected floods
- Flood forecasting system for abnormal rainfall using precipitation radar

(4) Utilization of meteorological techniques for basin control

- Establish three-dimensional weather monitoring system and real-time forecasting system of precipitations in basins that integrates IT

5. Conclusion

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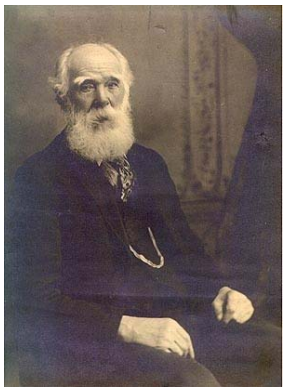
(5) Suggestions for reforming water management system suitable for climate changes

- Consider flexible dam operation that accounts uncertainties of weather conditions caused by climate changes
- Review variable restricted water level of dam during flood seasons and overall flood control system
- Consider changing the system into the one that can secure water storage throughout the year and can effectively distribute the stored water when necessary

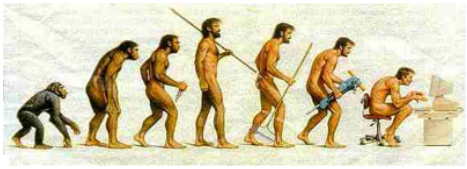
(6) Establishment of evaluation system for climatic impacts on water resources

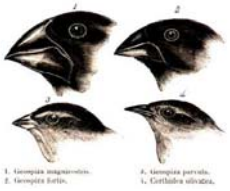
- Establish system where climate change scenarios written from water resources perspective can be used in creating and analyzing runoff scenarios



"It is not the strongest of the species that survive, nor the most intelligent, but the one most responsive to change!"

- Charles Darwin -





Q & A

Directions for Water Resources Management for Coping with Climate Change

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[2] Senior Researcher, Water Resources Research Dept., Korea Institute of Construction Technology, 2311, Daehwa-Dong, Ilsan-Gu, Goyang-Si, Gyeonggi-Do, Korea

1. Introduction

Lab researchers in an American university put a frog into a beaker. The beaker was then heated by an alcohol lamp. The goal of the experiment was to observe the frog's reaction. Because the upper part of the beaker was open, the frog had ample opportunity to escape. The frog, however, was boiled. It was too late when the frog realized the situation. This is so-called "Boiled frog syndrome." Changes are gradual; they do not suddenly arrive at a gigantic scale. Most changes are imperceptible and gradual. "Boiled frog syndrome" occurs when progression of change is not perceived. Responding to climate change necessitates enhanced ability to perceive change. Prompt understanding and responses to climate change are necessary to prevent victimization of human race.

The existence of climate change is no longer disputed. In particular, the field of water resources has been directly affected by climate change. Since the 1990s, frequent floods and droughts in succession have jeopardized water resources management. In particular, Korea's small land area and excessive population necessitate intensive use of land and resources to a greater extent than other countries. As a result, water resources management in Korea is potentially vulnerable to slight climate change caused by global warming. Therefore, lack of sufficient scientific evidence about climate change can be no longer an excuse to ignore or delay revision of national water resources policies, which is urgently need. It is because it may take more than 20 years, which is long enough to aggravate climate situation, from the establishment to actual implementation of water resources policies.

In the 20th century, fossil fuels such as oil were the most important resources. International organizations warn that water may cause international disputes in the 20th century. In particular, Korea, which is classified as a "water stress country," water issue is a crucial problem that has to be solved for enhancing quality of life and maintaining international competitiveness in the 20th century. Threats involving water include drought or localized water shortage, flood, and water pollution. In addition, research on social and economic impact of water issues and provision of legal and institutional framework are necessary for effective management of water. Recently, climate change began to greatly affect hydrological phenomena and made it more difficult for hydraulics engineers to accurately grasp processes of water circulation. Furthermore, climate change has increased uncertainty in the establishment of water resources plans for stable provision of water and extreme natural disasters such as floods and floods have caused greater difficulties in preparing for countermeasures. To cope with climate change, quantitative assessment of changes in water resources should be carried out and apply the findings to national water resources policies.

This paper has carried out comprehensive a review of climate change and its impacts on water resources management. Then, strategies for coping with climate change are proposed. Finally, analyses and discussions for sustainable development are made.

2. Impacts of climate change on hydrological circulation and water resources

Impacts of climate change on water resources and water resources management are direct and

fundamental. Development and management of water resources tended to take precedence over efforts to find solutions to climate change. Furthermore, hydrology has developed by focusing on precipitation and seasonal and annual changes in the quantity of flow. Responding to issues involving floods and droughts is the most important responsibility of world's organizations in charge of water. The capacity to deal with climate change and its unpredictability is the decisive factor that determines effective use of water.

It is important to note that even minute climate change can lead to large-scale changes as it undergoes hydrological circulation. This observation is very important for managers of water resources. Table 1 below shows trends in water drought in West Africa in the 1970s and 1980s (Servat et al., 1999). As can be seen in the table, about 25% decrease in precipitation during the period caused about 50% decrease in annual quantity of flow. This means that small temporary changes in precipitation can lead to large-scale changes in water resources.

Table 1 Decreased precipitation in West and Central African countries and reduction of water quantity in rivers (Servat et al., 1998).

Country	Reduction in Precipitation (%)
Cameroon	16
Togo	16
Central African Rep.	17
Benin	19
Ghana	19
Nigeria	19
Guinea	20
Chad	20
Ivory Coast	21
Burkina Faso	22
Guinea Bissau	22
Mali	23
Senegal	25

River	Gauging Station	Reduction of Annual Flow (%)
Comoe	Aniassue	50
Chari	Ndajmena	51
Logone	Lai	39
Niger	Malanville	43
Niger	Niamey	34
Bani	Douna	70
Oueme	Sagon	42
Sassandra	Semien	36
Senegal	Bakel	50
Bakoye	Ouali	66
Black Volta	Dapola	41
Black Volta	Boromo	46
Oubangui	Bangui	30

Table 2. Climate change (a summary) and its impacts on water resources (IPCC, 2001)

Climate change forecast	Climatic change already observed?	To occur in the 21st century?	Effects on water resources
Higher maximum temperatures and more hot days over nearly all land areas	Likely	Very likely	Water resources reduced
Higher minimum temperatures, fewer cold days and frost days, over near all land areas	Very likely	Very likely	Water resources reduced
Diurnal temperature range reduced over most land areas	Very likely	Very likely	
Increase of heat index over land areas	Likely over many areas	Very likely over most areas	Water resources reduced
More intense precipitation events	Likely over many northern hemisphere mid-to-high latitude areas	Very likely over many areas	More frequent and more severe floods
Increased summer continental drying and associated risk of drought	Likely in a few areas	Likely over most mid-latitude continental interiors	More frequent and more severe droughts
Increases in tropical cyclone peak wind intensities	Not observed in the few analyses available	Likely over some areas	More frequent and more severe storm-surge floods
Increases in tropical cyclone mean and peak precipitation intensities	Insufficient data	Likely over some areas	More frequent and more severe floods

Natural disasters caused by climate change are drastically increasing every year. Globally, increased intensity and frequency of floods and droughts and seasonal drying up of rivers caused by global warming have emerged as serious issues. Climate change affects the process of hydrological circulation and this causes changes in water resources. According to a study, average annual precipitation increased by about 7% in a drainage area in Korea under the influence of climate change. Because of decreased duration of dry and wet days, precipitation and frequency of extreme precipitation events have increased. Furthermore, it was found that quantity of water flow increased in winter and autumn although the annual average decreased (Kim Byeong-sik et al., 2004).

Temperature and precipitation are the most important hydrological elements that affect quantity of water flow. The factors can cause vulnerabilities in some aspects of water resources: change in the ecological system of drainage area, changes in capacity to produce electricity, water supply, water quality, flood, and drought. The following figure shows changes in hydrological circulation caused by climate change in a drainage area and their impacts on water resources. It should be noted that date may be different depending upon drainage area because hydrological circulation in specific drainage area reflects local characteristics.

Korea, which is characterized by wide variability in precipitation and high population density, is extremely vulnerable to floods and droughts that are expected to increase under climate change. Increased precipitation under climate change greatly affects large scale facilities such as dams. Because collapse of dams can cause tremendous damage to drainage area, Probable Maximum Precipitation is taken into consideration when dams are designed. Probable Maximum Precipitation is determined by the amount of moisture in the atmosphere and the dew point. In general, 1℃ increase in temperature leads to about 10% increase on Probable Maximum Precipitation. If climate change causes 1-2℃ increase in temperature, more than 10% increase in Probable Maximum Precipitation is very likely.

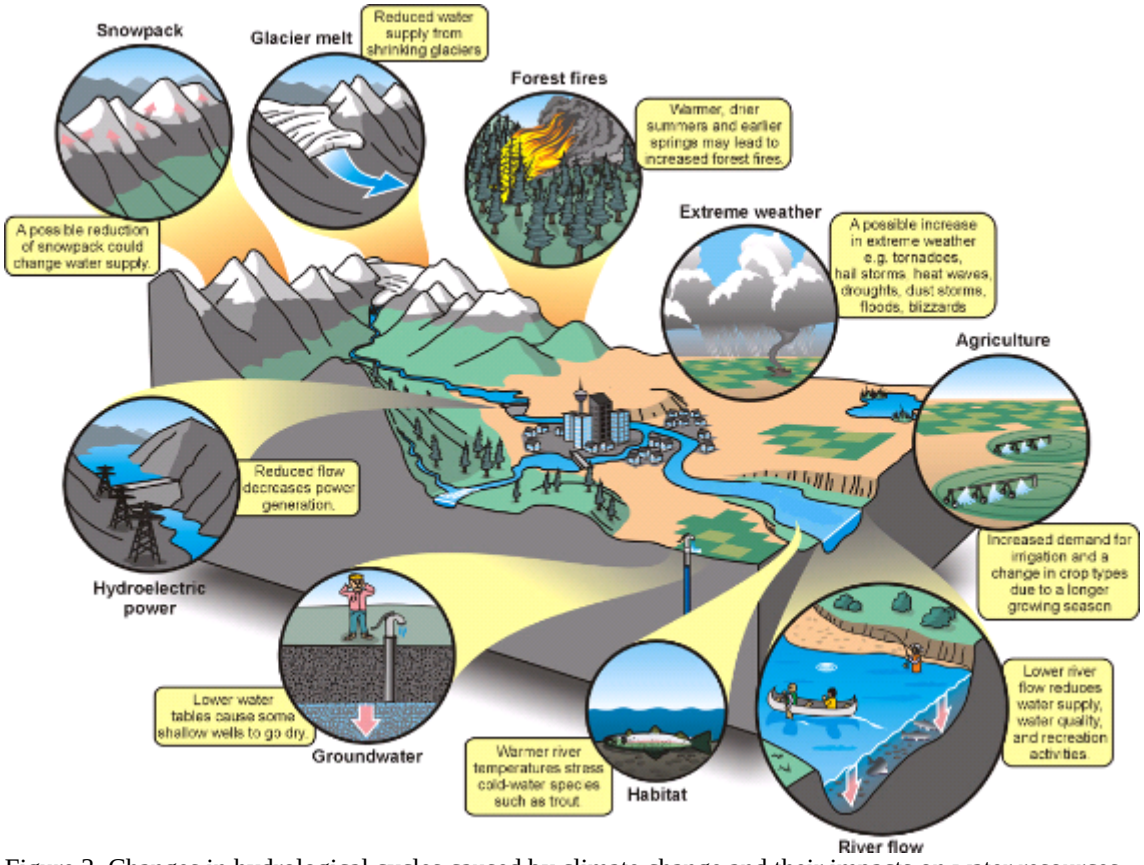


Figure 3. Changes in hydrological cycles caused by climate change and their impacts on water resources

Climate change not only affects quantities of elements of hydrological circulation but also temporal and spatial characteristics of each hydrological element. For instance, the increase of the minimum temperature in winter alters snowfall and snow melting period and may cause drought in spring. Furthermore, many studies predict that the amount and timing of water flow will be changed under the impact of climate change. This will maker planning and management of water resources difficult as they are greatly influenced by temporal and spatial changes in the amount of water flow. Climate change can induce great spill-over effects on the demand for public and industrial water. Changes in the amount of precipitation and evapotranspiration will affect amount of irrigation water and return flow. For stable supply of water resources, efficient long-term planning of water resources is necessary. However, severe changes in water reserves and demands caused by climate change will increase uncertainty in securing water resources.

2.1 Impacts on droughts

Climate change greatly affects human activities. Increased occurrence of droughts is a form of climate change that emerged as a serious threat. Although the danger of droughts cannot be easily recognized, it is true that damage from droughts is occurring. In the case Korea, people are becoming more aware of the crisis caused by droughts and diverse researches on droughts are being carried out. Until now, researches on climate change in Korea have been carried out in diverse fields including water resources, weather, ecology, and environmental aspects. In particular, water utilization studies have been carried out in the field of water resources.

Since the 1960s, droughts in Korea have occurred in five to seven-year cycles. Major droughts in Korea during the period include a nationwide drought in 1968 that centered on Jeolla and Gyeongsang provinces; droughts in 1977, 1982, and 1988; and a drought in 1994 in the central and southern regions. Since the 1990s, small and large-scale droughts depending on the region are occurring every year. In the

spring drought of 2001, from March 1 to June 16, lowest level of precipitation was observed in 58 observatories, which is more than 80% of 72 observatories operated by the Meteorological Administration. In some observing points, spring drought was so extreme that frequency of precipitation during the three months from March to May amounted to 50-60 years. Considering that average precipitation at multipurpose dams in 2001 was 919mm, the level was similar to drought condition in 1994. During the period, shortage of water made it necessary to designate emergency water supply areas in 381 eup and myeon administrative units affecting about 300 thousand people. Farmland areas damaged by the drought totaled about 19,000 ha. It is difficult to say that climate change is solely responsible for the decrease in the amount of precipitation and rainfall days. However, the portion of climate change in causing drought is viewed as considerable. It is important to recognize that concentration of population caused by urbanization and industrialization and increase in the amount of direct runoff are also important factors that contribute to the occurrence of droughts.

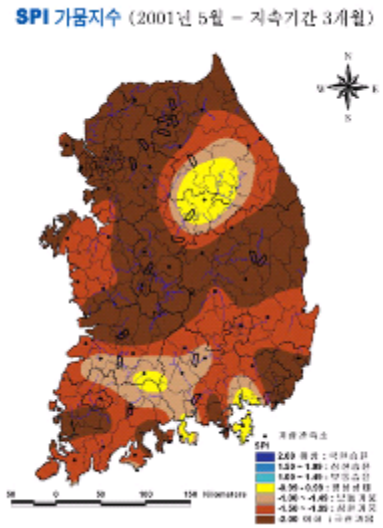
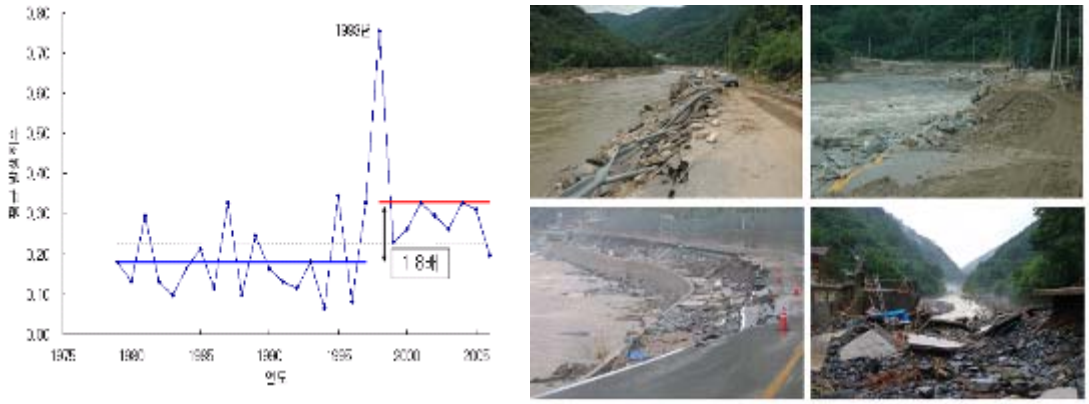


Figure 4. Distribution of drought events in Korea (2001)

2.2 Impacts on torrential rains and floods

Recently, damages from typhoons, hurricanes, and heavy rains are rapidly increasing throughout the world. Since the late 1990s, serious casualties and property damage occurred in Korea: grand floods in 1998 and 1999, typhoon Rusa in 2002, typhoon Maemi in 2003, and torrential rains in 2006. In particular, property damage and restoration expenditures caused by typhoon Rusa and Maemi amounted to about KRW 26 trillion (Ministry of Government Administration and Home Affairs, 2003). In addition, astronomical amount of property damage and restoration expenditure were incurred by the largest rainfall in history that lasted for 46 days in June and July of 2006. A newspaper reported that the amount of damage was KRW 1.8 trillion and that restoration expenditure would reach KRW 3 trillion (Donga Ilbo, July 29, 2006). From sources, we are informed about frequent occurrence of abnormal flood in diverse parts of the world in this century. Such torrential rains and floods are probably not caused by climate change alone. However, it is true that climate change is causing changes in the characteristics of extreme precipitation events in the Korean Peninsula.

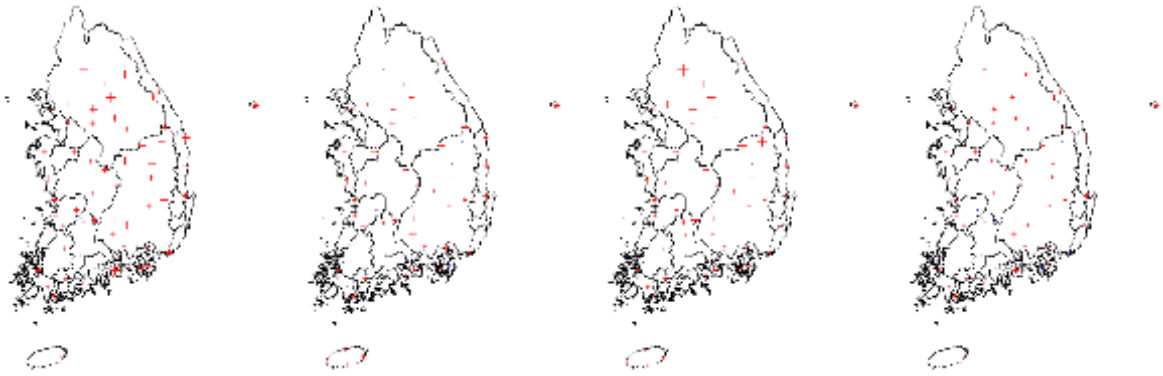


(a). Frequency of 100 mm precipitation events (b) Flood damage in Gangwon Province in photos (2006)

Figure 5. Flood Impacts on torrential rains and floods

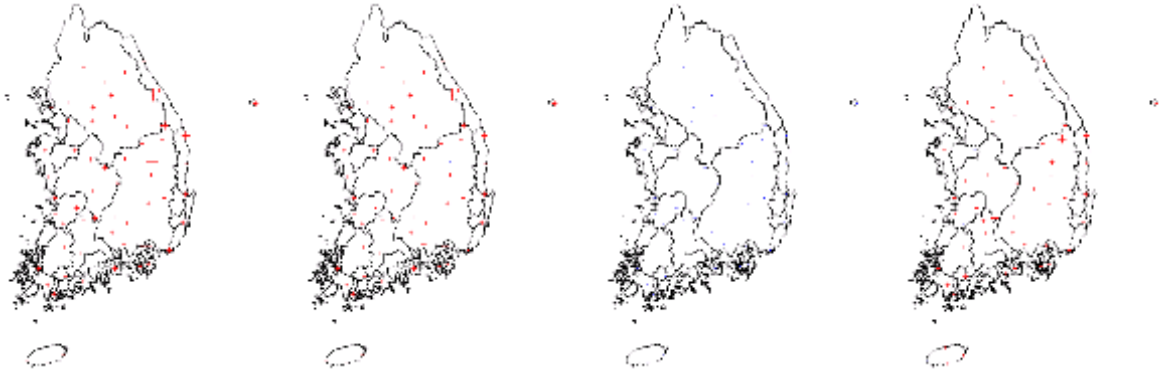
Figure 6 shows the results of an analysis of characteristics of extreme precipitation events recorded by 66 observatories run by Korea's Meteorological Administration. "+" represents an indicator's increasing trend from the past to the present. Larger size the sign means that the corresponding tendency is comparatively more pronounced. Sign "-" represents a decreasing trend. Increasing trends in summer rather than autumn included: (a) critical point of torrential rain, (b) maximum amount of precipitation during five-day period, (c) precipitation intensity in wet days, (e) percentage of torrential rains above the critical point, and (f) the number of occurrence days. It was found that (d) maximum duration of dry days were concentrated in autumn. In the past, precipitation was concentrated during summer because of monsoon, the seasonal rain front. However, from 1998 to 2004 excluding 2001, rainfall increased after the rainy season (Cha Eun-jeong, 2006). As a result, rainfalls occur without interruption in July and August. In the case of (a) the critical point of of torrential rains, the tendency increased in autumn (Sept.-Nov.) rather than in summer (June-August). This phenomenon was observed in Masan, Wando, Jeju-do, Seogwipo, and Taebaek. The administrative units are located in coastal areas rather than the interior. This phenomenon is caused by the size and path of typhoons that moves from Jeju-do to southern coast. In contrast, summer increase of critical point of torrential rain occurred in 55 locations (80%) in the central region of the interior including Cheolwon, Incheon, Seoul, Hongcheon, and Andong. In particular, the tendency in these locations either gradually decreased or were marked with "-" sign. (b) refers maximum amount of precipitation during five-day duration. The value of the indicator clearly increased in locations such as Cheolwon and Hongcheon where the critical point of torrential rains was high as well as in Bonghwa, Yeongju, and Mungyeong. In the case of (e) the rate of occurrence above the critical point of torrential rains, the rate of torrential rainfall occurrence increased in summer rather than autumn. Similar result was found for (f) number of days above the critical point of torrential rains. This means that as in the past rainfall is concentrated in summer in Korea. However, extreme precipitation events are occurring earlier. A long-term trend is that the amount of precipitation is increasing. At the same time, frequency of extreme precipitation events is increasing.

In general, it is in summer that Korea is influenced by precipitation. An analysis that focuses on extreme precipitation events reveals that unlike in the past when precipitation events during rainy season tended to be continuous and regular, today's rainfall tends to be localized, temporary, irregular, and more intensive. Such finding can support other researches: Im Gi-seok et al. (2002) found that torrential rainfall in Korea are characterized by localization and extreme spatial and temporal irregularity whereas Kim Byeong-sik et al. (2003) found that global climate change will cause more frequent torrential rainfall because precipitation intensity will increase in the Korean Peninsula and duration of wet and dry days will be shortened.



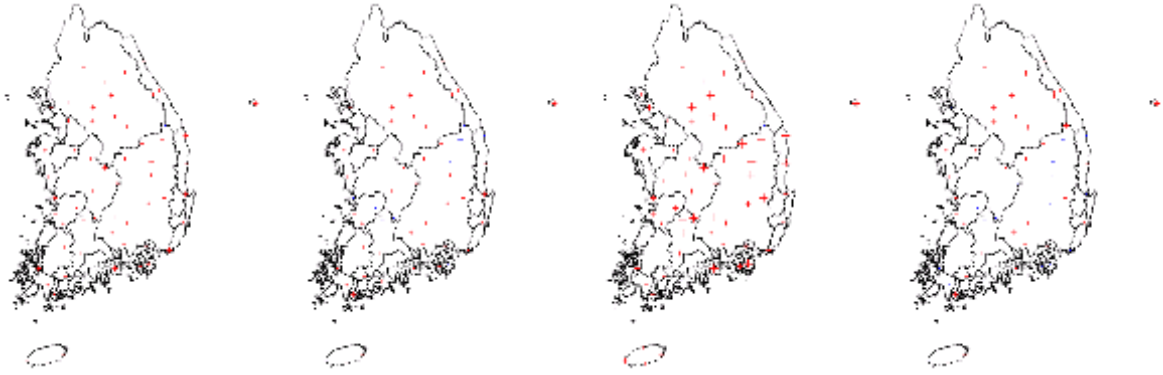
Summer (June-August) Autumn (Sept.-Nov.) Summer (June-August) Autumn (Sept.-Nov.)

(a) Critical point of torrential rains (b) Maximum precipitation of five-day duration



Summer (June-August) Autumn (Sept.-Nov.) Summer (June-August) Autumn(Sept.-Nov.)

(c) Precipitation intensity in wet and dry days (d) Maximum duration of dryness



Summer (June-August) Autumn(Sept.-Nov.) Summer (June-August) Autumn(Sept.-Nov.)

(e) Rate of occurrence above the critical point of torrential rains (f) Occurrence days above the critical point of torrential rains

Figure 6. A comparison of spatial and temporal characteristics of precipitation

4. Responding to impacts of climate change on water resources

Because climate change has caused statistical characteristics of climate, use of past data to interprete frequency is not a rational choice for establishing water resources plans. In 1991, World Climate Conference stated, **"Past record of climate or hydrological phenomena are no longer reliable guidelines for the future and design and management of water resources system have to consider potential impacts of climate change."** To water resources managers, IPCC (1996) strongly

recommended systematic review of the design scope of water resources system, operation rules, emergency plans, and water distribution policy and improvements in water demand management and institutional improvement to cope with uncertainties of climate change. For proactive water resources management and planning under the impact of climate change, the Ministry of Construction and Transportation has carried out following measures.

4.1 Research on design criteria for hydrological constructs that can cope with abnormal climate

As mentioned above, water resources planning and designing methods based on past records have to be revised. Methods that consider impacts of past and future climate change must be developed and applied. In particular, optimum design method that maximizes net profit has to be replaced by a design method that can cope with extreme weather conditions. To that end, the Ministry of Construction and Transportation has formed a "research group for strengthening facilities criteria to cope with abnormal climate" inside Korea Institute of Construction and Transportation Technology Evaluation and Planning in September 2005 to carry out diverse related researches.

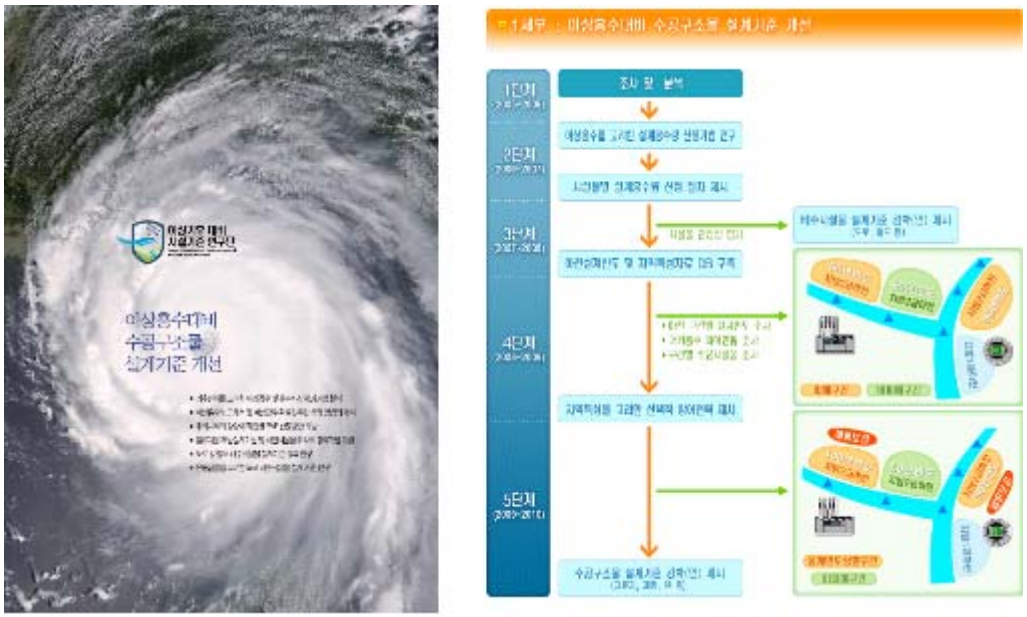


Figure 7. Researches on strengthening of construction criteria for hydrological facilities to prepare for abnormal weather

4.2 Research on water security strategies to cope with climate change

In Korea as well as in other countries, frequent abnormal occurrence of droughts and floods has negatively affected the society and the economy. Researches to cope with abnormal weather have been actively carried out in advanced industrialized countries. In preparation of floods, droughts, and ecological changes caused by future climate change, Water Resources Planning Office of the Ministry of Construction and Transportation has launched in 2007 "National Water Security Planning Against Climate Change" to develop long-term water resources policies and to secure national water security. Currently, the ministry is planning a joint research project with "**Tyndall Centre for climate change**,**"** a world-class climate change research organization in the United Kingdom.

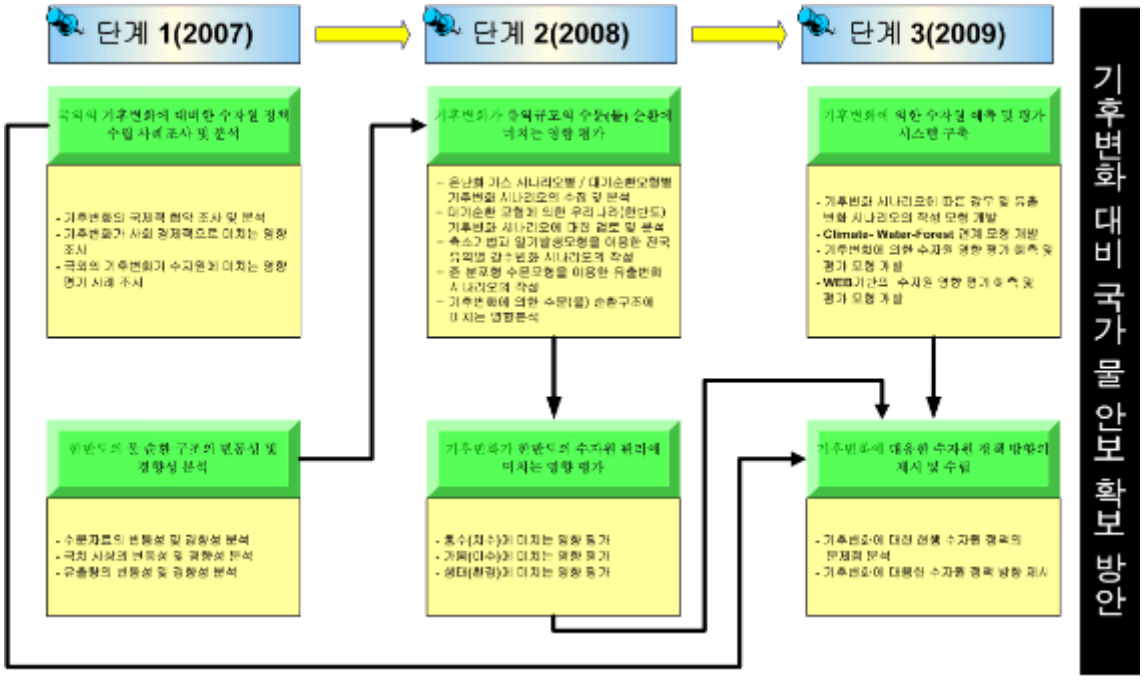


Figure 8. Flow of researches on national water security in preparation for climate change

5. Proposals for overcoming negative impacts of climate change on water resources

5.1 Water resources planning and improvement of its designing method

Since 1965, Korea has established and carried out ten-year comprehensive water resources plans. In 2006, Korea established "Long-term Comprehensive Water Resources Plan (2001-2020). Until recently, however, impacts of climate change were not considered. In establishing and implementing the long-term water resources plan, supply and demand of water resources will be estimated and flood vulnerability of the whole national territory will be analyzed. The findings will be applied to comprehensive dam development plans and drainage area plans. However, statistical analyses are based on past data. Considering that statistical characteristics of the climate have changed by climate change, such approach is not rational. Therefore, it is necessary to develop a design method for water resources planning that can consider climate change.

5.2 Improvement of existing method of system operation

Climate change will create extreme hydrological conditions that will obliterate assumptions behind existing water resources systems and operations. Complexity and difficulty of water resources management will increase. However, countermeasures for climate change consist in finding effective operational method for existing system. Whether existing system can cope with impacts of climate change is reviewed and economic costs are considered. In other words, the best option for system managers is to verify sensibility of a system with expanded scope and develop methods and technologies that can improve operational efficiency.

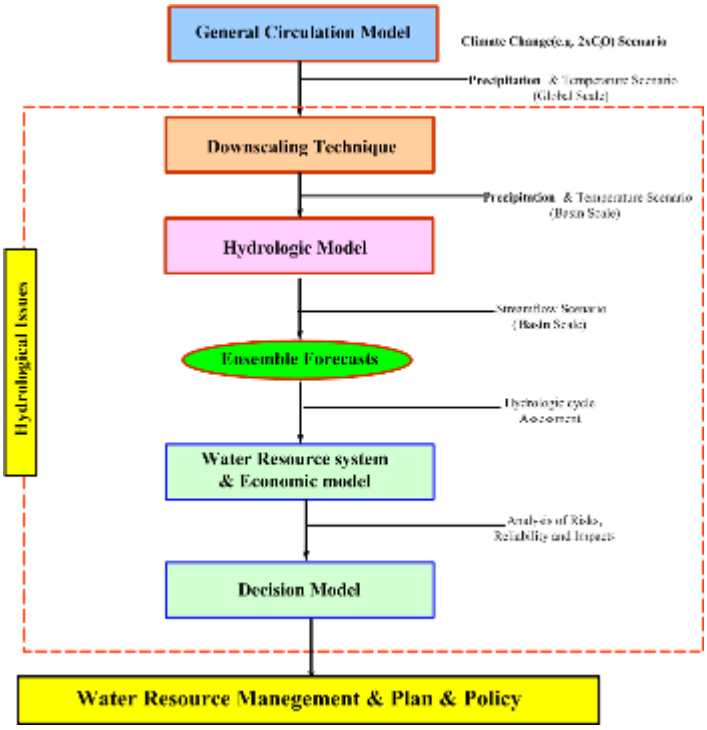


Figure 9. Improvement of water resources planning and system operation methods in consideration of climate change

5.3 Use of weather technology for drainage area management

Recently, climate change has caused abnormal localized torrential rains. As a result, unanticipated floods are occurring frequently and management of drainage area has become more difficult. To cope with the difficulty, it is necessary to secure reliability of precipitation forecast that uses radar precipitation and numerical forecast data. Furthermore, it is necessary to establish a system that can forecast and broadcast precipitation condition in drainage areas.

5.4 Comprehensive review of management of flood in drainage area controlled by dams

Because of changes in the precipitation pattern in the Korean Peninsula, torrential rains can occur earlier or later than in the past. Because of the uncertainty, water level limits in dams must be revised for a more flexible management of dams. The current system, which consists in containing water during summer for use in water shortage season, should be replaced by a more complex water management system for efficient water containment and distribution throughout the year.

5.5 National-level evaluation of the readiness to counter flood situation and drainage area-level countermeasures against flood

Because climate change is causing abnormal floods, capacity of existing flood-related infrastructure—levees, dams, bridges, etc.—have to be re-evaluated. Furthermore, comprehensive flood management by Integrated Water Resources Management (IWRM) of drainage areas is necessary. To minimize damage in drainage area, flow function in the upper stream, containing function in the middle stream, drainage function in the lower stream have to be enhanced.

5.6 Establishment of a system for assessing the impacts of climate change on water

resources

To establish long-term water resources plans that can proactively cope with climate change, drainage area-level climate change scenarios have to be produced. The scenarios must be used to establish a system that can produce outflow scenarios. Furthermore, to enhance forecast and understanding of climate change and to enhance Korea's international status, it is necessary to forge an international system of cooperation in East Asia.

6. Conclusion

Recently, frequent occurrence of abnormal weather events such as droughts and floods in foreign countries has seriously affected the society and the economy. In Korea, water resources problems associated with climate change have appeared in the 1990s. Since the 1980s, advanced industrialized countries have actively carried out researches on climate change and the researches include evaluation of impacts of climate change on water resources. The most representative project in the field of water resources is GEWEX (Global Energy and Water Experiment), which selected five major rivers of the world to monitor and study changes in hydrological phenomena caused by climate change. Furthermore, NWS (National Weather Service) and NASA (National Aeronautics and Space Administration) have heavily invested in the field of water resources. In particular, the state of California in the United States has established a long-term water resources plan in July 2006. In the case of the United Kingdom, barriers will be reconstructed in the lower stream of the Thames in 2100 to fight floods. In the case of water resources management in Korea, no specific measures were taken to impacts of climate change. However, Korea is frequently experiencing extreme flood events that surpass original flood design. Therefore, more active and new approaches and technology development have to be pursued. By carrying out more systematic and in-depth researches for the development of water resources evaluation technology that can counter impacts of climate change, it will be possible to contribute to establish plans and develop policies that can upgrade residents' security and quality of life.

Objective

- To present the current status of Sewerage Management in Malaysia
- To conduct sewerage adoption to Integrated Water Resources Management and Global Climate Change

WHY DO WE NEED TO TREAT SEWAGE ?

Water is a major route by which bacteria, Viruses and parasites are transmitted. Engineering of water supplies and waste water management have prevented waterborne diseases.

Need sewage treatment to control:

- Harmful pathogens (Public Health)
- Improve water quality (Water Resource)
- Enhance environmental values (Environment)

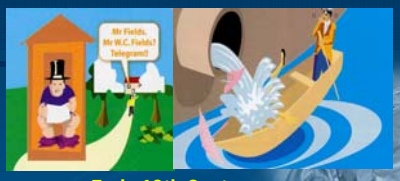
EVOLUTION OF SEWAGE TREATMENT METHODS OVER THE CENTURIES AROUND THE WORLD

Stone Age
(Sewage not an issue)

Nomadic Age
(Leave as they move)

The Growing Sanitation Needs in Early Civilisation
(Need for Sanitation arises)

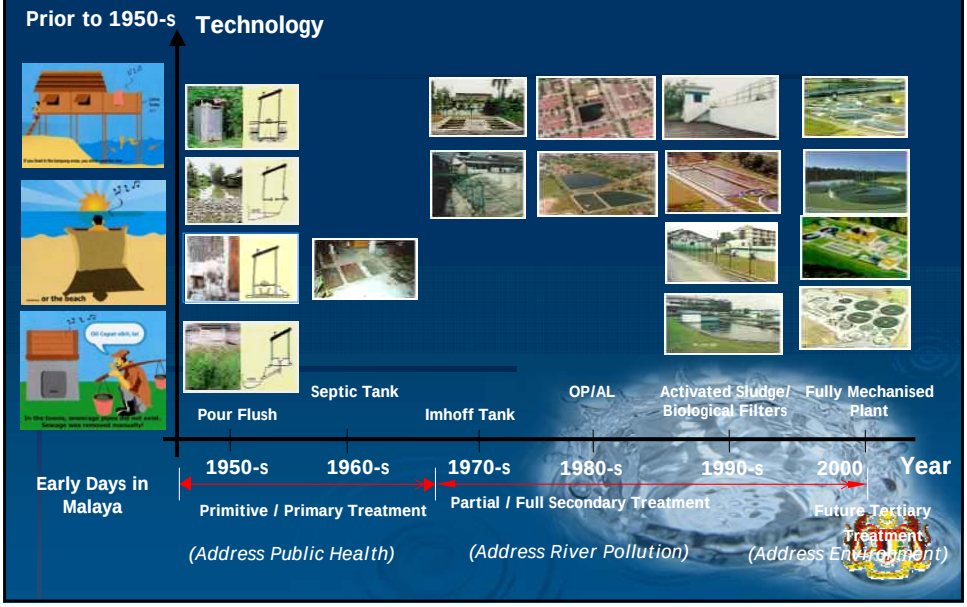
Middle-Ages in Europe
(Collect and throw)



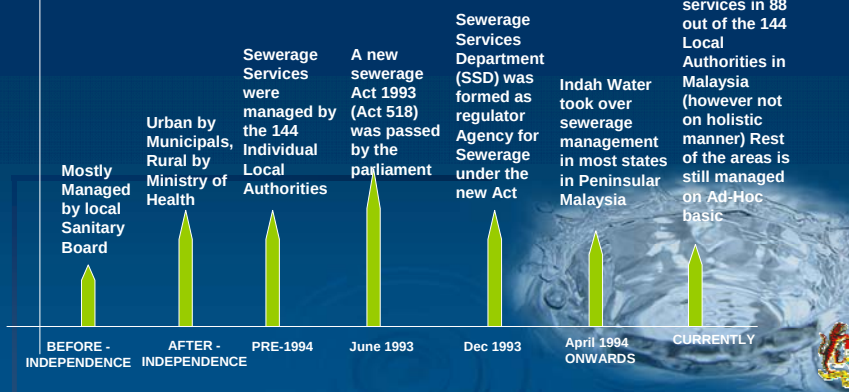
Early 19th Century
(Pour Flush & Sewers to Rivers)

Mid 19th Century
(Existence of Sewage Farms)

EVOLUTION OF SEWERAGE SYSTEMS IN MALAYSIA



BACKGROUND OF SEWERAGE DEVELOPMENT IN MALAYSIA



CHANGES TO THE SEWERAGE SECTOR AFTER INTRODUCTION OF NEW SEWERAGE SERVICES ACT 1993 (ACT 518)

DEPARTMENT OF SEWERAGE SERVICES

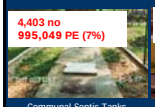
- Regulator Sewerage Services Act, 1993
- Industry / Operational regulator
- Regulates service provider
- Sets industry standards & guidelines
- Oversees Sewerage Developments

DEPARTMENT OF ENVIRONMENT

- Regulates Environmental Quality Act, 1974
- Sets standards for environment and Pollution Control
- Enforcement of discharge standards
- Monitoring existing Final Effluent Standard A, where plant is in Water intake Areas and Standard B in other areas
- Drives National Environmental Policies

CONTROL OF SEWAGE POLLUTION ON RIVER BASINS

Coverage Area

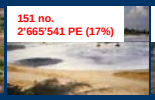


Communal Septic Tanks & Imhoff Tanks

Mechanical plants

Pipe Network

Oxidation Pond



Aerated Lagoon

Pump Stations

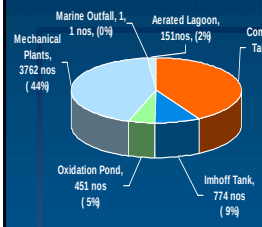
Individual Septic Tanks

As at JUNE 2007

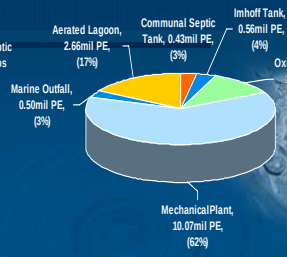
TYPE OF SERVICE AND POPULATION SERVED

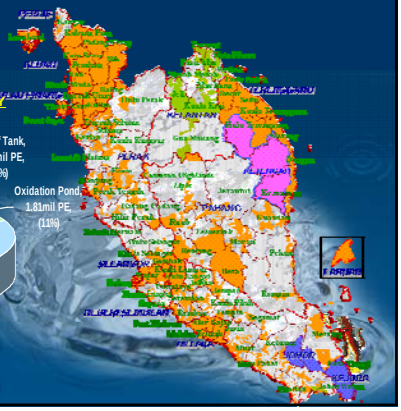
Type of Service	IWK service areas	Non-IWK service areas	Total	%
Connected	14,799,710	1,371,311	16,171,021	60.6
Septic Tank	4,533,858	355,890	4,889,748	18.3
Pour Flush	2,958,485	512,790	3,471,275	13.0
Unidentified	Nil	2,163,253	2,163,253	8.1
TOTAL	22,292,053	4,403,244	26,695,297	100.0

TYPES OF TREATMENT PLANTS JUNE 2007



POPULATION EQUIVALENT CATERED BY TREATMENT PLANTS





SEWERAGE CUSTOMER CATEGORIES

Domestic

eg Houses
Apartments
Govt Qtrs
...etc.

Once Every 6 Months
From RM 2 - RM 8/Month

Commercial

eg. Shopping Complexes
Hotels
Restaurants
...etc.

Monthly
21 Bands Based on Annual Values
Excess Water Charge > 100 m3

Government

eg. Offices
Hospitals
Schools
...etc.

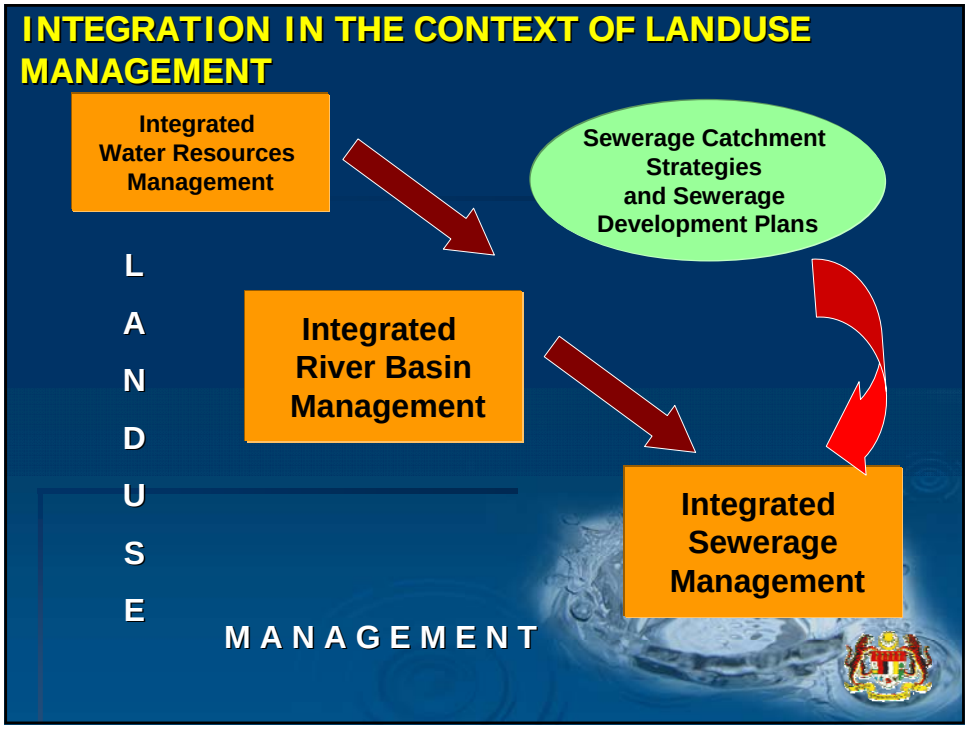
Basic Charge
RM 25 - RM 40 /Month
Excess Water Charge > 100 m3

Industry

Eg. Factories
...etc.

Monthly
Based on Head Count
RM 2 - RM 2.50 per Head/Month

INTEGRATION IN THE CONTEXT OF LANDUSE MANAGEMENT



IWRM Vs IRBM

An Integrated Water Resources Management (IWRM) sets goals and objectives for the management of water resources at a wider scale and includes policies for regions, catchments, shared or transboundary water resources, and inter-basin transfers, all within a single framework. It addresses both the quantity and quality aspects of both surface and groundwater resources and also deals with delivery of water services. It is a dynamic approach often set within a catchment (watershed) framework.

Therefore, the process of policy making for IWRM requires extensive consultation as well as raising the awareness of the importance of integration among policy makers, stakeholders, and the general public. The sustainability of resources and policies should be a central goal.

However, water flows according to natural characteristics and does not respect administrative boundaries – therefore, from pure water resources point of view there might be much logic in managing water according to river basin boundaries. An Integrated River Basin Management (IRBM) describes the framework for management of the water and related land resources in the river basin. The IRBM is a tool that outlines how the concept of integrated water resources management is going to be implemented at the river basin level.

WHAT IWRM AND IRBM ADDRESSES?

They typically address such aspects as :

- Physical description of the basin
- Land use inventories
- Current water availability and demands
- Pollution sources inventories
- Aquatic and terrestrial ecosystem needs
- Vulnerability to floods or extreme meteorological events
- Identification of stakeholders
- Implications of changing land use
- Identifications of priority issues (impact issues or user requirement issues)
- Short and Long term goals for the river basin
- Water related development scenarios, future water demands
- Water allocation and water quality objectives
- Strategy, measures and action plan achievement of goals
- Financing of water use and management
- Responsibility and schedule for implementation
- Mechanisms for monitoring and updating

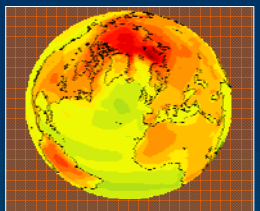
Organisations with water supply, sewerage, treatment and reuse functions are increasingly driven by the need to make efficiency gains : to do more with less water, to eliminate subsidies, incorporate externalities and minimise impacts, to recover costs of operation, maintenance and replacement of water and wastewater systems, and to transfer the cost of supply and treatment from the provider (usually Government) to the consumer within the IWRM and or IRBM frameworks

WHAT ARE THE POTENTIAL ENVIRONMENTAL IMPACTS FROM SEWERAGE ACTIVITIES ?

Climate Change - Global Warming

OVERVIEW

Varying sources of Greenhouse Gases (GHGs) i.e. emmisions from power sector, industries, transportation, waste treatment & landfills



Global Warming

Rising Temperature

Extreme weather

Rising sea level

Changing Ecology, emerging diseases

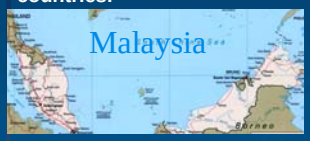
Climate Change - Malaysia

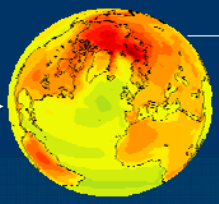
Global Warming

Local Context

For Malaysia the estimated (in 1994) GHG emissions is 144 million Tonne of CO2 equivalent (or 3.7 per capita) about 2% of total world CO2 equivalent.

Wastewater sector accounts for 0.05% i.e. 73.5kiloTonne of national emissions, relatively insignificant compared to other countries.





Adaptation & Mitigation Initiatives required

Disproportionately, the impacts will be felt locally e.g.:

- Water resources (increase in frequency and extent of extreme droughts).
- Extreme flooding and risk to infrastructure.
- Increase energy cost for operating treatment systems.
- Increase need for treatment improvements to protect threaten water resources.

Sewage Treatment and Climate Change

Identify local sources

Sources of GHGs from Sewage and Sludge Treatment Process

Indirect Sources

- Energy Consumption of non-renewable energy that releases CO_2.
- Activities that relies on power from the national grid will contribute indirectly to releases CO_2 i.e :
  - Pumping and aeration of sewage
  - Vehicular movements for desludging works sludge disposal and network services etc.

Direct Sources

- Fugitive Methane from anaerobic process.
- Nitrous Oxides (N2O) from nitrification and denitrification processes.
- Methane from on-site septic systems (ISTs/CSTs)
- Flaring of methane gas or methane combustion will also generate Co_2 and contribute to overall GHGs in the atmosphere
- Methane from sewage sludge disposal sites

Sewage Treatment and Climate Change

Indirect Sources

TNB, the main energy utility in Malaysia relies on a largely fossil based power plants.

Activities that relies on power from the national grid will contribute indirectly to releases CO_2 i.e.:

1)Pumping and aeration of sewage.
2)Vehicular movements for desludging works sludge disposal and network services etc.

Summary & Conclusion

- **Sewerage in Malaysia had progressed well over the decade**
- **Sewerage planning in now looked together in the context of Integrated Water Resources Management for maximum benefits**
- **Global Climate Change has minimal impacts on sewerage management for now and next era**

Water Cycle Should End Here ....

Thank You

COUNTRY REPORT OF THE PHILIPPINES

Integrated Water Resource Management Adapting to the Global Climate Change

JICA EXECUTIVES' SEMINAR ON PUBLIC WORKS AND MANAGEMENT

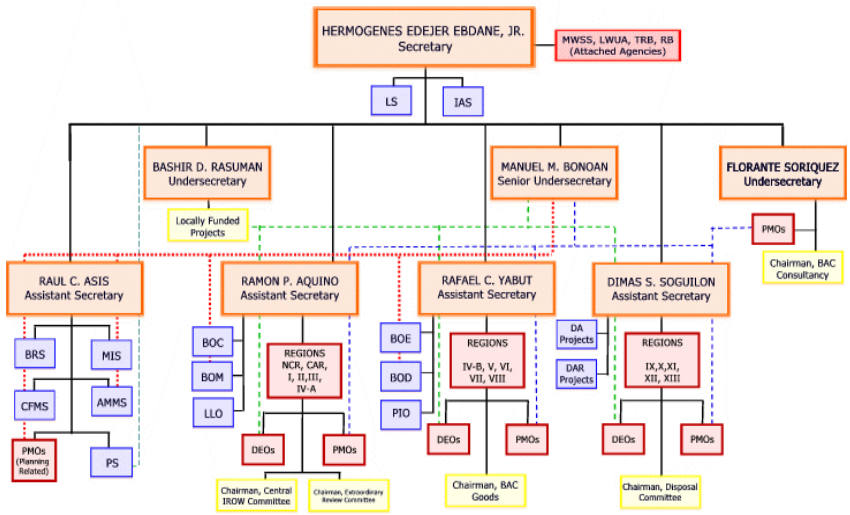
JFY 2007

Dr. JUDY F. SESE
Director III
BUREAU OF RESEARCH AND STANDARDS
Department of Public Works and Highways (DPWH)

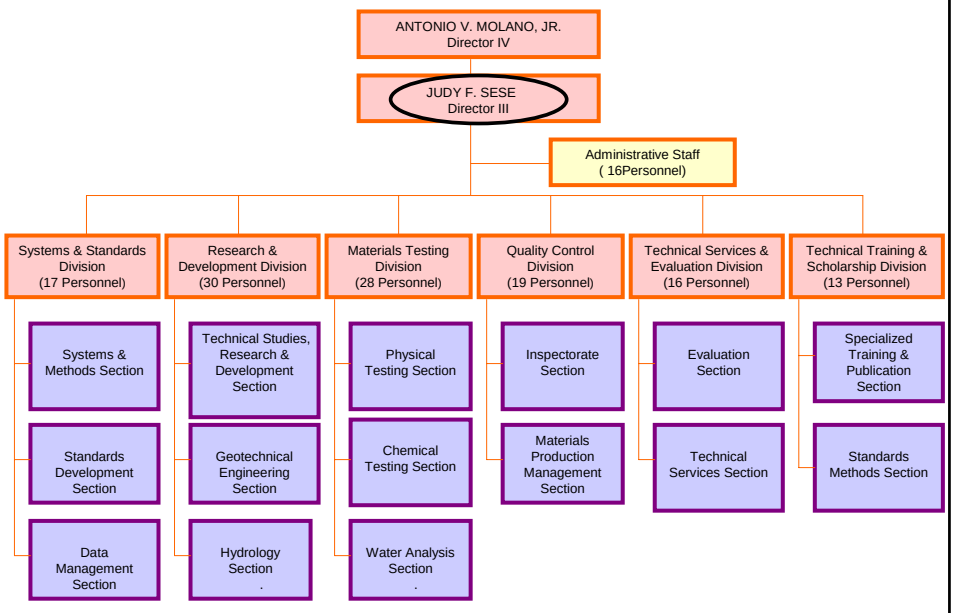
The Department of Public Works and Highways (DPWH), being the country's engineering and construction arm, is responsible for the planning, design, construction and maintenance of infrastructure such as: roads and bridges, flood control systems, water resource development projects and other public works structure.

The DPWH is likewise responsible in the monitoring of National Water Data Collection Program and recognizes the importance of Integrated Water Resources Management (IWRM) to ensure and secure sustainable water for all. This mechanism is also accepted as a way of adapting to the effects of global climate unpredictability.

DPWH ORGANIZATIONAL CHART



BUREAU OF RESEARCH AND STANDARDS ORGANIZATIONAL CHART



Philippines Integrated Water Resource Management (IWRM)

The Philippines has participated in the following IWRM activities:

- January 2006, UNEP assisted IWRM 2005 South East Asia Project
- Formation of Project Steering Committee composed of UP-NHRC and NWRB
- A Multi-Sectoral Task Force (MSTF) undertakes plan preparation represented by key government agencies
- IWRM Southeast Asian Project Meeting in Thailand
- Other workshops and meetings conducted

Series of Key Activities relative to IWRM Plan Framework

- Multi-Sectoral Task Force (MSTF) workshops and conferences
- Consultation-Workshop with Non-Government Organizations and Civil Society Organizations
- Multi-Sectoral Consultation-Workshops on the proposed National IWRM and Water Efficiency Improvement Plans in Visayas and Mindanao

PURPOSE OF PHILIPPINE IWRM PLAN FRAMEWORK

- The IWRM Plan Framework is a directional plan to guide the stakeholders in preparing their respective IWRM plans.
- Take-off in the preparation of regional and local IWRM Operational and Action Plans

PHILIPPINE WATER RESOURCES

a. Land and Water Systems

- Philippines consists of 7,100 islands
- Land Area of 300,000 square kilometers
- 421 Principal River Basins, 20 major river basin (at least 900 sq.km.)
- 15 major lakes (400 hectares and above)
- Total coastline is about 36, 289 kms.
- Average rainfall is about 2,400 mm.

PHILIPPINE WATER RESOURCES

b. Availability of Water Resources: Increasing Water Stress and Potential Scarcity

- Abundant water resources but facing possible water crisis due to rapid population growth, urbanization, industrialization and economic growth
- 1,907 cu.m. availability per capita is second lowest in Southeast Asia
- As of December 2006, about 19, 247 water rights grantees
- Irrigation facilities is about 1,515,347 hectares where 48.4% total irrigable area
- Total water resources production is 5,792,857 liters/sec.

PHILIPPINE WATER RESOURCES

c. Water Quality

- Water quality standards are regulated by the Environment Management Bureau, DENR
- Drinking standards are set by the Department of Health (DOH)
- 36% of rivers are potential source of water for drinking

PHILIPPINE WATER RESOURCES

d. Water Supply: Equity and Sustainability Issues

- Water supplies are provided by Local Government Units and Community-Based Organization

- Types of Facilities:
  - Level I – Point Source System
  - Level II – Communal Faucet System
  - Level III – Individual Household Connection

Philippine Water Resources Situations

e. Water Supply: Equity and Sustainability Issues

- Water supplies are provided by Local Government Units and Community-Based Organization
- Access to safe drinking water, 81.4% in 1999 to 80% in 2002
- Decline due to increasing population

Philippine Water Resources Situations

f. Inadequate Sanitation and Sewerage Services

- In 2000, access to adequate sanitation was estimated to be 74.2%
- Sewerage coverage is less 8% in Metro Manila and urban sewerage is 4% (six cities)

Philippine Water Resources Situations

g. Degradation of Major Ecosystems

- Philippine coral reefs, only 4.0-5.0 % in excellent condition
- More than 70% of mangroves converted to aquaculture, logged or reclaimed
- Beaches and foreshores have problems on erosions, sedimentation and water quality

Philippine Water Resources Situations

h. Increasing frequency and intensity of extreme climate events and variability

- Increase of floods, droughts, forest fires and tropical cyclones
- 5 La Niña and 7 El Niño episodes from 1970 to 2000 from only 3 La Niña and 2 El Niño in 1950-1970
- Tropical cyclones increased, strongest and very destructive

Philippine Water Resources Situations

i. Water Governance and Regulation: Sectoral Approach

- Water Resources governance is a responsibility of multiple government agencies (30 government agencies)

Current Researches and Studies of the Department of Public Works and Highways (DPWH)

a. **Study on the Nationwide Flood Risk Assessment and Flood Mitigation Plan for the Selected Areas in the Republic of the Philippines**

- Study covers 954 flood prone areas

Current Researches and Studies of the Department of Public Works and Highways (DPWH)

b. **The Project for Enhancement of Capabilities in Flood Control and Sabo Engineering**

The Project is a JICA-Assisted Technical Cooperation Project that enhance the capability of the DPWH in the planning and design of flood control and sabo structure to address the water-induced disaster in the country.

This Project is directly under the supervision of Director David of PMO-FCSEC.

POLICIES AND PRACTICES

a. Integrated Water Resources Management Plan Framework

The National IWRM Plan Framework is not just a water plan. There are key differences between this plan and the traditional water plan. The IWRM Plan Framework has the following distinctive features:

1. Broader Focus:

It looks at water in relation to other dimension needed to achieve larger development goals and meet strategic water related challenges.

Policies and Practices

2. It is Dynamic and Adaptive

It provides framework for a continuing and adaptive process of strategic, integrated and coordinated action in all levels.

3. It is Integrated and Holistic

all the different uses of water are considered together. Water allocation and management decisions consider the interrelationships and effects of these various uses. They are not viewed purely from a sectoral or project focus.

SUSTAINABLE OUTCOMES

Four (4) sustainable outcomes were identified. These are the medium to long-term goals that we aspire for our water resources management system. These outcomes reflect our development aspirations for IWRM, and would ensure sustainability for our water resources. These include the following:

Sustainable Outcomes

1. Effective Protection and Regulation for Water Security and Ecosystem Health
2. Sustainable Water Resources and Responsive Services for Present and Future Needs
3. Improved Effectiveness, Accountability and synergy among water-related Institutions and stakeholders
4. Adaptive and Proactive Response ro Emerging Future Challenges.

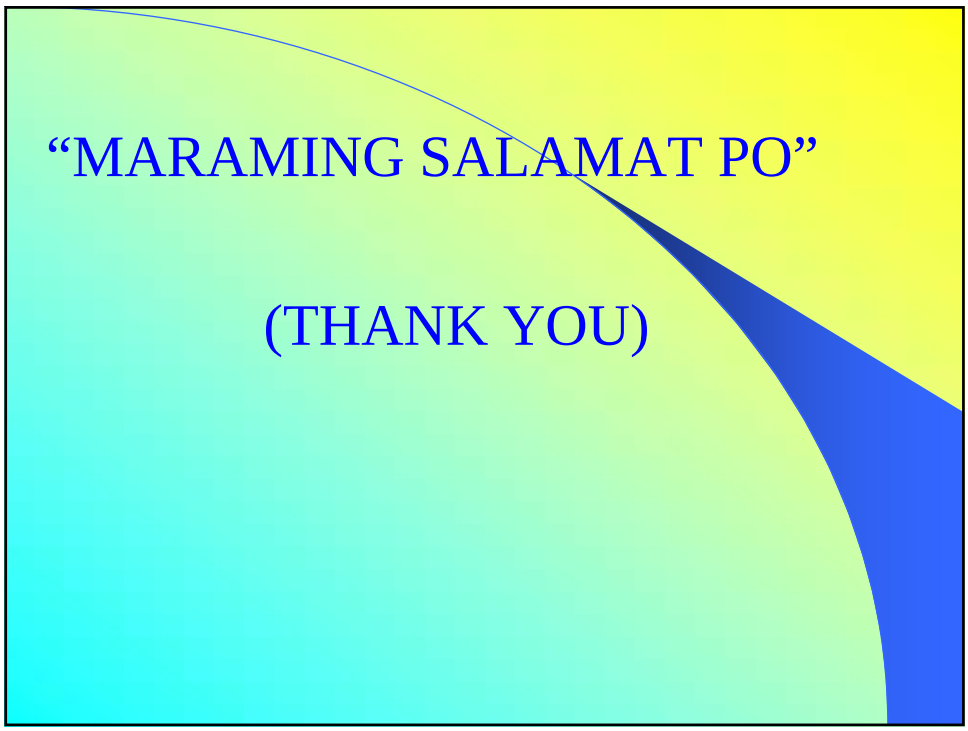
STRATEGIC THEMES

Each of these sustainable outcomes is supported by nine (9) strategic themes:

1. Ensuring rational, efficient and ecologically sustainable allocation of water
2. Enhancing effectiveness in groundwater management and acquifer protection
3. Achieving clean and healthy water
4. Managing and mitigating risks from climate change events and water related disasters

Strategic Themes

5. Promoting water conservation and improving water use efficiency
6. Expanding access and ensuring availability of affordable and responsive water supply and sanitation services
7. Promoting participatory water governance and supportive enabling environment
8. Strengthening knowledge management and building capacity for IMRM
9. Exploring new pathways to water resources management: Water Sensitive Design and Water Rights Trading.


“MARAMING SALAMAT PO”
(THANK YOU)

AYUBOWAN… …KONNICHI WA

Symposium Presentation

on

Integrated Water Resource Management Adapting to the Global Climate Change in Sri Lanka

Presented by

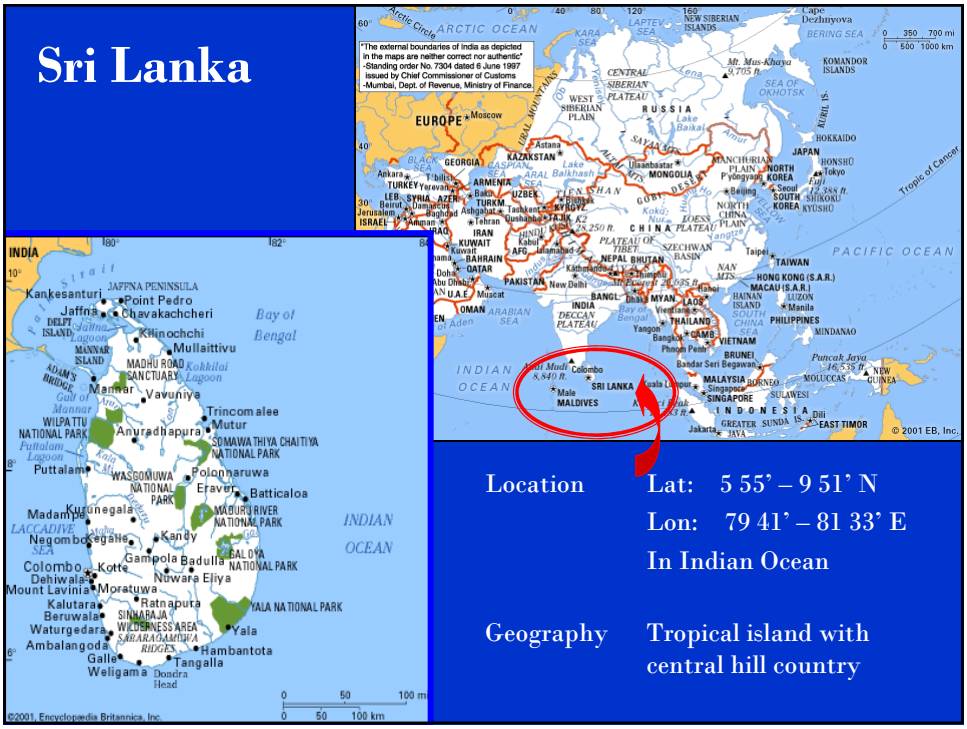
Eng. (Mrs.) P.N.S Yapa

Deputy General Manager

National Water Supply & Drainage Board

Sri Lanka.

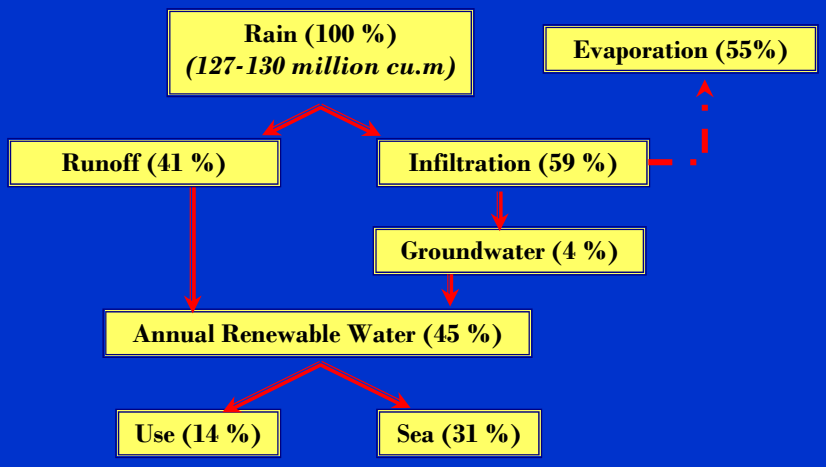
Sri Lanka



Location	Lat: 5 55' – 9 51' N Lon: 79 41' – 81 33' E In Indian Ocean
Geography	Tropical island with central hill country

National Water Balance, Seepage Characteristics and Main Usage Pattern

National Water Balance of Sri Lanka



Main Usage & Demand Pattern

Main Usage

Agricultural usage (in series with hydro-power)	: 96%
Domestic & Industrial usage	: 04%

Access for Domestic Usage

Pipe borne water *(of 30% National Coverage)*	Urban	: 70%
	Rural	: 15%
Dug wells		: 27%
Tube wells		: 08%
Streams & Lakes		: 35%

Impacts of Climate Change

Vulnerability of

Natural & Human Systems

to Climate Change

in Sri Lanka

Vulnerability on Human Settlements and Health due to Change in Flood, Drought and Cyclonic Pattern

Affects directly & indirectly on

- Natural environment of settlements
- Economic activities
- Building and infrastructure
- Health of resident and commuting population
- Exacerbating existing air pollution, poor waste management and inadequacy of water and sanitation facilities

Vulnerability on Human Settlements… Contd.

Unexpected Extreme Events beyond Natural Expectation in recent past

Year	Event	Extent of Damage
1992	Drought	Tea production reduced by 26% Increased production cost by 19%
1993	Flood	43,000 houses destroyed 219,870 persons displaced
1993	Flood	Submerged whole Colombo city (Capital of Sri Lanka)
1994	Flood	52,900 houses destroyed 353,000 persons displaced
1997	Drought	Food insecurity & loss of income rose to 90-99% in Hambantota district
2001/2002	Drought	Shut down hydro-power generation Forced fossil-fuel power generation
2002	Cyclone	77,000 houses destroyed 146,190 families affected
2003	Flood / Landslide	236 deaths 9,294 houses completely destroyed 30,360 houses partially destroyed 138,973 families severely affected
2006	Persistent rain/ landslide	Forced to shift an entire city called 'Peradeniya' to a safer location
2006	Tornado	Hit twice over a week and destroyed 1,500 houses in Colombo city
2006	Abrupt Heat Wave	Wave reached 40^0 C in Colombo city

Vulnerability on Human Health… Contd.

- Urban squatters in unauthorized make-shifts were exposed to *helminthic* and *protozoal* parasites due to floods and dengue epidemic (*aedes aegeypgy and aeds albopictus*) due to heavy rains (*Wanasinghe 1995*)
- Increased *Malaria, Dengue and Japanese Encephalitis* due to changed climate factors in North-western and increase of *anopheline* mosquitoes in dry North-central due to heavy rainfall and prolonged droughts (*De Alwis et al 2004*)
- Expansion of Malaria transmission from dry zone to areas that are hitherto free and change of its seasonal pattern [current mid year peak would be enhanced while the traditional high transmission season during North – East monsoon (Nov – Feb) extended] (*Dhanapala 1998*)
- Increase and spread of water washed and water borne diseases by floods, landslides and droughts
- Collapse of health infrastructure and displacement of affected persons would bring illnesses, injuries, deaths and physical and physiological trauma as well

Vulnerability of the Coastal Zone due to Sea Level Rise

(Sea level rise of 0.3m in Southwest coast leads to land loss of 06 sq.km and 1.0 m rise would cause 11.5 sq.km)

- 24% of total land area and 32% of population
- 65% of urbanized area
- 80% of tourism related infrastructure
- 65% of industrial output
- 100% commercial ports and fishery harbours and anchorage
- 80% of fish production
- Major highways and infrastructure
- Richest area with biodiversity; coral reefs, lagoons, mangroves, etc. covering 160,000 hectares
- Increased coastal erosion which is 0.3 – 0.35m per year at present

Siltation of Reservoirs

Polgolla Reservoir : 44% storage with 2.8% siltation rate per year

Rantembe Reservoir : 54% storage with 4.3% siltation rate per year

Victoria Reservoir : 0.08 siltation per year

Minor Tanks : 2.4% siltation per year

Importance of Adaptation

In Sri Lanka, poor communities are heavily dependant, directly or indirectly, on natural systems and their behavioral pattern…

…..Thus the poor in the country will be the mostly affected and will find it difficult to recuperate !

Policy Adapted to Minimize the Impact

Policies

- Ratification of 36 Multilateral Environmental Agreements (MEAs) which include the development of National Environment Policy, National Forestry Policy, National Policy on Wildlife Conservation and National Air Quality Management Policy,
- Development and adoption of National Environmental Action Plans (ie: Biodiversity Action Plan, National Climate Action Plan, Coastal 2000 Action Plan, Clean Air 2000 Action Plan and National Forestry Sector Master Plan.)
- Preparation of National Strategy for Clean Development Mechanism to implement the Kyoto Protocol
- Establishment of Climate Change Secretariat, Bio Diversity Secretariat and Ozone Secretariat to strengthen the capacity of implementing agencies

Practices

The environmentally friendly practices that have already benefited the country are;

- Introduction and popularization of fuel efficient stoves that reduce fuel woods
- Introduction of cleaner production technologies among polluting industries
- Installation of mini-hydro power plants as stand-alone and grid connecting system
- Facilitation of rain water harvesting in the dry zones. National Rainwater Harvesting Policy is to be adopted, making rainwater harvesting mandatory
- Identification of cost-effective utility scale wind power development (Young and Vihaure 2003)

Mitigatory and Adaptative Physical Measures

- Recent flood control, water resource development and management projects
- Construction of Salinity Barrier and Dams to prevent salinity intrusion
- Step-land agriculture in Hill country
- Advanced capacity building programme on integrated water resource management under ‘Pavithra Ganga’ (Clean Rivers) pogramme
- Promotion of Rain Water Harvesting in Dry Zone

Research & Survey

Year	By	Concern
2004	*Nugawela, Rodrigo & Munasinghe*	Increased carbon fixing capacity of Rubber
2004	*Sirisena et al*	Methane emission from paddy fields
2004	*Abeywardana*	Paddy with high responsiveness to elevated carbon for future breeding
2004	*Emmanual*	Urban heat island effect
2004	*Senanayake*	Greenhouse gas emission from Desiccated coconut industry
2004	*Pannilage*	Effect on water yield by land use practice in catchments areas
2004	*Ariyananda*	Type of tanks for rain water harvesting

Mitigatory Actions in Legislation / Water Reforms

The following is a summary of the water 'reform' process in Sri Lanka during the last quarter century

Date	Instrument	Authority	Provisions
1980	*water resources Bill*	*Ministry of Irrigation, Power and Mahaweli Development*	*Bulk water allocation to various sectoral agencies (and further allocation by those agencies) and for the establishment of a National Water Resources Council (this legislation, however, was never submitted to Parliament due to lack of cabinet support).*
1983	*Irrigation Ordinance (amendment)*		*Enable farmers to be prosecuted for non-payment of water taxes.*
1984			*Commencement of charging water taxes from farmers*
1988	*Policy of "Participatory Management of Irrigation Systems"*		*Substantial devolution of authority and responsibility to farmer organizations*
1988	*Irrigation Management Policy Support Activity (IMPSA)*	*International Irrigation Management Institute (IIMI)*	

Mitigatory Actions in Legislation / Water Reforms….Contd.

Date	Instrument	Authority	Provisions
1992	Summary Report IMPSA	International Irrigation Management Institute (IIMI)	Recommendations on land, watershed and water resource management, and that the government should establish a high-level advisory National Water Resource Council and Secretariat.
1992			Proposal to carry out a water resources master plan was presented to external support agencies.
1993	Institutional Assessment for Comprehensive Water Resources Management (IACWRM) Project.		Assess the institutional capacity for water resources management. The action plan of the project focused mainly on the need to develop a National Water Resources Policy, to establish a permanent institutional arrangement for water sector coordination and to prepare and enact" National Water Act'
1994	Irrigation Ordinance was amended by Act No. 13 of 1994		Enable farmer organization to levy charges from the members of the organization for the operation and distribution of water through canal systems.
1995		Cabinet	The implementation of the Strategic Framework and Action Plan for the "Institutional Strengthening for Comprehensive Water Resources Management (ISCWRM) Project.
1996	IACWRM project	Government	Establishment of a Water Resources Council (WRC) and a Water Resources Secretariat (WRS).

Mitigatory Actions in Legislation / Water Reforms….Contd.

Date	Instrument	Authority	Provisions
1996 to early 2000	ISCWRM project		Production of the "National water Resources Policy and Institutional Arrangements" and the " National Water Resources Authority (NWRA) Bill"
28th March 2000		Cabinet of Ministers	Approval of the National Water resources Policy.
Septembe r 2000		Legal draftsmen's department	Release of the Draft National Water Resources Authority Bill. (Government, however, failed to push the Act through the parliament and to establish NWRA).
2001			National Policy on Rural Water Supply and Sanitation was approved.
2001	The '100 day' programme	Ministry of Irrigation and Water Management	Setting up task forces for the implementation of its water management policy at 4 levels; Village Irrigation Committee. Divisional Secretariat Irrigation Committee, District Irrigation Committee and National Irrigation Committee.
2002	PRSP	GOSL	Published the Poverty Reduction Strategy Paper (PRSP) including proposed reforms on water sector.
2002	Regaining Sri Lanka	GOSL	PRSP was incorporated into the policy document " future: Regaining Sri Lanka". Water reform policy was not taken for public discussions.

Mitigatory Actions in Legislation / Water Reforms….Contd.

Date	Instrument	Authority	Provisions
22 nd October 2003	Water Services Reform Bill	GOSL	Presented the " Water Service Reform: A Bill: to privatize pipe borne water supplies in the country in both rural and urban areas and public sewerage services. The Bill refers to drinking water and other sources of water'.
2003 to 2004	Civil action	Supreme Court	Civil Society Organizations and citizens challenged the bill before Supreme Court and a decision against the introduction of the bill was given
August 2004	Basic Policies of Usage, Conservation and Development of Local Water resources (Draft)	Agriculture Livestock, Land and Irrigation Ministry	
Septembe r 2004	water Resources Policy (Draft)	Water Resources Secretariat under the Mahaweli and River Basin Development and Rajarata Development Ministry	
22nd November 2004		The cabinet	Decided to amalgamate these two documents and come up with a common one.
24 th November 2004	National Water Resources Policy (Draft)	The special Presidential Task Force	The "common" policy document

Mitigatory Actions in Legislation / Water Reforms….Contd.

Date	Instrument	Authority	Provisions
21st December 2004		The cabinet	The document was discussed, with the versions in Sinhala and English being significantly different from each other.
January 2005		The cabinet	A four-member Cabinet sub committee was formed to come up with new proposals for a water policy.
January 2005	National Rainwater Policy And Strategies	Ministry of Urban Development and Water Supply.	In the light of increasing operational and maintenance costs to, rationalize investments, both by Government and non Government sectors, in the field of pipe borne water supply, drainage, flood control, soil conversation etc.and promote the practice on a Regional Community and family basis, in order to ensure that the 'City of tomorrow' applies Rain water harvesting broadly, by the control of water near its source, in its pursuance of becoming a 'Green city' in the future.
8th September 2005	Draft National Water Resources Management Policy	Presidential Secretariat	Attempt to reconcile the "Basic Policies of Usage, Conservation and Development of Local Water Resources (Draft)" and National Water Resources Policy (Draft)"
17th November 2005			Presidential election. At the opening of the new Parliamentary sessions, the President declares the need for National Water Policy.
2-12 December 2005	Aid-memoir on the proposed National Water Management Improvement (NAWAM) Project.	Agreement between the Cabinet and the World bank.	US$ 70 M loan from the IDA

THANK YOU !

16th International symposium on national land development and engineering in Asia

Vietnam

and it's Integrated water resource management adapting to climate change

Case study

by Dang Anh Thu

Introduction

The rapid economic growth rate following the economic reform policy from 1986 onwards.

2

Geography background

Socialist Republic of Vietnam

- Forms an "S", located in centre of South East Asia
- Population: 83 million, 26.8% are urban habitant
- Capital City: Hanoi
- Area: 330,000km^{2,} eight special zones
- Coastline of 3,300km
- Bordered by China in North and Laos and Cambodia in West
- Major industries: rice, rubber, food processing, sugar, textiles, chemicals, bags

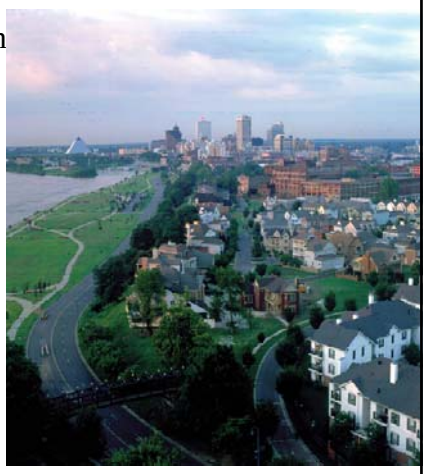
3

Vietnam's water resources

Vietnam has water resources at medium scale in the world and has unsustainable elements.

Vietnam's water resources at medium scale in the world

• Total surface water: 830 billion m3 in which have only 310 billion m3 creating by rainfall
• Sum exploitability of reserves groundwater: 60 billion m3/year.
• Water reserves in preliminary survey stage: 8 billion m3/ year (about 13% Sum reserves)
• Surface water and groundwater: 4400 m3/person in average, (in the world is 7400 m3/capita, year).



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Vietnam's water resources has degradation tendency by impact of global climate change.

Vietnam is effected by global climate change with two impacts:
• Global climate change will lead to reduce water resources.

Factor	At present	2015	2025	2100
Total of water surface (billion m3)	830	660	627	592
		96%	91%	86%

• Sea level to increase considerably. The WB's research shown that sea - level may be increase more than expected before and Vietnam is one of the countries may be effected impacts strongly. Prediction with each 1 meter of sea- level increase, about 10.8% population of Vietnam 'll be remove them living place.

6

Unsustainable elements of Vietnamese's water resources

- The water capacity from outside of Vietnam has occupied approximately 2/3 of total achieved water volume,
- Allocation of both surface water and groundwater are snatchy.
- Disadvantage of water resource in use and exploitation
- Exhaustion of natural water more and more increase

Case study

Management and development of water resource adapting to impacts of climate change at Huong river in Hue city

8

Case study: Management and development of water resource adapting to impacts of climate change at Huong river in Hue city

Hue is a central province of VN

- Area: 5.009, 2 km2,
- Coastline of 126 km
- Average precipitation: 2500 mm

The Huong River is most big river, there is 300 km2 catchment area

9

Case study: Management and development of water resource adapting to impacts of climate change at Huong river in Hue city

Exploitation and utilization of water source at Huong's valley

Water utilization

Total demand of water utilization for all sectors: 444.4 million m3/year in which:

- Piped water: 13.4 million m3/year,
- Industry: 2.0 million m3/year,
-Agriculture: 390 million m3/year,
- Breeding: 3 million m3/year and
- Aquaculture: 36 million m3/year.

10

Case study: Management and development of water resource adapting to impacts of climate change at Huong river in Hue

Difficulty and Problems

Currently the exploitation system and using of water source at Huong's river were mainly irrigation works

- **Irrigation:** not enough in 8 months of dry season. Reservoir, irrigation works were limited that did not satisfy irrigation purposes and unstable.
- **Water supply**: Source of water supply was not stable and water supply system for urban areas, industry and living purposes were not appropriate.
- **Drainage:** Drainage works were not adequate
- **Anti-flood:** Anti-flood was only carried out in floods and Tieuman at low and evarage intensity

11

Case study: Management and development of water resource adapting to impacts of climate change at Huong river in Hue

Impacts of climate change for water resources of Huong's river

Scenario of climate change in northern central

Factor	Region	2010	2050	2070
Increase temperature (0C)	Northern central	0.3	1.1	1.5
Sea level (cm)	Coastal	9	33	45

- **For river flow**

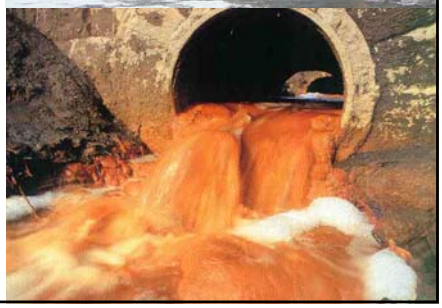
In 2070: annual flow will reduce mainly in central region 23 - 40,5% and increase 49% at south central region. Annual flow in Ta Trach river (main branch of Huong river) is only 1.350 mm, reduce 42,9% compared with existing figure of 2.362 mm.

- **For potential evaporation level** in Hue City is correspondent with the scenario of temperature increase of 10C at 3,2% and 2,50C at 8,1% respectively.

12

Case study: Management and development of water resource adapting to impacts of climate change at Huong river in Hue

Climate change will impact directly to source of water at Huong basin and caused the following effects:



- Flow at rivers will reduce. Increased temperature and evaporation volume will reduce capacity and water quality at valley.
- Irregular fluctuation of rain intensity, flood and drought for the plant crops will happen regularly.
- Changing of climate with increased temperature, variation of rainfall and sea water will impact to the coastal region and lagoon.
- Sea water encroached on the land will impact to ecosystem of some aquaculture species....

Case study: Management and development of water resource adapting to impacts of climate change at Huong river in Hue

Proposed methods to ensure water demand for long term:

- Reasonable, economic and effective utilization of existing water source
- Renovation policy and improvement of institutional management for water source
- Environmental and ecosystem protection at valley and riverside
- Construction of reservoir works by multi mode and scale
- Development of human resources for management and exploitation of water source
- Propaganda and Community education

Case study of Tien Giang

- **Tiền Giang Province** is a province in the Mekong Delta region of southern Vietnam.
  - Capital: Mỹ Tho
  - Population: 1,635,700
  - Area: 2,367 km²

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Case study of Tien Giang

Difficulty and Problems

- Half of the land area is exposed to annual floods and the other half to saline intrusion.
- Traditional sources of domestic water are naturally polluted by alluvium acidity and salinity
- Water related diseases have been very serious
- Only about half the urban residents had regular access to piped water
- Rural residents developed their own water sources by drilling of wells, but without any resources planning.
- The first real impact was disastrous. The water quality from the shallow wells was so bad that the water was undrinkable.
- Abandoned wells were not closed properly, resulting in aquifer deterioration that affected a widespread area.
- The limited national and provincial budgets prevented rehabilitation and support to these areas.

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Case study of Tien Giang

- The formulation of the National RWSS Strategy (in 1998) provided a good opportunity for the Province to effect changes. After three years, TienGiang Province manages both surface and groundwater resources, ensuring water supply for 50% of rural population. The Province and the communities worked through self-help.
- Key components of the strategy included:

  - A participatory approach, throughout project planning and implementation

  - Technical support from the provincial government

  - Appropriate financial policies for poor and difficult areas

  - Establishment of water user groups, with the legal entity to hold, manages and operates facilities.

  - Training and educating for water user groups so that they have enough ability to make plans choose technology, manage the water resources and the environment. M

17

Case study of Tien Giang

- **Lessons learned**

  - RWSS is considered as a useful point of departure for poverty elimination and rural development, and achievements from RWSS help to motivate other social efforts.

  - Information, education and communication (IEC) activities are very important to all levels including communities, local authorities, technical and credit agencies.

  - Water resources for RWSS are of small quantity and dispersed in nature, and mainly related to groundwater, the monitoring of which is still very weak. Therefore this development must be integrated within integrated regional and basin planning, thus avoiding negative impacts to water resources and the environment.

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Case study of Tien Giang

- **Importance of case for IWRM**

  - The case shows how good planning leads to efficient use of water resources, and the integrated approach has led to a harmonious and equitable share of economic and social benefits among communities: all people have clean water for use and improved their life quality by their own contribution.

  - The management of sanitation, domestic waste and rural waste production has contributed to good water quality and preservation of eco-systems.

These ideas are embodied in the concept of integrated water resources management (IWRM).

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Conclusion

Degradation of water resource due to climate change and socio-economic development is clear and remarkable. Overcoming or diminishing measures are only effective when they are comprehensive implementation, unification in action from lower to upper levels, from raising awareness to specific activities, deeds