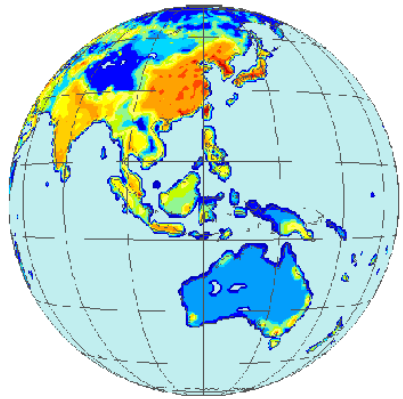
Introduction of water management in AIM/CGE



Yasuaki Hijioka

National Institute for Environmental Studies

APEIS Training Workshop, NIES, 9 November 2005

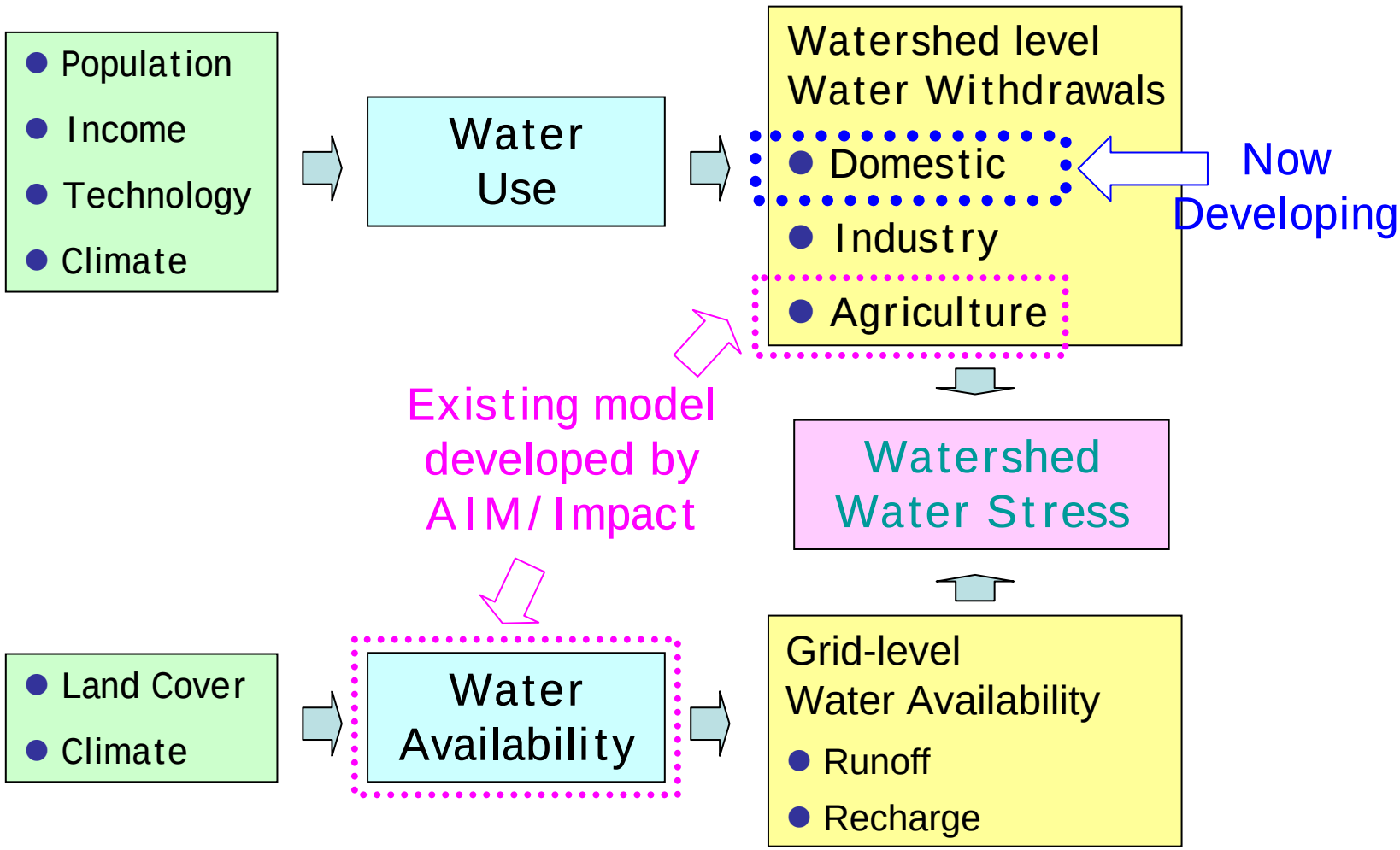
Presentation outline

- Background
  - Water issues
- Objectives of water management model development
  - Present situation of global water use
  - Millennium development goal
  - Improved water supply and sanitation
- Outline of model structure
  - Model concept
  - Model structure coupling with CGE model
  - Preliminary results
  - Future task

Water issues

- Water availability (Dr. Takahashi developed the model coupling with GCM data)
  - Global warming will lead to change of the global hydrological cycle
  - Changes in the total amount of precipitation and its frequency and intensity
  - Changes in the magnitude and timing of run-off and the intensity of floods and droughts
- Water supply and demand
  - Rapid increase of population and life style change caused by economic growth have increased water demand dramatically
- Basic water requirement for human activities
  - All peoples, whatever their stage of development and their social and economic conditions, have the right to have access to drinking water in quantities and of a quality equal to their basic needs (UN).
- Water quality degradation and health impacts (next step)
  - Wastewater treatment, Eutrophication, Diarrhea, etc…

Block diagram of impact model for water resources



Objectives of Water Management Model Development

- Objective of water management model development is to reinforce water demand part in the water resource model and link to CGE model
- Focus on water demand and water supply and sanitation services
  - Water demand
    - ✓ Sectoral assessment: Domestic, Industry, Agriculture
    - ✓ Water savings: Technology, System, Institution, Behavior
  - Access to improved water supply and sanitation
    - ✓ Millennium Development Goals 7, Target 10: Halve by 2015 the proportion of people without sustainable access to safe drinking water and basic sanitation
    - ✓ VISION 21: By 2025 to provide water, sanitation, and hygiene for all (Water Supply and Sanitation Collaborative Council)
  - Current situation of access to safe water and sanitation
    - Around 1.1 billion people globally do not have access to improved water supply, whereas 2.4 billion people do not have access to any type of improved sanitation. About 2 million people die every year due to diarrhoeal diseases.
- Assessment of optimal solution for sustainable water management

Overview of Water Management Model

- Target area: Global, Region, Country, County
- Unit area: Region, Country, County, City
- Basic concepts
  - Process type model
  - Separation of urban and rural area
  - Sector: Domestic, Industry, Agriculture
  - Assessment of …
    - ✓ domestic water demand considering water supply and sanitation conditions
    - ✓ environmental investment to achieve the target of access to safe water and sanitation
    - ✓ institutional, behavioral and technological water saving quantitative benefits

Linkage of CGE model and Domestic water demand

- Traditional method to estimate domestic water demand
  - Domestic water demand
    = Population * per capita water demand
  - ✓ Explanatory variable: Per capita GDP

- Advanced method to estimate domestic water demand linking to CGE model
  - Domestic water demand
    = Σ (Population by water supply service * per capita water demand by water supply service)
  - ✓ Explanatory variables : Investment cost, Per capita GDP, Life style change (installation of water savings)

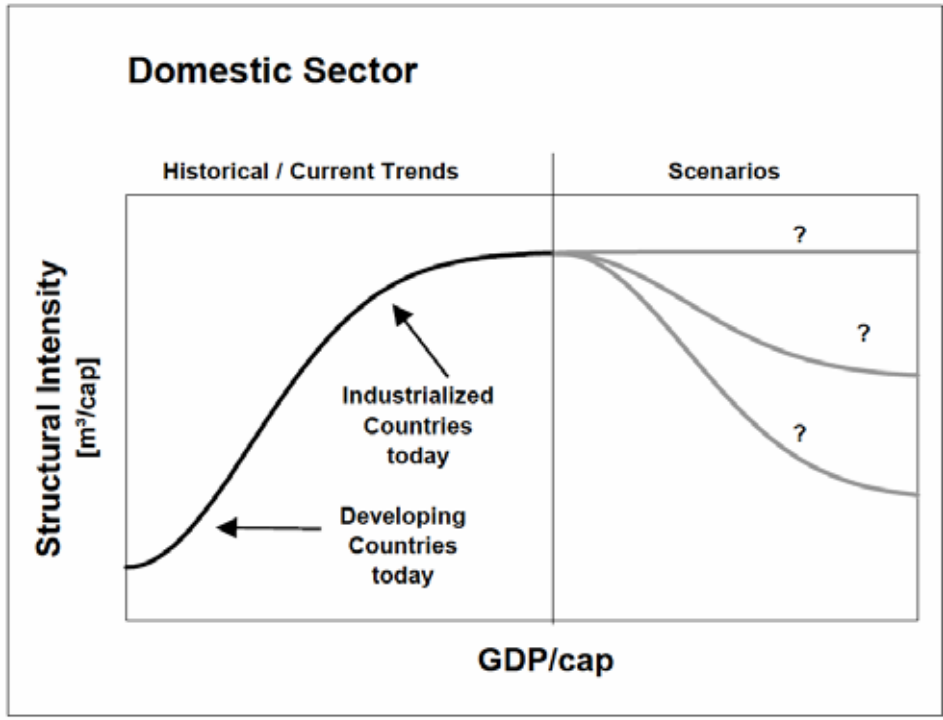
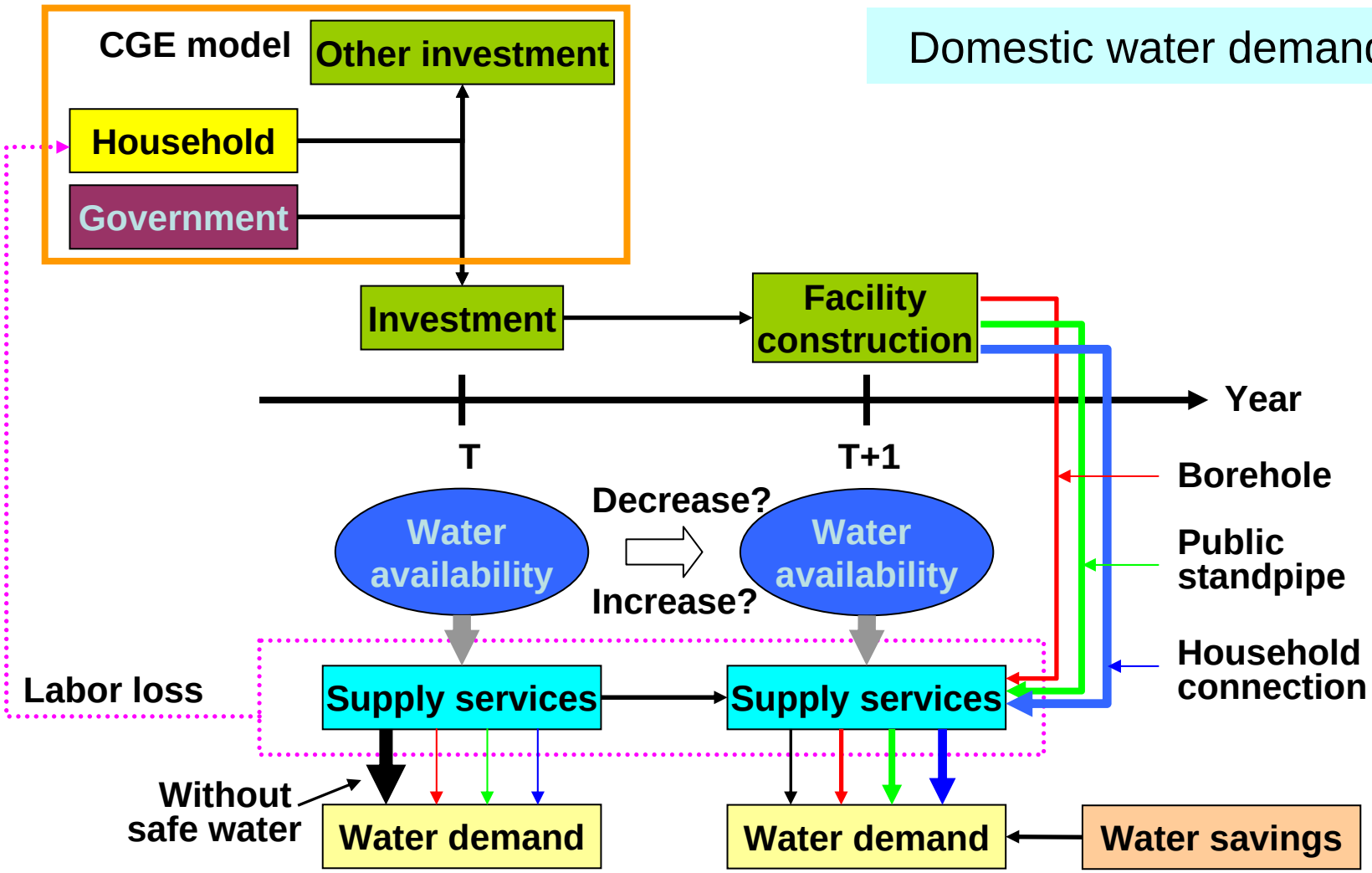


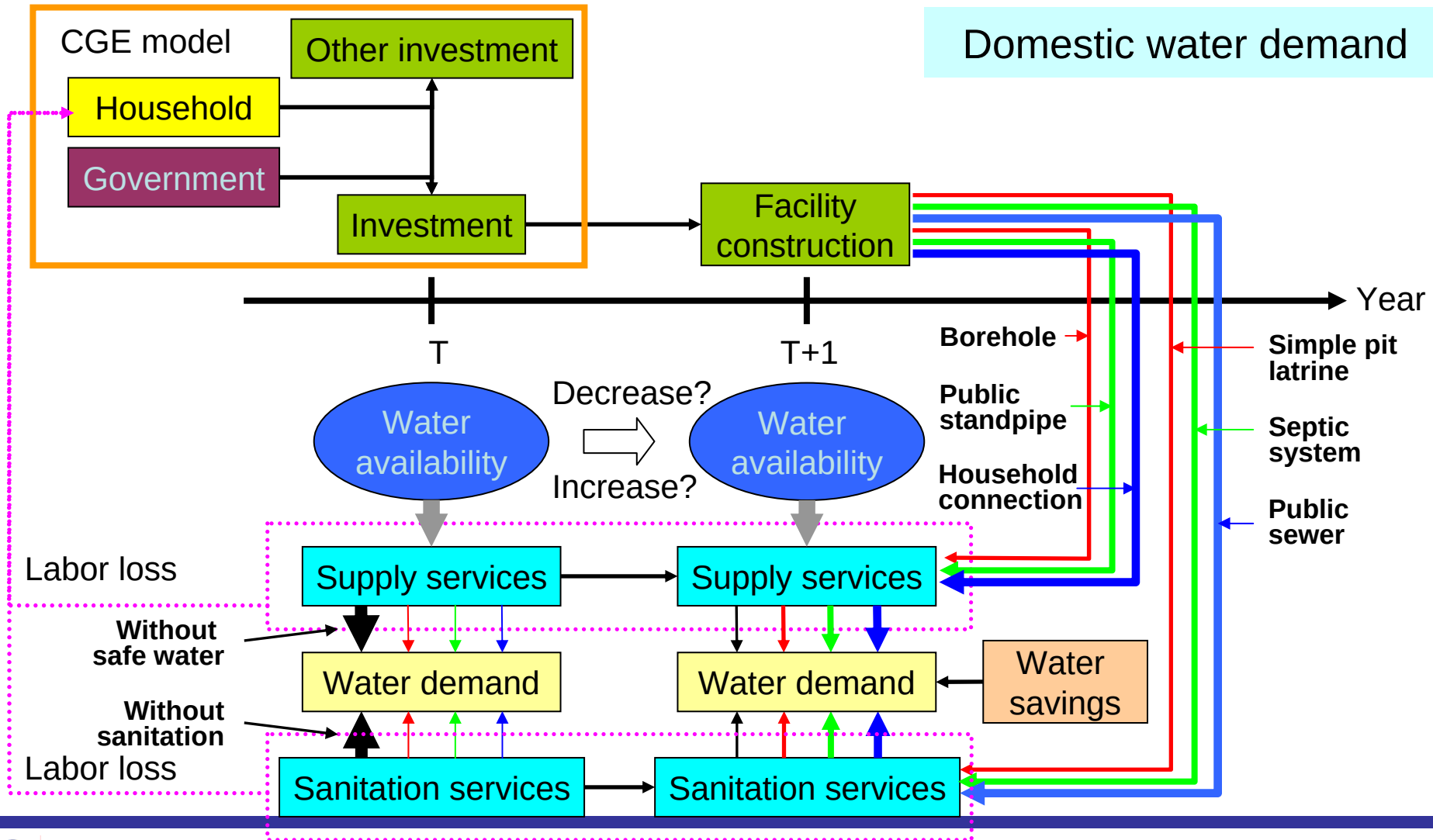
Figure 3 (a). Conceptual model of structural change in the domestic sector.

Alcamo, J., et al., World Water in 2025 Global modeling and scenario analysis for the World Commission on Water for the 21st Century, 2000

Structure of Water Management Model link to CGE model (1)



Structure of Water Management Model link to CGE model (2)



Category of “Improved” and “Not improved” water supply and sanitation technologies

BOX 1.5 WATER SUPPLY AND SANITATION TECHNOLOGIES CONSIDERED TO BE “IMPROVED” AND THOSE CONSIDERED TO BE “NOT IMPROVED”

The following technologies were considered “improved”:

Water supply	Sanitation
Household connection	Connection to a public sewer
Public standpipe	Connection to septic system
Borehole	Pour-flush latrine
Protected dug well	Simple pit latrine
Protected spring	Ventilated improved pit latrine
Rainwater collection	

The following technologies were considered “not improved”:

Water supply	Sanitation
Unprotected well	Service or bucket latrines (where excreta are manually removed)
Unprotected spring	Public latrines
Vendor-provided water	Open latrine
Bottled water[1]	
Tanker truck provision of water	

[1] *Not considered “improved” because of limitations concerning the potential quantity of supplied water, not the quality.*

Example of water management assessment

- Target:
  - Halve by 2015 the proportion of people without sustainable access to safe water and sanitation
  - By 2025 to provide water, sanitation, and hygiene for all
- Country (Country-wise projection): Bangladesh, Indonesia, Philippines
- Scenarios and Output:
  - Coverage of water supply and sanitation technologies
  - Investment, operation and management cost
  - Water supply volume (Water demand + Leakage)
  - Health impacts: Diarrheal mortality
- Base year: 2000, Target year: 2015, 2025
- Data: GDP, Population, Improved water supply and sanitation data, etc (Coverage, Cost, Unit water use (L/person/day), Potential risk of diarrhoeal mortality based on access to improved water and sanitation)

Household connection, Health impact

- Cost of Household connection (HC)
  - Total water use in HC = Residential water use + Commercial water use + Unaccounted for water (UfW)
  - Unit cost: $/m^3 ▸▸▸ assess benefits of UfW reduction
- Health impacts: Potential risk of diarrhoeal mortality
  - Assessment of potential risk based on access to safe water supply and sanitation excluding present condition and other related factors (medical, dietary, climate condition)

Scenario	Water supply	Sanitation	Diarrhoeal Risk
S1	HC	IS with SC	2.5
S2	IWS without HC	SC	4.5
S3	IWS without HC	IS without SC	6.9
S4	NIWS	IS with SC	6.9
S5	IWS with HC	NIS	8.7
S6	NIWS	NIS	11.0

HC: Household Connection, IWS: Improved Water Supply, NIES: Not Improved Water Supply, IS: Improved Sanitation, SC: Sewer Connection, NIS: Not Improved Sanitation,

Case 1 (without water savings)

- Target:
  - Halve by 2015 the proportion of people without sustainable access to safe water and sanitation
  - By 2025 to provide water, sanitation, and hygiene for all

- Case 1: Assessment of water supply cost and potential risk of diarrheal mortality under different conditions of access to safe water and sanitation
  - Case 1.1

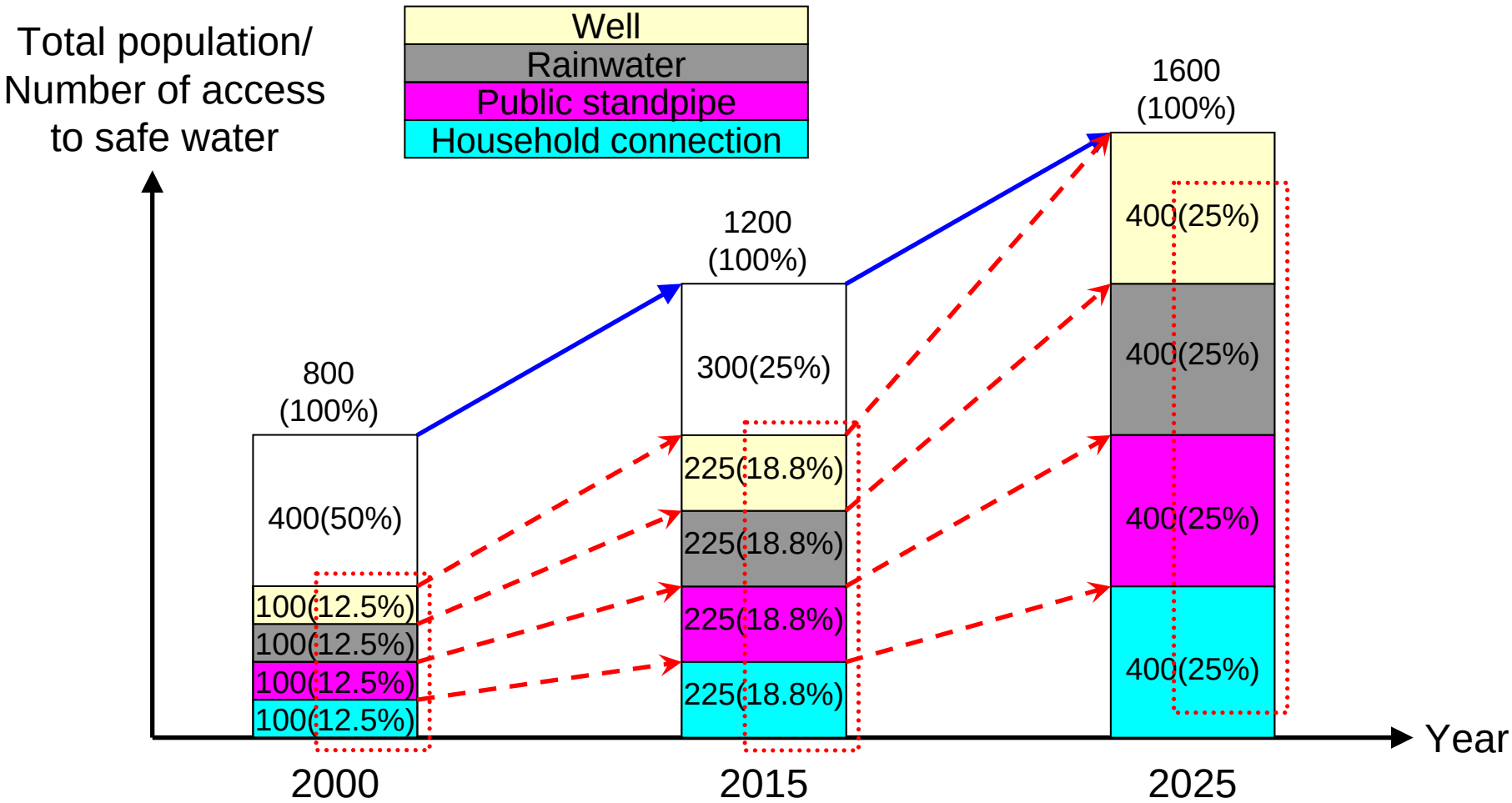
    Keep up present ratios between technologies until 2025
  - Case 1.2

    Provide household connection and sewer connection for all by 2025
  - Case 1.3

    Provide cheap technologies (Well/Pond/Borehole and VIP/Simple pit latrine) for additional people who can access to improved water and sanitation

Case 1.1

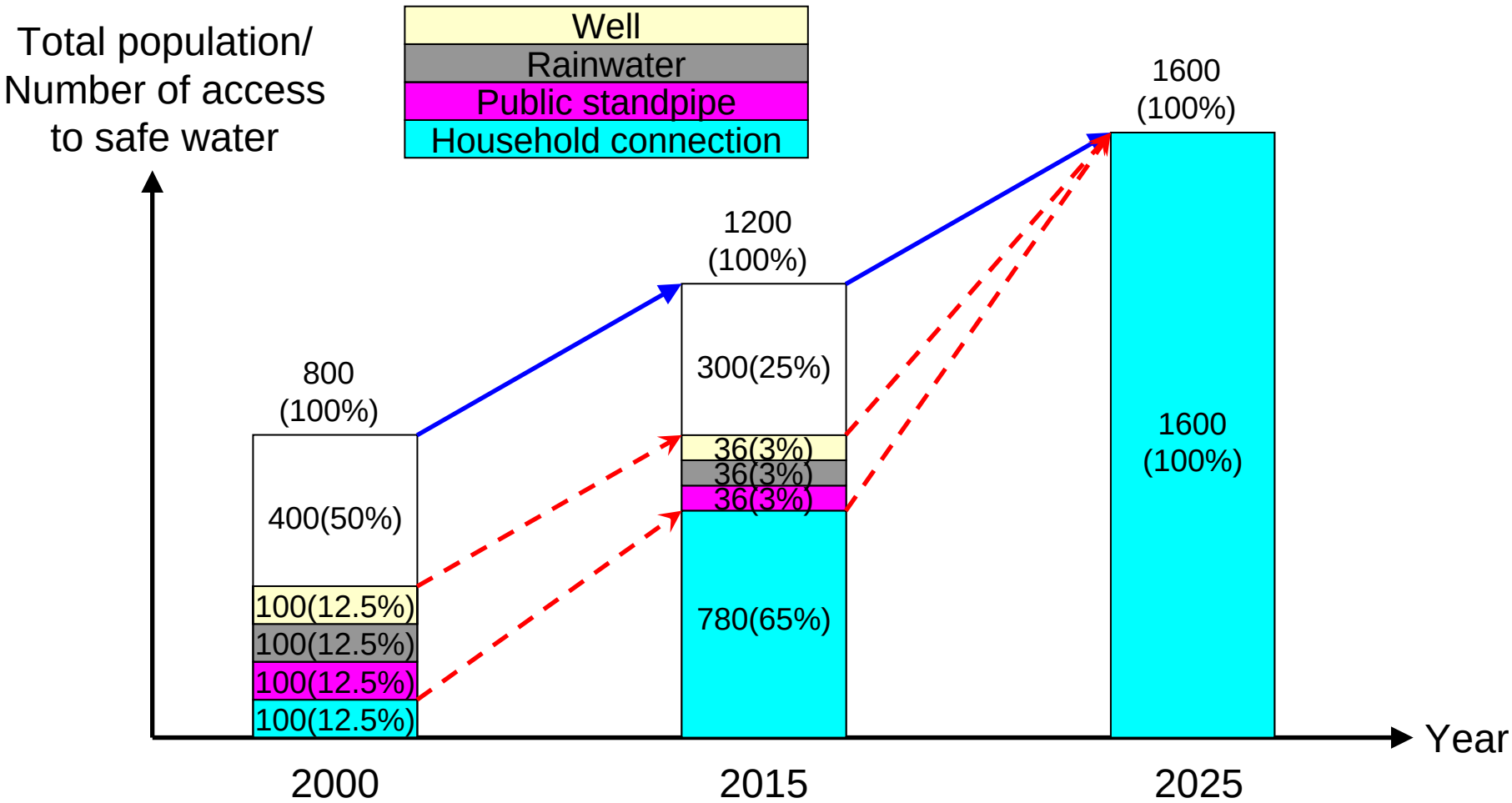
- Constant ratios between coverage of water supply and sanitation



- Number of access to safe water and percentage: example

Case 1.2

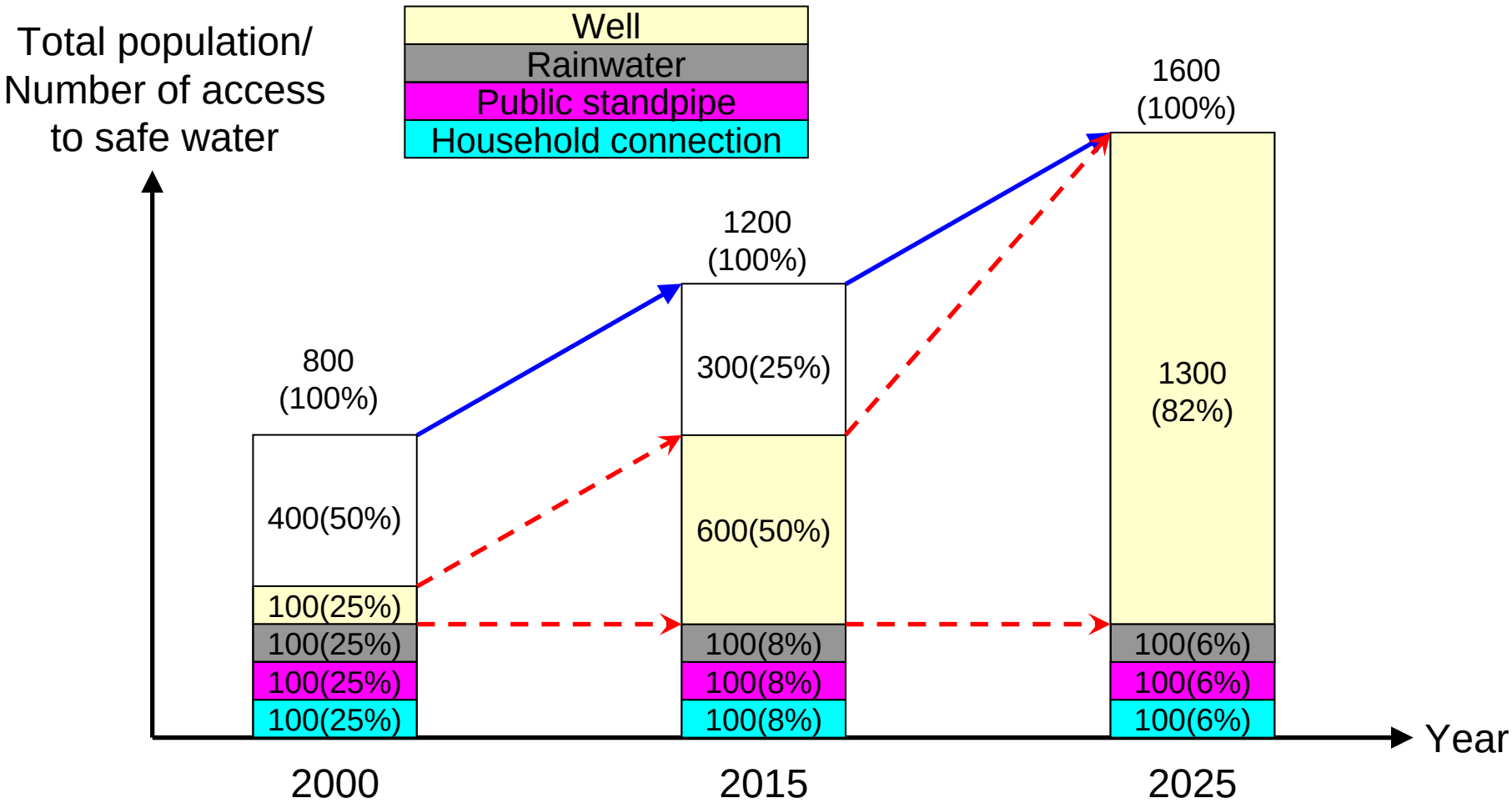
- Linear increase of Household Connection coverage
- Provide household connection for all by 2025



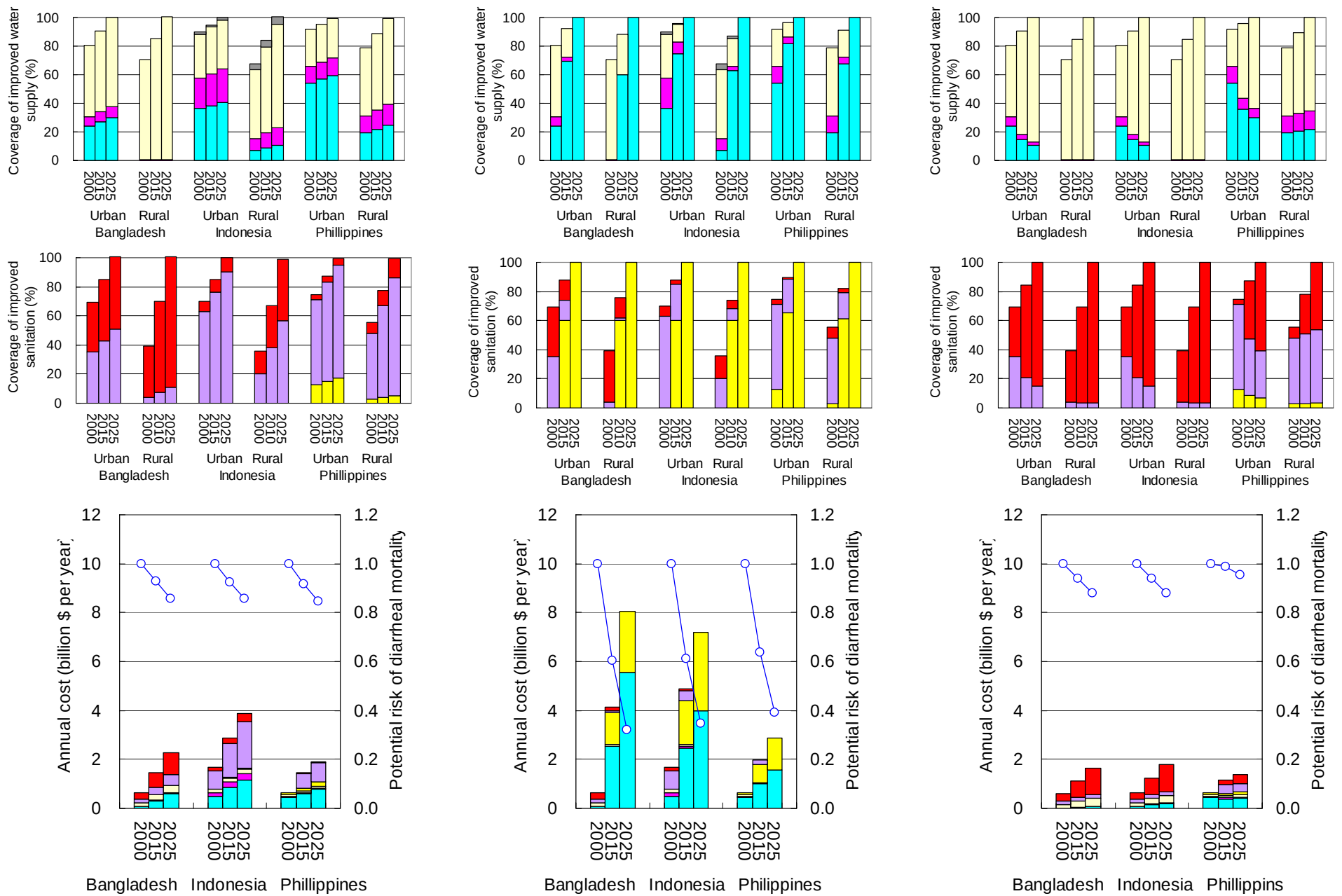
◆ Number of access to safe water and percentage: example

Case 1.3

- Additional people with safe water are served by Well
- Numbers of access to Household Connection, Public Standpipe and Rainfall are constant



◆ Number of access to safe water and percentage: example


Coverage of improved water supply (%)
Coverage of improved sanitation (%)
Annual cost (billion $ per year)
Potential risk of diarrheal mortality
2000
2015
2025
2010
Urban
Rural
Bangladesh
Indonesia
Phillippines
Philippines
Phillippins
Case 1.1
Case 1.2
Case 1.3
Household connection
Sewer connection
Public standpoint
Septic tank
Well/Pond/Borehole
VIP/Simple pit latrine
Rainwater
Diarreha

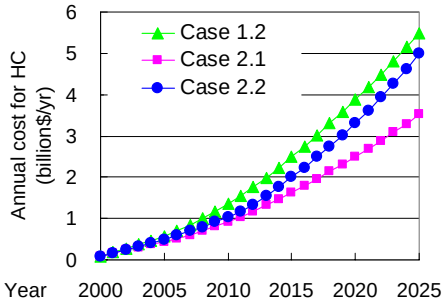
Case 2 (with water savings)

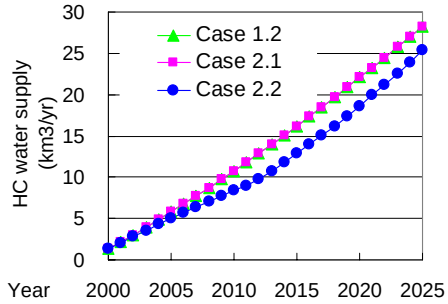
- Assessment of water saving benefits under same safe water and sanitation coverage of Case 1.2 (Provide household connection and sewer connection for all by 2025)

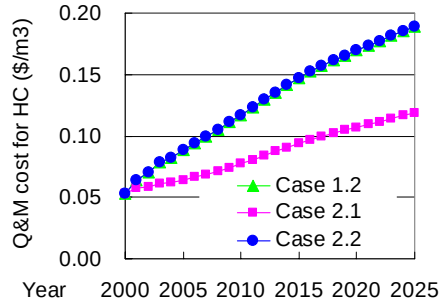
  - Efficiency of water supply management
    - ✓ Annual cost = Investment cost + Operation and Maintenance cost
      - – Actual O&M = C_t/m_t, $m_t = 1-m^0*\exp(1-\beta t)$
      - – m^0 is estimated by “Number of staff/connection”
    - ◆ Case 2.1: Improvement of water supply management (β =2%)
      - ✓ Case 1.2: β =1%

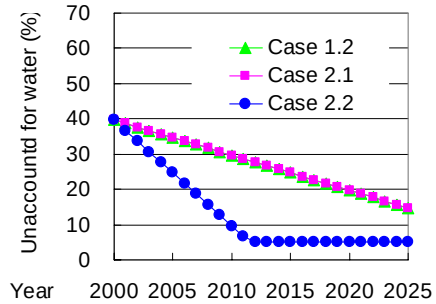
  - Reduction of Unaccounted for water
    - ✓ Reduction cost: 50% of investment unit cost
    - ✓ Minimum UfW ratio: 5%
    - ◆ Case 2.2: Improvement of UFW (Reduction rate = 3%/yr)
      - ✓ Case 1.2:Reduction rate=1%/yr

Bangladesh

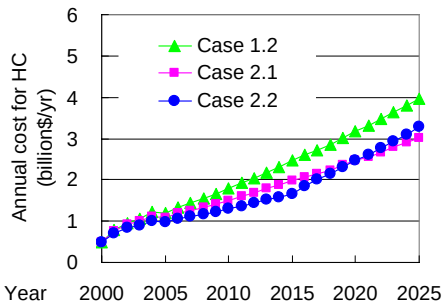


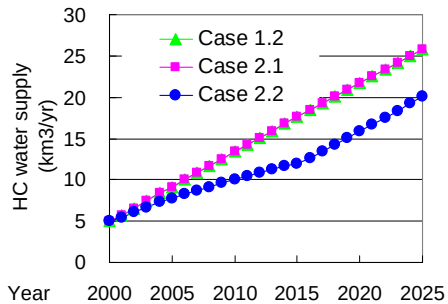


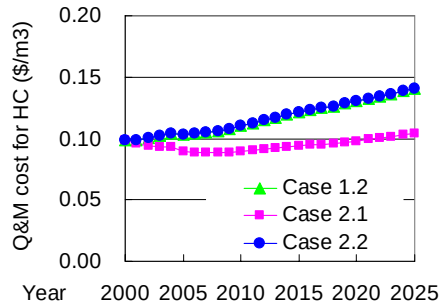


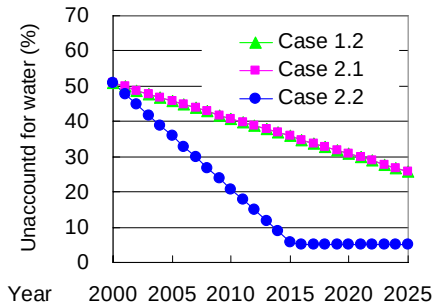


Indonesia

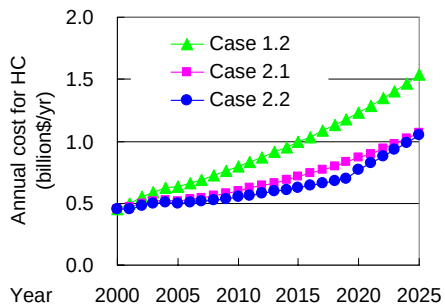


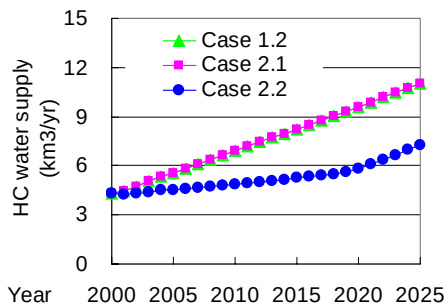


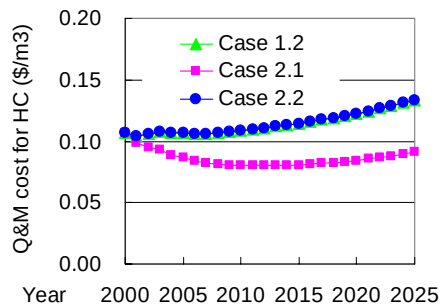


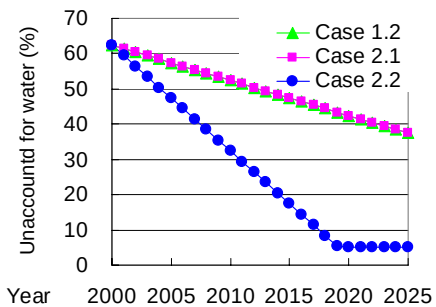


Philippines









Annual cost for HC | **Annual HC water supply** | **O&M cost for HC** | **Unaccounted for water**

- **Case 2.1: Improvement of water supply management (β =2%), Case 1.2: β =1%**
- **Case 2.2: Improvement of UFW (Reduction rate = 3%/yr), Case 1.2:Rr=1%/yr**

Conclusion

- Development of water management model to analyze future domestic water demand, investment costs and health impacts (diarrhea mortality) considering condition of access to safe water and sanitation
  - ✓ Achievement of Millennium Development Goals 7, Target 10
  - ✓ Quantitative analysis on benefits of water savings

- Nest step
  - ✓ Development of industrial water use model
  - ✓ Link to CGE model and water resource model