New JICA’s Initiative on Climate Change Adaptation in Water Related Disasters

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Global Environmental Department
Japan International Cooperation Agency

2010 Asia Pacific Water Forum GC
2 July 2010, Singapore
1. Situation in Japan
2. Stationarity is dead
3. JICA’s new initiative
4. Case study
   - Tagaloan River Basin in the Philippines -
Recent change on Climate in Japan

Daily rainfall over 200mm is significantly increasing

Incidence of daily rainfall over 200mm per year

- **1901~1930**
  - Average: 3.5 days
  - Source: JMA

- **1978~2007**
  - Average: 5.1 days
  - Source: JMA

Hourly rainfall over 100mm is increasing

Incidence of hourly rainfall over 100mm per year

- **1976~1986**
  - Average: 1.7 days
  - Source: JMA

- **1987~1997**
  - Average: 2.0 days
  - Source: JMA

- **1998~2008**
  - Average: 3.6 days
  - Source: JMA

Source: JMA
### Areas with increased rainfall amount

Future rainfall amounts predicted
**Average rainfall in 2080-2099 period**
**Average rainfall in 1979-1998 period**

maximum daily precipitation
GCM20 (A1B scenario)

<table>
<thead>
<tr>
<th></th>
<th>Region</th>
<th>Rainfall Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hokkaido</td>
<td>1.24</td>
</tr>
<tr>
<td>2</td>
<td>Tohoku</td>
<td>1.22</td>
</tr>
<tr>
<td>3</td>
<td>Kanto</td>
<td>1.11</td>
</tr>
<tr>
<td>4</td>
<td>Hokuriku</td>
<td>1.14</td>
</tr>
<tr>
<td>5</td>
<td>Chubu</td>
<td>1.06</td>
</tr>
<tr>
<td>6</td>
<td>Kinki</td>
<td>1.07</td>
</tr>
<tr>
<td>7</td>
<td>Southern Kii</td>
<td>1.13</td>
</tr>
<tr>
<td>8</td>
<td>San-in</td>
<td>1.11</td>
</tr>
<tr>
<td>9</td>
<td>Setouchi</td>
<td>1.10</td>
</tr>
<tr>
<td>10</td>
<td>Southern Shikoku</td>
<td>1.11</td>
</tr>
<tr>
<td>11</td>
<td>Kyushu</td>
<td>1.07</td>
</tr>
</tbody>
</table>

**Legend**
- Section under the direct jurisdiction of Ministry of Land, Infrastructure and Transport
- Designated section (under the jurisdiction of governor)
- Border between prefectures

3. Impacts of heavy rains
6. Japan’s response to climate change

(i) Adaptation measures based on regional development through such actions as restrictions on and review of land use
(ii) Adaptation measures centering around risk management

Image of adaptation measures in future

Red figures indicate present degree of safety against flood.
Blue figures indicate future degree of safety against flood.

Present

Future (For example, after 100 years)

Degree of safety against flood presently aimed at
Degree of safety against flood currently secured
Degree of safety against flood currently aimed at in 100 years’ time
Degree of safety against flood currently secured

1/150
1/70
1/40
1/20

Deterioration of the degree of safety against flood currently secured

Reconfiguration of river improvement for increasing external force

Adaptation by Structural measures

comprehensive flood control etc
2. Stationarity is dead
2. Stationarity is Dead\textsuperscript{1)}
we are in trouble

 Satoshi M Uemura

\begin{itemize}
  \item Conventional Method of Water Planning
    Assumption: fluctuate within an unchanging envelope of variability
  \item Under changing and uncertain climate
    \begin{itemize}
      \item Climate is changing
      \item Prediction possible, but with uncertainty
    \end{itemize}
  \item Prediction possible, but with uncertainty
\end{itemize}

Designing methods of water infrastructures are needed
River bank heights, dam reserve capacity, bridge heights etc.


Furthermore……
2. Stationarity is Dead

Society to sustainably response changes

1. to respond continuously changing climate
2. to plan and implement infrastructure projects through predicting future impacts with uncertainty
3. to change systems of water management according to developing technology for prediction and adaptation of climate change
2. Stationarity is Dead
Is flood Control Philosophy Dead, also?

- Can we continue to construct higher dykes according to increasing flood scale?
2. Stationarity is Dead
Flood Control Philosophy is Dead as Well.

- Conventional philosophy is abandoned.
  “Long liner bank system along river from river mouth to mountain”

- Proposed philosophy
  “Multi-layered measures in river basin”
  1) Step 1: Strategic area protect by structures
  2) Step 2: Urban planning and land use regulation for risk areas
  3) Step 3: CBDM
3. JICA’s new initiative
**<conventional project>**

Objective: to mitigate human and economic losses

- Historical hydro-meteorological data
- Target setting
  - To decide target floods scale based on probability analysis
  - Run-off Analysis

**<Climate Change Adaptation Project>**

Objective: to minimize human loss

- Climate Change Prediction
- Evaluation on Impact on Extreme Events by Climate Change
- Runoff and Inundation analysis
- Target setting
  - 1) Strategic Area Protection by Structural Measures
  - 2) Land Use Regulation
  - 3) Community-based Risk Management

**River Basin Governance**

- Urban, Regional Planning (land use regulation)
- Non-structural Measures (early warning,Evacuation)
- CBDM
- Poverty Alleviation, Vulnerability Consideration

**<Project>**

- Structural Measures (such as river bank, and dam)
- Non-structural Measures (such as flood early warning)
Climate change perdition ensemble of GCM
Climate change perdition
Study in South Western Sri Lanka

Study Area

<table>
<thead>
<tr>
<th>River Basin</th>
<th>C.A.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kalu River basin</td>
<td>2,719km²</td>
</tr>
<tr>
<td>Kelani River basin</td>
<td>2,292km²</td>
</tr>
<tr>
<td>Gin River basin</td>
<td>932km²</td>
</tr>
<tr>
<td>Nilwara River basin</td>
<td>971km²</td>
</tr>
</tbody>
</table>

Study Schedule

21 months
(from January 2010 to September 2011)

<table>
<thead>
<tr>
<th></th>
<th>First Year</th>
<th>Second Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work in Sri Lanka</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work in Japan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Climate change perdition

**Study in South Western Sri Lanka**

<table>
<thead>
<tr>
<th>(1) Data Collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Projected Rainfall Data from CMIP3</td>
</tr>
<tr>
<td>Recorded Rainfall Data in Project Area</td>
</tr>
<tr>
<td>Mesh Rainfall data from APHRODITE daily precipitation</td>
</tr>
</tbody>
</table>

| (2) Examination of Appropriateness of **GCM20** by Comparison with CMIP3 Rainfall Data |

| (3) **Bias Correction** and **Statistic Downscaling** |

| (4) Evaluation of Flood Risk (Hydrological and Hydraulic Analyses) |

*Note: CMIP3: Phase 3 of Coupled Model Intercomparison Project
GCM20: General Circulation Model (20km grid)
APHRODITE: Asian Precipitation-High Resolved Observational Data Integration Towards Evaluation of the Water Resources*
Climate change
adaptation measures

- Governance at river basin level
  - various sectors, organizations, stakeholders are involved
  - Need for consensus building and responsibility sharing
- Land use regulation
- Capacity Development
4. Case study
4-1 Tagaloan River Basin, the Philippines

100 yrs flood → 25-50yr flood in 2100
50 yrs flood → 25yr flood in 2050
<table>
<thead>
<tr>
<th>Scenario</th>
<th>Increase rate of rainfall intensity (%)</th>
<th>Return period (year)</th>
<th>Design rainfall (mm)</th>
<th>Probable Flood Discharge (m³/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>5yr</td>
<td>10yr</td>
<td>25yr</td>
</tr>
<tr>
<td>Status quo</td>
<td>-</td>
<td>125</td>
<td>142</td>
<td>164</td>
</tr>
<tr>
<td>A1F1 2050</td>
<td>11</td>
<td>150</td>
<td>170</td>
<td>197</td>
</tr>
<tr>
<td></td>
<td>2100</td>
<td>161</td>
<td>183</td>
<td>211</td>
</tr>
<tr>
<td>B1 2050</td>
<td>20</td>
<td>138</td>
<td>157</td>
<td>182</td>
</tr>
<tr>
<td></td>
<td>2100</td>
<td>142</td>
<td>162</td>
<td>187</td>
</tr>
</tbody>
</table>
Tagaloan River Basin, the Philippines

Planning

Original MP

Revised MP
4-2. Metro Manila Suburb, Philippines: Cavite Area

**Table:**

<table>
<thead>
<tr>
<th>River Basin</th>
<th>Catchments Area (km²)</th>
<th>River Length (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imus</td>
<td>115.5</td>
<td>45.0</td>
</tr>
<tr>
<td>San Juan</td>
<td>147.76</td>
<td>43.4</td>
</tr>
<tr>
<td>Canas</td>
<td>112.32</td>
<td>42.0</td>
</tr>
<tr>
<td>Residual</td>
<td>32.84</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>407.4</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Graph:**

- $Q_p = 880 \text{ m}^3/\text{s}$
- $Q_p = 1,090 \text{ m}^3/\text{s}$ Year 2050 under Scenario B1
- $Q_p = 1,300 \text{ m}^3/\text{s}$ Year 2050 under Scenario A1 FI

**Fig. 1 General Map of Study Area**
<table>
<thead>
<tr>
<th>Case No.</th>
<th>Scenario of Climate Change</th>
<th>Urbanized Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Status Quo</td>
<td>26%*</td>
</tr>
<tr>
<td>2</td>
<td>States Quo</td>
<td>43%**</td>
</tr>
<tr>
<td>3</td>
<td>In 2050 under B1 Scenario</td>
<td>43%**</td>
</tr>
<tr>
<td>4</td>
<td>In 2050 under A1FI Scenario</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>States Quo</td>
<td>65%***</td>
</tr>
<tr>
<td>6</td>
<td>In 2050 under B1 Scenario</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>In 2050 under A1FI Scenario</td>
<td></td>
</tr>
</tbody>
</table>

### Probable Flood Inundation Area (km²)

<table>
<thead>
<tr>
<th></th>
<th>Flood Depth below 1m</th>
<th>Flood Depth above 1m</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status Quo</td>
<td>31.51</td>
<td>1.05</td>
<td>32.56</td>
</tr>
<tr>
<td>States Quo</td>
<td>35.82</td>
<td>1.50</td>
<td>37.32</td>
</tr>
<tr>
<td>In 2050 B1</td>
<td>41.10</td>
<td>2.52</td>
<td>43.62</td>
</tr>
<tr>
<td>In 2050 A1FI</td>
<td>44.64</td>
<td>3.54</td>
<td>48.18</td>
</tr>
<tr>
<td>States Quo</td>
<td>41.05</td>
<td>2.45</td>
<td>43.50</td>
</tr>
<tr>
<td>In 2050 B1</td>
<td>43.92</td>
<td>2.97</td>
<td>46.89</td>
</tr>
<tr>
<td>In 2050 A1FI</td>
<td>47.27</td>
<td>3.98</td>
<td>51.25</td>
</tr>
</tbody>
</table>

### Number of Houses/Buildings Inundated (thousand houses)

<table>
<thead>
<tr>
<th></th>
<th>Flood Depth below 1m</th>
<th>Flood Depth above 1m</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status Quo</td>
<td>20.1</td>
<td>1.7</td>
<td>21.8</td>
</tr>
<tr>
<td>States Quo</td>
<td>31.4</td>
<td>2.9</td>
<td>34.4</td>
</tr>
<tr>
<td>In 2050 B1</td>
<td>35.5</td>
<td>4.4</td>
<td>39.9</td>
</tr>
<tr>
<td>In 2050 A1FI</td>
<td>38.4</td>
<td>5.9</td>
<td>44.3</td>
</tr>
<tr>
<td>States Quo</td>
<td>56.4</td>
<td>7.2</td>
<td>63.6</td>
</tr>
<tr>
<td>In 2050 B1</td>
<td>60.1</td>
<td>8.5</td>
<td>68.6</td>
</tr>
<tr>
<td>In 2050 A1FI</td>
<td>63.0</td>
<td>11.2</td>
<td>74.2</td>
</tr>
</tbody>
</table>

Note:

*: The present urbanized ratio as of 2003
**: The urbanized ratio in 2020 proposed by the JICA Study Team
***: The urbanized ratio in 2020 projected by the local governments
3. *multiplication of CC and Urbanization*

- 都市化 Urbanization
- 気候変動 Climate Change
- 降雨 Rain
- 海面上昇 Sea Level
- 表面流 Surface flow
- 洪水 Floods volume
- 危険地域の家屋 Houses at risk area
- 危険地域 Risk area
適応策検討 Climate Change Adaptation

遊水地計画を将来拡張する可能性
→都市計画に開発抑制地域として線引き

1. 河川工事・遊水地
River improvement works

Legend
- Zone A
- Zone B1
- Zone B2
- Zone C

Off-site Flood Retarding Basin
Partial River Improvement Section
### Climate Change Adaptation

#### Land Use Control

<table>
<thead>
<tr>
<th>Description</th>
<th>Peak River Discharge before Retarding</th>
<th>Peak River Discharge after Retarding</th>
<th>Reduction of Peak Discharge</th>
<th>Storage Volume</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proposed in the Study</td>
<td>430 m$^3$/s</td>
<td>245 m$^3$/s</td>
<td>185 m$^3$/s</td>
<td>1.87 (10$^6$m$^3$)</td>
<td>45ha</td>
</tr>
<tr>
<td>Required in 2050 B1 Scenario</td>
<td>550 m$^3$/s</td>
<td>245 m$^3$/s</td>
<td>305 m$^3$/s</td>
<td>3.01 (10$^6$m$^3$)</td>
<td>75ha</td>
</tr>
<tr>
<td>Required in 2050 A1FI scenario</td>
<td>690 m$^3$/s</td>
<td>245 m$^3$/s</td>
<td>445 m$^3$/s</td>
<td>4.06 (10$^6$m$^3$)</td>
<td>100ha</td>
</tr>
</tbody>
</table>
On-site Flood Regulation Pond
(3% of Sub-Division)

- Offset increment of peak runoff discharge
- Control sediment runoff

Dry Type

Wet Type

Climate Change Adaptation
On-site Regulation ponds

気候変動適応
宅地での調整池

On-site Flood Regulation Pond

Creek
適応策  Climate Change Adaptation
ソフト対策  Software measures

Flood Hazard Map (Kawit)

What to do in the event of flood:
- Keep the weather news to always be aware of.
- Stay away from low-lying areas and high-pressure areas.
- Avoid driving onto floods and stay at home.
- If you are in a flood-prone area, switch off the power.
- Children and old and sick people should evacuate. (emergency contact: 864-703, 864-704, 864-705, 864-706)
適応策  Climate Change Adaptation
コミュニティ防災  Community based disaster management
適応策 Climate Change Adaptation
コミュニティ防災 Community based disaster management
JICA handbook

Ver.0 was produced (sorry only in Japanese)

Ver.1 will be issued at the end of FY2010
Comments are welcomed
Okiura.Fumihiko@jica.go.jp
Figure H13. Cost and Benefit of Adaptation

Note: ‘mean’ indicates the average outcome of the simulations and the range of estimates from the 5th to the 95th percentile is shaded area. Benefit in terms of avoided damage is based on A2 scenario.

Source: ADB study team.

Stern: better spend 1% GDP now, than 5% GDP later!