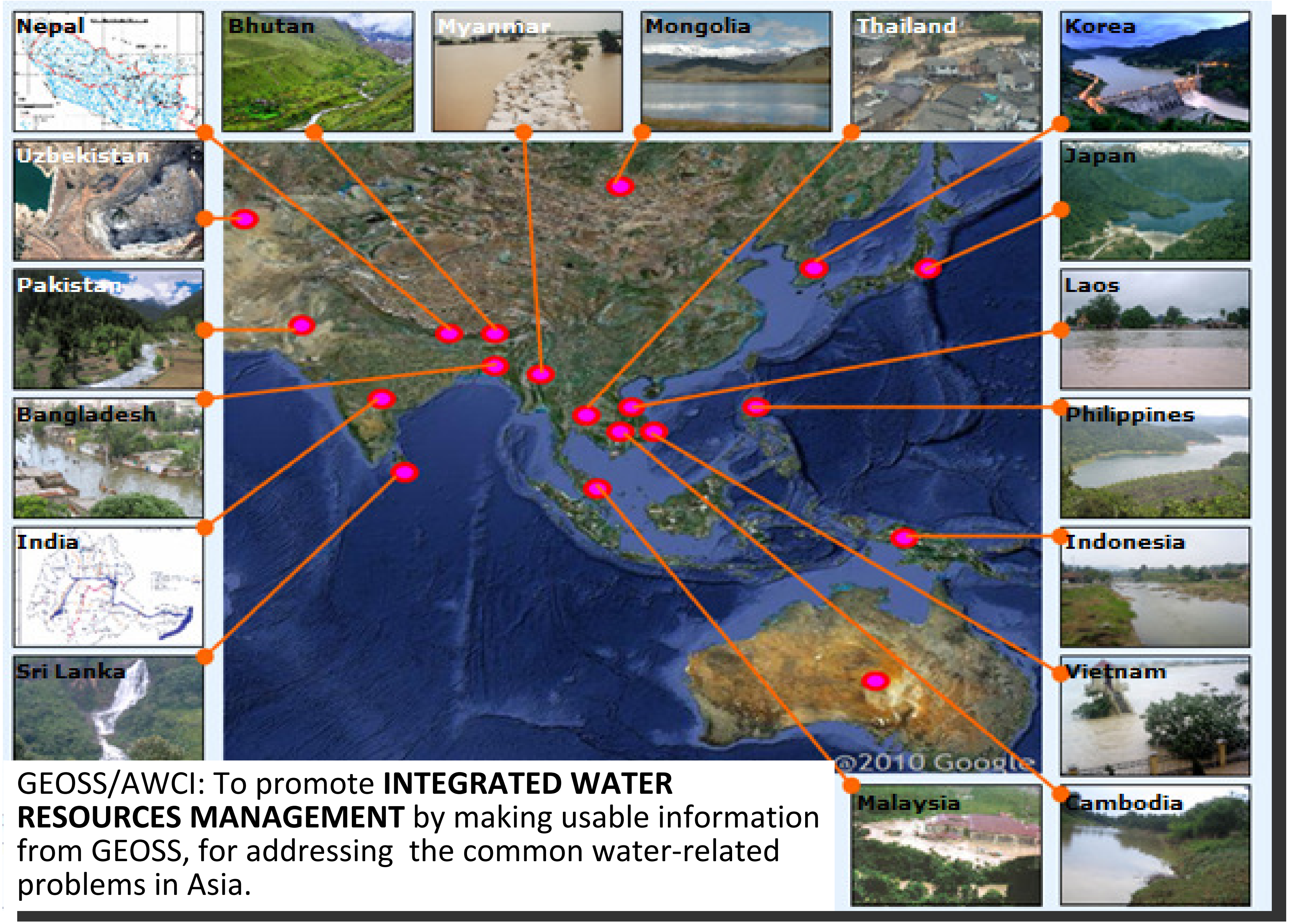
# 8th Meeting of the GEOSS/AWCI-ICG & 1st AWCI Climate Change Assessment and Adaptation Workshop

# COUNTRY REPORT OF MALAYSIA: LANGAT DEMONSTRATION PROJECT AND CLIMATE CHANGE ASSESSMENT AND ADAPTATION (CCAA)

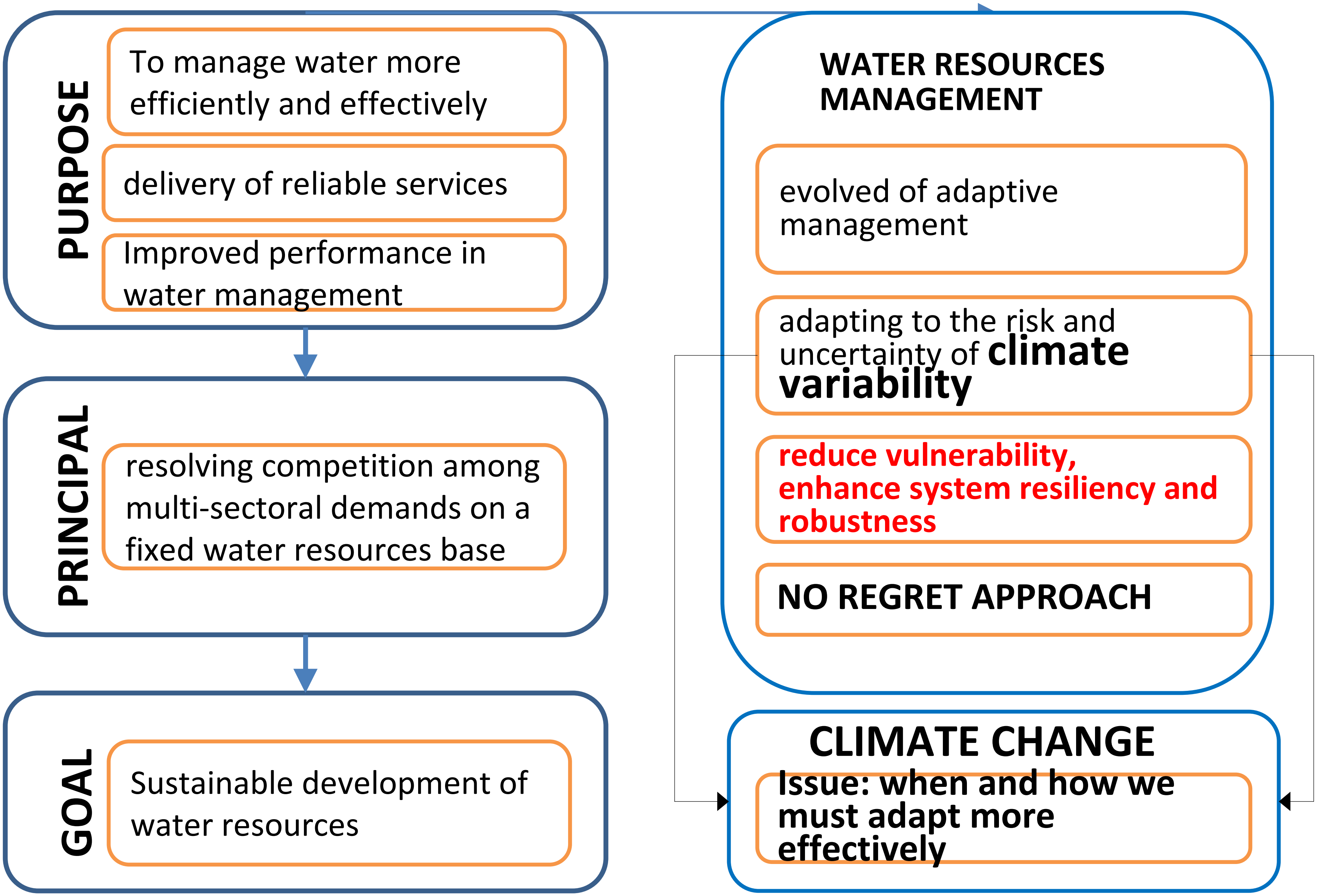
**IR. MOHD ZAKI M.AMIN**
National Hydraulic Research Institute of Malaysia
Ministry of Natural Resources & Environment

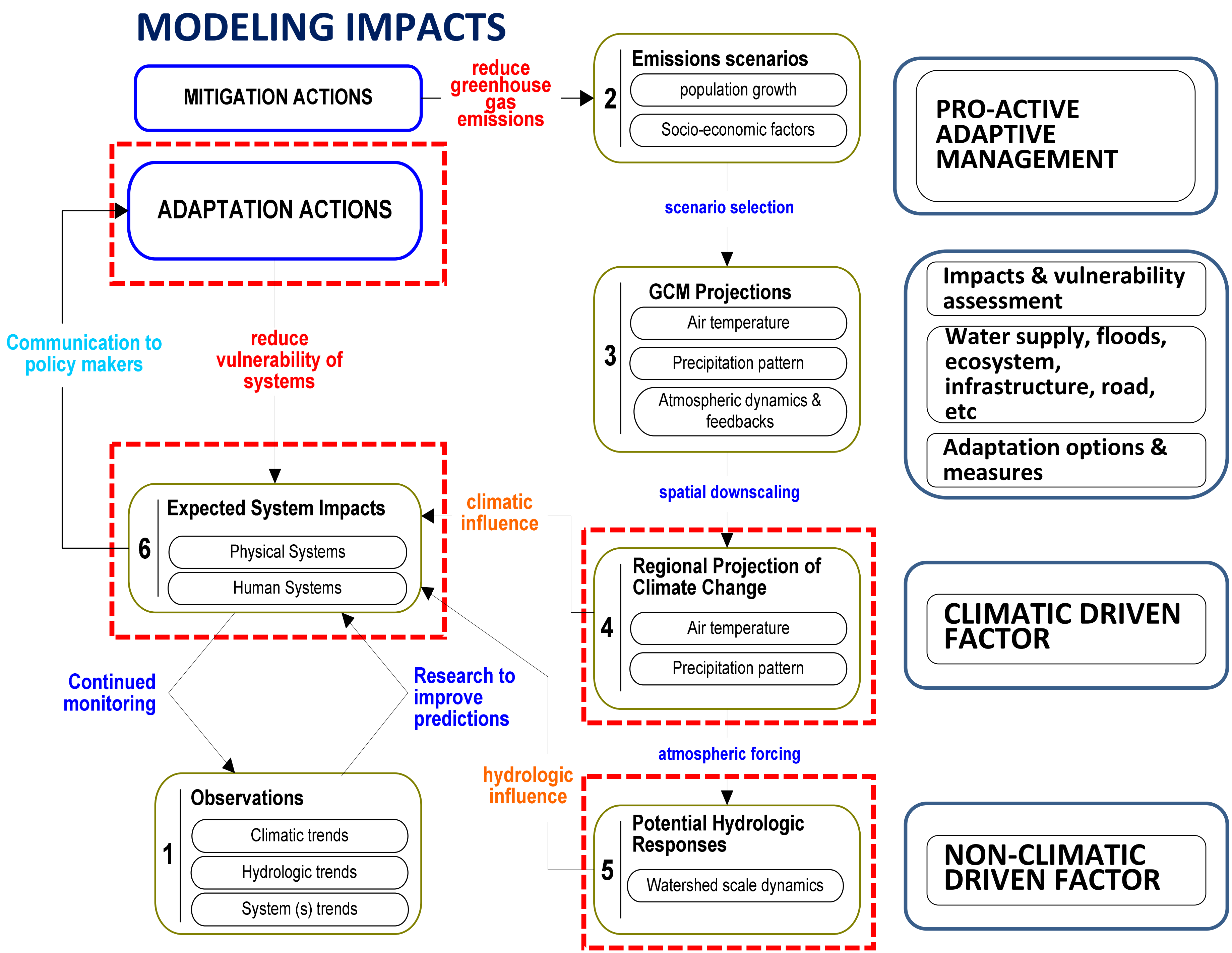
**OCT. 06, 2011**

**SEOUL, KOREA**

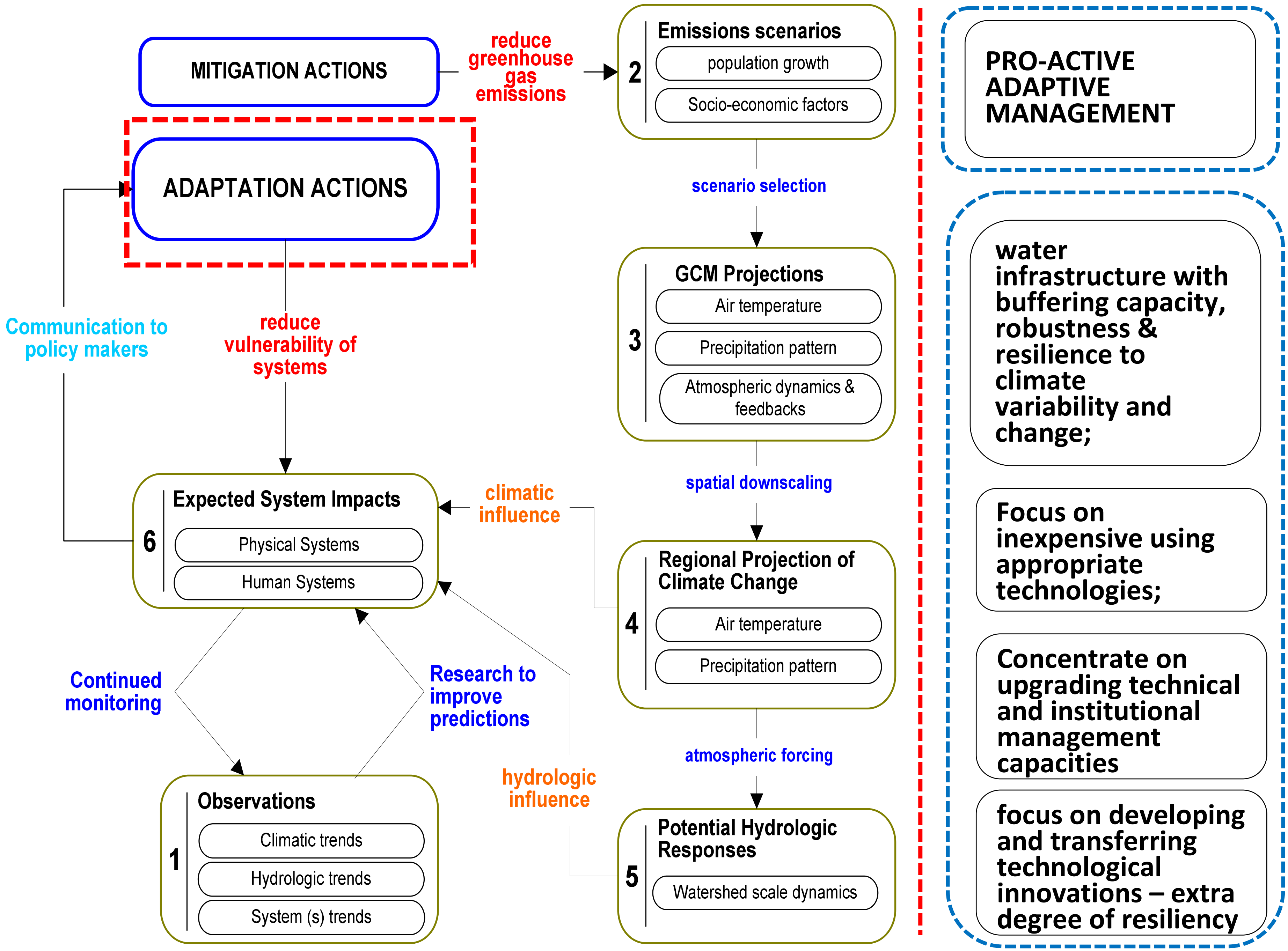



GEOSS/AWCI: To promote **INTEGRATED WATER RESOURCES MANAGEMENT** by making usable information from GEOSS, for addressing the common water-related problems in Asia.


PURPOSE
To manage water more efficiently and effectively
delivery of reliable services
Improved performance in water management
PRINCIPAL
resolving competition among multi-sectoral demands on a fixed water resources base
GOAL
Sustainable development of water resources
WATER RESOURCES MANAGEMENT
evolved of adaptive management
adapting to the risk and uncertainty of climate variability
reduce vulnerability, enhance system resiliency and robustness
NO REGRET APPROACH
CLIMATE CHANGE
Issue: when and how we must adapt more effectively



MODELING IMPACTS
MITIGATION ACTIONS
reduce greenhouse gas emissions
2
Emissions scenarios
population growth
Socio-economic factors
PRO-ACTIVE ADAPTIVE MANAGEMENT
ADAPTATION ACTIONS
scenario selection
3
GCM Projections
Air temperature
Precipitation pattern
Atmospheric dynamics & feedbacks
Impacts & vulnerability assessment
Water supply, floods, ecosystem, infrastructure, road, etc
Adaptation options & measures
Communication to policy makers
reduce vulnerability of systems
spatial downscaling
6
Expected System Impacts
Physical Systems
Human Systems
climatic influence
4
Regional Projection of Climate Change
Air temperature
Precipitation pattern
CLIMATIC DRIVEN FACTOR
Continued monitoring
Research to improve predictions
atmospheric forcing
hydrologic influence
1
Observations
Climatic trends
Hydrologic trends
System (s) trends
5
Potential Hydrologic Responses
Watershed scale dynamics
NON-CLIMATIC DRIVEN FACTOR


MITIGATION ACTIONS
reduce greenhouse gas emissions
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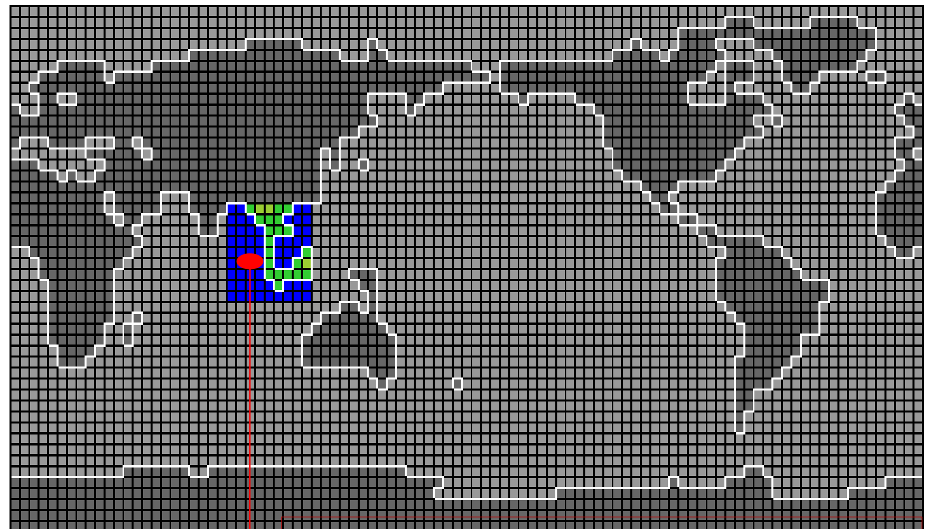
1
Climatic trends
Hydrologic trends
System (s) trends
Potential Hydrologic Responses
5
Watershed scale dynamics
PRO-ACTIVE ADAPTIVE MANAGEMENT
water infrastructure with buffering capacity, robustness & resilience to climate variability and change;
Focus on inexpensive using appropriate technologies;
Concentrate on upgrading technical and institutional management capacities
focus on developing and transferring technological innovations – extra degree of resiliency

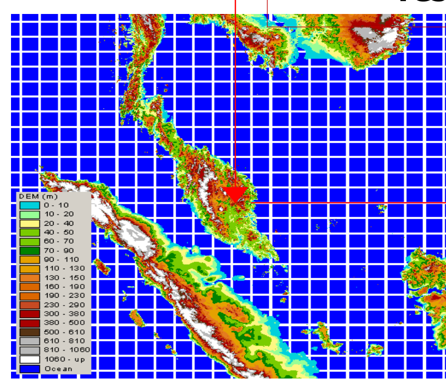
# Impacts Assessment

## Research on the Impacts of Climate Change on Hydrologic Regime & Water Resources

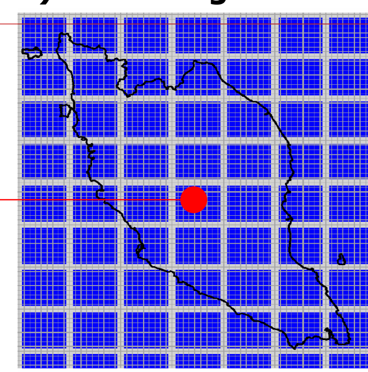
- **Regional Climate Model: prerequisite in identification of climate change impact**
- **2006:** A regional hydrologic-atmospheric model of Peninsular Malaysia called as '**Regional Hydro-climate Model of Peninsular Malaysia (RegHCM-PM)** was developed
- **Downscaling** global climate change simulation data (Canadian GCM1 current and future climate data) that are at very **coarse resolution** (~ 410km), to Peninsular Malaysia (West Malaysia) at **fine spatial resolution** (~9km) – for future period of 2025 to 2050 (2025-2034 & 2041-2050)



**The grid layout for the outer domain (1st Domain, 26x28 grids, 81 km resolution) of the RegHCM-PM**



27km x 27km

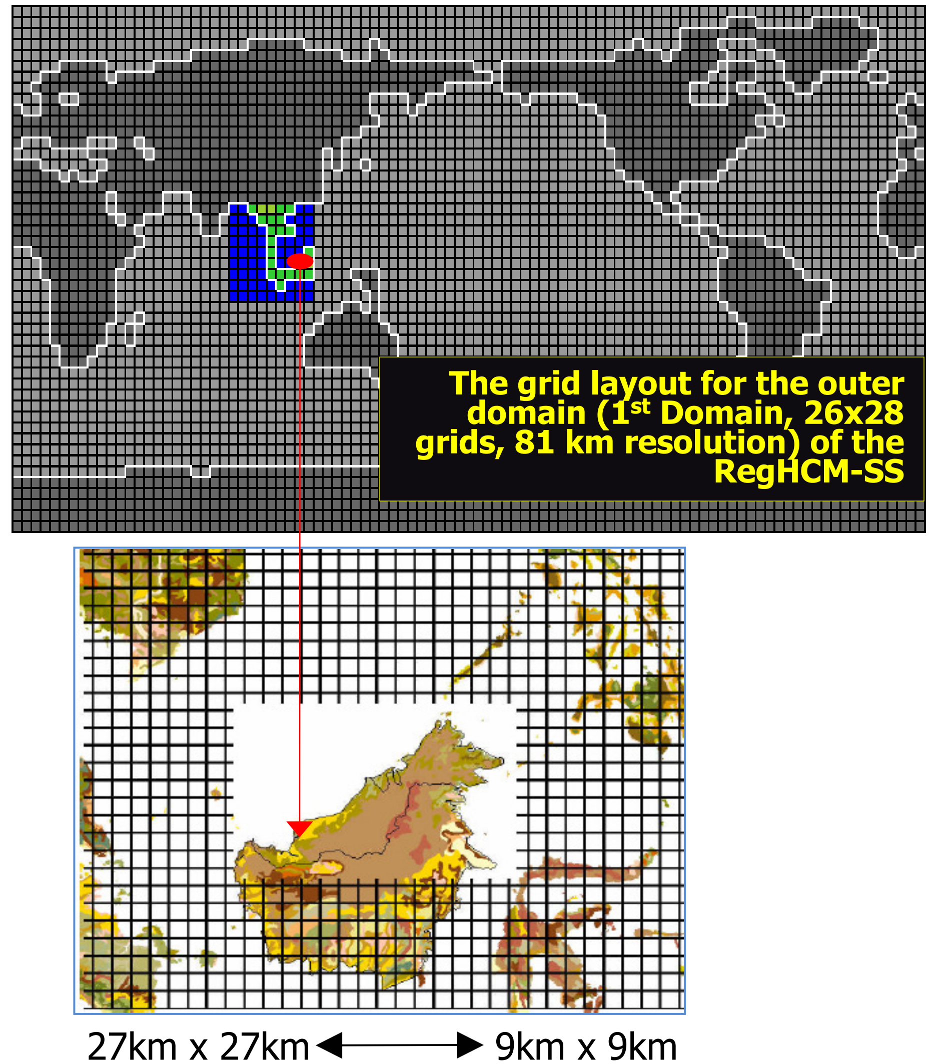


9km x 9km

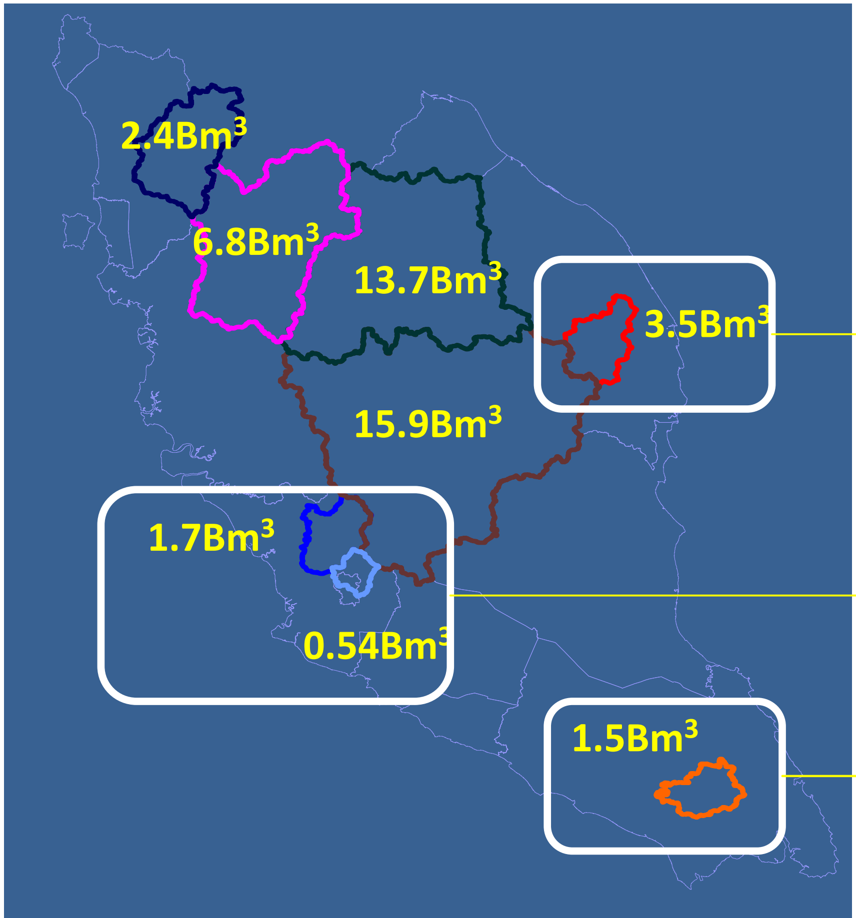
# Impacts Assessment

## Research on the Impacts of Climate Change on Hydrologic Regime, Water Resources & Landuse Change

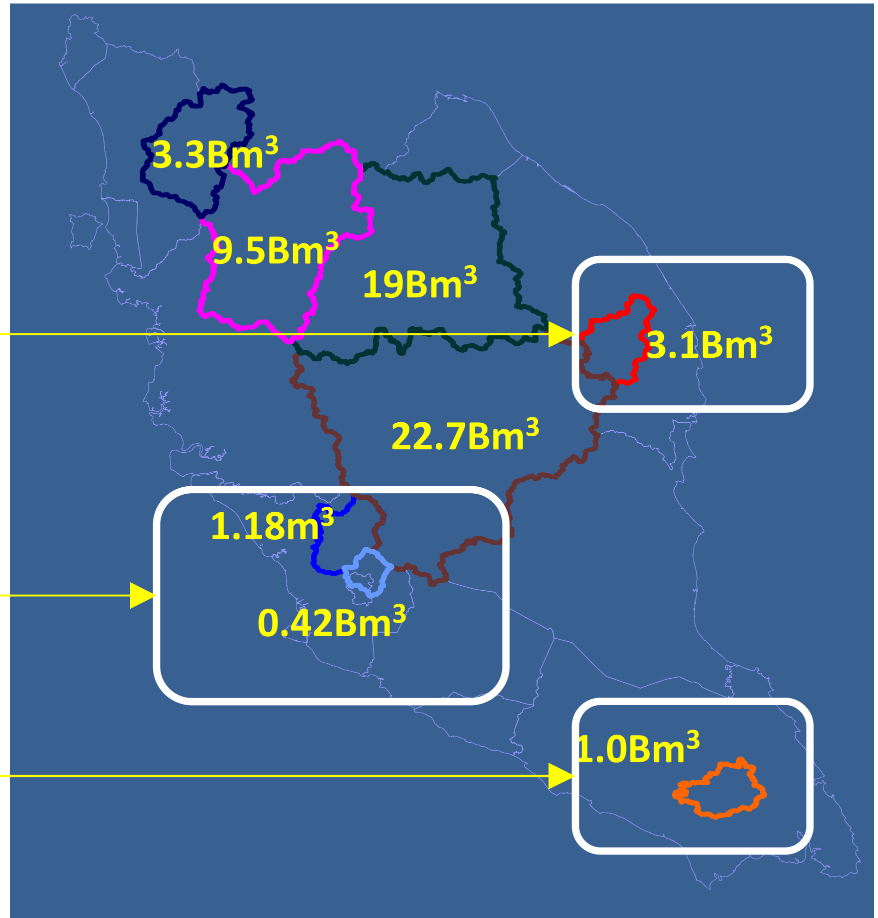
- **2010:** A regional hydrologic-atmospheric model of Peninsular Malaysia called as '**Regional Hydro-climate Model of Sabah and Sarawak (RegHCM-SS)** was developed
- **Downscaling** global climate change simulation data (ECHAM5 GCM and MRI GCM2.3.2 at control run simulation and future climate simulation data) that are at very **coarse resolution** (~ 208/310km), to Sabah & Sarawak (East Malaysia) at **fine spatial resolution** (~9km) – for future period of 2010 to 2100



## 40-Y RUNOFF VOLUMES OF SELECTED DRAINAGE SYSTEM

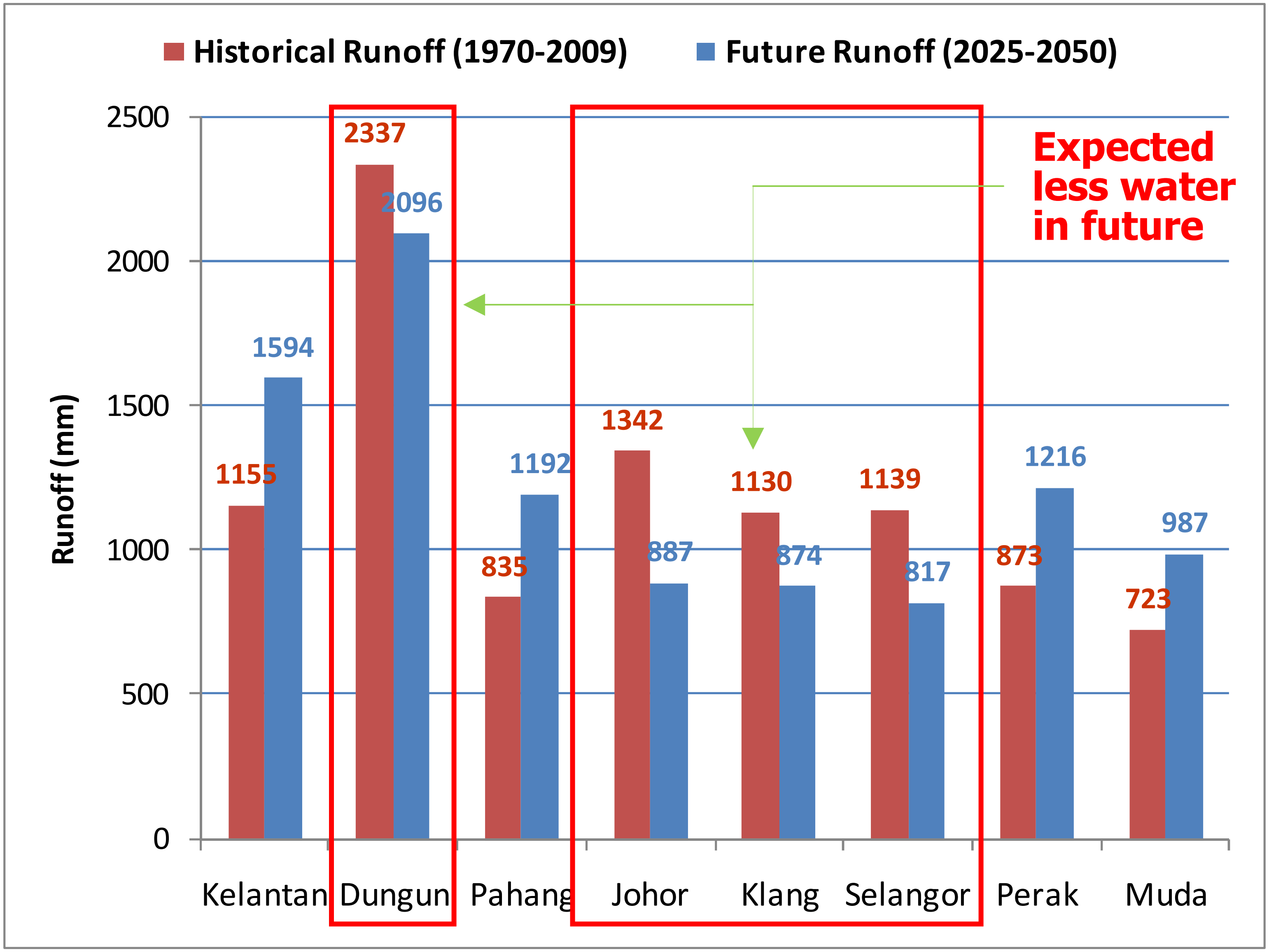



## FUTURE RUNOFF VOLUMES OF SELECTED DRAINAGE SYSTEM

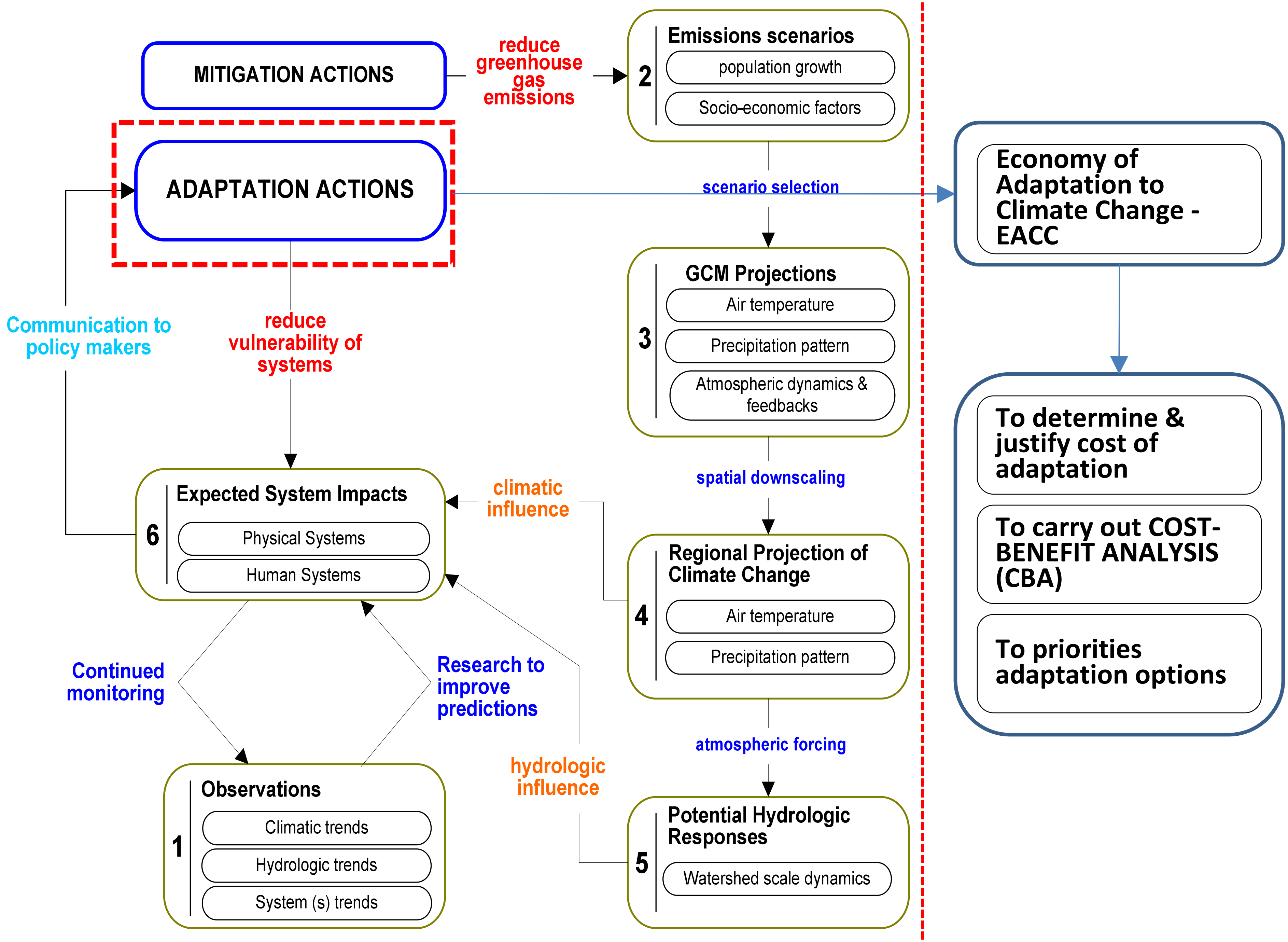



**FUTURE DEMAND**

# COMPARISON OF HISTORICAL & FUTURE WATER AVAILABILITY



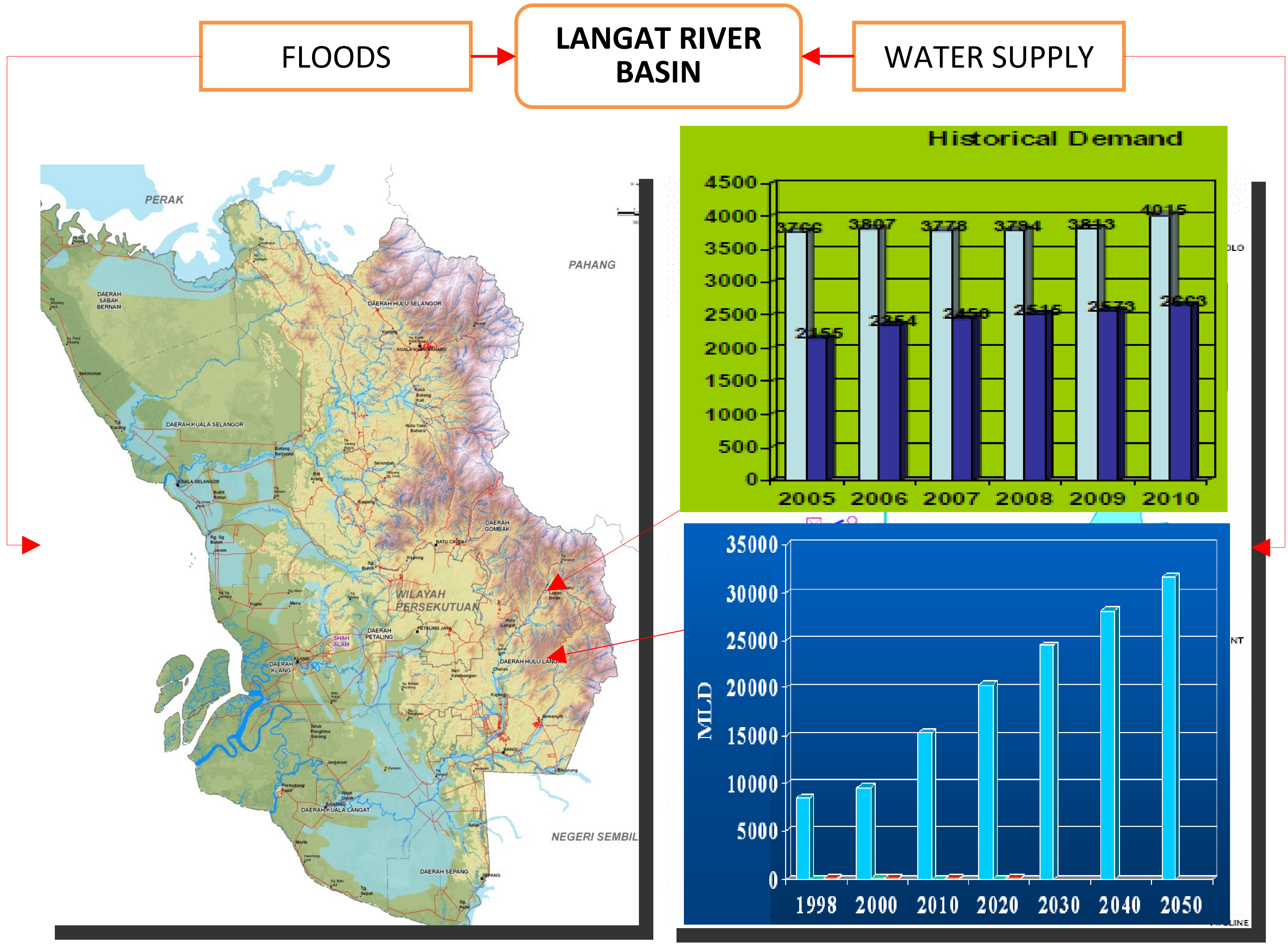
# HOW TO TRANSLATE RESEARCH FINDING?



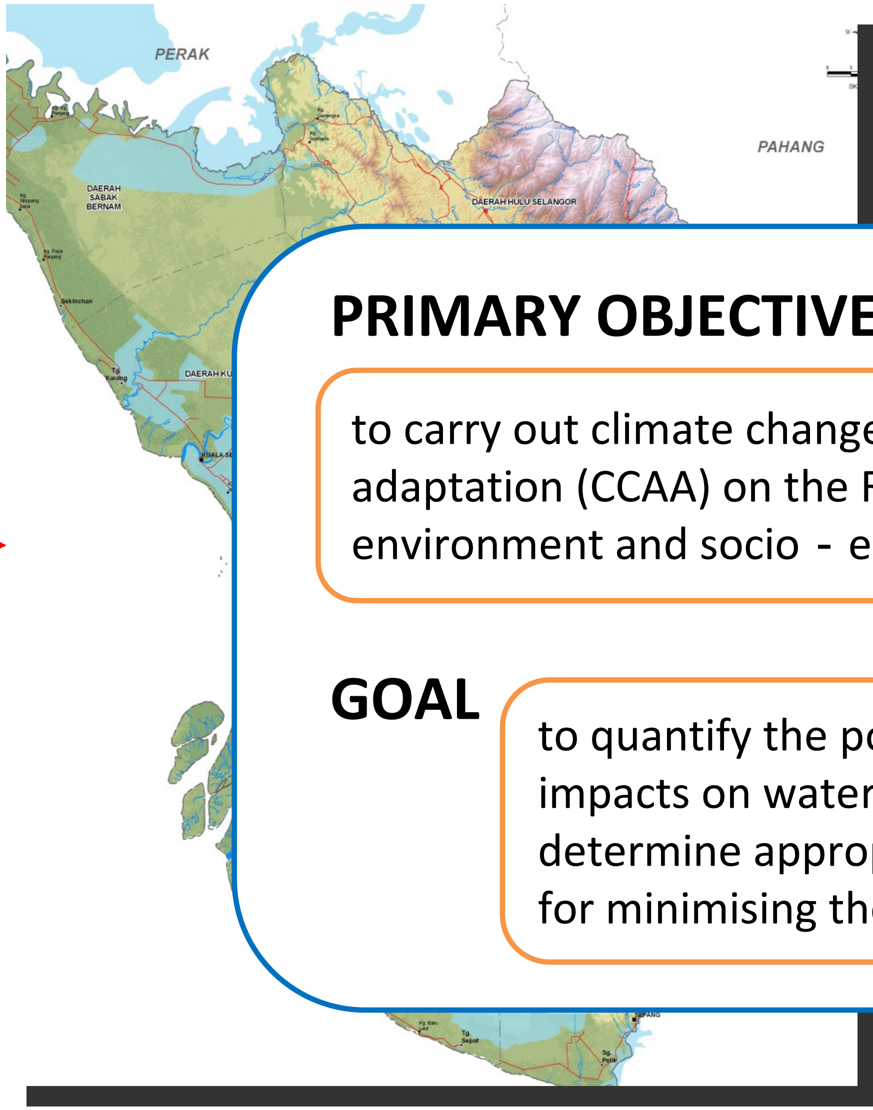
# ↗ WATER RESOURCES

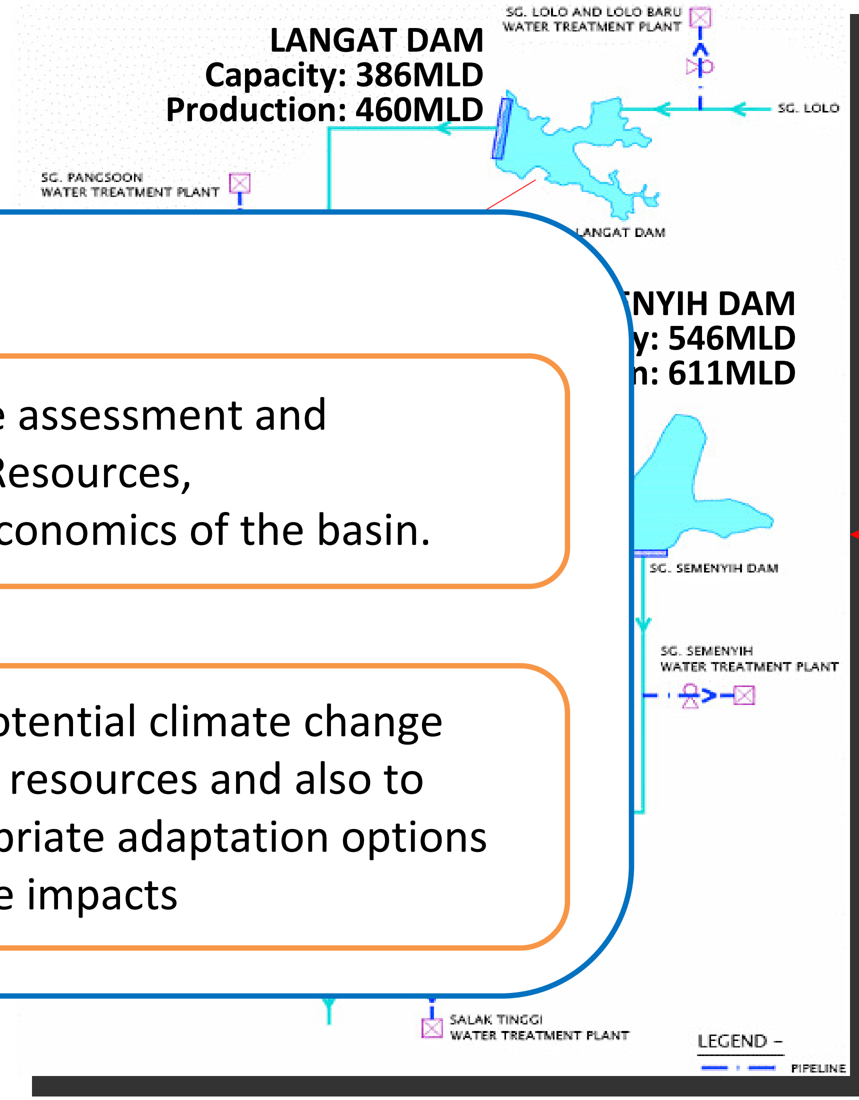
## ❑ Floods

- **BASELINE: costs of providing** flood mitigation based in 2050, WITHOUT CLIMATE CHANGE. Assumes no flood protection is in place at present;
- **BASELINE AND CLIMATE CHANGE:** assumes that the costs of adaptation in the baseline will increase or decrease by the same percentage as the percentage change in magnitude of the **100-year flood** (for urban areas) or the **25-year flood** (for rural areas)
- **CLIMATE CHANGE ONLY** (CC): difference between baseline and baseline & CC scenario.


FLOODS
LANGAT RIVER BASIN
WATER SUPPLY
PERAK
PAHANG
WILAYAH PERSEKUTUAN
Historical Demand
4500
4000
3500
3000
2500
2000
1500
1000
500
0
4015
2005
2006
2007
2008
2009
2010
MLD
35000
30000
25000
20000
15000
10000
5000
0
1998
2000
2010
2020
2030
2040
2050

FLOODS → LANGAT RIVER BASIN ← WATER SUPPLY



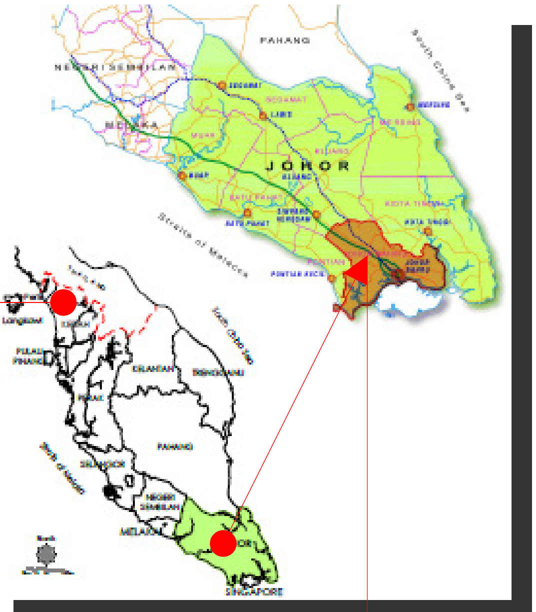

## PRIMARY OBJECTIVE

to carry out climate change assessment and adaptation (CCAA) on the Resources, environment and socio - economics of the basin.

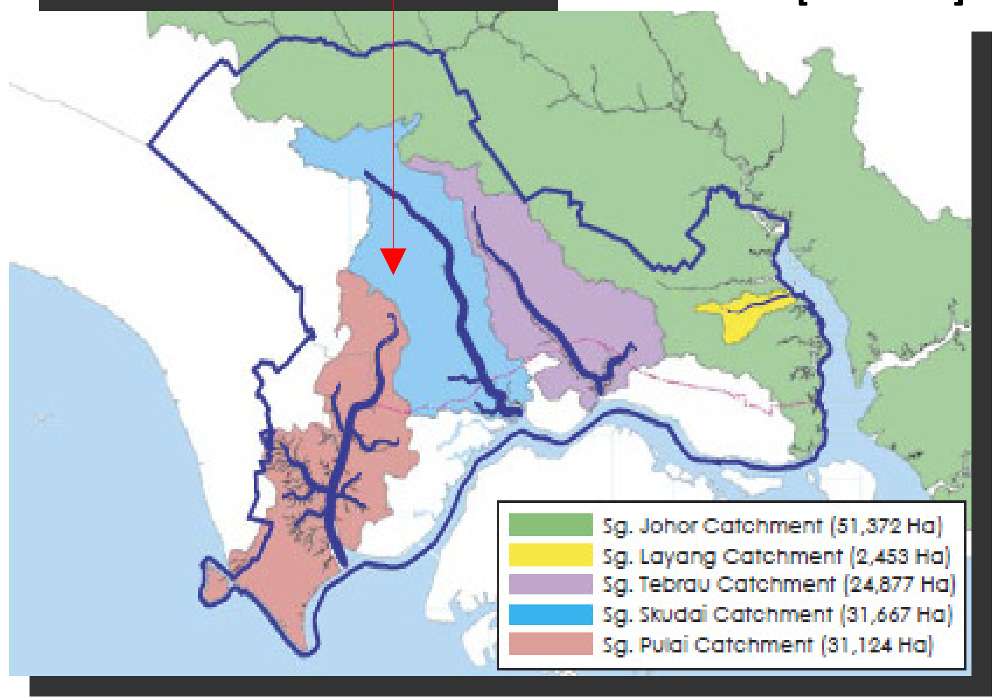
## GOAL

to quantify the potential climate change impacts on water resources and also to determine appropriate adaptation options for minimising the impacts


NORTH CORIDOR ECONOMIC REGION
[FLOODS & WATER SUPPLY]

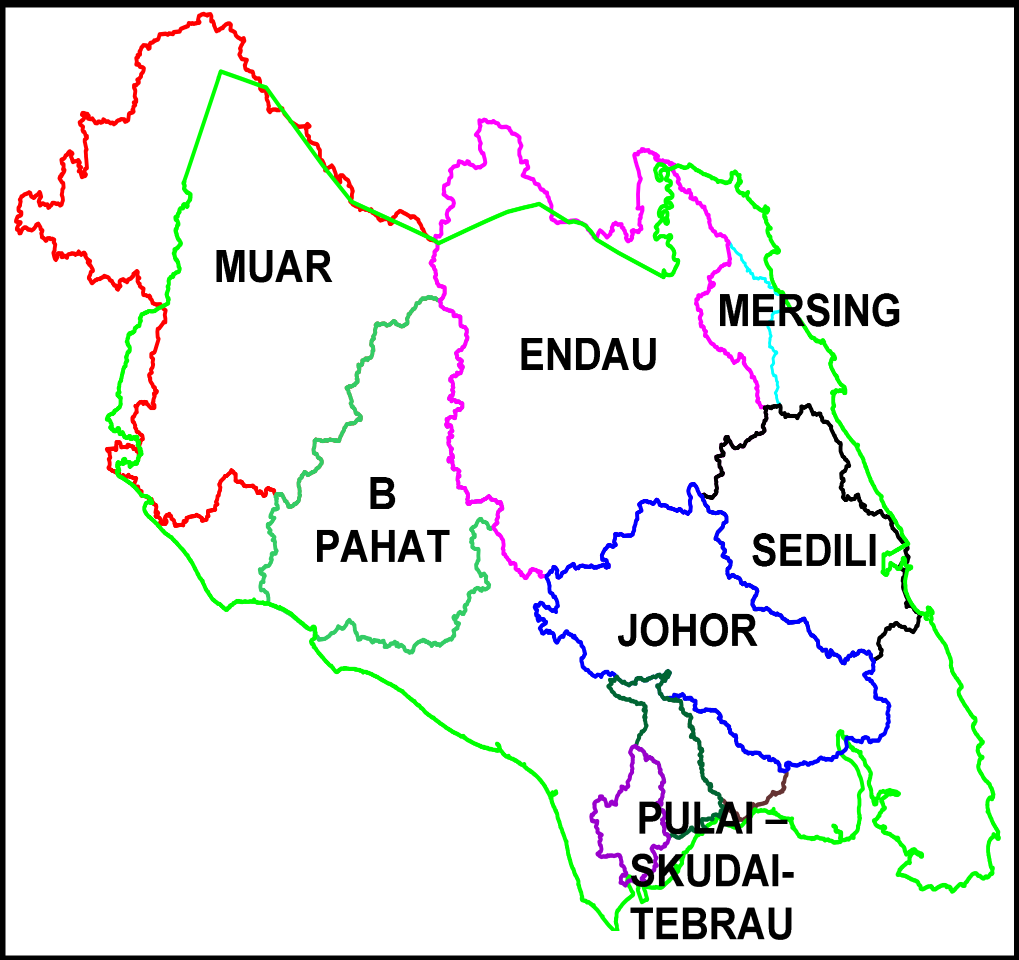



ISKANDAR MALAYSIA
ECONOMIC REGION
[FLOODS]



# FRAMEWORK OF CLIMATE CHANGE – WATER RESOURCES ADAPTATION

Sub-Catchment of River Drainage System – what is really needed?




**BASELINE SCENARIO**

**Design Floods Estimation**

- Event based data - calibration & validation
  - Rainfall
  - Flood flow
  - Evaporation
- Design based information
  - **Design rainstorm – Intensity - Duration-Frequency (IDF)**
- Area-Reduction Factor

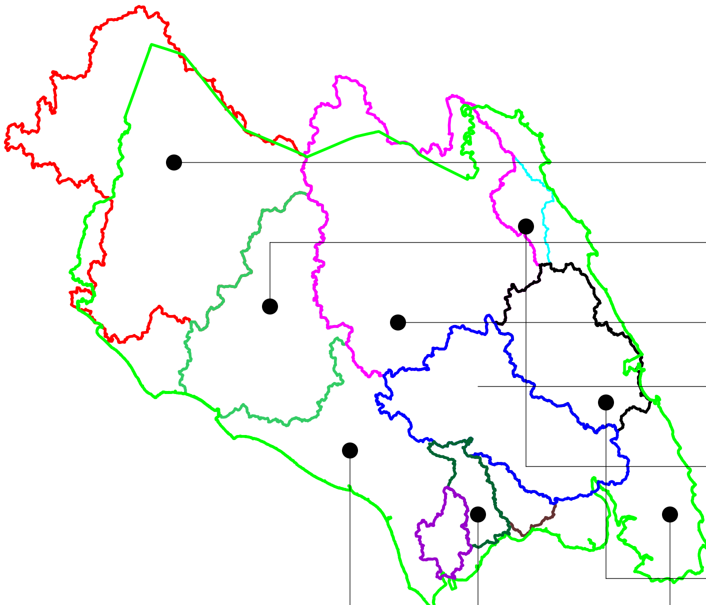
**CLIMATE CHANGE**

- **TO INCORPORATE WITH CLIMATE CHANGE FACTOR**

# Adaptation to Climate Change

# **Climate Change Factor** of Extreme Events

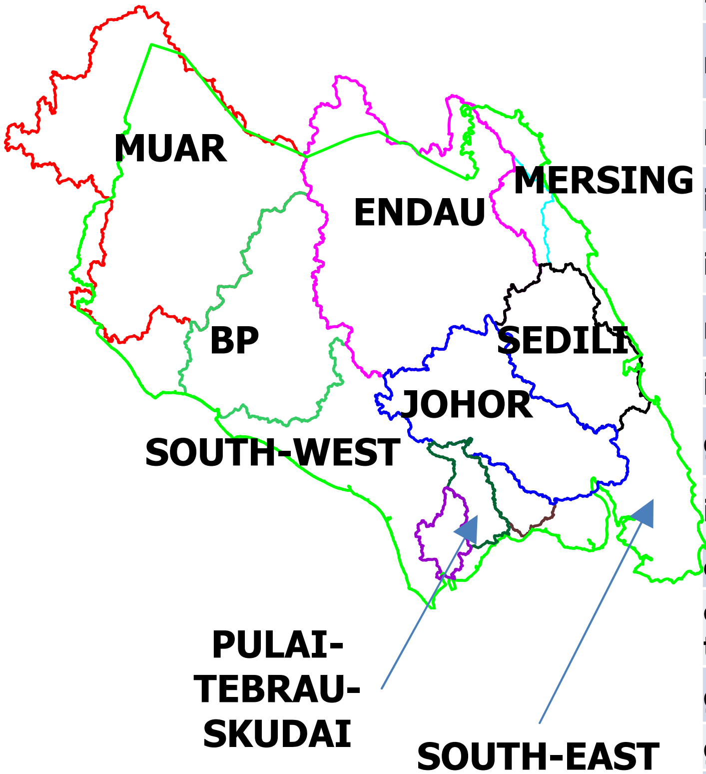
**Johor , South of Pen. Malaysia**



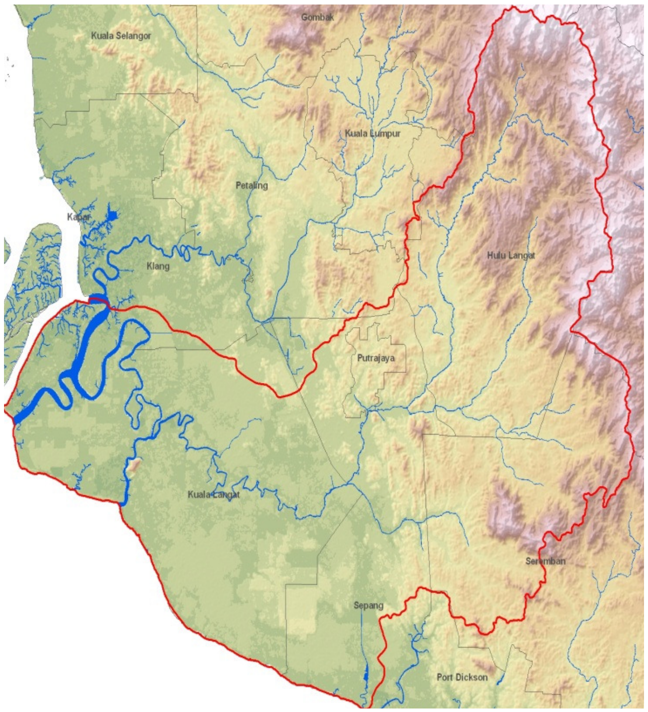
| | 1-day Design Rainstorm at 100-years ARI | | | | |
|---|---|---|---|---|---|
| Region | 2020-2059 | 2030-2069 | 2040-2079 | 2050-2089 | 2060-2099 |
| Muar | 1.19 | **1.23** | 1.22 | 1.03 | 0.78 |
| BPahat | **1.77** | 1.48 | 2.12 | 1.38 | 1.15 |
| Endau | 1.14 | 1.07 | 1.28 | 1.21 | **1.10** |
| Johor | 0.85 | 0.82 | 0.90 | 0.61 | 0.73 |
| Mersing | 1.20 | 0.95 | 1.17 | 1.15 | 1.13 |
| Sedili | 1.38 | 1.19 | 1.00 | 0.87 | 0.96 |
| Pulai-Tebrau-Skudai | **0.80** | 0.76 | 0.85 | 0.65 | 0.82 |
| South East | 1.02 | 1.20 | **1.42** | 1.29 | 1.34 |
| South West | 1.02 | 0.96 | **1.44** | 0.78 | 0.93 |

# **Climate Change Factor** of Extreme Events

Johor , South of Pen. Malaysia



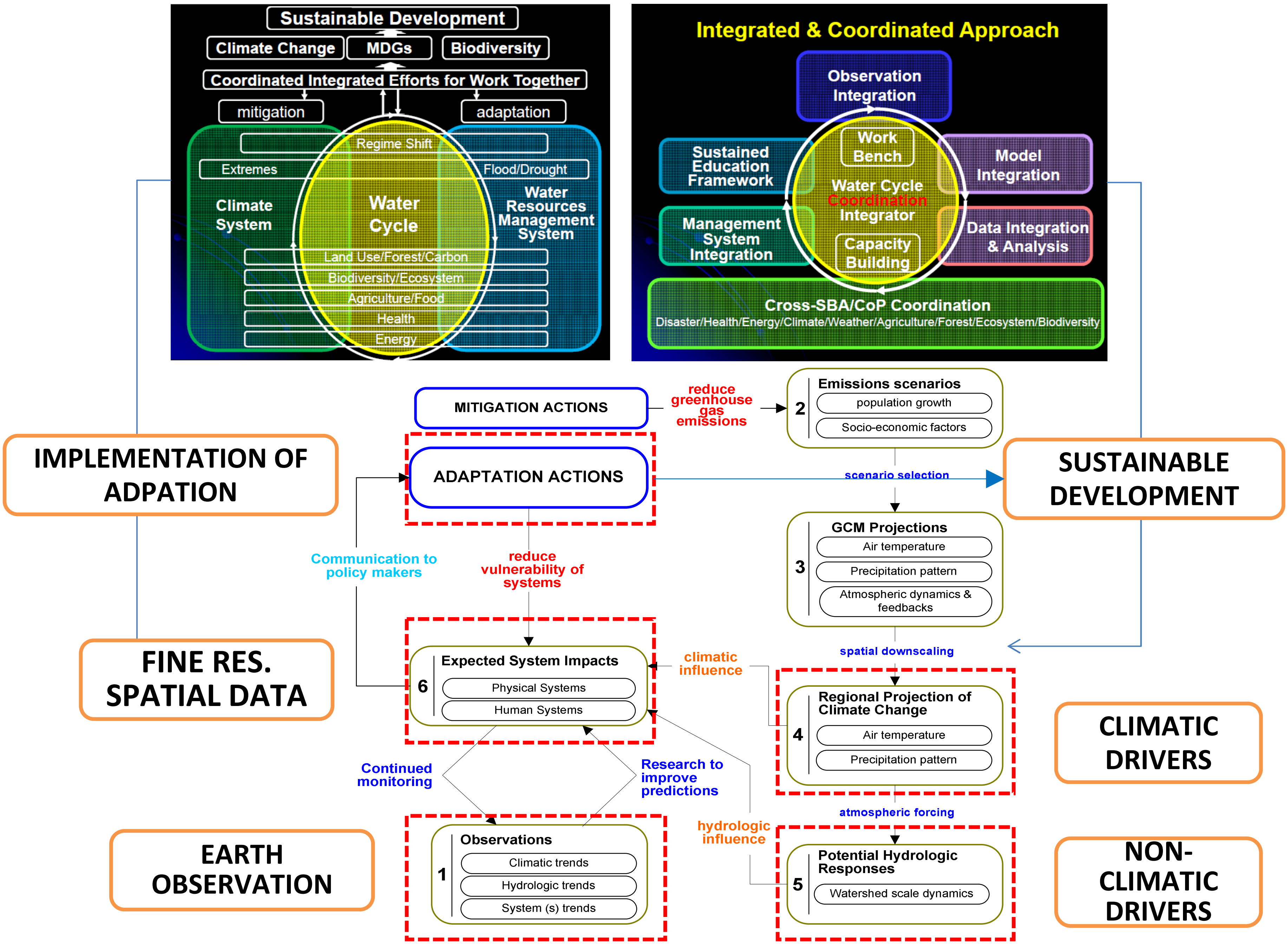

| GCMs | 1-day Design Rainstorm at 100-years ARI | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | M | BP | E | J | Ms | S | PT S | SE | SW |
| cnrm_cm3 | 1.32 | 1.35 | 1.35 | 1.35 | 1.35 | 1.35 | 1.35 | 1.35 | 1.35 |
| giss_aom | 1.21 | 1.21 | 1.21 | 1.20 | 1.21 | 1.07 | 1.21 | 1.02 | 1.21 |
| miroc3_2_hires | 1.35 | 2.05 | 1.17 | 2.36 | 0.74 | 2.29 | 2.36 | 1.46 | 2.36 |
| miroc3_2_medres | 1.39 | 1.62 | 1.62 | 1.62 | 1.62 | 1.62 | 1.62 | 1.62 | 1.62 |
| mpi_echam5 | 1.07 | 1.10 | 1.07 | 1.10 | 1.07 | 1.11 | 1.24 | 1.10 | 1.23 |
| ipsl_cm4 | 1.47 | 1.43 | 0.86 | 0.86 | 0.88 | 0.86 | 0.86 | 0.86 | 0.86 |
| ingv_echam4 | 1.33 | 1.34 | 1.21 | 1.19 | 1.21 | 1.14 | 1.19 | 1.27 | 1.19 |
| miub_echo_g | 1.40 | 1.45 | 1.14 | 1.14 | 1.14 | 1.14 | 1.14 | 1.14 | 1.14 |
| inmcm3_0 | 1.25 | 0.94 | 1.23 | 1.00 | 1.25 | 0.95 | 1.00 | 1.00 | 1.00 |
| giss_model_e_r | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 |
| iap_fgoals1_0_g | 1.66 | 1.33 | 1.33 | 1.33 | 1.33 | 1.33 | 1.33 | 1.33 | 1.33 |
| cccma_cgcm3_1 | 0.85 | 0.92 | 1.11 | 1.11 | 1.11 | 1.11 | 1.11 | 1.11 | 1.11 |
| cccma_cgcm3_1_t63 | 1.19 | 1.30 | 1.30 | 1.30 | 1.30 | 1.30 | 1.30 | 1.30 | 1.30 |
| gfdl_cm2_0 | 3.02 | 2.31 | 3.02 | 1.55 | 3.00 | 1.99 | 1.55 | 0.30 | 1.55 |
| gfdl_cm2_1 | 0.96 | 1.27 | 1.02 | 1.25 | 0.97 | 1.29 | 1.25 | 1.25 | 1.25 |
| mri_cgcm2_3_2a | 1.22 | 1.03 | 1.03 | 1.03 | 1.03 | 1.03 | 1.03 | 1.03 | 1.03 |
| ncar_pcm1 | 1.92 | 1.89 | 1.89 | 1.89 | 1.89 | 1.89 | 1.89 | 1.89 | 1.74 |
| csiro_mk3_5 | 0.91 | 0.96 | 0.91 | 0.80 | 0.91 | 1.12 | 0.75 | 1.03 | 0.76 |
| **AVERAGE** | **1.31** | **1.31** | **1.25** | **1.23** | **1.23** | **1.26** | **1.24** | **1.12** | **1.23** |

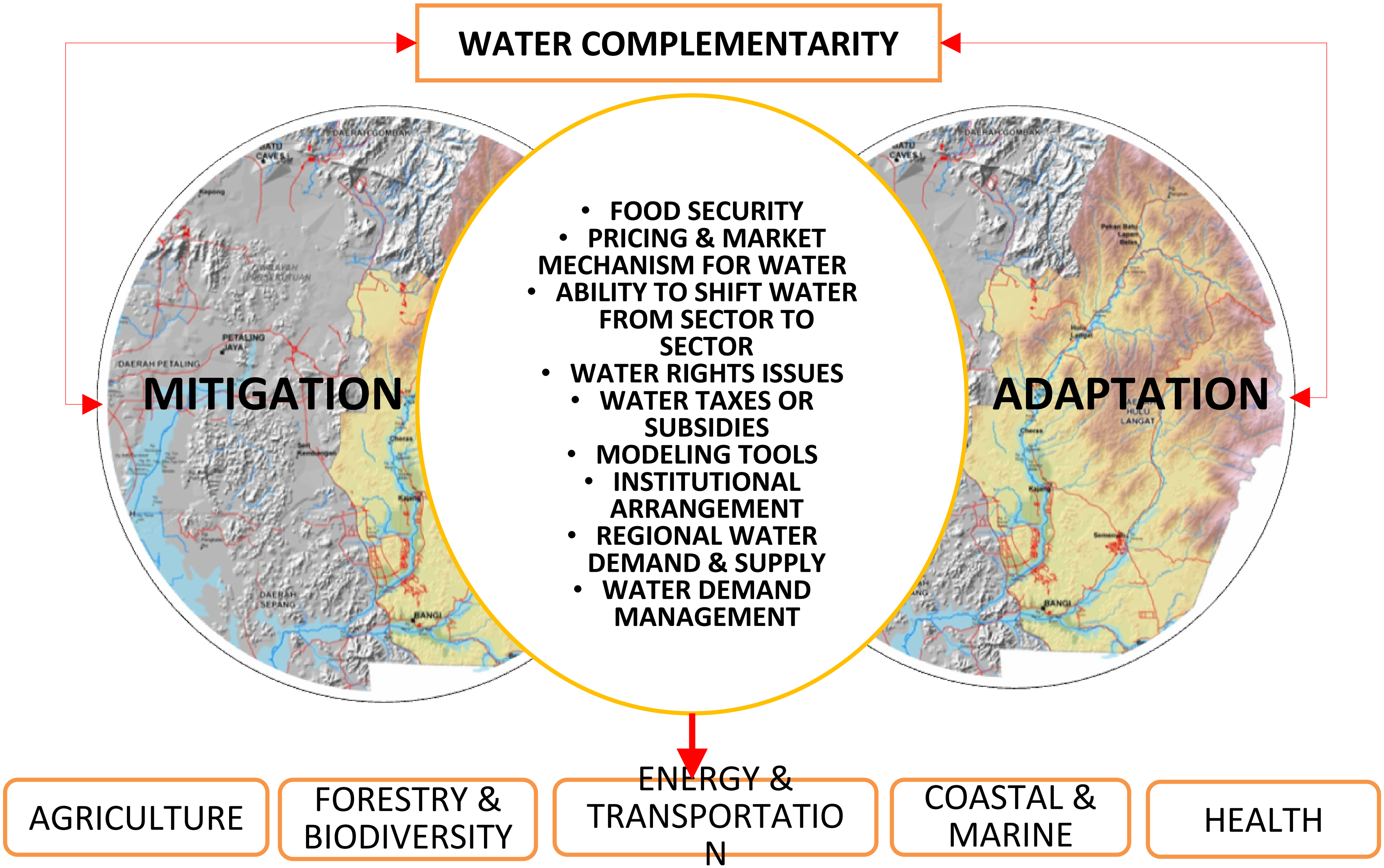



| GCMs | 1-day Design Rainstorm at 100-years ARI | | | | | | |
|---|---|---|---|---|---|---|---|
| | PJ | LB | SM | TG | KjG | Amp | PS |
| **cccma_cgcm3_1** | 1.03 | 1.02 | 1.06 | 1.02 | 1.06 | 1.02 | 1.04 |
| **cccma_cgcm3_1_t63** | 1.26 | 1.11 | 0.88 | 1.00 | 0.79 | 0.85 | 0.76 |
| **cnrm_cm3** | 1.62 | 1.45 | 1.02 | 1.37 | 1.38 | 2.15 | 0.91 |
| **csiro_mk3_0** | 0.98 | 1.05 | 0.88 | 0.98 | 1.07 | 1.13 | 0.93 |
| **csiro_mk3_5** | 0.62 | 1.14 | 1.74 | 1.05 | 1.10 | 0.78 | 1.17 |
| **gfdl_cm2_0** | 0.97 | 1.31 | 1.37 | 1.16 | 1.44 | 1.20 | 1.51 |
| **gfdl_cm2_1** | 1.25 | 1.09 | 1.12 | 1.05 | 1.14 | 1.05 | 1.18 |
| **giss_aom** | 1.03 | 1.67 | 1.85 | 1.27 | 1.31 | 1.31 | 1.34 |
| **iap_fgoals1_0_g** | 0.91 | 2.38 | 1.69 | 1.30 | 1.67 | 1.31 | 1.84 |
| **ingv_echam4** | 0.99 | 2.48 | 2.87 | 1.68 | 2.13 | 1.97 | 2.25 |
| **inmcm3_0** | 1.02 | 1.15 | 1.18 | 1.06 | 1.09 | 1.09 | 1.10 |
| **ipsl_cm4** | 1.00 | 1.69 | 1.83 | 1.60 | 1.49 | 1.36 | 1.53 |
| **miroc3_2_hires_K-1** | 1.08 | 2.93 | 3.46 | 1.77 | 2.38 | 2.19 | 1.51 |
| **miroc3_2_hires** | 0.98 | 2.93 | 3.46 | 1.77 | 2.38 | 2.19 | 1.51 |
| **miroc3_2_medres** | 0.98 | 1.57 | 1.83 | 1.29 | 1.47 | 1.43 | 1.54 |
| **miub_echo_g** | 1.02 | 1.64 | 1.80 | 1.27 | 1.48 | 1.40 | 1.57 |
| **AVERAGE** | **1.04** | **1.20** | **1.23** | **1.10** | **1.16** | **1.14** | **1.18** |


| GCMs | 1-day Design Rainstorm at 100-years ARI | | | | | | |
|---|---|---|---|---|---|---|---|
| | NRG | KRM | JNG | AS | KGR | AP | PS |
| **cccma_cgcm3_1** | 0.90 | 0.90 | 0.91 | 0.91 | 0.87 | 0.94 | 0.89 |
| **cccma_cgcm3_1_t63** | 0.97 | 0.92 | 1.05 | 0.94 | 0.88 | 1.14 | 0.93 |
| **cnrm_cm3** | 0.46 | 0.55 | 0.50 | 0.90 | 0.69 | 0.45 | 0.63 |
| **csiro_mk3_0** | 0.64 | 0.67 | 0.68 | 0.84 | 0.62 | 0.92 | 0.63 |
| **csiro_mk3_5** | 0.38 | 0.47 | 0.51 | 0.43 | 0.32 | 0.41 | 0.50 |
| **gfdl_cm2_0** | 0.98 | 1.10 | 1.10 | 0.78 | 1.07 | 1.06 | 1.12 |
| **gfdl_cm2_1** | 0.65 | 0.72 | 1.27 | 0.77 | 0.68 | 0.81 | 0.79 |
| **giss_aom** | 0.97 | 0.98 | 1.29 | 0.86 | 1.15 | 1.01 | 1.08 |
| **iap_fgoals1_0_g** | 0.72 | 0.78 | 0.82 | 0.64 | 0.74 | 0.93 | 0.71 |
| **ingv_echam4** | 2.11 | 1.36 | 1.52 | 1.31 | 1.64 | 1.28 | 2.16 |
| **inmcm3_0** | 0.77 | 0.79 | 0.93 | 1.03 | 0.87 | 1.01 | 0.76 |
| **ipsl_cm4** | 2.74 | 2.41 | 2.72 | 1.02 | 1.97 | 1.03 | 3.00 |
| **miroc3_2_hires_K-1** | 2.78 | 1.55 | 1.53 | 2.21 | 1.99 | 0.83 | 2.85 |
| **miroc3_2_hires** | 2.78 | 1.55 | 1.53 | 2.21 | 1.99 | 1.71 | 2.85 |
| **miroc3_2_medres** | 1.27 | 1.19 | 1.20 | 1.39 | 1.08 | 1.25 | 1.27 |
| **miub_echo_g** | 1.22 | 1.19 | 1.19 | 1.14 | 1.15 | 1.24 | 1.23 |
| **mpi_echam5** | 0.84 | 0.85 | 0.83 | 0.64 | 0.86 | 0.98 | 0.84 |
| **mri_cgcm2_3_2a** | 1.31 | 1.02 | 1.30 | 1.10 | 1.42 | 1.11 | 1.21 |
| **AVERAGE** | **1.25** | **1.06** | **1.15** | **1.06** | **1.09** | **1.00** | **1.31** |

# GEOSS – WCI WORK BENCH : INTEGRATED & COORDINATED APPROACH





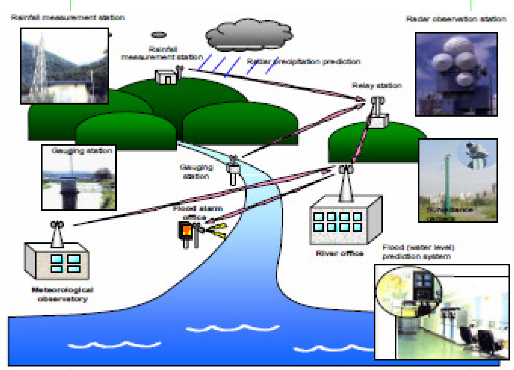
WATER COMPLEMENTARITY
MITIGATION
ADAPTATION
• FOOD SECURITY
• PRICING & MARKET MECHANISM FOR WATER
• ABILITY TO SHIFT WATER FROM SECTOR TO SECTOR
• WATER RIGHTS ISSUES
• WATER TAXES OR SUBSIDIES
• MODELING TOOLS
• INSTITUTIONAL ARRANGEMENT
• REGIONAL WATER DEMAND & SUPPLY
• WATER DEMAND MANAGEMENT
AGRICULTURE
FORESTRY & BIODIVERSITY
ENERGY & TRANSPORTATIO N
COASTAL & MARINE
HEALTH

# GREEN GROWTH WITH BLUE

**Runoff Reduction – Rainwater Utilization & Management**

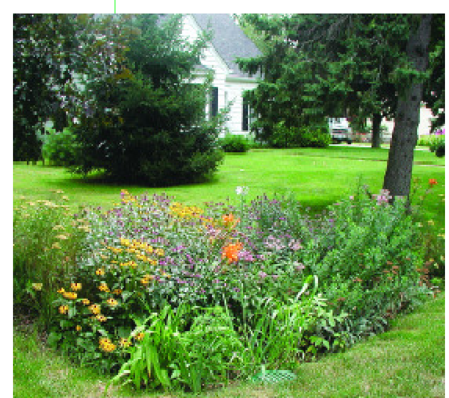

**Rain street**

**LOW IMPACT DEVELOPMENT (LID)**




**Real-Time Information: Flood Forecasting & Warning System**

**Green Infrastructure**

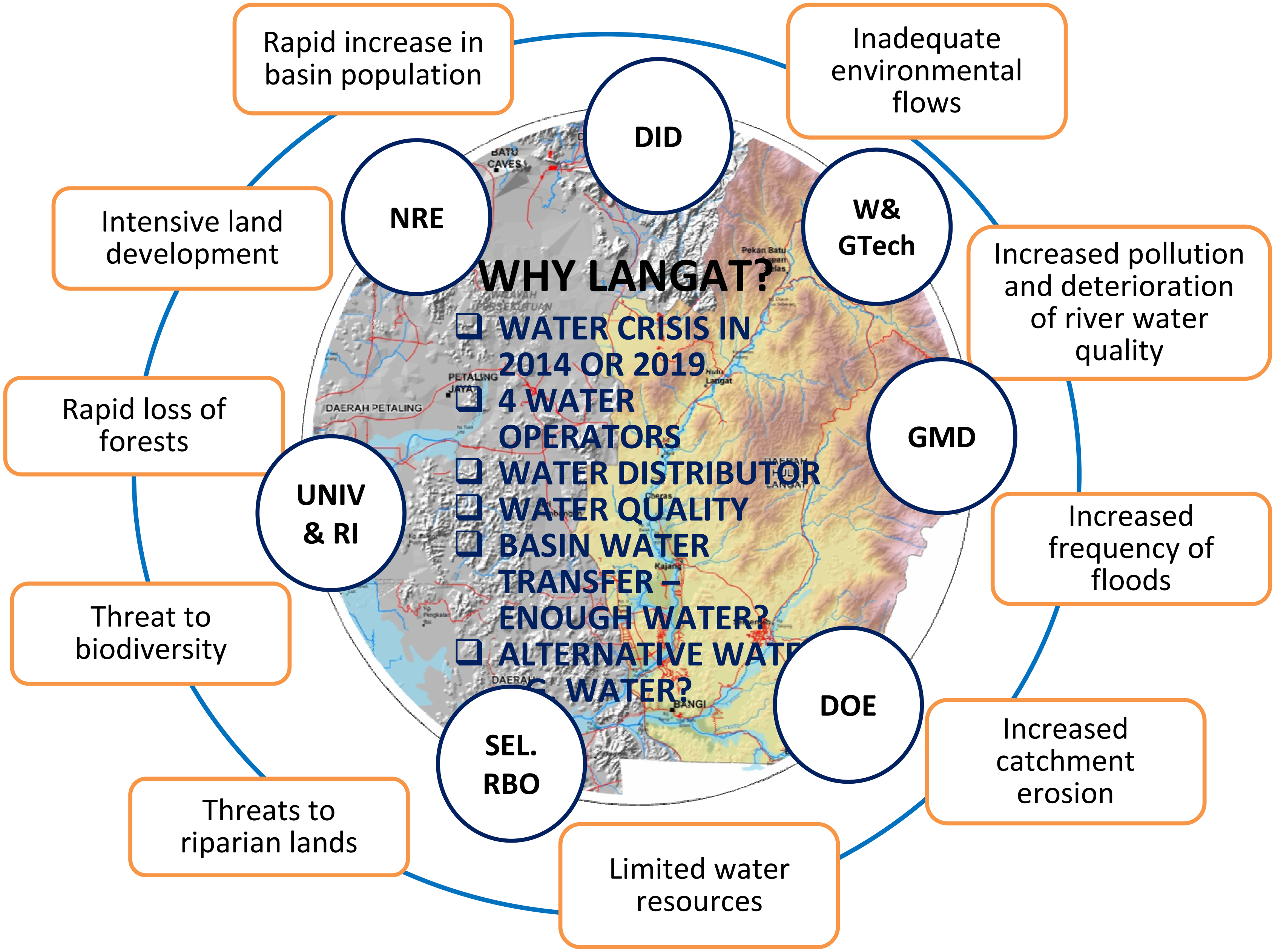
**LOW IMPACT DEVELOPMENT (LID)**

Reduce flooding on neighboring property, overflow in sewers and erosion in streams by absorbing water from impervious surfaces

Provide habitats for beneficial insects and birds

Filter oil and grease from driveways, pesticides and fertilizers from lawns, and other pollutants before they reach the storm drain and eventually streams, wetlands, lakes and marine water

Increase the amount of water that soaks into the ground to recharge local groundwater




**GEOSS – WCI WORK BENCH : INTEGRATED & COORDINATED APPROACH**

# THANK YOU