APWF WORKSHOP ON META-GUIDELINES FOR WATER & CCA

ADAPTATION TO CLIMATE CHANGE: DEVELOPING ENGINEERING KNOWLEDGE INTO PRACTICES FOR WATER RESOURCES SECTOR

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OUTLINE

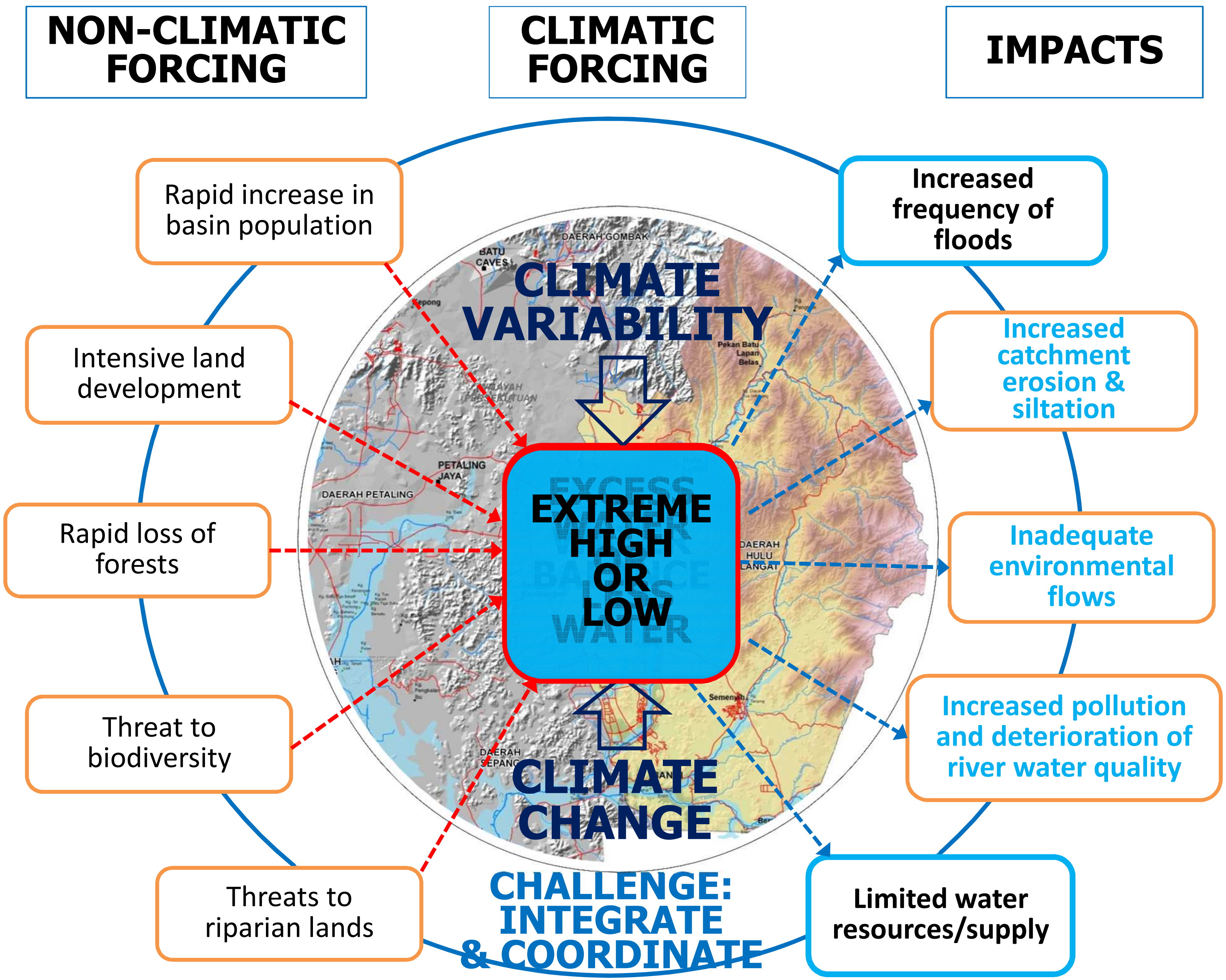
1 UNDERSTANDING WATER ISSUES, IMPACTS & CONSEQUENCES

2 KNOWLEDGE PATHWAYS TO ADAPTATION PRACTICES

3 KNOWLEDGE PATHWAYS TO ADAPTATION POLICIES

…….understanding the issues, impacts and consequences ……

water excesses, water shortages, water pollution

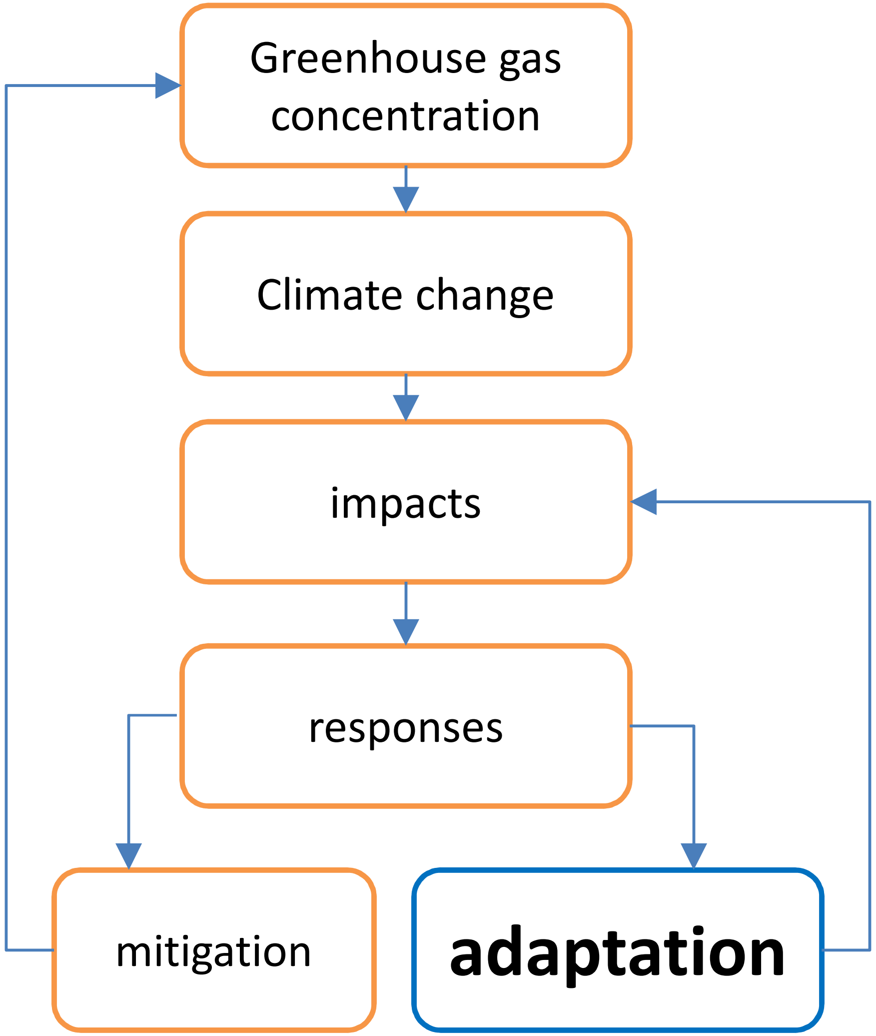

NON-CLIMATIC FORCING
CLIMATIC FORCING
IMPACTS
Rapid increase in basin population
Intensive land development
Rapid loss of forests
Threat to biodiversity
Threats to riparian lands
CLIMATE VARIABILITY
EXTREME HIGH OR LOW
CLIMATE CHANGE
CHALLENGE: INTEGRATE & COORDINATE
Increased frequency of floods
Increased catchment erosion & siltation
Inadequate environmental flows
Increased pollution and deterioration of river water quality
Limited water resources/supply
DAERAH GOMBAK
BATU CAVES
PETALING JAYA
DAERAH PETALING
DAERAH HULU LANGAT
DAERAH SEPANG

…..and increasing exposure of people and assets would be the major cause of changes in disaster losses…..

Source: SREX Report (IPCC, 2011)

…..but how we can "cushion" this impacts (climate and non-climate forcing)…?

.....through mitigation & adaptation process



Intervention to reduce the emmision sources

an adjustment in natural or human system systems in response to actual or expected climatic stimuli or their effects

- ❑ Primarily a **local issue** as adaptation mostly provides benefits at the local scale
- ❑ Adaptation can have a **short-term effect** on the reduction of vulnerability
- ❑ Adaptation is **a priority in the water sectors** as well as in health and coastal sectors

WHY ADAPTATION?

….pathways of adaptation practices……

.....how it can be done? ...develop climate knowledge base & bridge the gap of science, engineering & socio-economics ......

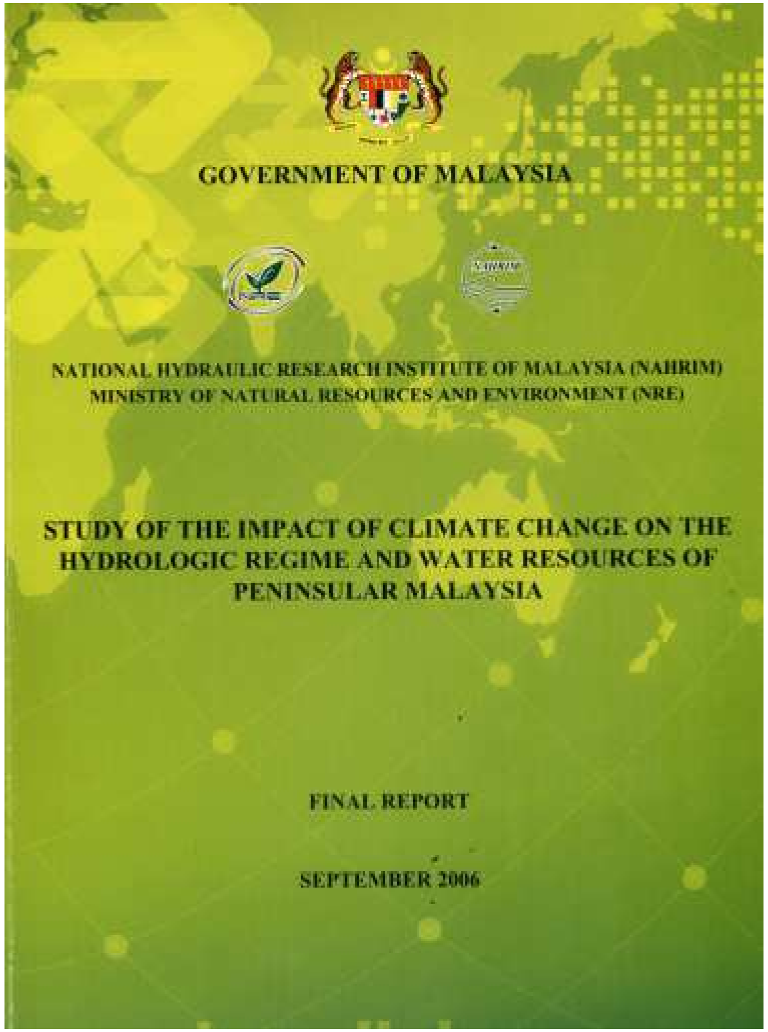
.....pathways from knowledge to adaptation practices......

Source: X. Wang, CSIRO 2012

PRACTICES DEVELOPMENT

….develop climate change knowledge & capacity building…….

…pre-requisite to have knowledge in climate change modeling and projection…..



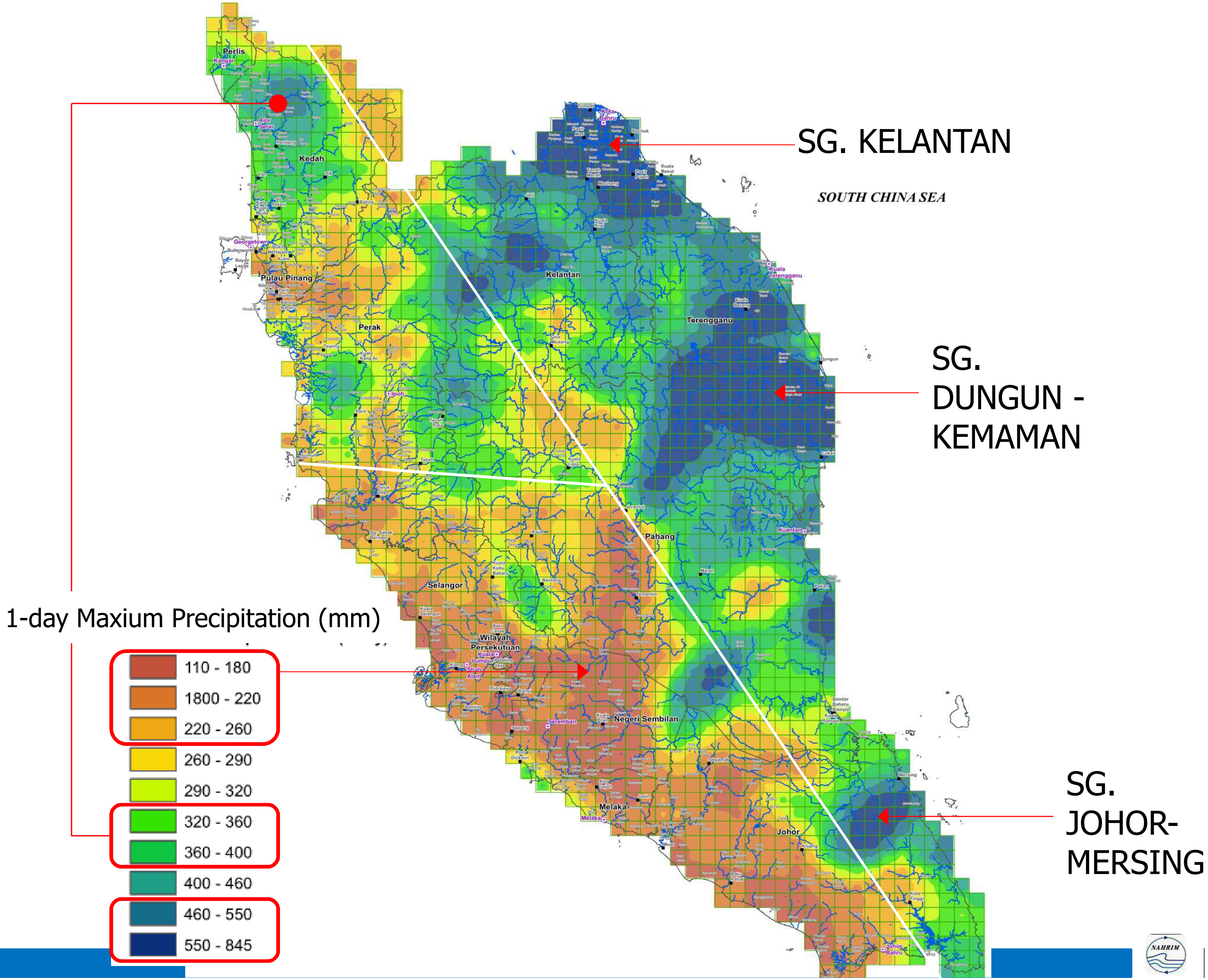
- **2006 - Downscaling** Canadian GCM1 (~ 410km resolution), to **fine spatial resolution** (~9km)
- **Extention study**:
  - **3 GCMs** – MPI-ECHAM5, CCSM3 and MRI-CGCM2.3.2
  - **15 scenarios** – SRES A1B (5), B1 (5), A2 (1) and A1Fi (1)
  - Downscaling GCMs (~150-310km) to watershed scale **spatial resolution of 6km**
  - **Hourly** time interval resolution
  - Study period – 18 months (Sept. 2012 – Feb. 2014)

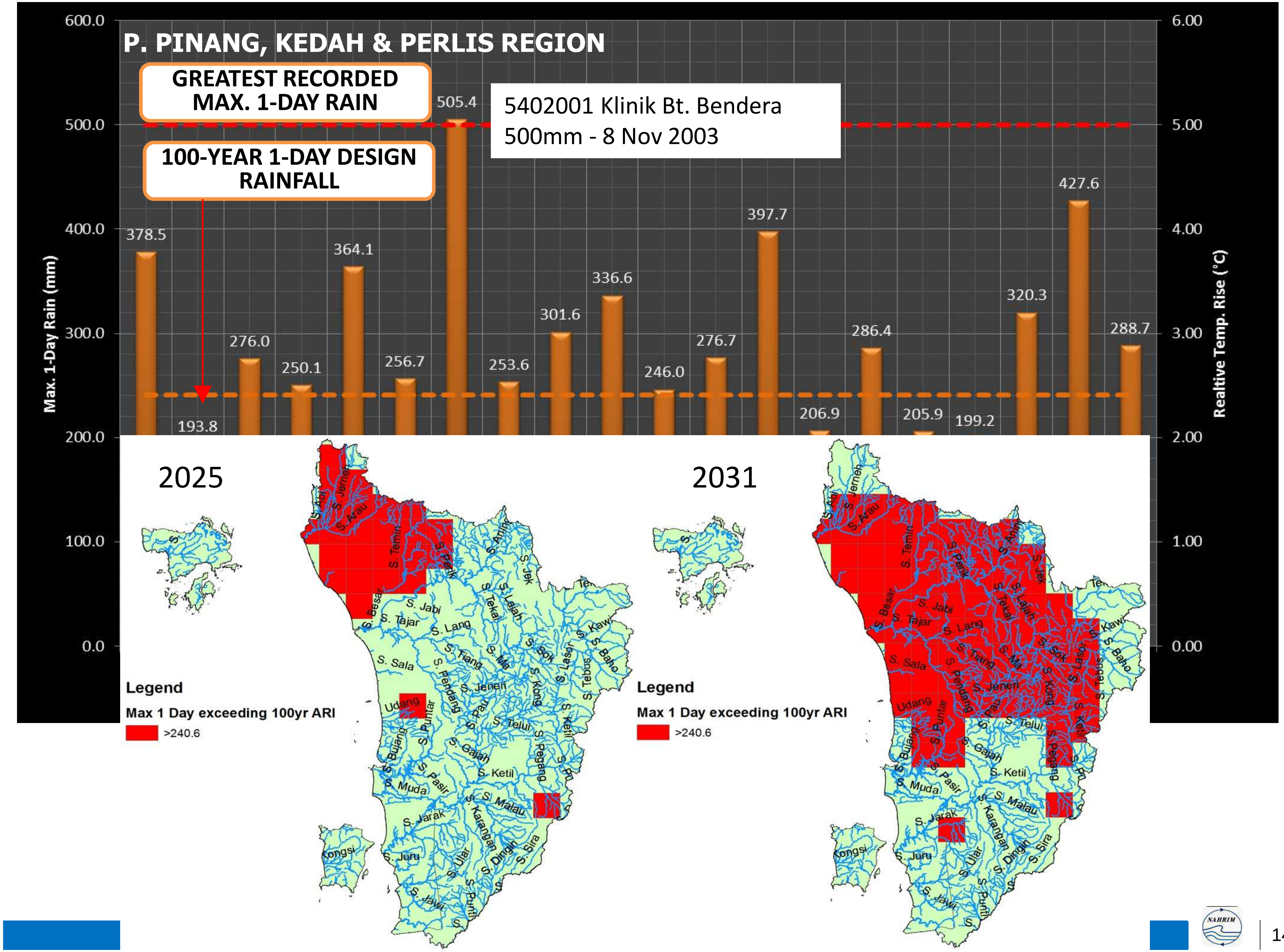
Future Rainfall for Pen. Malaysia

- More extreme weather conditions in the future (2025-2050) may be expected since higher maximum and lower minimum rainfall are observed.
- Increase in maximum monthly rainfall of up to 51% over Pahang, Kelantan and Terengganu.
- Decrease in minimum monthly rainfall from 32% to 61% for all over Peninsular Malaysia.

....insufficient information for engineering knowledge....

….develop climate change engineering knowledge…….


SG. KELANTAN
SOUTH CHINA SEA
SG. DUNGUN - KEMAMAN
SG. JOHOR-MERSING
Perlis
Kedah
Pulau Pinang
Perak
Kelantan
Terengganu
Pahang
Selangor
Wilayah Persekutuan
Negeri Sembilan
Melaka
Johor
1-day Maxium Precipitation (mm)
110 - 180
1800 - 220
220 - 260
260 - 290
290 - 320
320 - 360
360 - 400
400 - 460
460 - 550
550 - 845



P. PINANG, KEDAH & PERLIS REGION
GREATEST RECORDED MAX. 1-DAY RAIN
100-YEAR 1-DAY DESIGN RAINFALL
5402001 Klinik Bt. Bendera
500mm - 8 Nov 2003
Max. 1-Day Rain (mm)
Realtive Temp. Rise (°C)
600.0
500.0
400.0
300.0
200.0
100.0
0.0
6.00
5.00
4.00
3.00
2.00
1.00
0.00
378.5
193.8
276.0
250.1
364.1
256.7
505.4
253.6
301.6
336.6
246.0
276.7
397.7
206.9
286.4
205.9
199.2
320.3
427.6
288.7
2025
2031
Legend
Max 1 Day exceeding 100yr ARI
>240.6

….develop engineering methodology and design standards…

…..common questions in water resources engineering …….

Bekok Dam

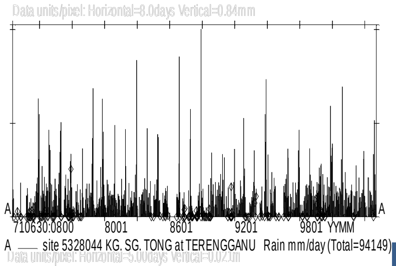
Tanjung Piai Mangrove

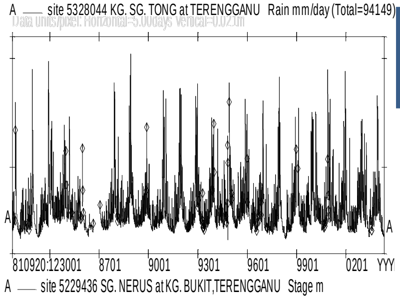
Redang Island

Related issues due to the frequencies of hydrologic and precipitation phenomena:

- **How high should a bund be, and what is the risk to those living behind it?**
- How to characterize and identify a 100-year floodplain?
- **How to manage a reservoir to accommodate uncertain runoff**?
- How much storage in a reservoir should be allocated to irrigation versus other competing future needs?
- **How safe is the structure under extreme flood conditions**?
- How to size the spillway for a rare flood?
- What criteria should be used to "recertify" flood mitigation structures where the flow frequencies have changed or are in the process of changing?
- **How should our procedures on life-cycle infrastructure management and performance accommodate our evolving understanding of climate change?**
- What flood/drought frequency distribution should be used in a particular analysis to accommodate climate uncertainty?

.....hydroclimate data transformation to hydrologic & hydraulic design...



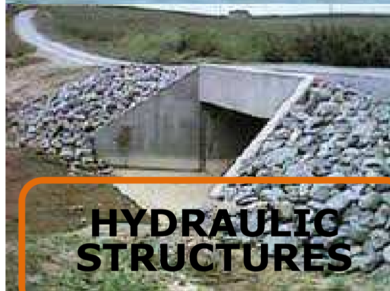


HYDRO-METEOROLOGY DATA

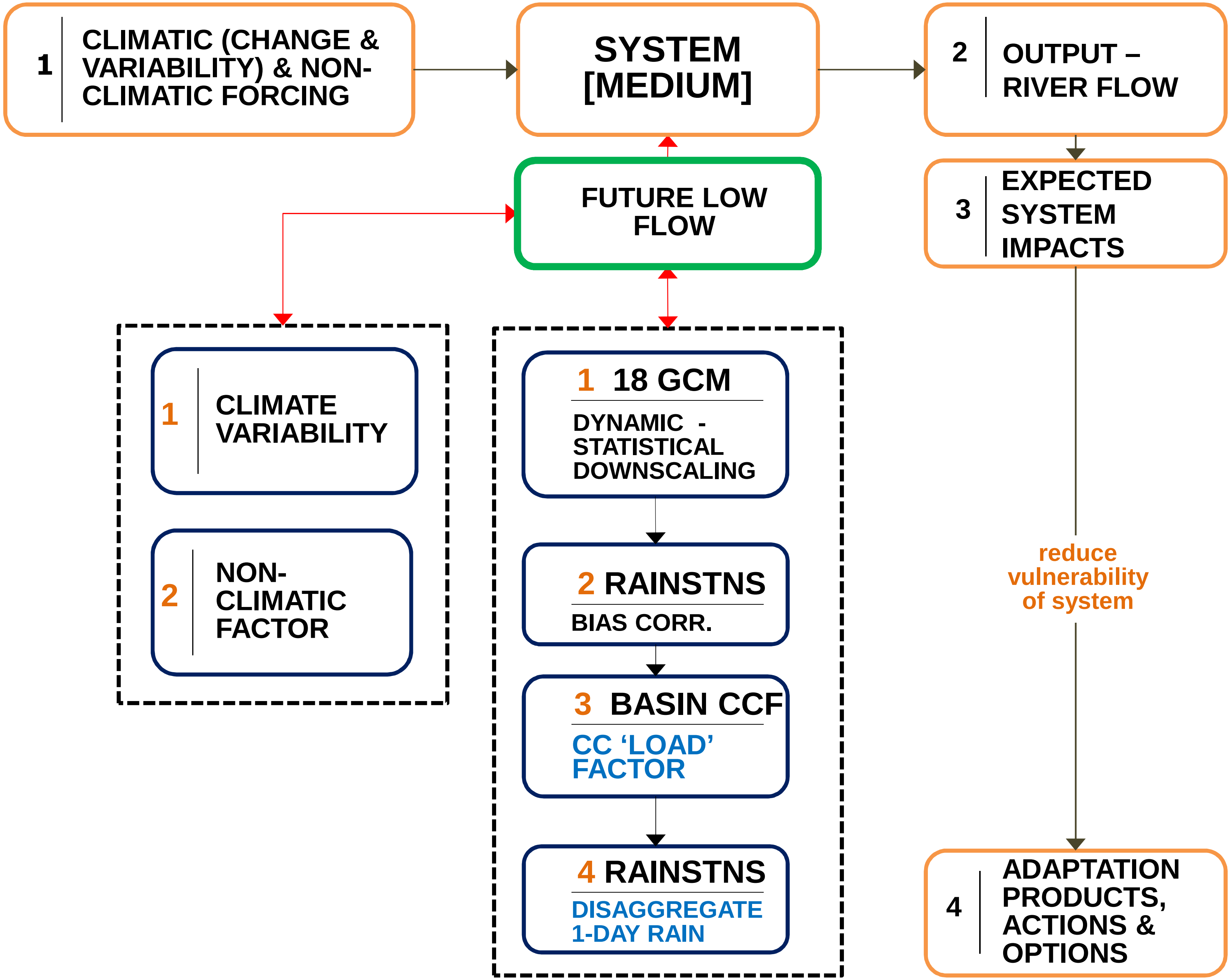
WATERSHED – "MEDIUM - SYSTEM"

HYDROLOGY MODELING

HYDRAULIC MODELING

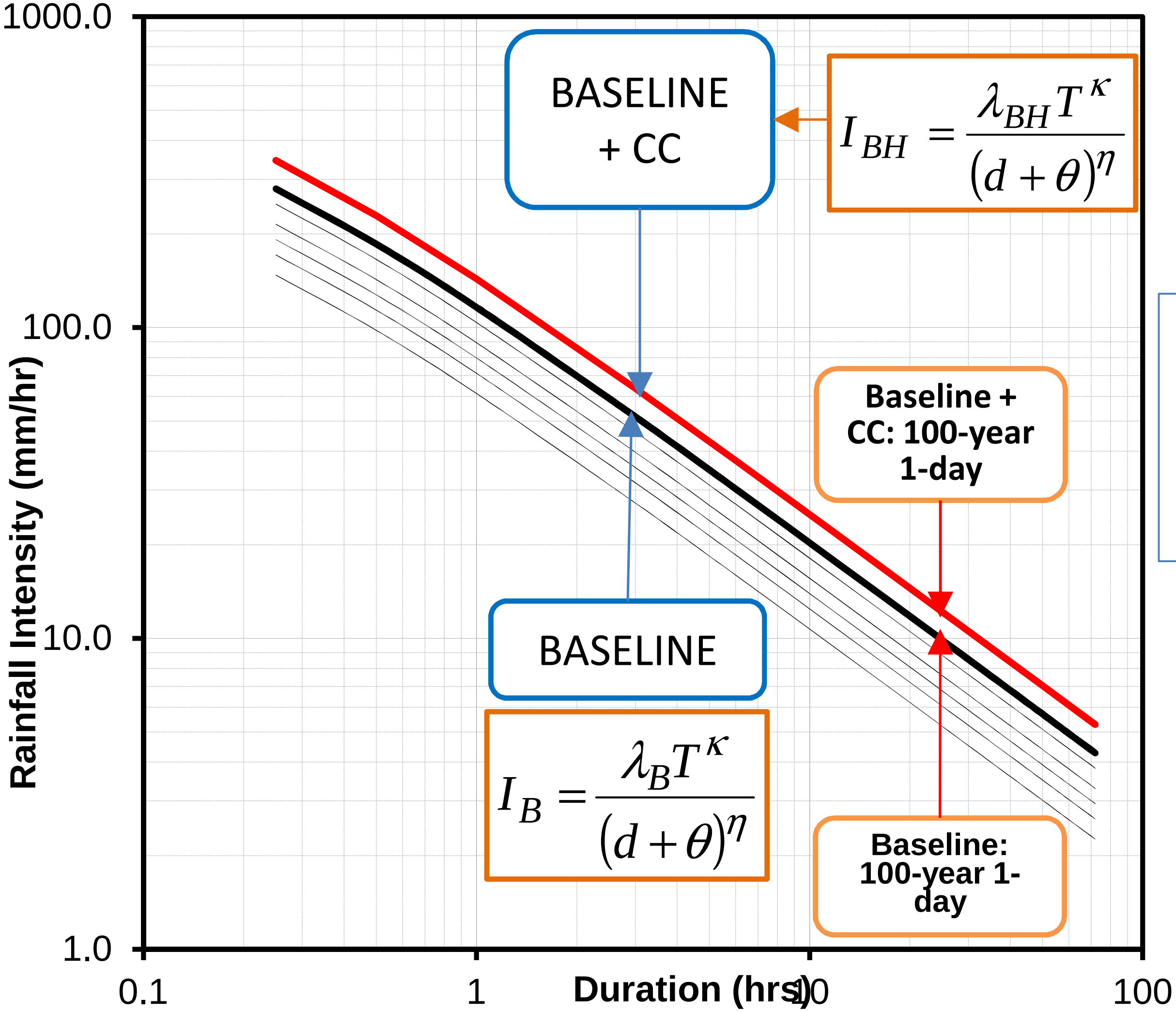


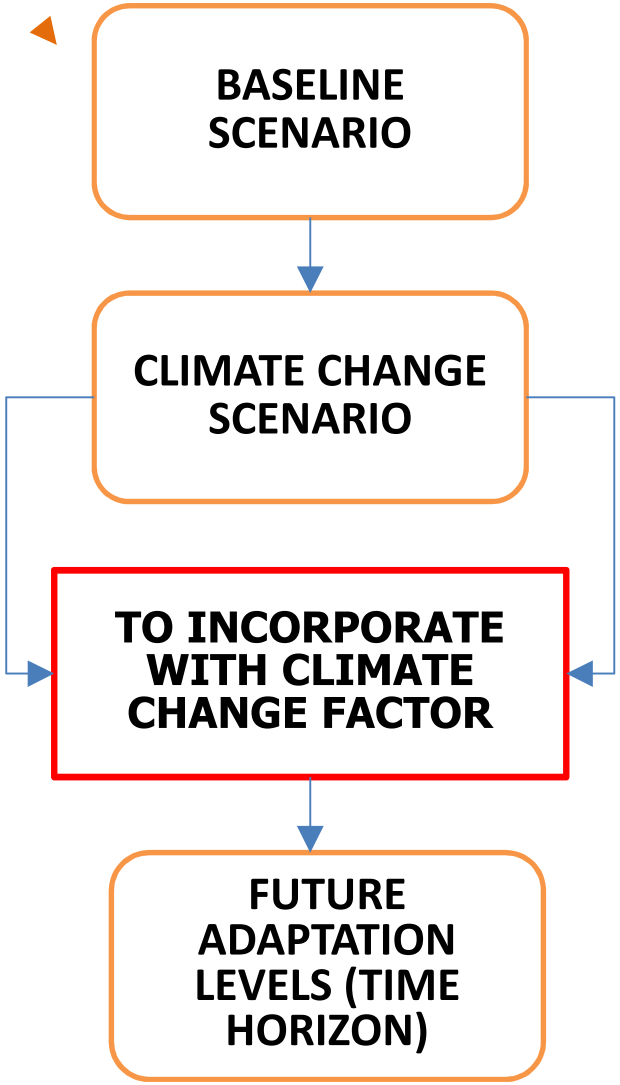
HYDRAULIC STRUCTURES



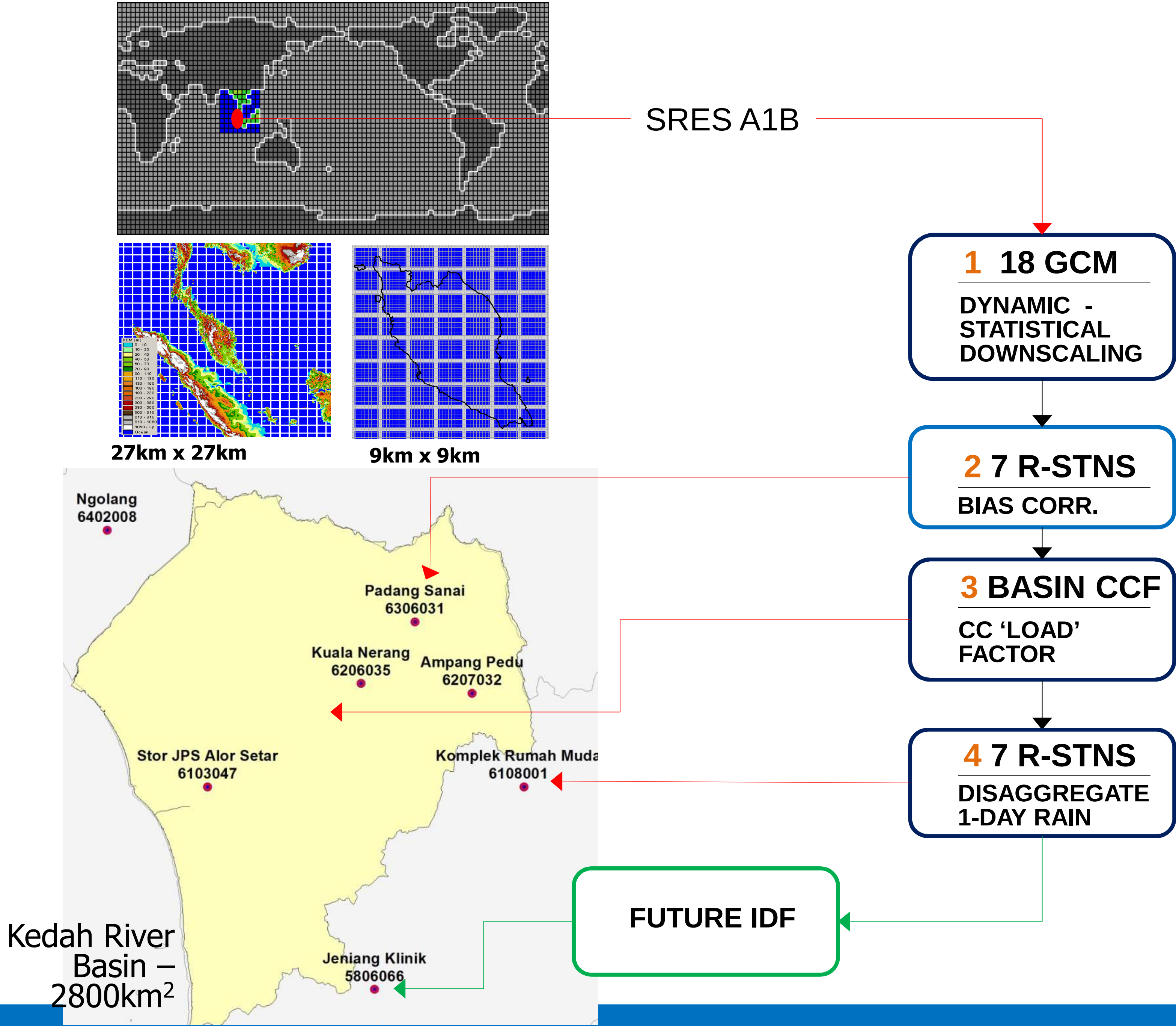
1 CLIMATIC (CHANGE & VARIABILITY) & NON-CLIMATIC FORCING
SYSTEM [MEDIUM]
2 OUTPUT – RIVER FLOW
FUTURE LOW FLOW
3 EXPECTED SYSTEM IMPACTS
1 CLIMATE VARIABILITY
2 NON-CLIMATIC FACTOR
1 18 GCM
DYNAMIC - STATISTICAL DOWNSCALING
2 RAINSTNS
BIAS CORR.
3 BASIN CCF
CC 'LOAD' FACTOR
4 RAINSTNS
DISAGGREGATE 1-DAY RAIN
reduce vulnerability of system
4 ADAPTATION PRODUCTS, ACTIONS & OPTIONS

DERIVATION OF CLIMATE CHANGE FACTOR





….apply engineering methodology for climate change adaptation…….


SRES A1B
27km x 27km
9km x 9km
Ngolang
6402008
Padang Sanai
6306031
Kuala Nerang
6206035
Ampang Pedu
6207032
Stor JPS Alor Setar
6103047
Komplek Rumah Muda
6108001
Jeniang Klinik
5806066
Kedah River Basin – 2800km²
1 18 GCM
DYNAMIC - STATISTICAL DOWNSCALING
2 7 R-STNS
BIAS CORR.
3 BASIN CCF
CC 'LOAD' FACTOR
4 7 R-STNS
DISAGGREGATE 1-DAY RAIN
FUTURE IDF

.......projected magnitude of peak floods with climate forcing....

(a) Item	(b) Time Horizon	(c) Climate Change Factor (CCF)	Peak Discharges (Q) 100 years ARI		
			(d) 1-Day Design Rainfall (Baseline= 240.6 mm)	(e) Baseline & Climate Change Scenario Flood Magnitude, Qp (Baseline= 2047.9 m^3/s)	(f) Climate Change Scenario Floods Magnitude (m^3/s)
1	2020	1.05	245	**2111**	63.3[3.1]#
2	2030	1.09	257	**2268**	220.0[10.7]
3	2040	1.14	268	**2430**	382.3[18.7]
4	2050	1.19	280	**2602**	554.0[27.1]
5	2060	1.25	292	**2785**	737.4[36.0]

Note: [3.1]# denotes as percentage of change in flood magnitude due to increasing design rainfall.

…….projected magnitude of peak floods with climate & non-climate forcing….

(a) Item	(b) Time Horizon	(c) Climate Change Factor (CCF)	Peak Discharges (Q) 100 years ARI			
			(d) 1-Day Design Rainfall (Baseline= 241 mm)	(e) Baseline, CC & **Future Landuse** (Baseline Q_P= 2048 m^3/s)	(f) Baseline & Climate Change Q_P (m^3/s)	(g) Adaptation value (m^3/s)
1	2020	1.05	245	**2313**	**2111**	**266**
2	2030	1.09	257	**2477**	**2268**	**429**
3	2040	1.14	268	**2645**	**2430**	**598**
4	2050	1.19	280	**2824**	**2602**	**776**
5	2060	1.25	292	**3014**	**2785**	**966**

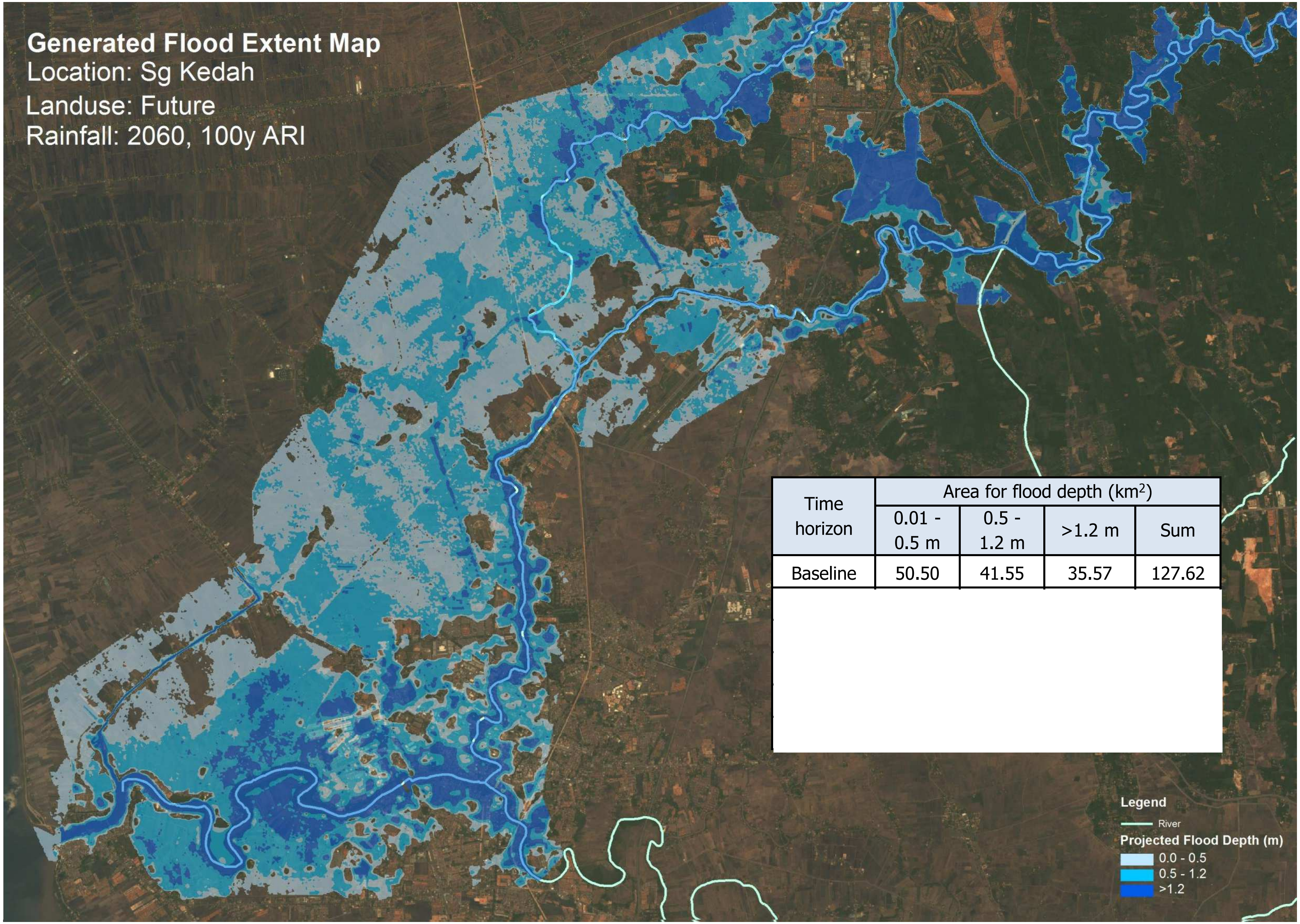
Note: [3.1]# denotes as percentage of change in flood magnitude due to increasing design rainfall.

Generated Flood Extent Map

Location: Sg Kedah

Landuse: Future

Rainfall: 2060, 100y ARI

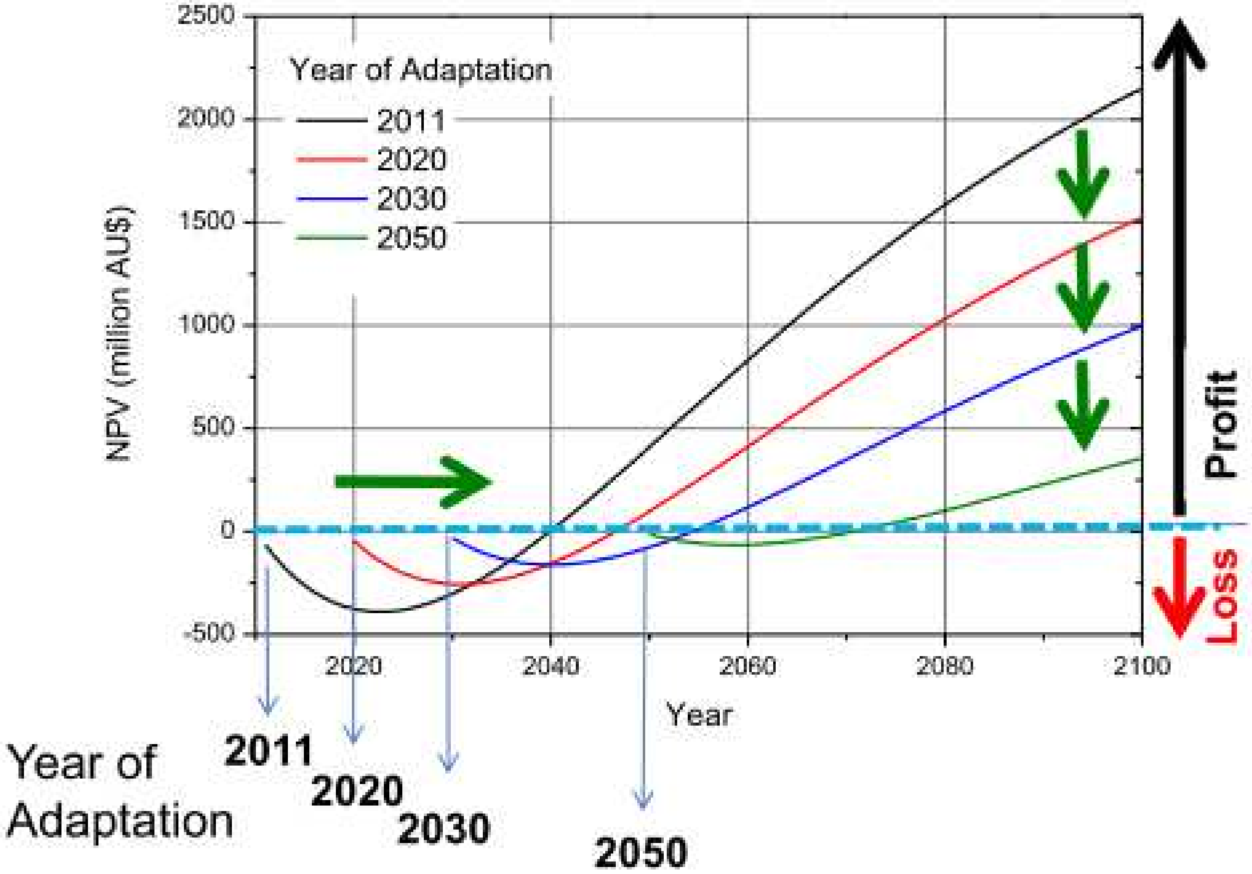


Time horizon	Area for flood depth (km^2)			
	0.01 - 0.5 m	0.5 - 1.2 m	>1.2 m	Sum
Baseline	50.50	41.55	35.57	127.62

….informing policy maker or planner….by means of economics assessment…..

..knowledge to informing policy making through cost benefit analysis….

NPV (Net Present Value) = Benefit - Cost

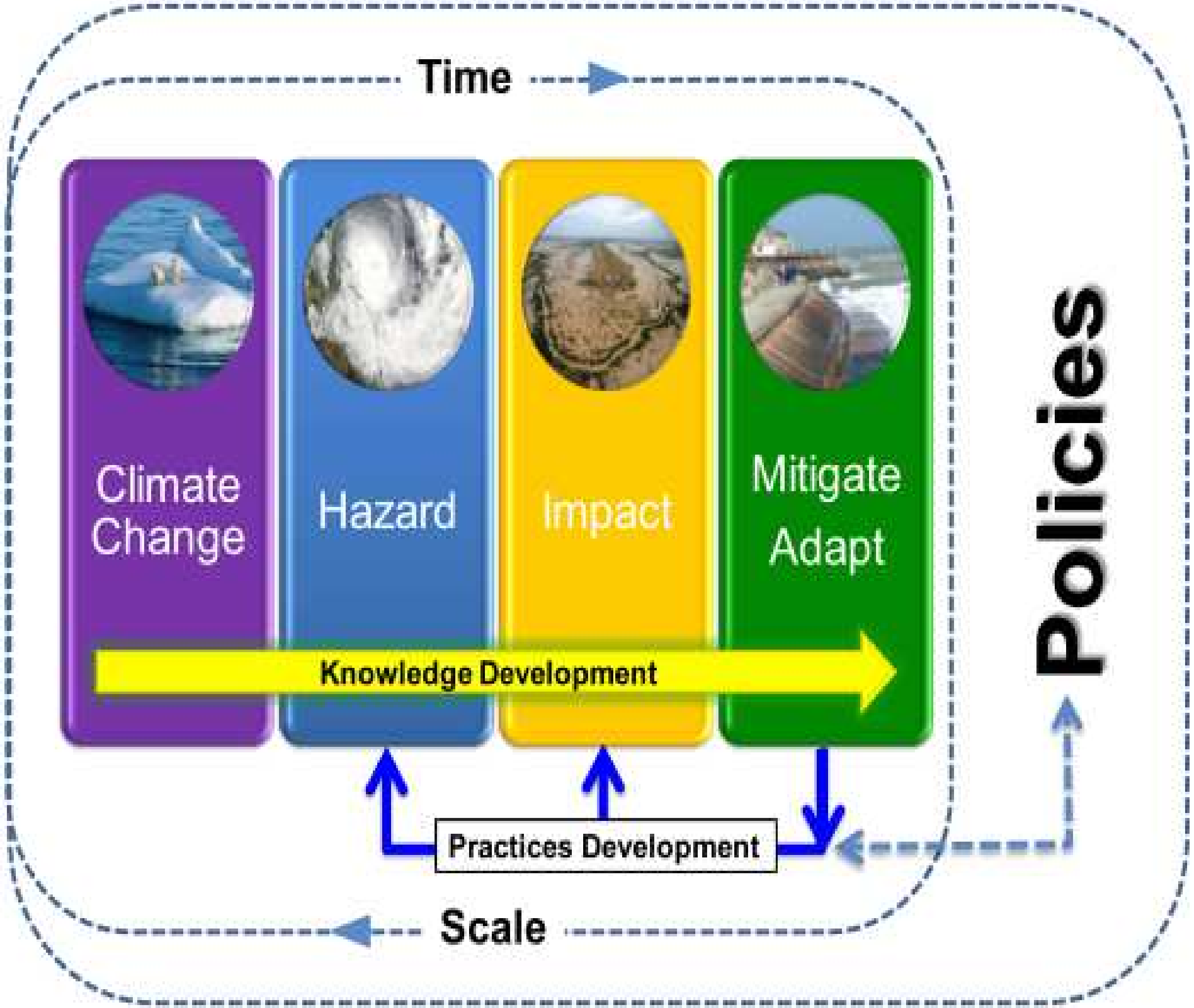


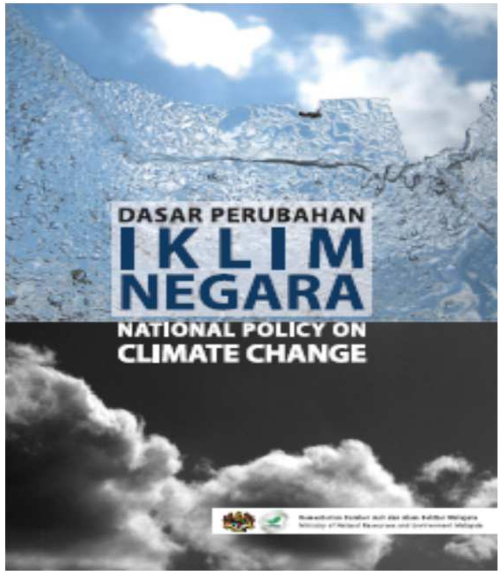
- To maintain long-term view in policy-making and planning
- Late action in adaptation may reduce the benefit significantly

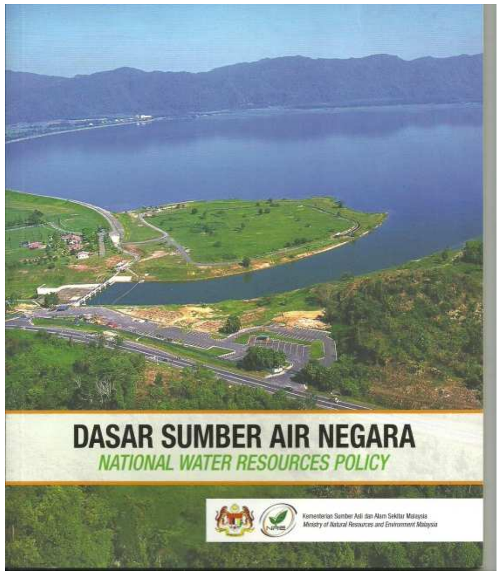
Source: X. Wang, CSIRO 2012

….subsequently, we have to "revisit" existing policy and provides pathway to adaptation policy…..

.....pathways from knowledge to adaptation policies......

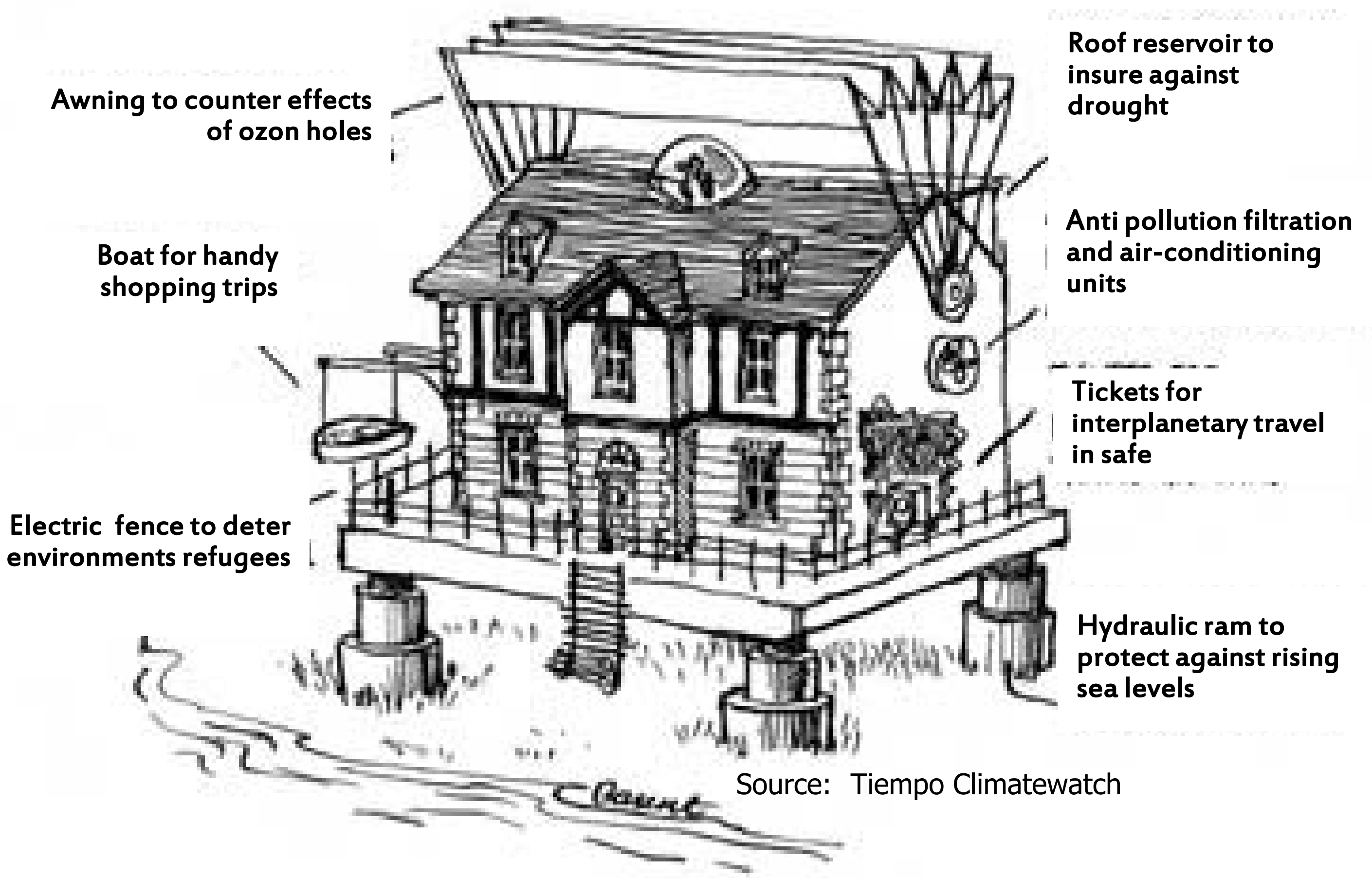






.....to strenghtening water related policies...

.....future climate proofing?...



Source: Tiempo Climatewatch

Think Climate Think Change Think Adaptation

THANK YOU

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http:/www.nahrim.gov.my