7th GEOSS ASIAN WATER CYCLE INITIATIVE (AWCI)INTERNATIONAL COORDINATION GROUP (ICG) MEETING

CLIMATE CHANGE IMPACTS ON THE HYDROLOGICAL AND HYDRAULIC PERFORMANCE OF BEKOK IN JOHOR

MOHD ZAKI M AMIN
Research Centre for Water Resources
National Hydraulic Research Institute of Malaysia
Ministry of Natural Resources & Environment

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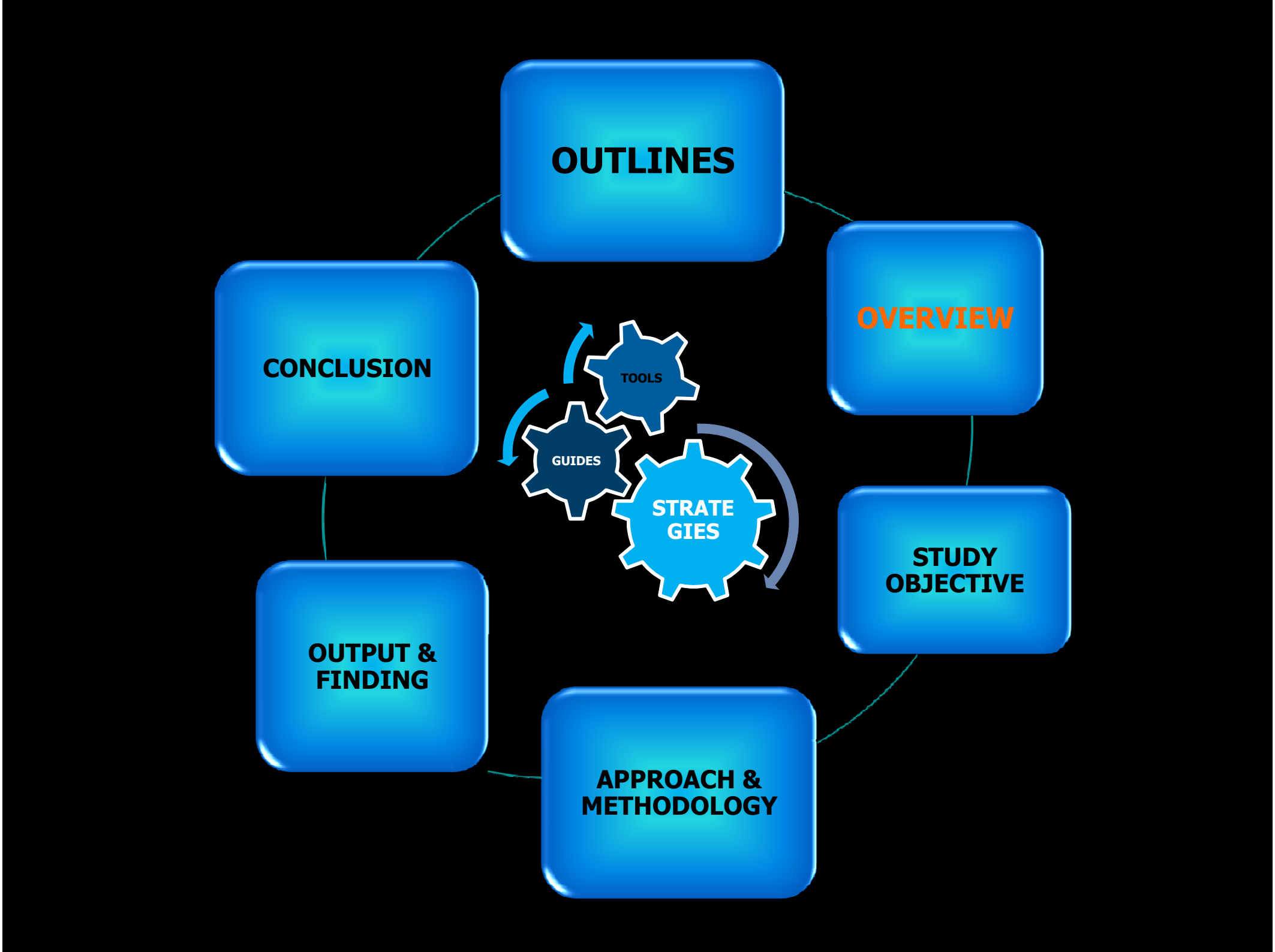
TOKYO, JAPAN


OUTLINES
OVERVIEW
STUDY OBJECTIVE
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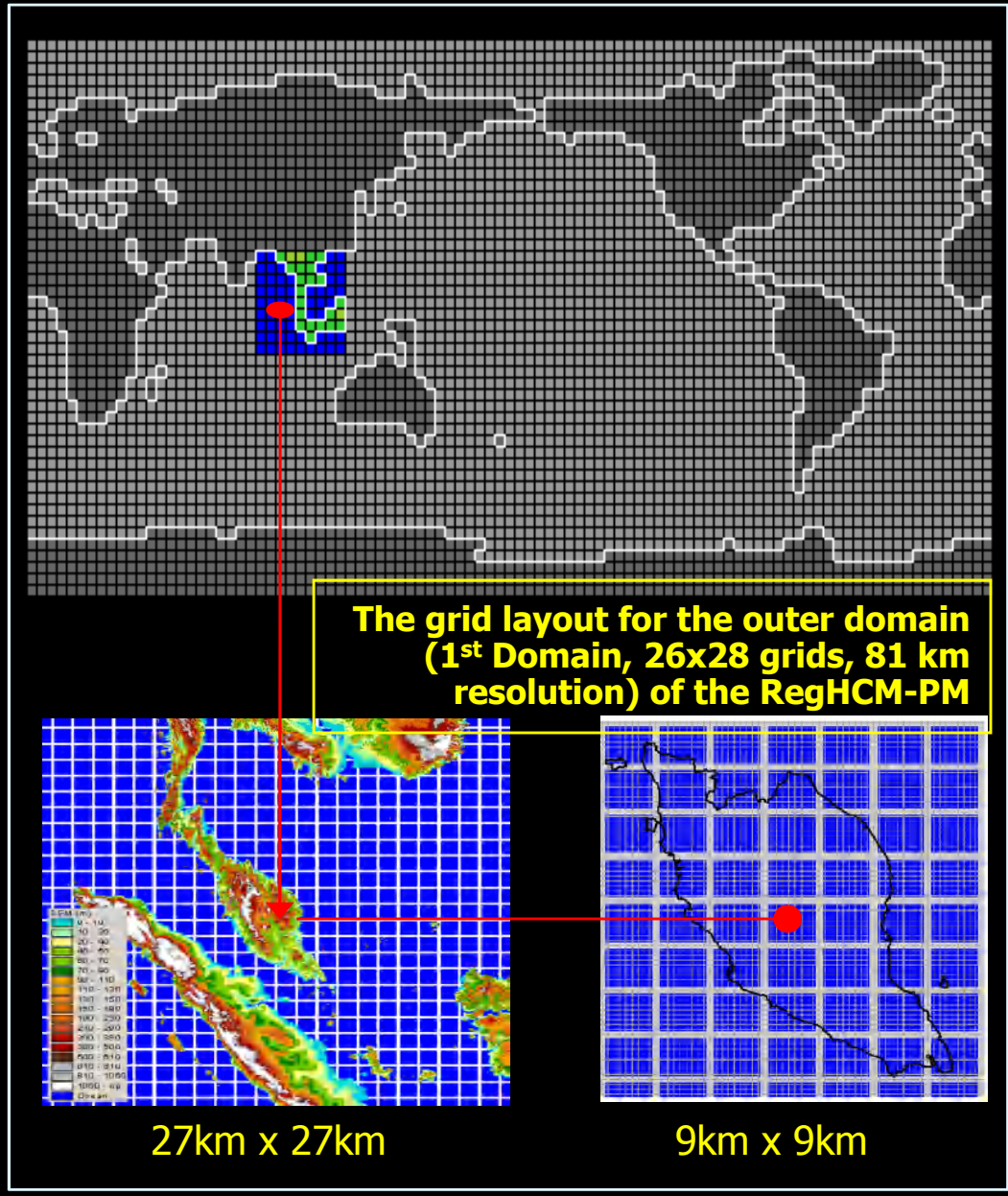
OVERVIEW

NAHRIM's Regional Hydro-climate Model (RegHCM-PM)

- **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 at fine spatial resolution (~9km) – for future period of 2025 to 2050 (2025-2034 & 2041-2050)
- Able to quantify the impact of the complex topographical and land surface features of Peninsular Malaysia on its climate conditions

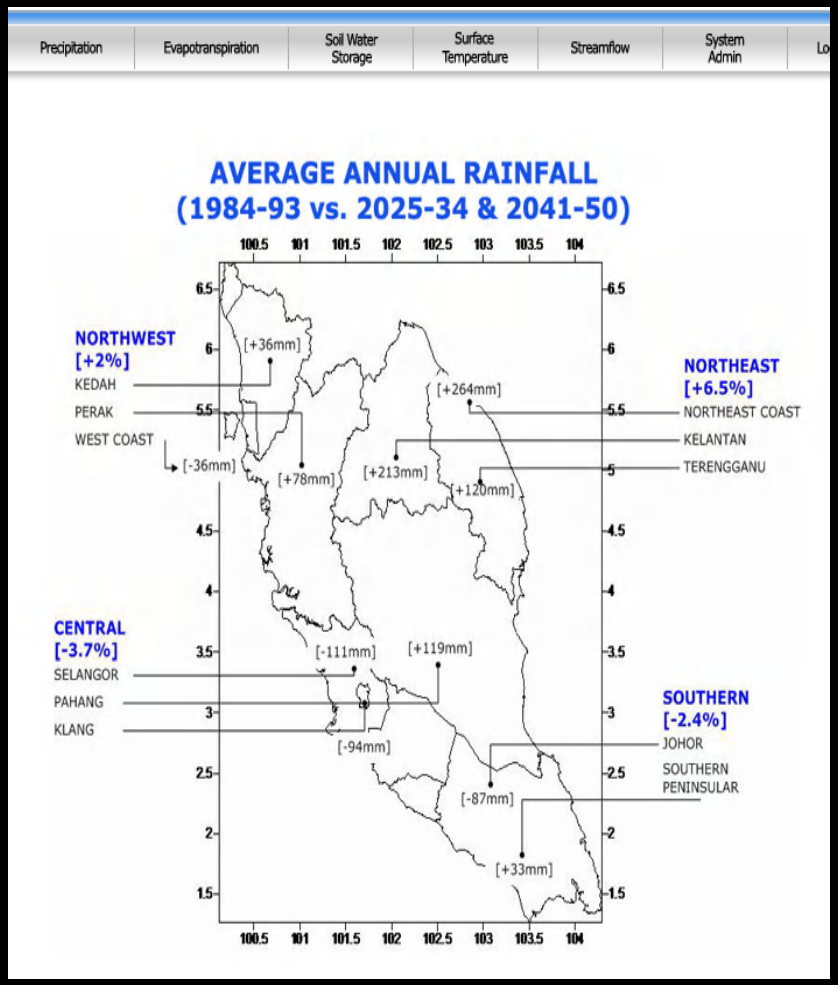


OVERVIEW

NAHRIM's Future Hydroclimate Change Projection Database

http:/www.futurehydroclimate.nahrim.gov.my

- 5 main modules/ para-meters:
  - Precipitation
  - Evapotrans-piration
  - Soil Water Storage
  - Surface Temperature
  - Streamflow



- 2 types of data sets for each module/para meter:
  - Simulated Past Data (1984 to 1993)
  - Simulated Future Data (2025 to 2034 and 2040 to 2050)

OVERVIEW

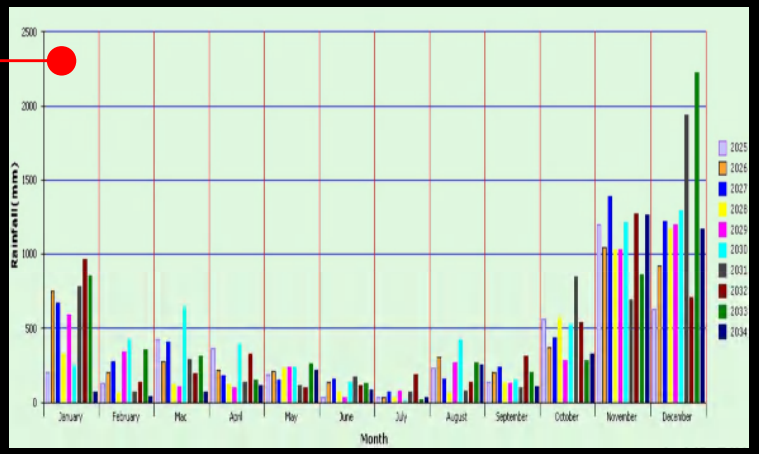
Future Hydroclimate Data Retrieval System for extreme events (9km x 9km)

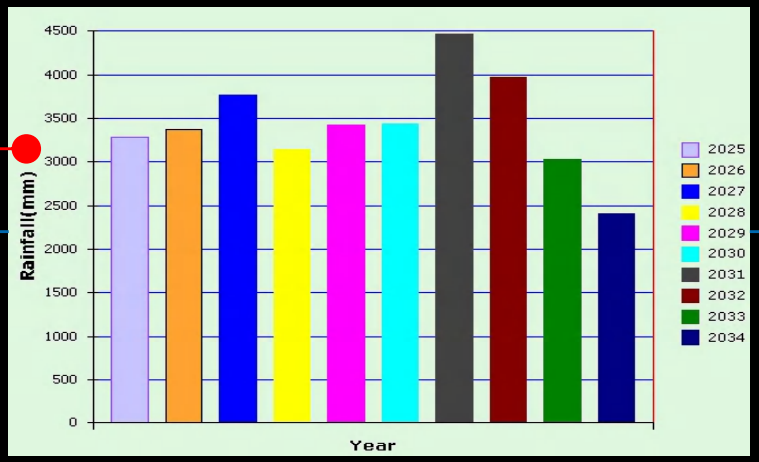
FUTURE HYDROCLIMATE DATA RETRIEVAL SYSTEM

102.5667 5.5405	102.6476 5.5405	102.7286 5.5405	102.8095 5.5405	102.8905 5.5405	
102.5667 5.4599	102.6476 5.4599	102.7286 5.4599	102.8095 5.4599	102.8905 5.4599	102.9714 5.4599
102.5667 5.3793	102.6476 5.3793	102.7286 5.3793	102.8095 5.3793	102.8905 5.3793	102.9714 5.3793
102.5667 5.2987	102.6476 5.2987	102.7286 5.2987	102.8095 5.2987	102.8905 5.2987	102.9714 5.2987
102.5667 5.2181	102.6476 5.2181	102.7286 5.2181	102.8095 5.2181	102.8905 5.2181	102.9714 5.2181
102.5667 5.1375	102.6476 5.1375	102.7286 5.1375	102.8095 5.1375	102.8905 5.1375	102.9714 5.1375

103.4571 2.9574					
103.4571 2.8765					
103.4571 2.7957	103.5381 2.7957				
103.4571 2.7148	103.5381 2.7148	103.619 2.7148			
103.4571 2.6339	103.5381 2.6339	103.619 2.6339	103.7 2.6339	103.7809 2.6339	
103.4571 2.5531	103.5381 2.5531	103.619 2.5531	103.7 2.5531	103.7809 2.5531	103.8619 2.5531
103.4571 2.4722	103.5381 2.4722	103.619 2.4722	103.7 2.4722	103.7809 2.4722	103.8619 2.4722

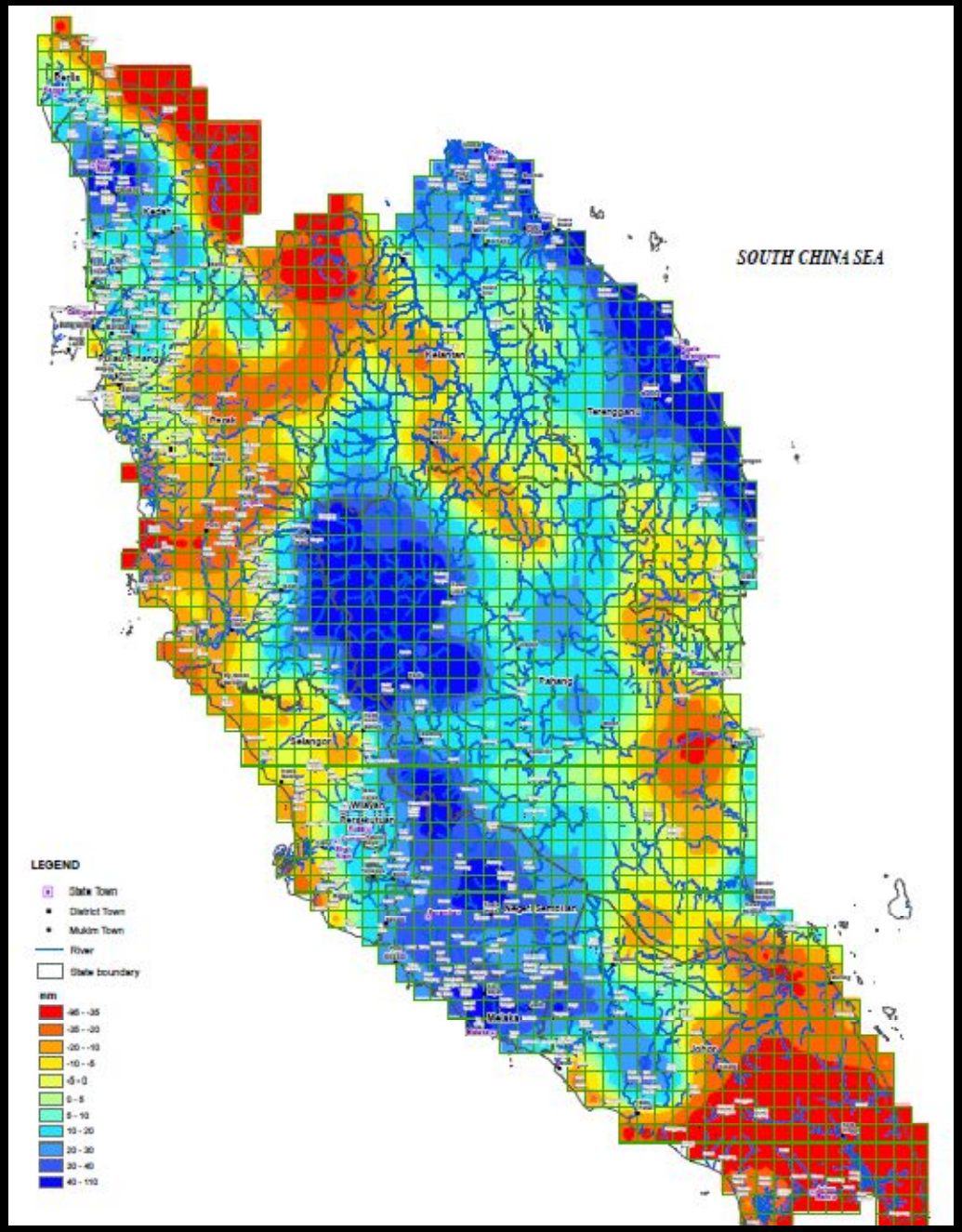
9km x 9km grid size



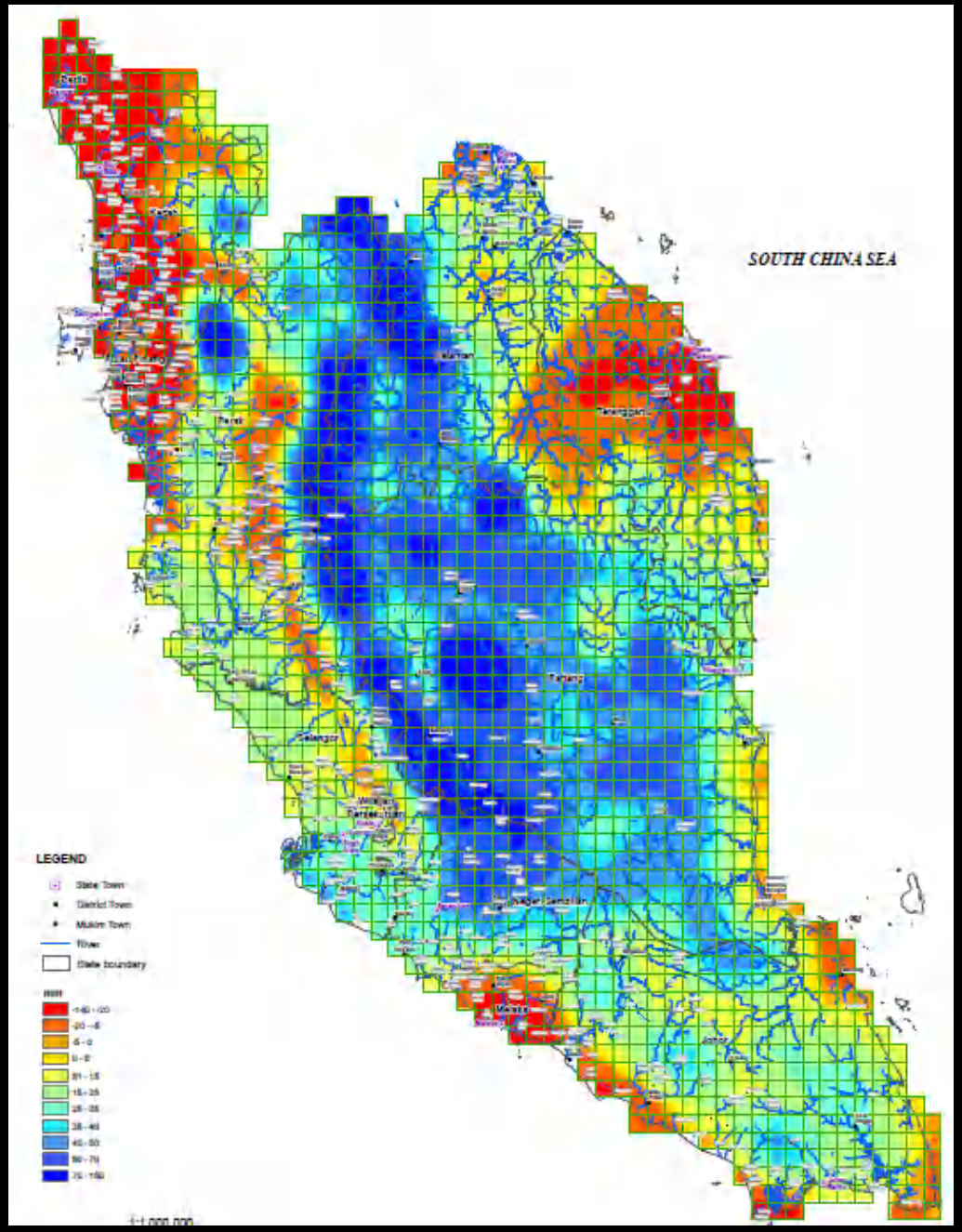


- Daily Rainfall
- Monthly Rainfall
- Annual Rainfall
- Daily Average
  - 1-Day Max
  - 2-Day Max
  - 3-Day max
  - 5-Day Max

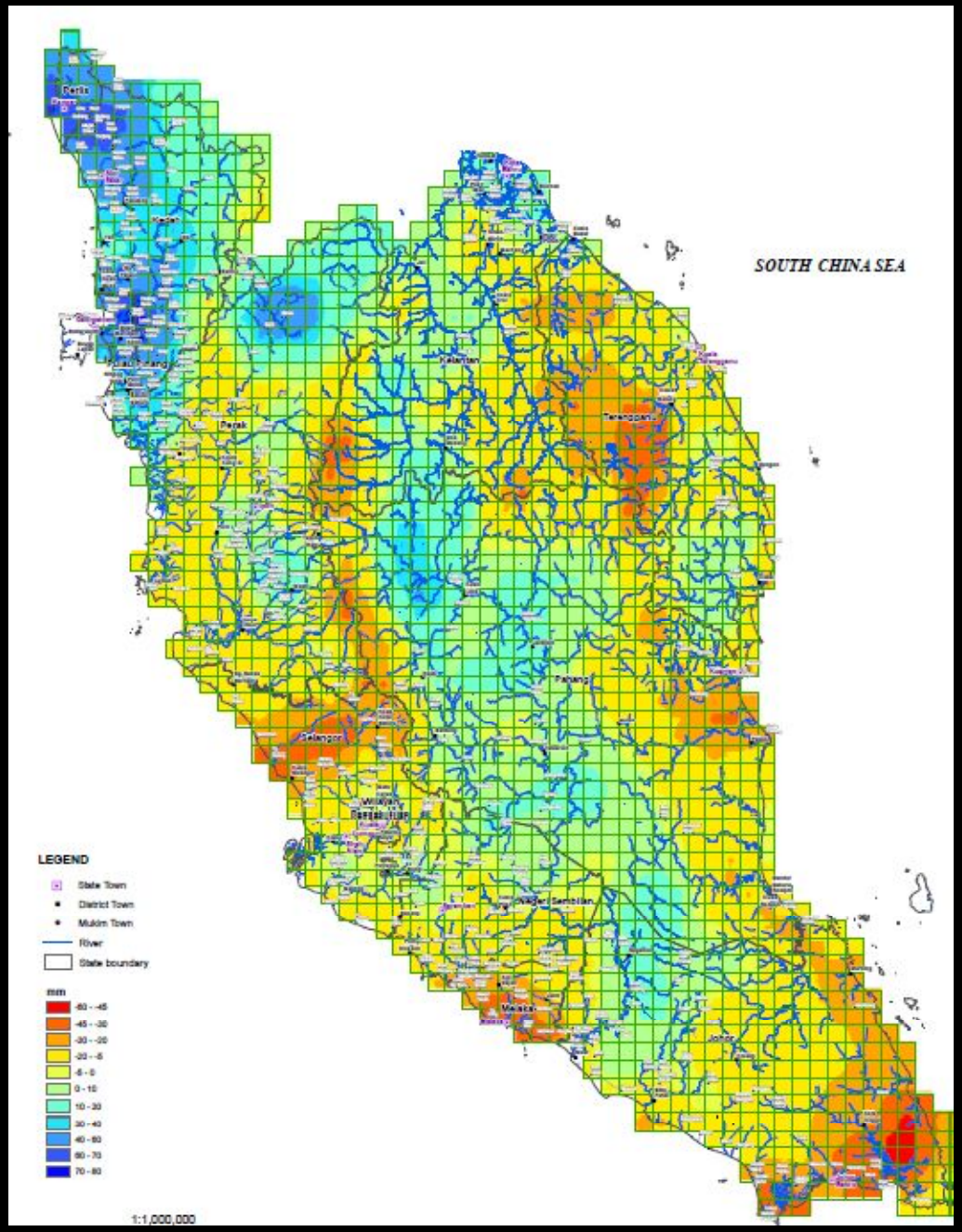
Monthly Rainfall Anomaly (April)



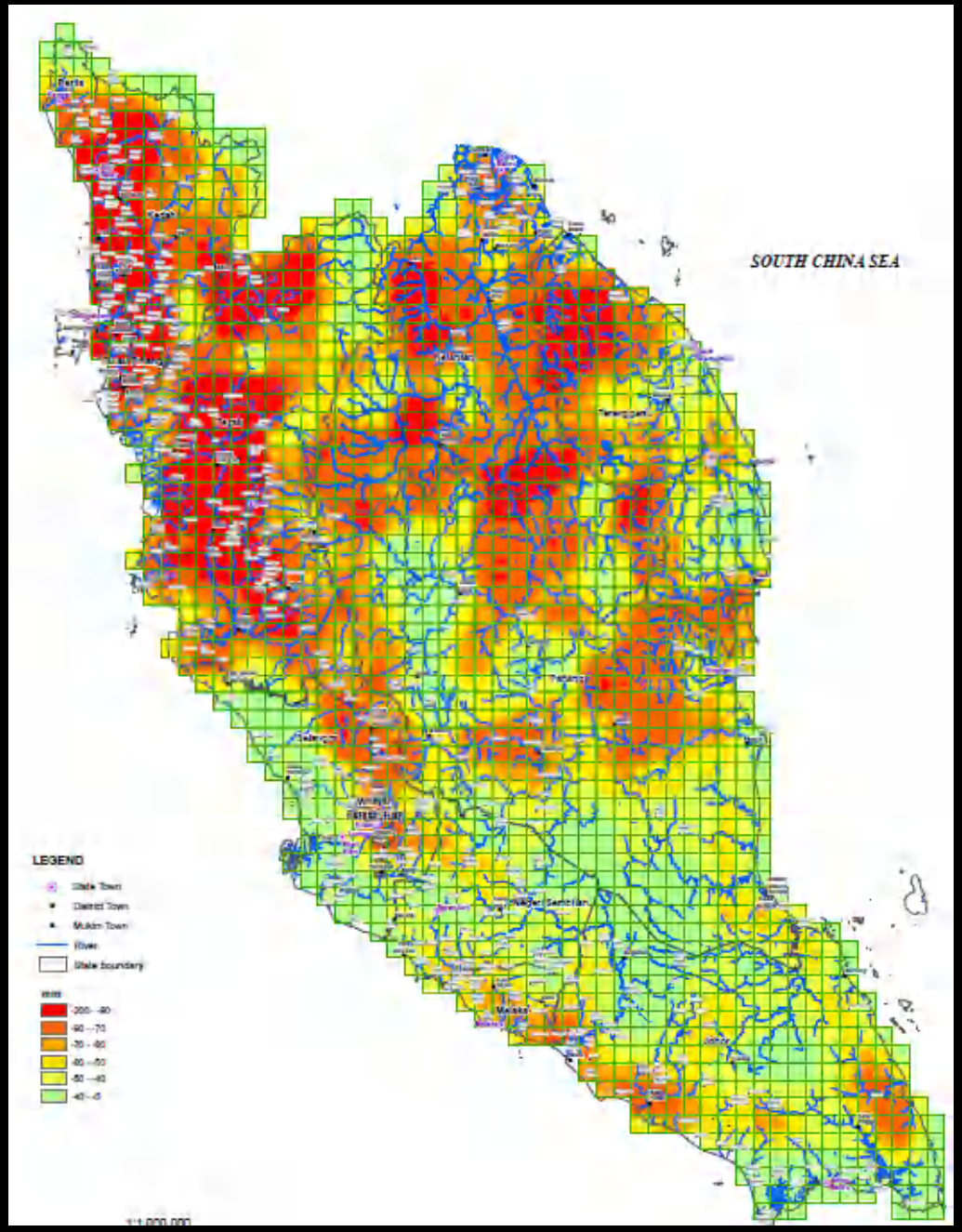
Monthly Rainfall Anomaly (May)



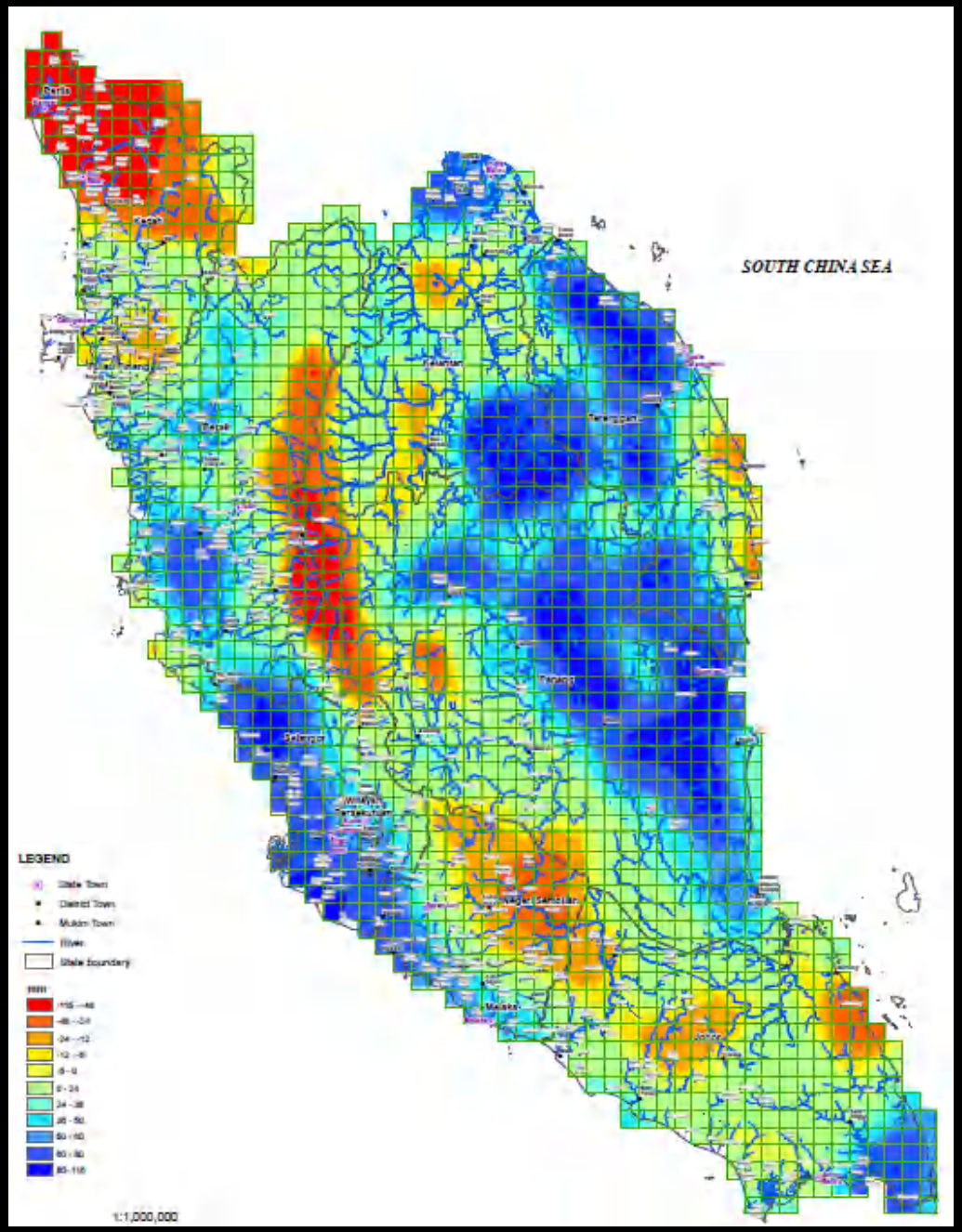
Monthly Rainfall Anomaly (June)



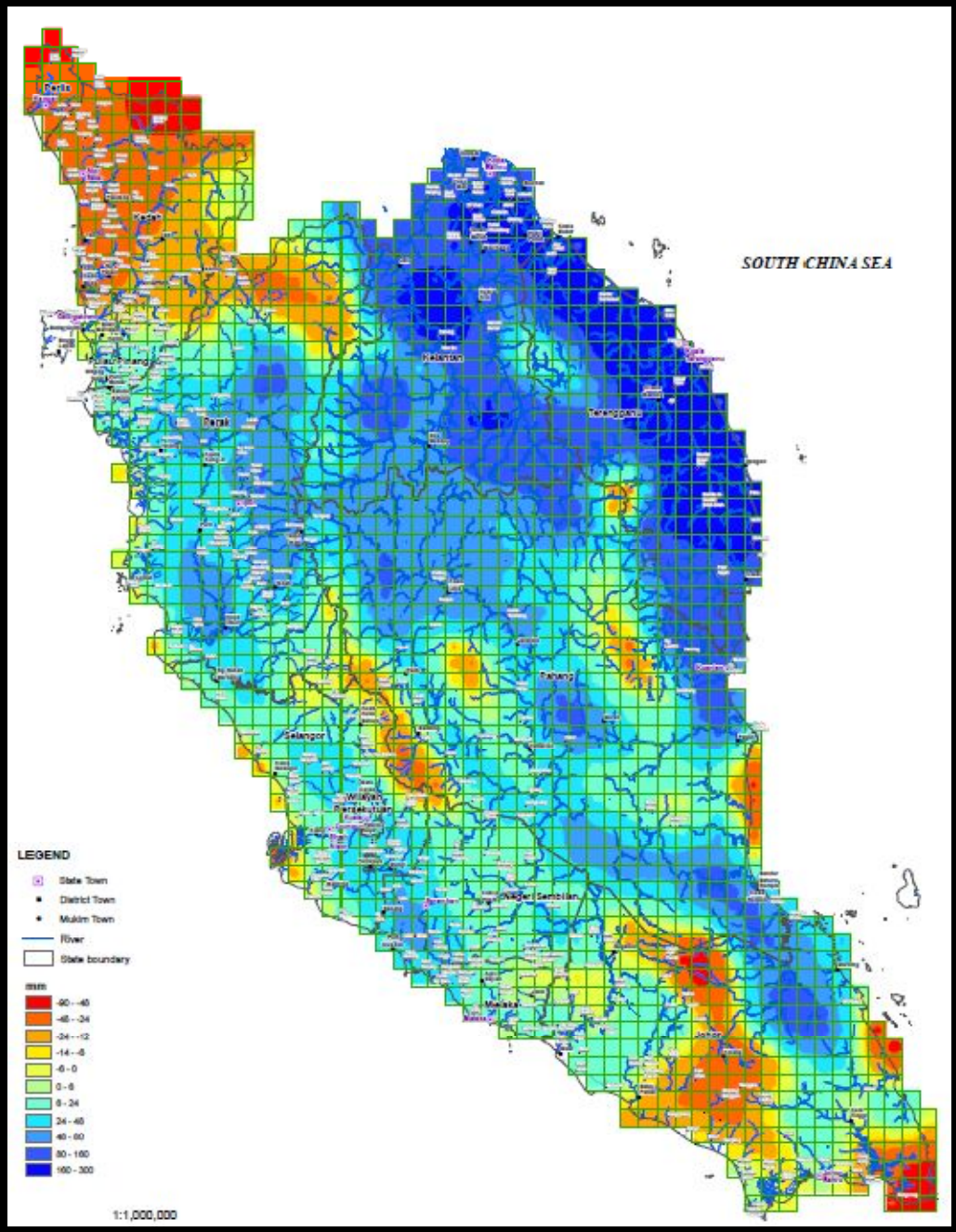
Monthly Rainfall Anomaly (August)



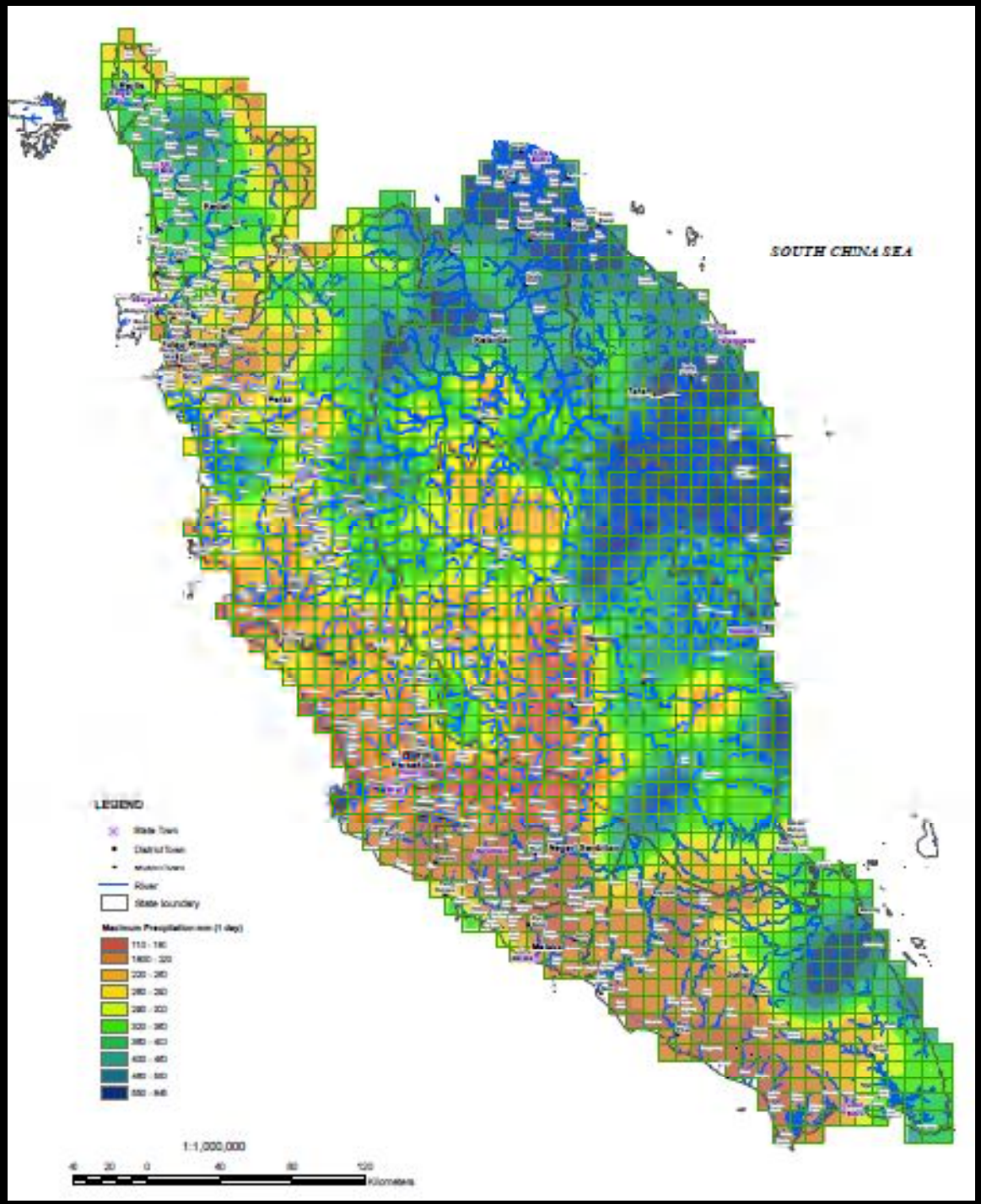
Monthly Rainfall Anomaly (November)



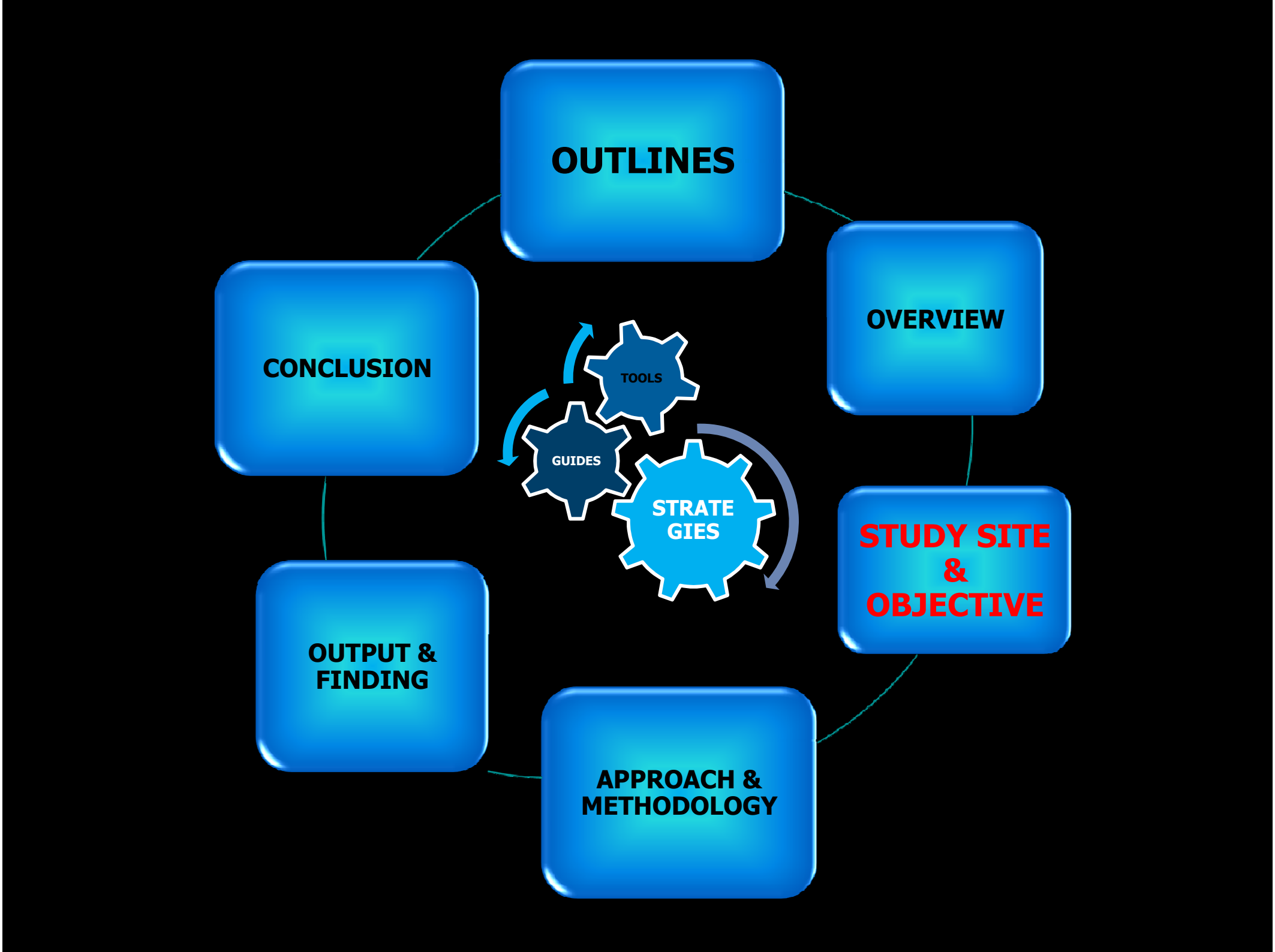
Monthly Rainfall Anomaly (December)



1-day Max Future Rainfall Over Pen Malaysia



110 – 460mm/day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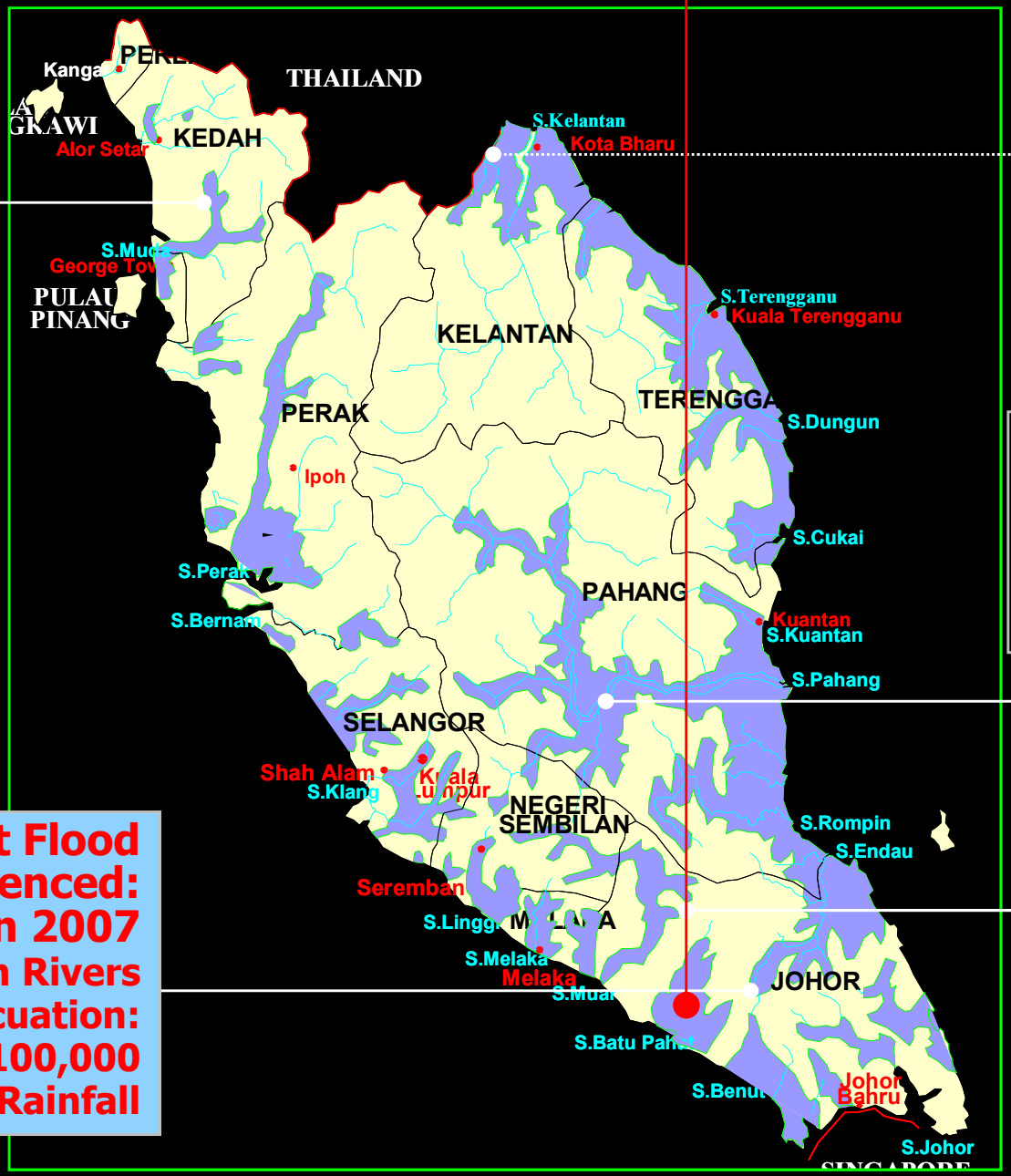
Study site - located to the west of Johor in Peninsular Malaysia



Muda River
Rainfall Period:
Dec. 5-17,2007

Golok River
Rainfall Period:
Dec. 5-21,2007

Pahang River
Rainfall Period:
Dec. 5-15,2007
Evacuation:
>25,000

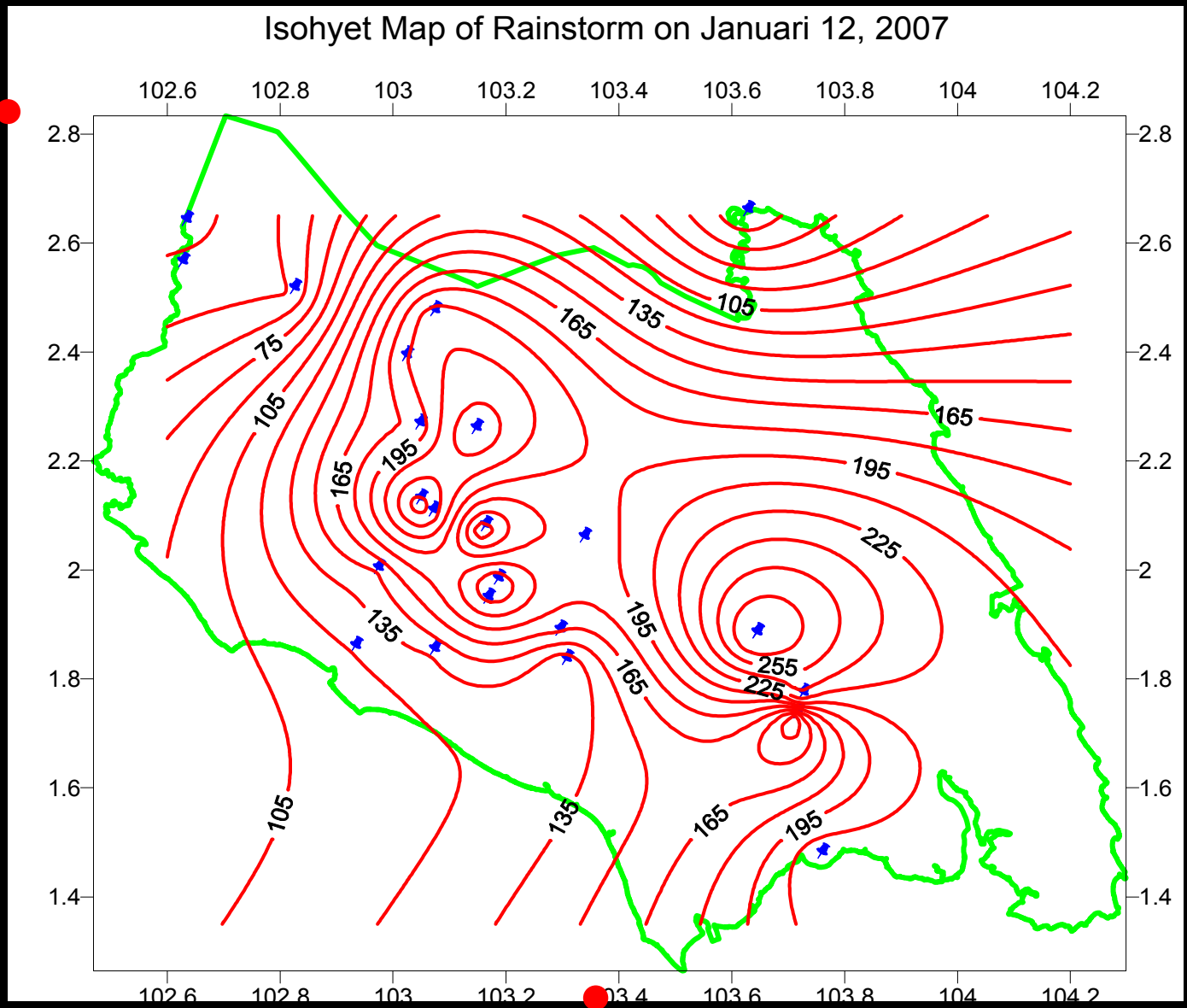
Muar River
Rainfall Period:
Dec. 5-22,2007

Worst Flood Experienced:
Dec 2006 & Jan 2007
[1] 3 main Rivers
[2] Evacuation: >100,000
[3] Abnormal Rainfall

MOTIVATION

DEC 2006 & JAN 2007 FLOOD EVENTS IN JOHOR

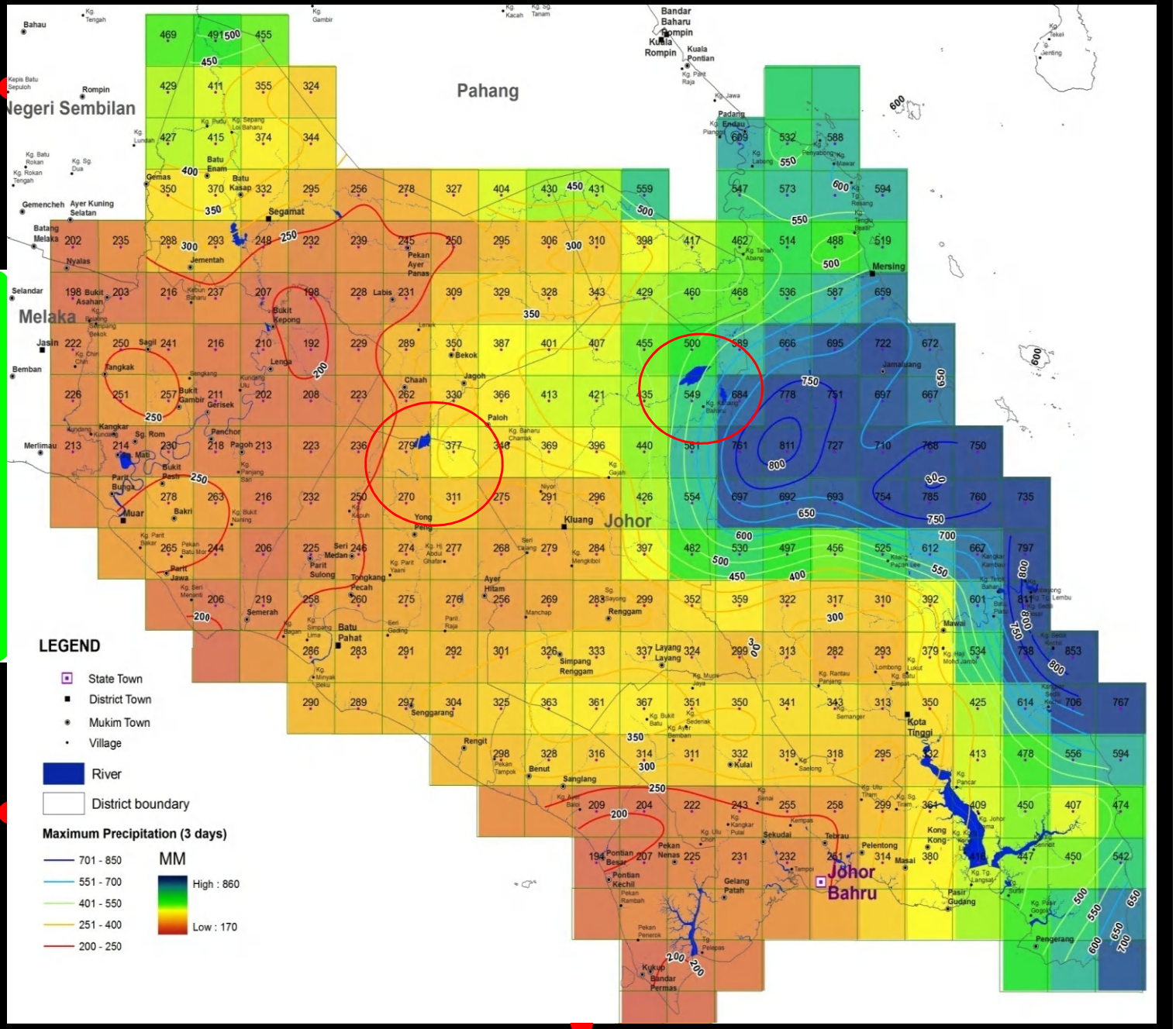
Sg. Johor Max. Daily Rain (1st wave)	Sg Johor Max Daily Rain (2nd wave)
19 Dec 2006	12 Jan 2007
200mm (460 ARI)	160mm (100 ARI)



MOTIVATION

1-3 DAY ANNUAL MAXIMA RAINFALL

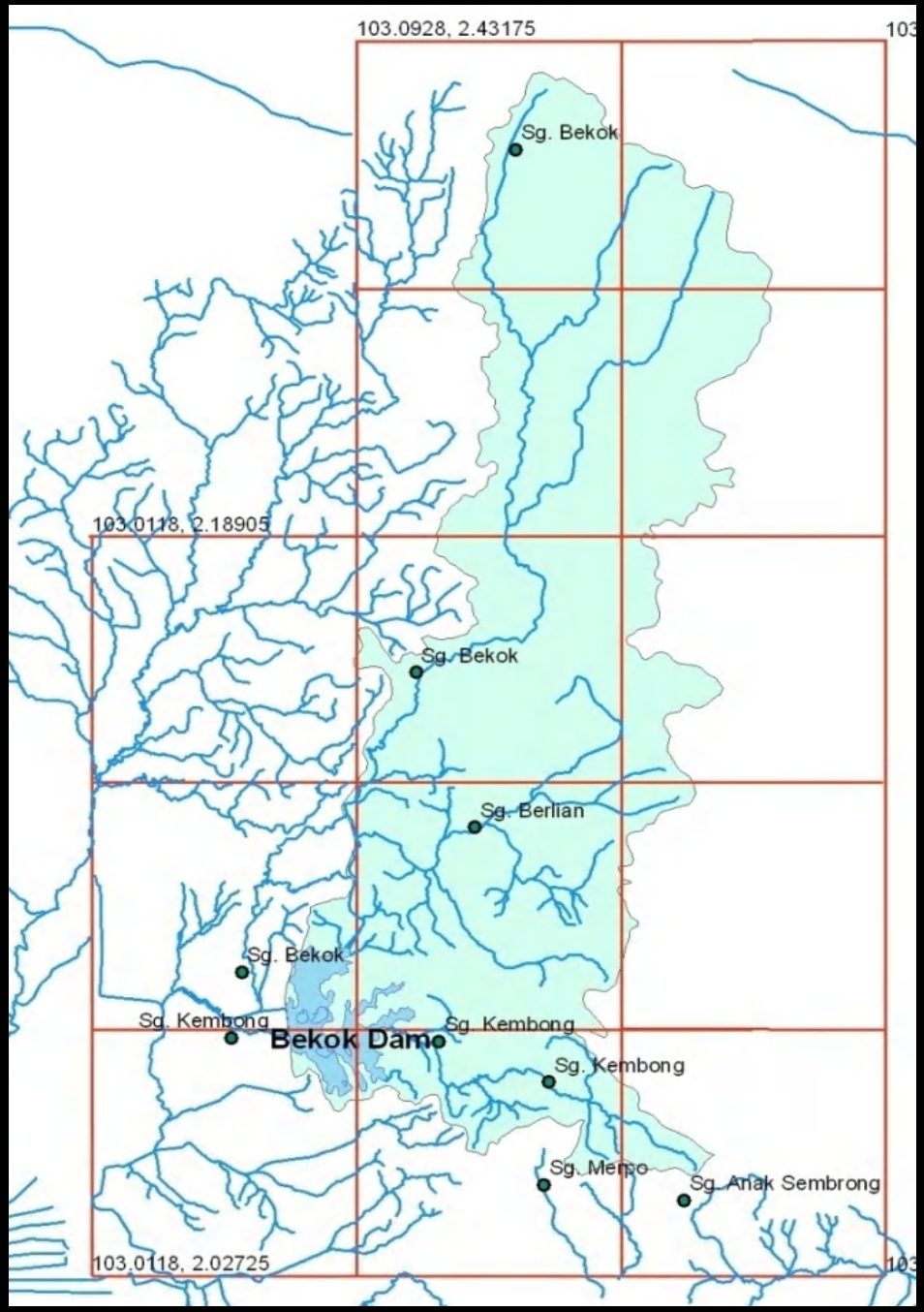
1-Day	2-Day	3-Day
Max: 720mm	Max: 785mm	Max: - 810mm
Min: 150mm	Min: 200mm	Min: 200mm



- **Objective** - to examines the impact of climate change on the Bekok Dam, a flood mitigation and water supply dam in Batu Pahat, Johor - **Structural Integrity (Spillway**)

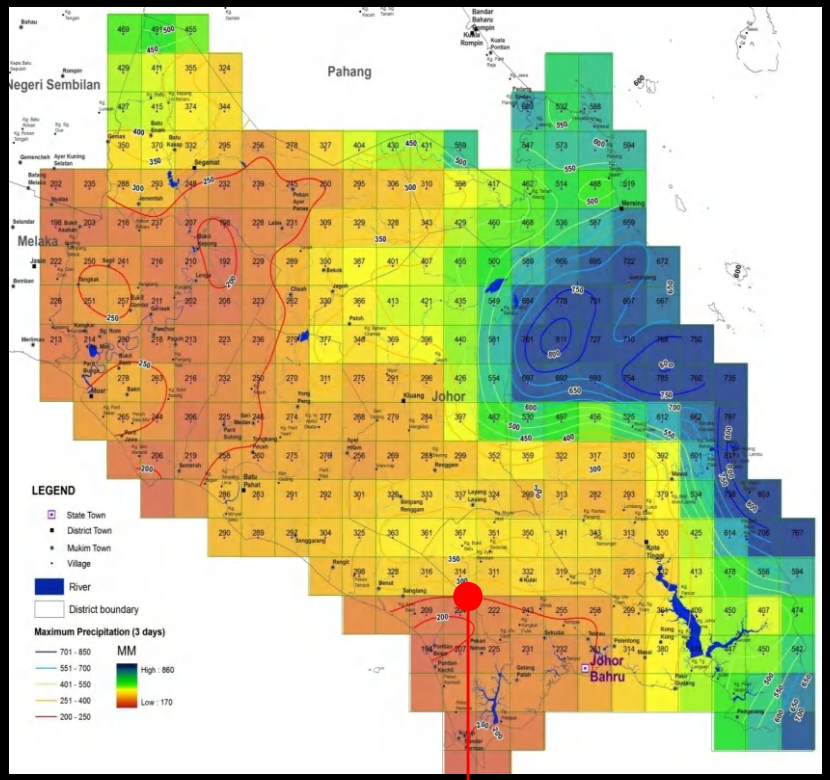
Brief Scope of Works

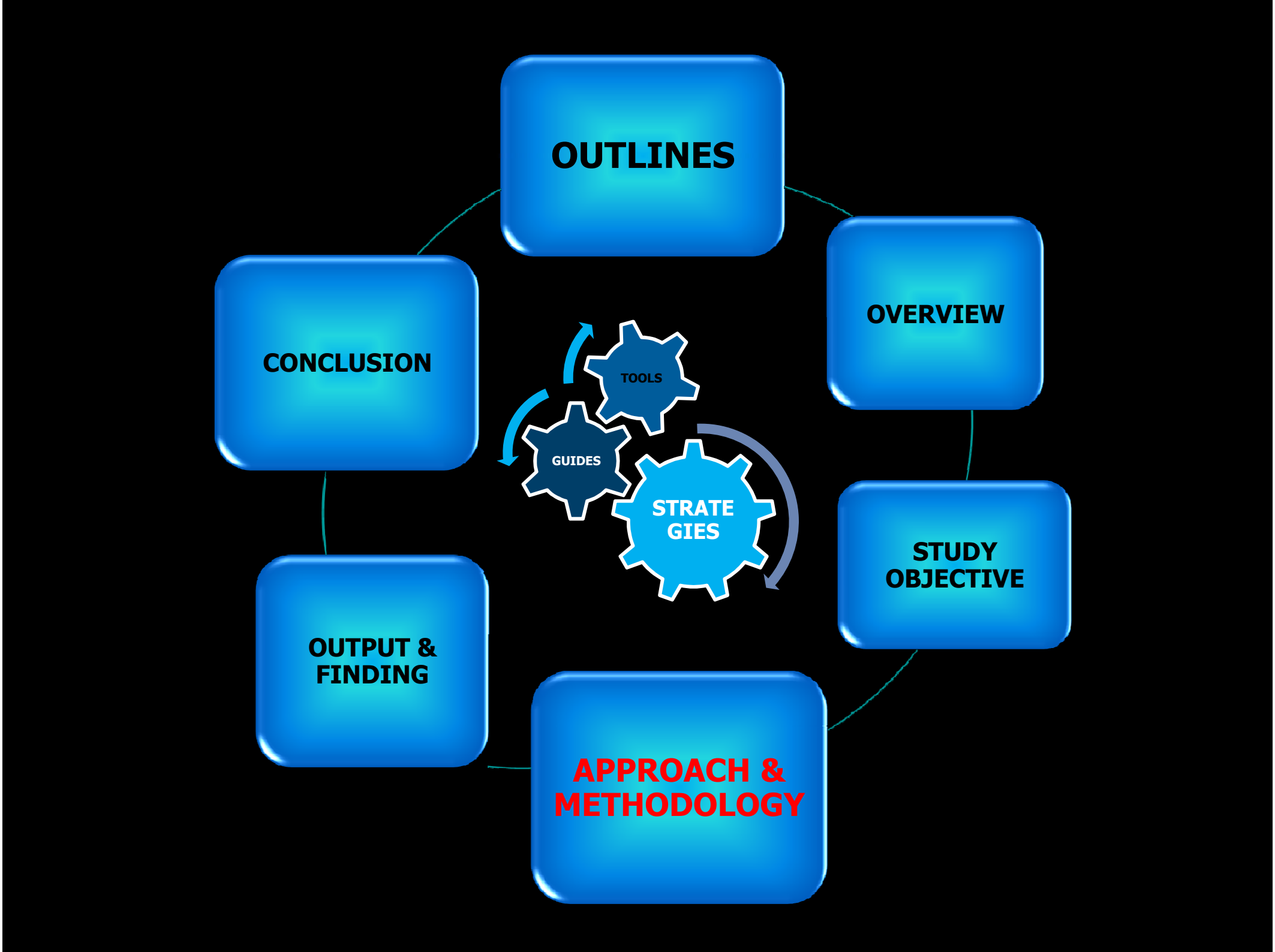
- Data collection & collation
- Retrieve data from **RegHCM –PM** output (future hydroclimate database system)
- Examines climate change on **floods**
- Examines climate change on **water resources**



Dam Characteristics

Gate			Existing Primary Spillway	Auxiliary Spillway
No.	2	Length (m)	20	100
Width (m)	7	Crest Level (m)	17.5	19.5
Height (m)	4	Conservation Level (m)		
Invert Level (m)	10.7	Existing (m)	13.3	

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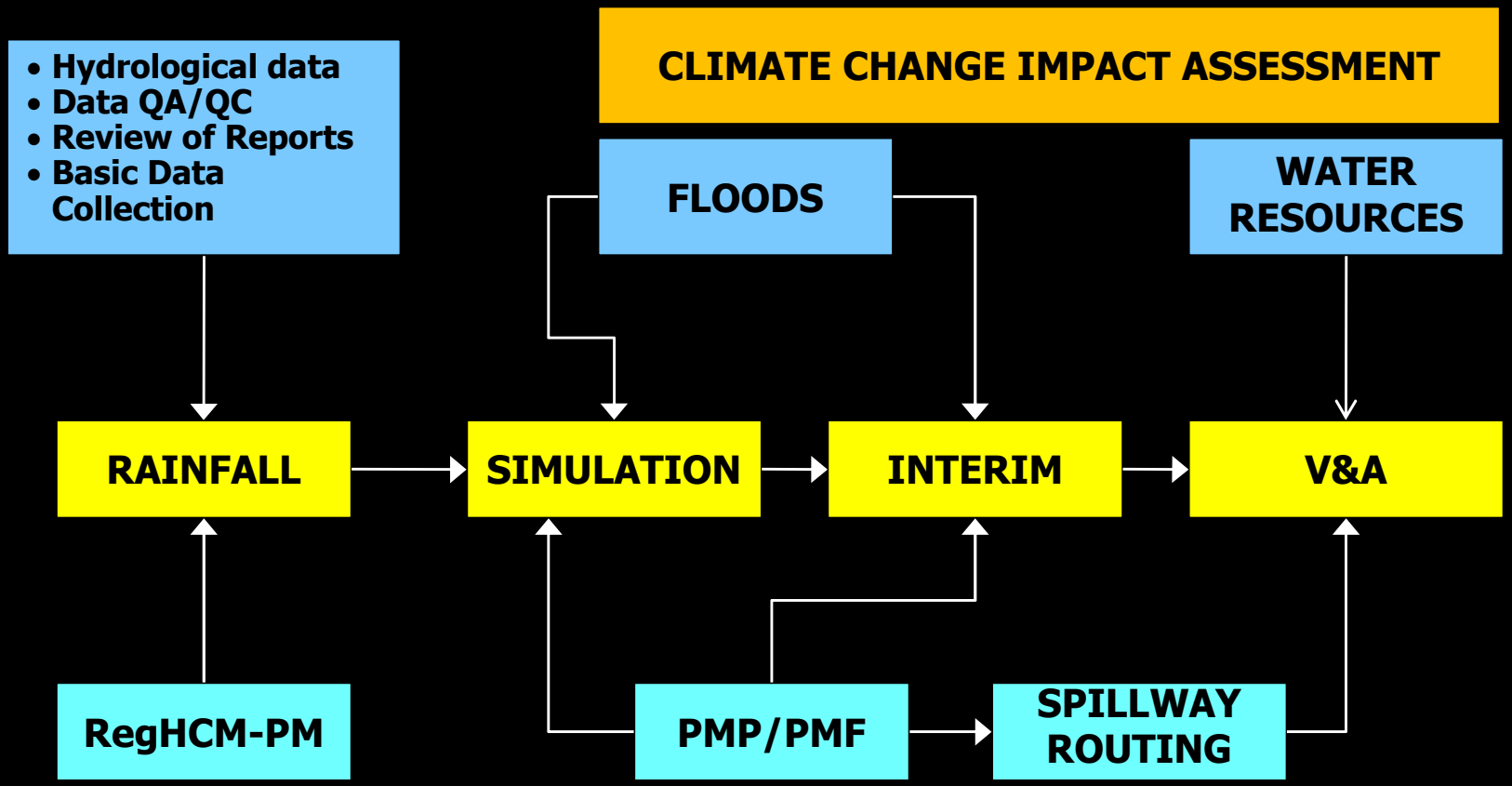
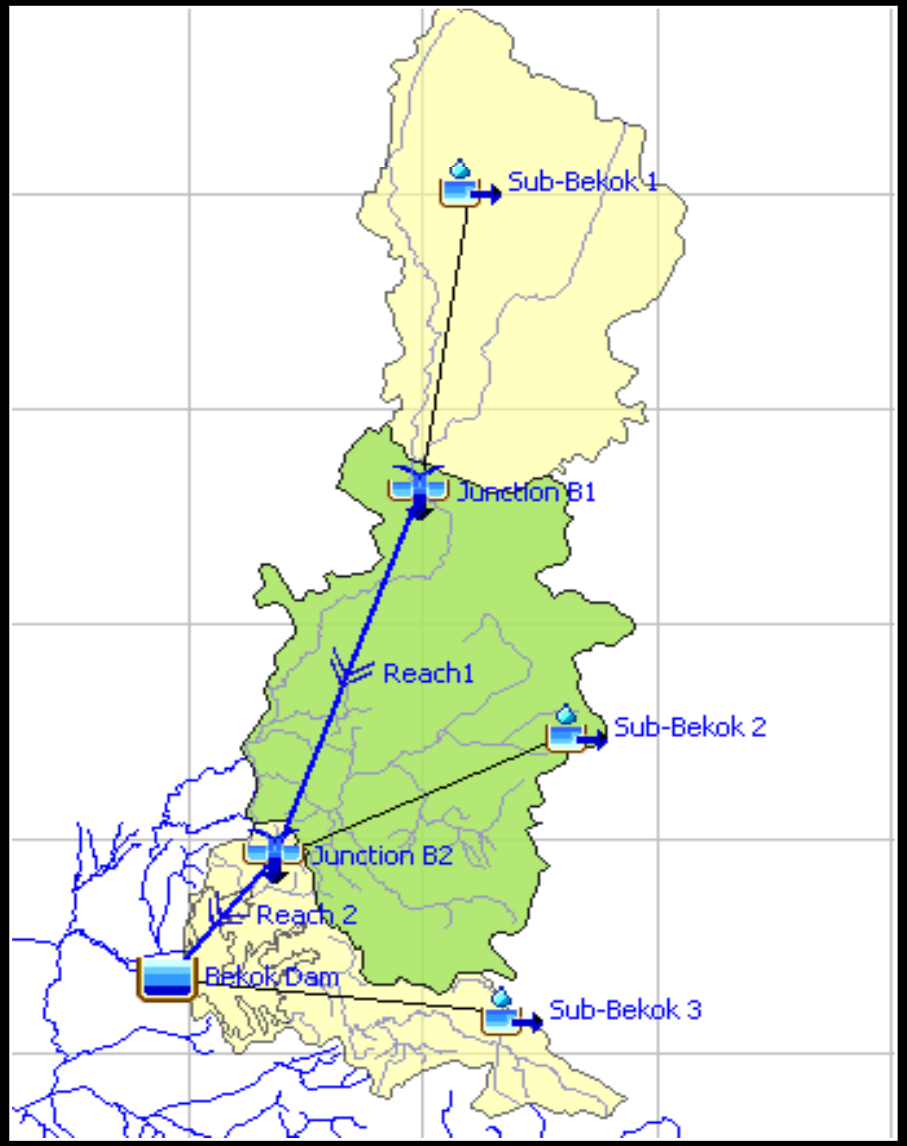
BRIEF METHODOLOGY AND APPROACH



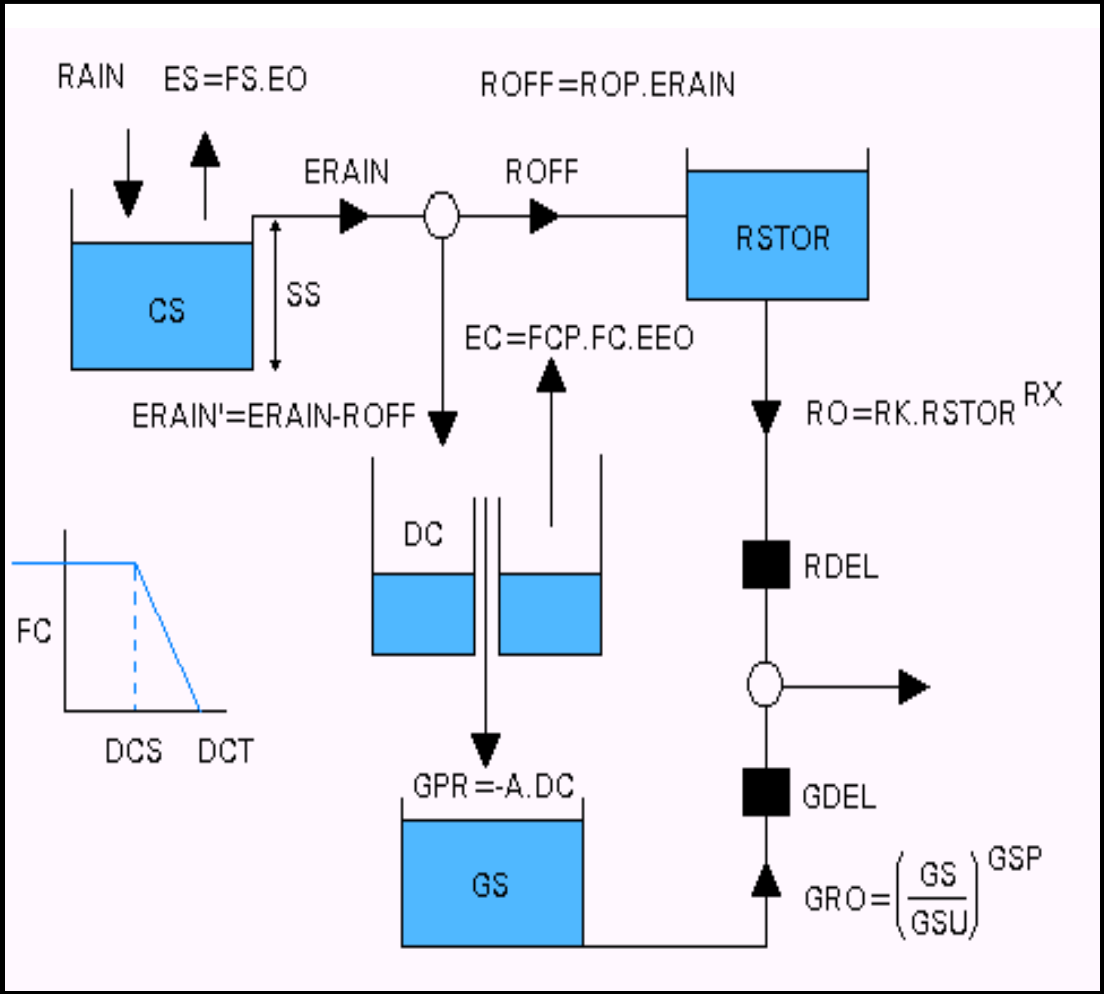
Flood Impact Assessment



Rainfall Runoff Simulation: HEC HMS

- Catchment - divided into 3 sub-catchment
- Parameters used and adopted:
  - Loss model: initial and constant
  - Transform model: Snyder UH
  - Baseflow model: recession
  - Routing Method: Muskingum

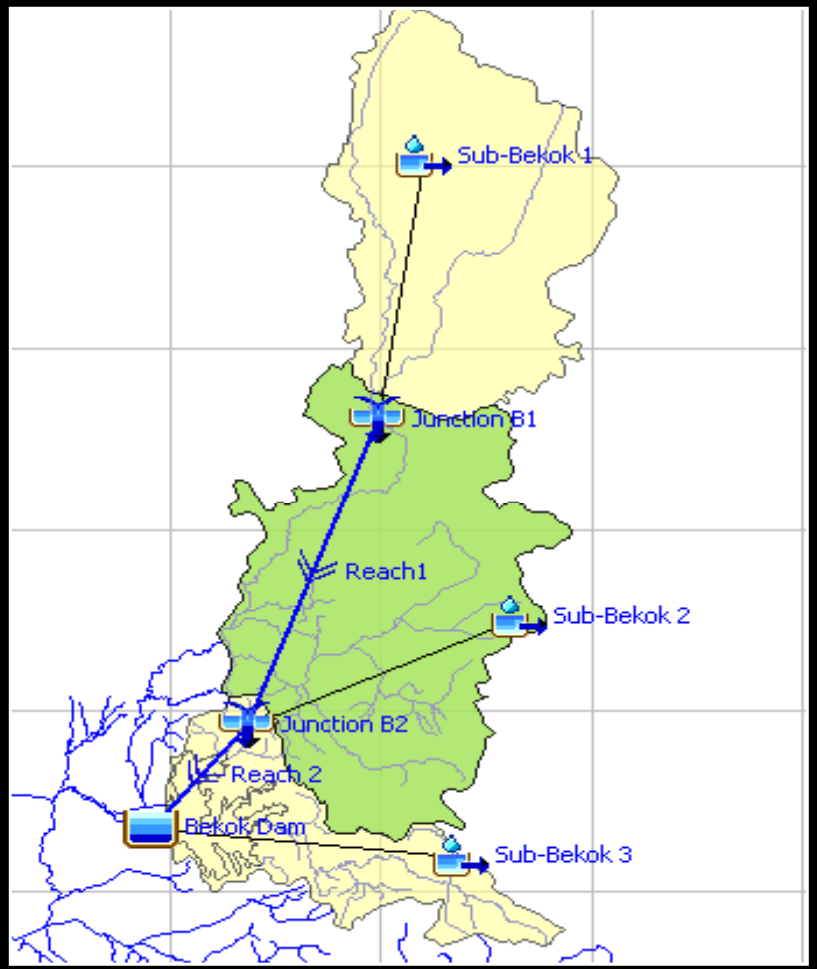
Water Resources Assessment



Conceptual Lumped Model by UK Institute of Hydrology

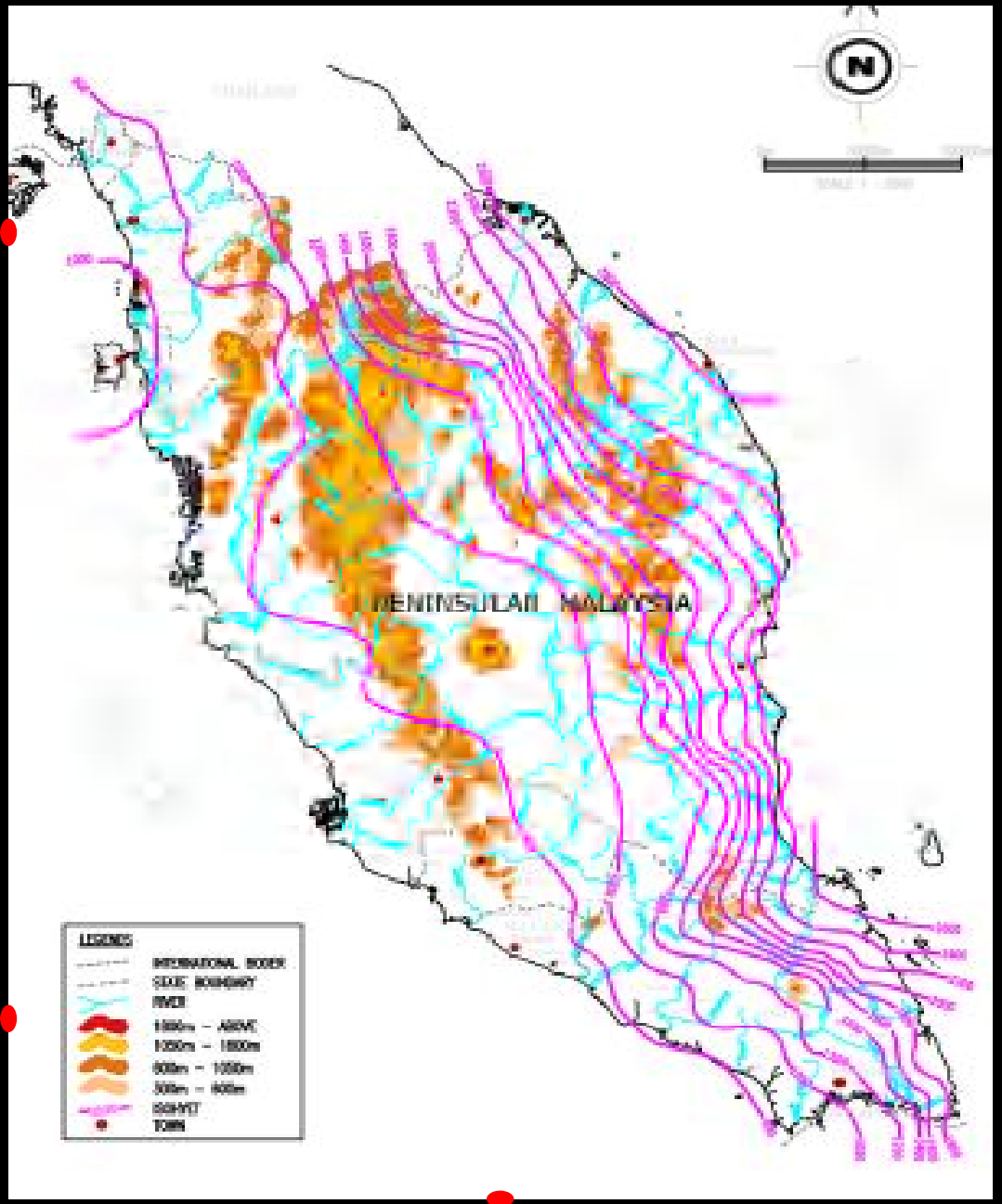
- Interception storages CS
- Surface detention storage RSTOR
- Soil moisture storage (DCT-DC)
- Ground water storage GS

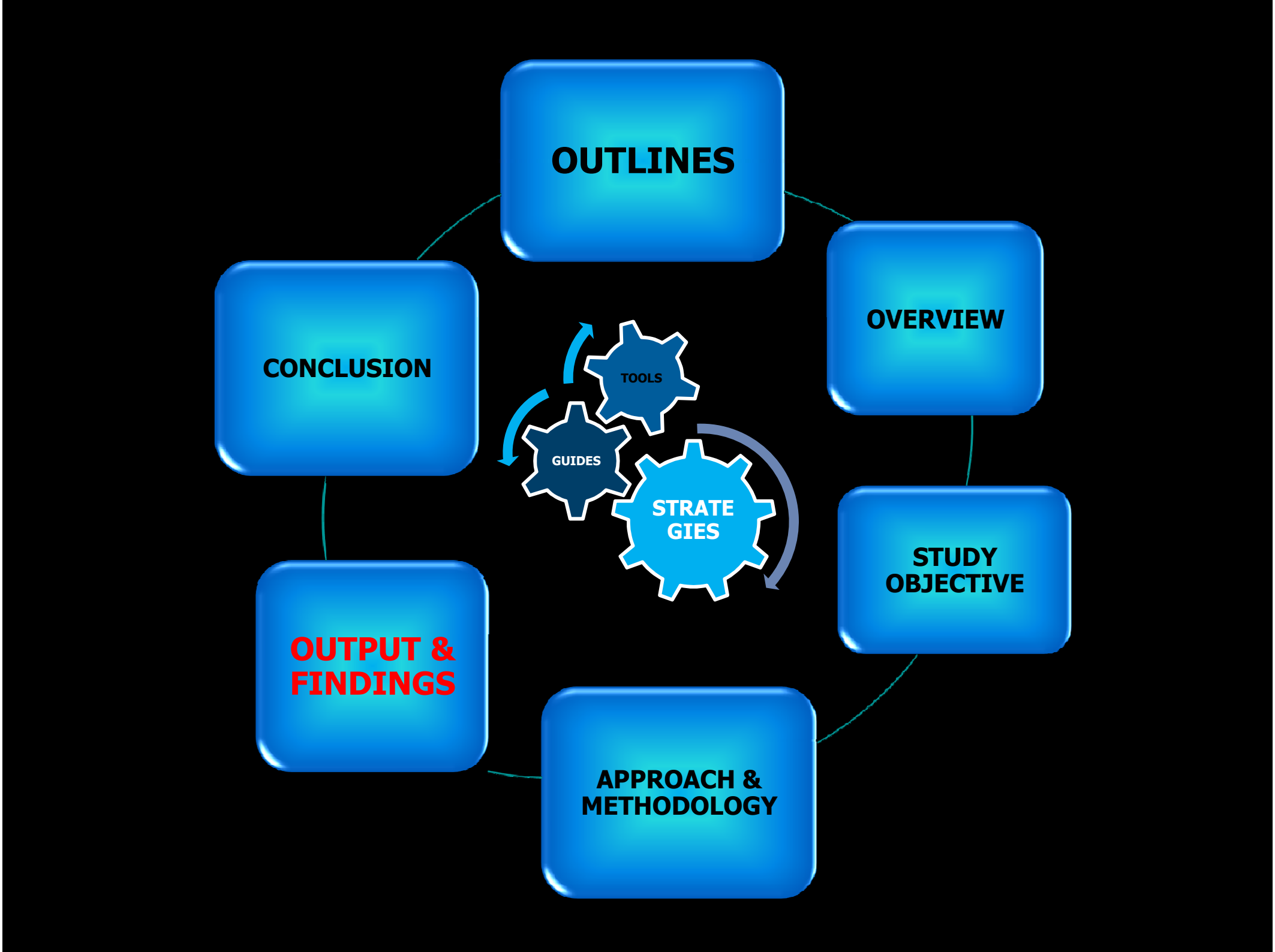
Model calibration & validation : Dec. 2006 & Jan. 2007 Flood Events



Probable Maximum Precipitation (PMP using Statistical "Hershfield" Method

1-Day	3-Day	5-Day
PMP: 650mm	PMP 900mm	PMP: 1100mm

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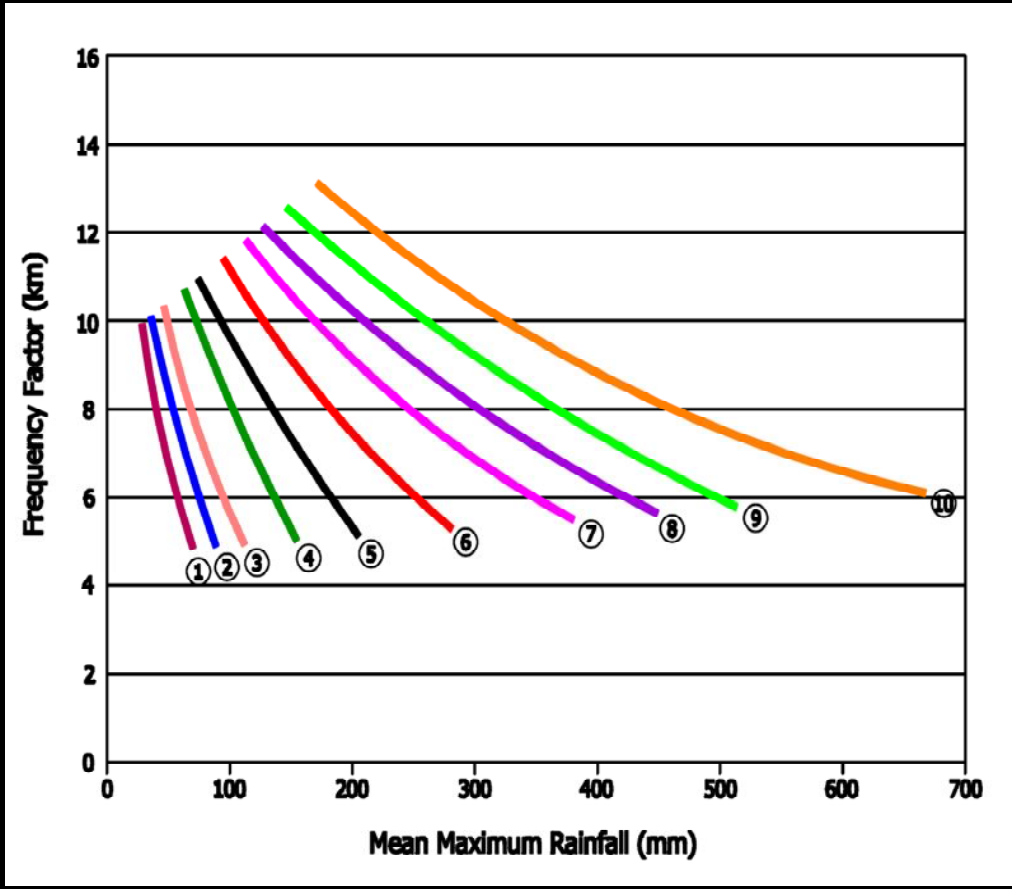
Probable Maximum Precipitation (PMP using Statistical "Hershfield" Method

PERIOD OF 2025-2034				
		24-hr	72-hr	120-hr
mean	X	94.88	159.43	218.13
maximum	X_1	148.66	283.90	429.71
PMP frequency factor (fig A.1)	Km	11.40	11.35	11.26
Point PMP (mm)		632	1002	1518
catchment area (km2)		336	336	336
Areal Reduction Factor	ARF	0.93	0.93	0.93
Catchment PMP (mm)		588	932	1412

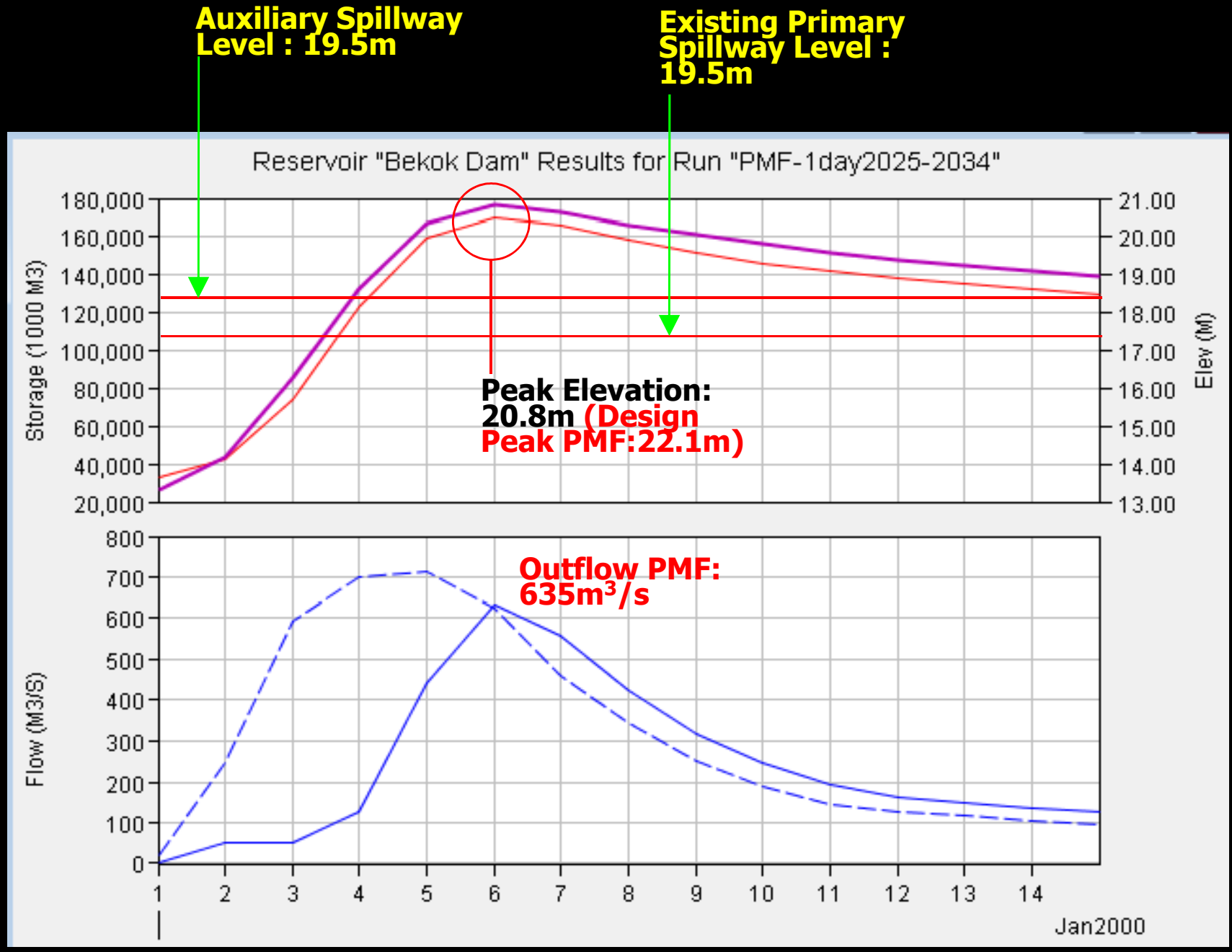
PERIOD OF 2041-2050				
		24-hr	72-hr	120-hr
Mean	X	106.73	159.43	200.04
maximum	X_1	234.25	283.90	310.26
PMP frequency factor (fig A.1)	Km	10.88	11.35	11.62
Point PMP (mm)		704	737	1260
catchment area (km2)		336	336	336
Areal Reduction Factor	ARF	0.93	0.93	0.93
Catchment PMP (mm)		654	686	1171

	24-hr	72-hr	120-hr
NAHRIM [Statistical]	650	900	1100
Designed [Storm Transposition]	687	1412	

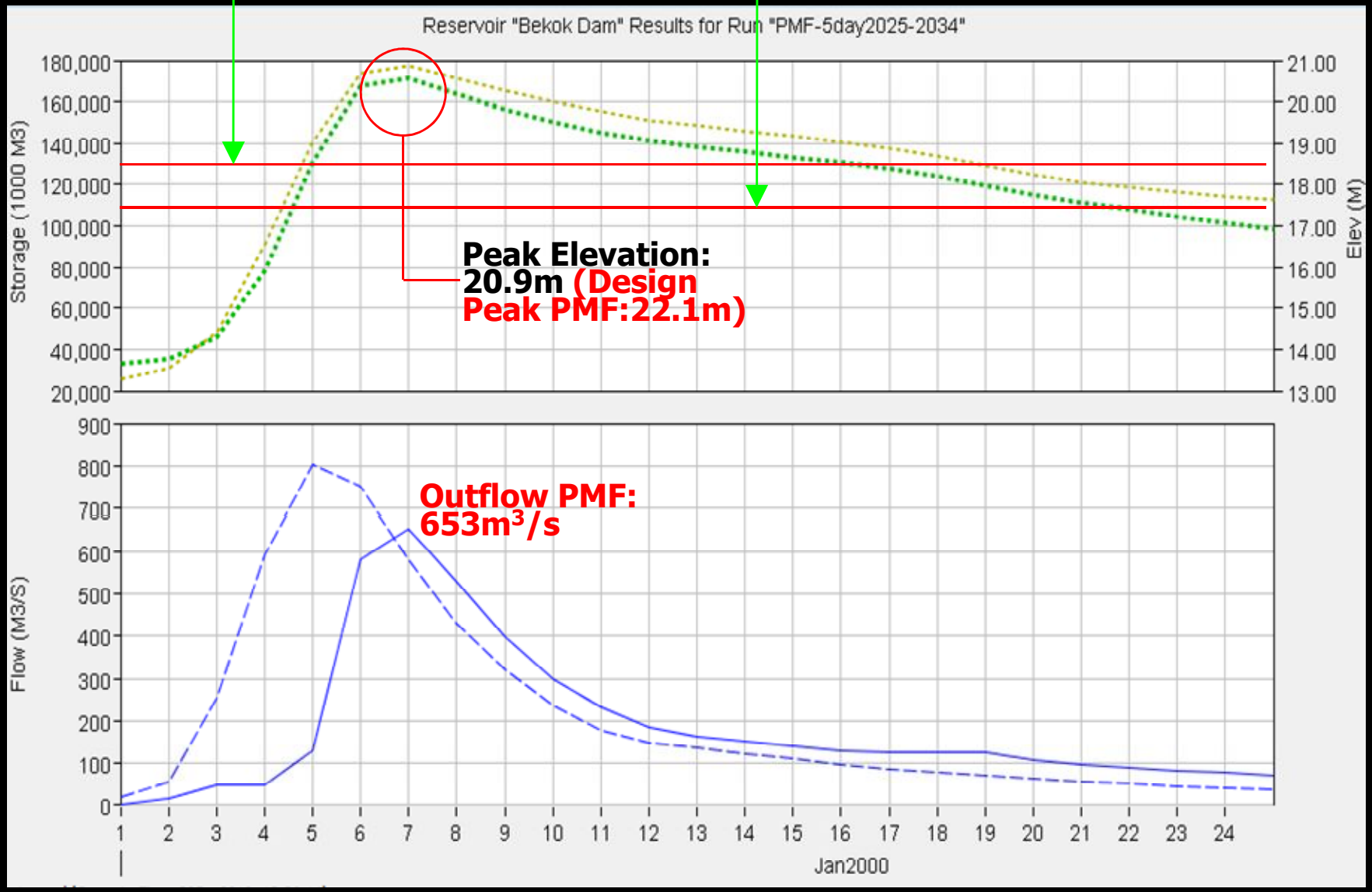


Frequency Factor Km based on "Derivation of PMP for Design Floods in Malaysia" [NAHRIM, 2007

Flood Impact Assessment: 1-day PMF Scenario (2025-2034)



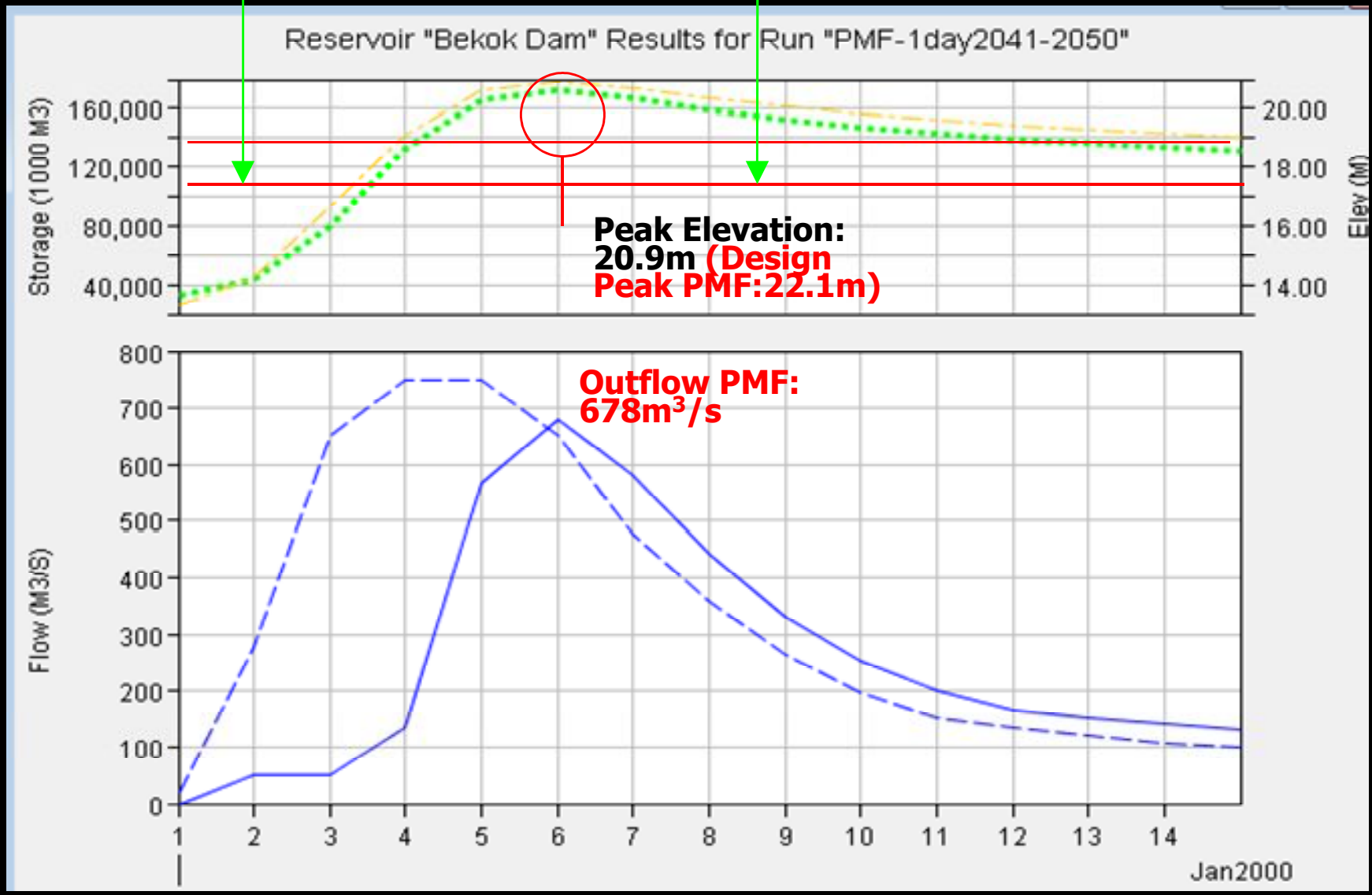
Flood Impact Assessment: 5-day PMF Scenario (2025-2034



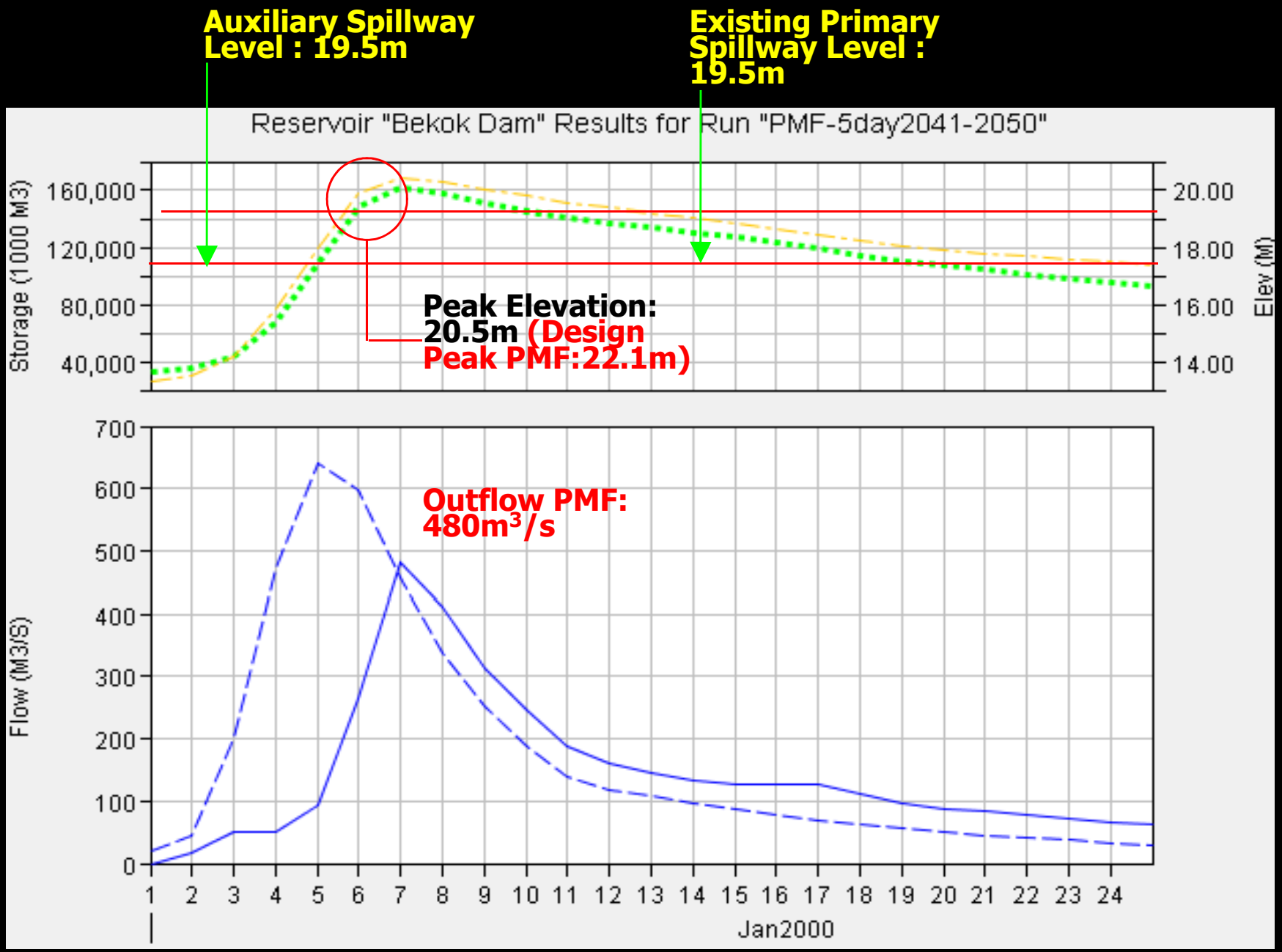
Flood Impact Assessment: 1-day PMF Scenario (2041-2050)

Auxiliary Spillway Level : 19.5m

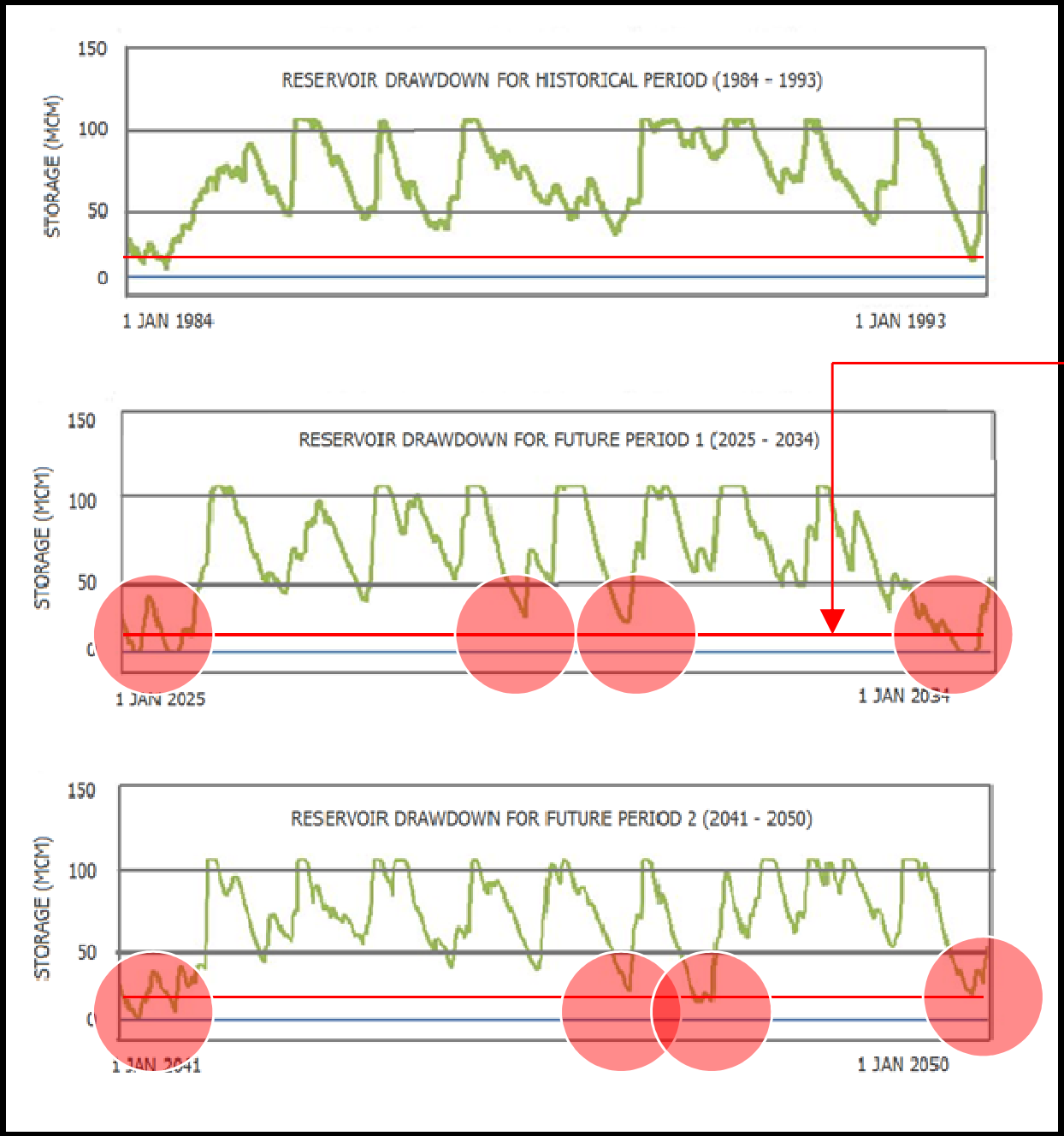
Existing Primary Spillway Level : 19.5m



Flood Impact Assessment: 5-day PMF Scenario (2041-2050)



Water Resources Assessment



drawdown seems to drop nearer to the dead storage for period of 2025-2034 & 2041-2050

CONCLUSION

- This study focused on **flood impacts** which includes a **PMF flood** and **water resources** which is reflected in the dam drawdown curves
- **FLOODING** - it can be seen that in **general future flooding is going to be worse** but there are slight variations. But if we consider more exceptional flood events such as the PMF, the impact is more significant as compared to conventional design floods of 10, 50 and 100- year ARI.
- **WATER RESOURCES** - the **drawdown seems** to drop nearer to the dead storage in period of 2025-2034 and 2041-2025 to the historical drawdown curve and there are instances where the **drawdown touches the dead storage levels** in both future periods studied.
- **CLIMATE MODELING** is **not a very precise science** and the results therefore cannot be taken as being very accurate but **serves to tell us** whether **climate change has significant consequences to projects** and thereafter the authorities concerned can at least be **forewarned of possible outcome** of the climate change phenomena.
- The study is still ongoing and effort will be made to at least consider some vulnerability and adaptation measures which needs to be looked into.

THANK YOU

zaki@nahrim.gov.my
http:/www.nahrim.gov.my