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ENHANCING IRRIGATION WATER SUPPLY CAPACITY AND PADDY PRODUCTION IN KELANTAN RIVER BASIN

WATER MANAGEMENT | CLIMATE CHANGE

RESEARCH CENTRE FOR WATER RESOURCES & CLIMATE CHANGE
NATIONAL HYDRAULIC RESEARCH INSTITUTE OF MALAYSIA (NAHRIM)
MINISTRY OF WATER, LAND & NATURAL RESOURCES

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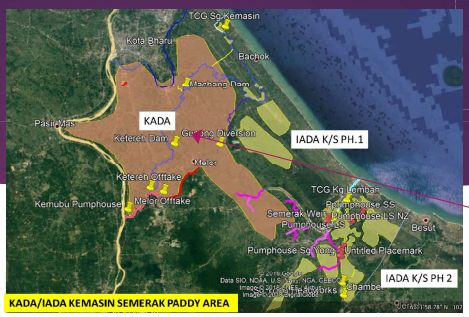
BACKGROUND

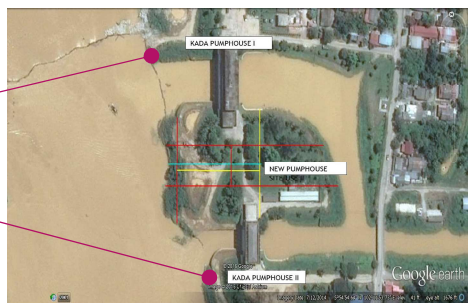
- *The Kemubu Irrigation Scheme covers a total area of **17,618 hectares** out of the total irrigation scheme under KADA of 28,072 hectares*
- *River water pumped into the main canals via the two **pumping stations** :*

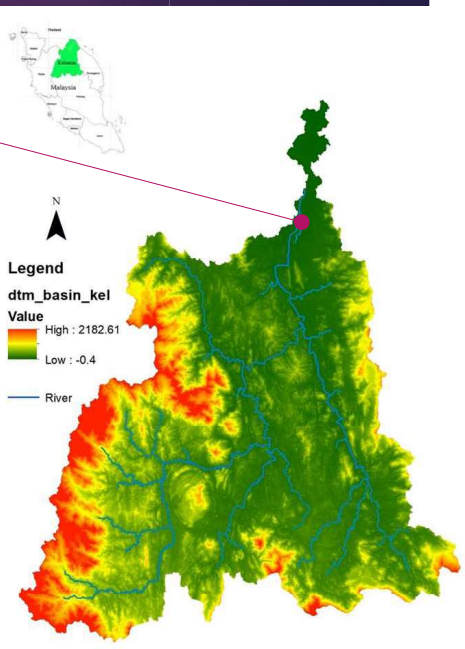
  Kemubu Pumphouse I (42m³/s)

  Kemubu Pumphouse II (16m³/s)



*Kelantan river is the **main water resources** for Kemubu irrigation Scheme*



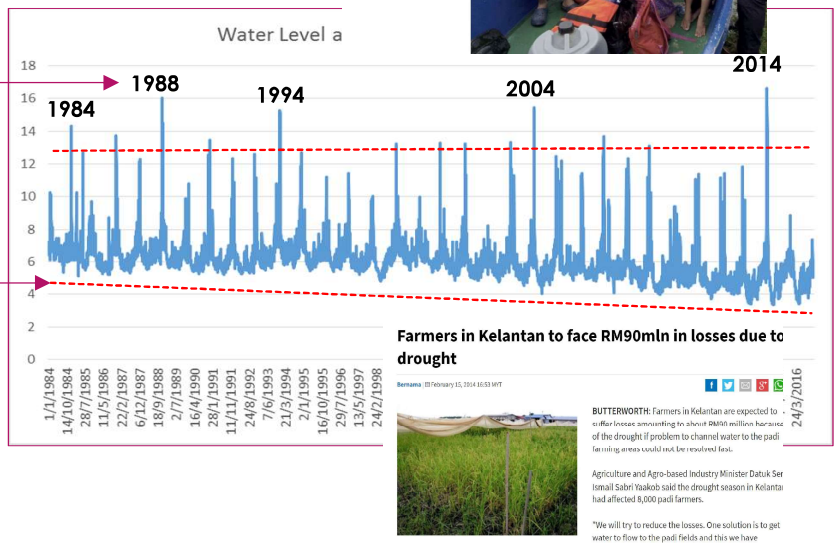


MAIN ISSUE

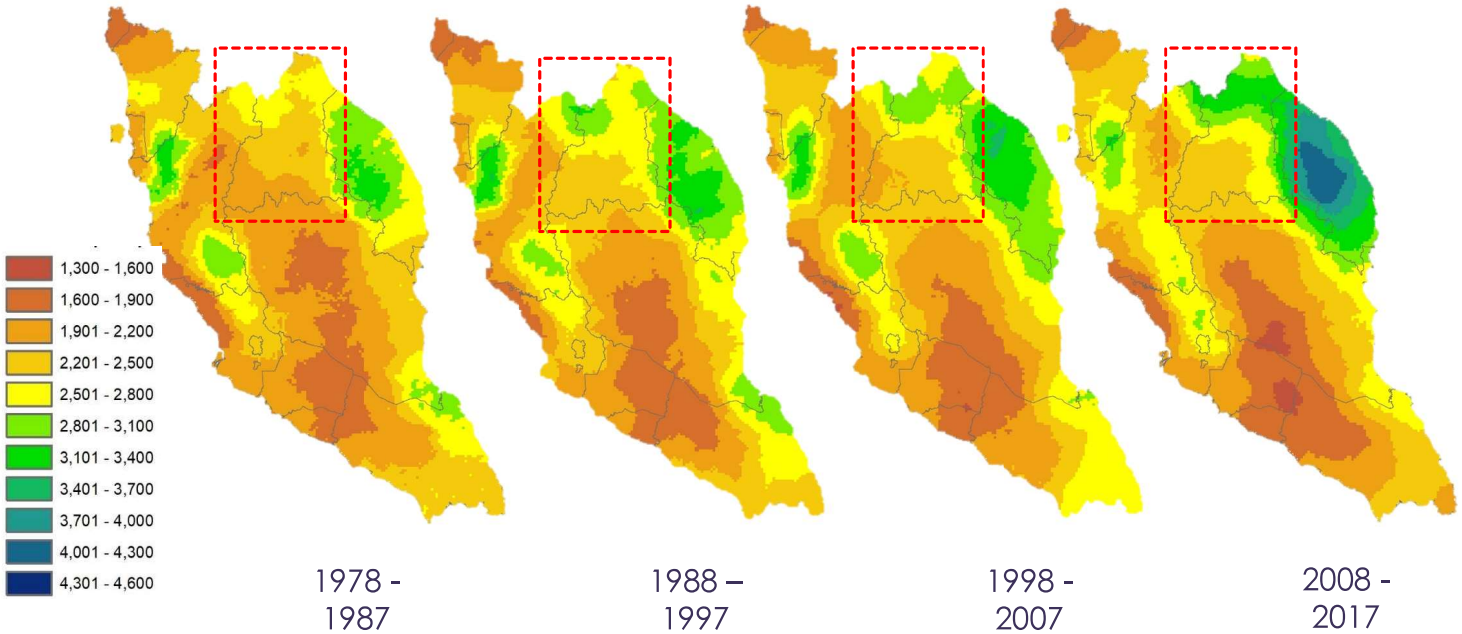
- ***Effect of monsoon floods – loss and damage***

2 extreme conditions

- ***Declination of river level during drought period, occurs below the existing pump operating level***



10 YEARS AVERAGE RAINFALL CHANGE



PROJECTED FUTURE AVERAGE ANNUAL RAINFALL & FLOW

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- *Ensemble averages of the annual mean flows of the 15 dynamically downscaled GCM projections – **increment 2.7% to 20.6%***
- *Lower future low flow **(-43.6%)** indicates critical dry spell may occur in the future although more rainfall projected received in the Kelantan River Basin*

Period	30-year mean of the basin-average annual precipitation (mm)	Increment	
		mm	%
Historical (1970-2000)	2,522		
Early-Century (2010-2040)	2,588	67	+2.7
Middle-Century (2040-2070)	2,731	209	+8.3
End-Century (2070-2100)	3,042	520	+20.6

Average			Maximum			Minimum		
Historical*	Future		Historical*	Future		Historical*	Future	
	m^3/s	%		m^3/s	%		m^3/s	%
530.5	606.9	+14.4%	4,087.5	10,114.7	+147.5	92.7	52.3	-43.6%

** Historical (1970-2000)*

PROJECTED AVERAGE YIELD REDUCTION (kg/ha | %)

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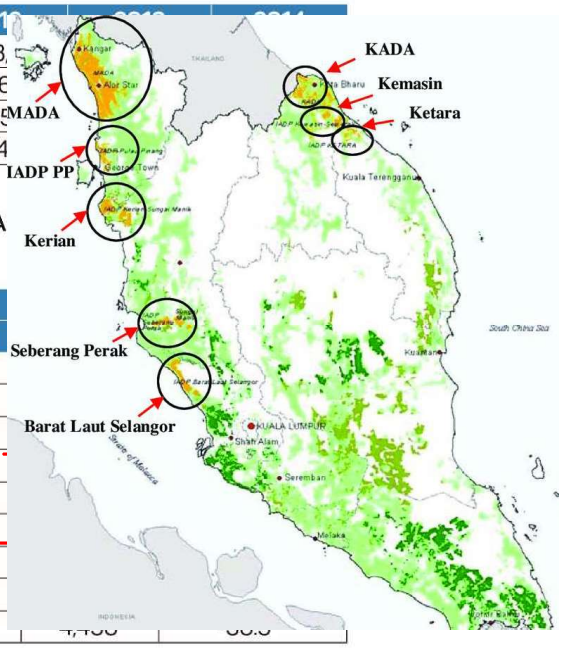
Table 4.7: Rice Production (metric tonnes)

Year	2000	2005	2010	2011	201
Peninsular Malaysia	1,202,098	1,259,696	1,312,132	1,383,405	1,403
Sabah	97,668	94,259	147,531	132,253	126
Sarawak	81,896	136,060	128,793	145,602	145
TOTAL	1,381,662	1,490,015	1,588,456	1,661,260	1,674

Table 4.8: Average Rice Yield in kg/ha and Percentage of Yield Reduction for MADA, KA in 2030 and 2050 due to the Impact of Climate Change

Areas	Seasons	2014 (kg/ha)	2030	
			kg/ha	Reduction (%)
MADA	Main	5,536	4,570	-17.4
	Off	5,542	4,971	-10.3
	All	5,539	4,771	-13.9
KADA	Main	4,406	3,844	-12.8
	Off	4,188	3,641	-13.1
	All	4,297	3,743	-12.9
IADA BLS	Main	6,247	4,186	-33.0
	Off	6,560	4,671	-28.8
	All	6,403	4,428	-30.8



Source: NAHRIM & Malaysia 3rd National Communication and 2nd Biennial Update Report to UNFCCC (2018)

1ST : INTERVENTION – WATER MANAGEMENT ADAPTIVE CAPACITY – LOW FLOW WEIR

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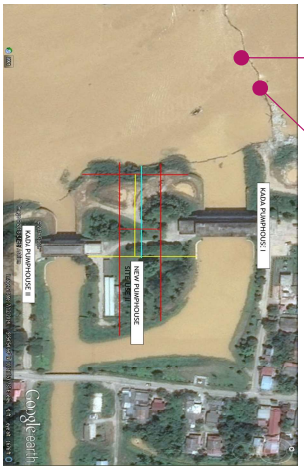

2ND : INTERVENTION – WATER MANAGEMENT ADAPTIVE CAPACITY

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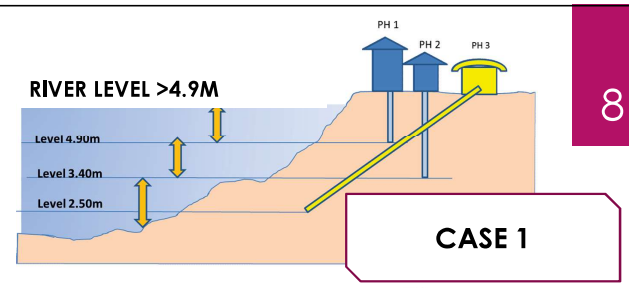
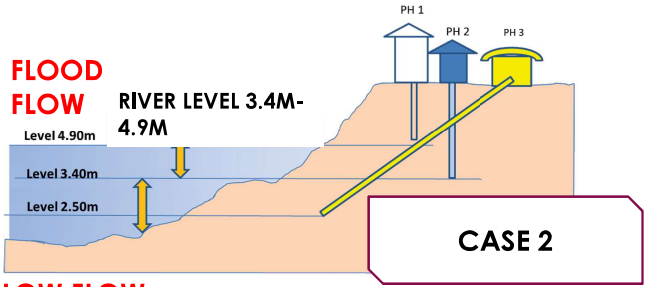
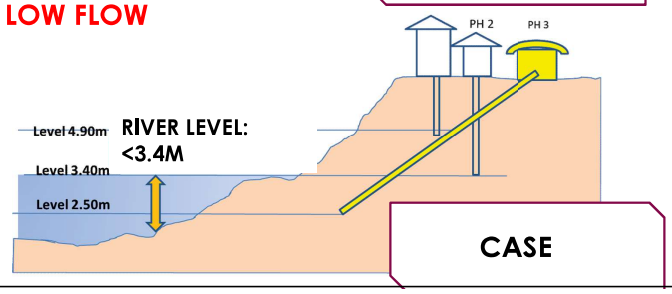
- *To assess the **lowest low flow volume and water level** at the intake point of the existing pumping system.*
- *To assessment the **future flood flow and design level***
- ***A new pumping system** is proposed to overcome the extreme river water level declination which can be below the existing pump operating level – **requires platform level***







CLIMATE CHANGE SCENARIO

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A total of 1440 years of GCM data were downscaled to the study region: **15 future projections, each 90 years long that were simulated** by the coupled atmosphere-ocean global climate models **ECHAM5, CCSM3 and MRI**, and three 30 years long simulations during the historical period by the three GCMs

Model Name	Run ID	GCM Grid Resolution	Period	Model Name	Run ID	GCM Grid Resolution	Period
ECHAM5 /MPIOM	20C	1.8 degree	1970-2000	MRI-CGCM2.3.2	20C	2.8 degree	1970-2000
	SRES A1B_1	1.8 degree	2010-2100		SRES A1B	2.8 degree	2010-2100
	SRES A1B_2	1.8 degree	2010-2100		SRES B1		2010-2100
	SRES A1B_3	1.8 degree	2010-2100	CCSM3	20C	1.4 degree	1970-2000
	SRES A2_1	1.8 degree	2010-2100		SRES A1B	1.4 degree	2010-2100
	SRES A2_2	1.8 degree	2010-2100		SRES A1FI		2010-2100
	SRES A2_3	1.8 degree	2010-2100		SRES A2	1.4 degree	2010-2100
	SRES B1_1	1.8 degree	2010-2100		SRES B1		2010-2100
	SRES B1_2	1.8 degree	2010-2100				
	SRES B1_3	1.8 degree	2010-2100				

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RESULT OF FLOOD & LOW FLOW ASSESSMENT

FLOOD FLOW ASSESSMENT: PROJECTED RIVER LEVEL AT KEMUBU PUMP HOUSE

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Period [1] 2010-2055 [2] 2055-2100	Return Period (ARI) T	Projected River Level (m)					
		Average All Scenarios (m)	Average Scenario A_1B	Average Scenario A_2	Average Scenario B_1	Max Level of All Scenario	Min. Level of All Scenario
1	10	15.73	15.75	15.83	15.62	17.25	13.85
2	10	16.21	16.08	16.35	16.21	17.49	14.99
1	20	16.24	16.29	16.35	16.11	17.87	14.17
2	20	16.79	16.65	16.91	16.82	18.24	15.65
1	50	16.85	16.93	16.97	16.67	18.76	14.51
2	50	17.44	17.33	17.57	17.44	19.21	16.44
1	100	17.27	17.38	17.41	17.06	19.41	14.72
2	100	**17.98**	**17.82**	**18.04**	**18.10**	**19.93**	**16.90**

Note: peak river level at Kemubu Pump House during the 2014 flood event in Kelantan River was recorded approximately 16.5m.

LOW FLOW ASSESSMENT: PROJECTED FLOW CAPACIRY & RIVER LEVEL AT KEMUBU PUMP HOUSE

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- Assessment result can be adopted for the design of hydraulic structure platform level.
- Water level values by using RC3 are recommended to be adopted for design of platform level.
- Adopted design levels for **50 year ARI**:
  - 1 day low flow : **2.24 m**
  - 7 day low flow : **2.4 m**

Scenario	Q Kemubu	50 year ARI 1 day Low Flow		Q Kemubu	50 year ARI 7 day Low Flow	
		Rating Curve 1 (RC1)	Enhanced Rating Curve 3 (RC3)		Rating Curve 1 (RC1)	Enhanced Rating Curve 3 (RC3)
		WL Kemubu	WL Kemubu		WL Kemubu	WL Kemubu
CCSM3A1B	39.29	3.86	2.24	42.11	3.93	2.40
CCSM3A1FI	29.67	3.56	1.61	28.71	3.53	1.53
CCSM3A2	45.22	4.01	2.56	49.05	4.10	2.74
CCSM3B1	66.30	4.45	3.42	69.74	4.51	3.53
ECHM5A1B1	91.30	4.84	4.14	93.73	4.87	4.20
ECHM5A1B2	96.60	4.91	4.27	95.04	4.89	4.23
ECHM5A1B3	104.47	5.01	4.44	101.80	4.98	4.39
ECHM5A2_1	92.41	4.85	4.17	91.74	4.84	4.15
ECHM5A2_2	93.72	4.87	4.20	88.57	4.80	4.07
ECHM5A2_3	110.24	5.08	4.57	107.52	5.05	4.51
ECHM5B1_1	96.98	4.91	4.28	90.73	4.83	4.13
ECHM5B1_2	104.51	5.01	4.45	103.63	5.00	4.43
ECHM5B1_3	102.60	4.99	4.40	98.49	4.93	4.31
MRIA1B	50.46	4.13	2.80	50.63	4.14	2.81
MRIB1	52.58	4.18	2.90	54.05	4.21	2.96
Average	63.21	5.09	4.58	65.28	5.17	4.72
AvA1B	57.81	4.96	4.36	61.84	5.06	4.54
AvA2	71.77	5.03	4.48	73.29	5.09	4.59
AvB1	77.81	5.10	4.60	79.05	5.14	4.67
Min. Q & WL	29.67	3.56	1.61	28.71	3.53	1.53
Min. Q & WL (excluded A1Fi)	39.29	3.86	**2.24**	42.11	3.93	**2.40**

SUMMARY OF RESULT

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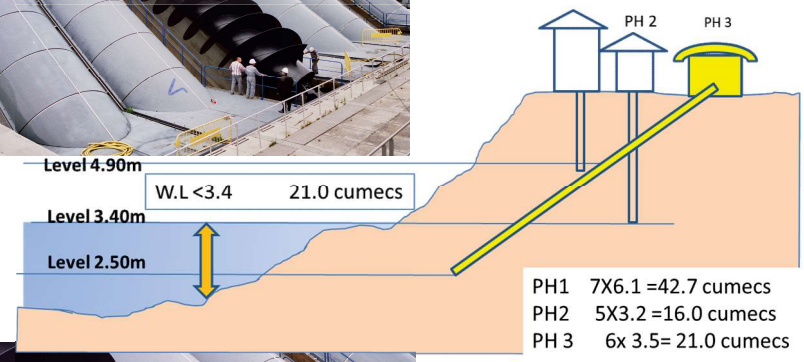
- ***Water Yield:*** *Kemubu water level at the water flow (water yield) of 95% of the time based on the developed FDC. It indicates that the water level ranges from 4.81m (123 m3/s) to 5.47 m (165 m3/s)*
- *Average **1 Day Low Flow** for 50 year ARI is (1) 45 m3/s (average 15 scenarios), (2) 40 m3/s (average A1B), (3) 53 m3/s (average A2), (4) 61 m3/s (average B1)*
- *Average **7 Day Low Flow** for 50 year ARI is (1) 46 m3/s (average 15 scenarios), (2) 43 m3/s (average A1B), (3) 54 m3/s (average A2), (4) 61 m3/s (average B1)*
- *Adopted design levels for 50 year ARI: (1) **1 day low flow = 2.24 m**, and (2) **7 day low flow are 2.4 m***



WAY FORWARD – LARGER PERSPECTIVE

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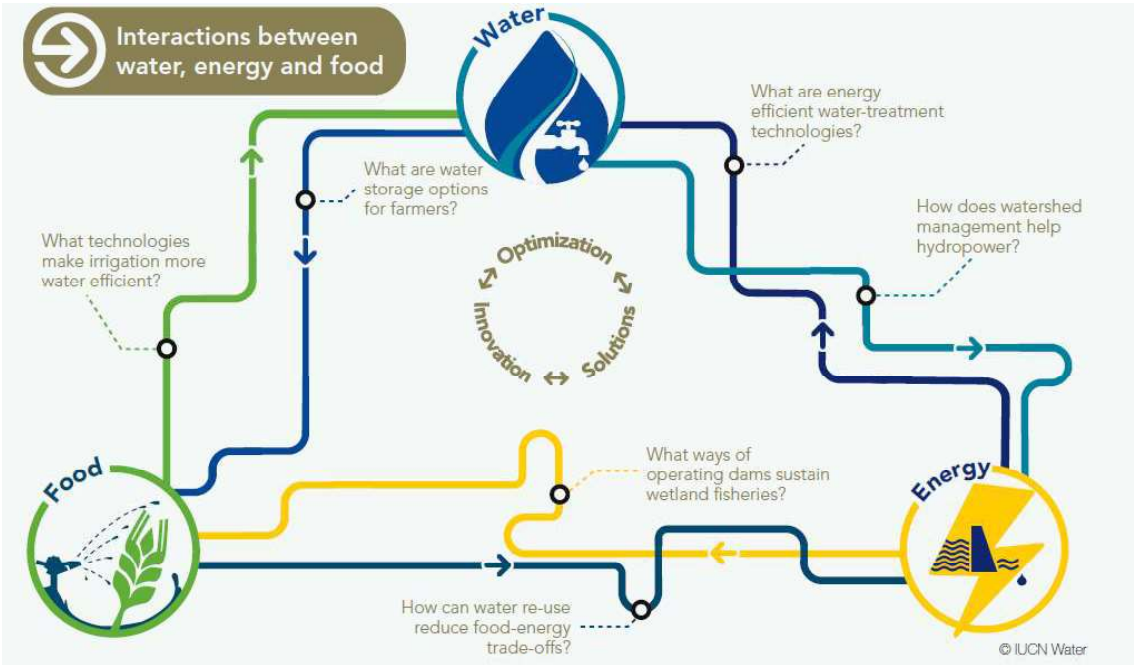

[1] MULTIPURPOSE DAM

[W] FLOOD PROTECTION | [E] HYDROELECTRIC | AGRICULTURE [F]

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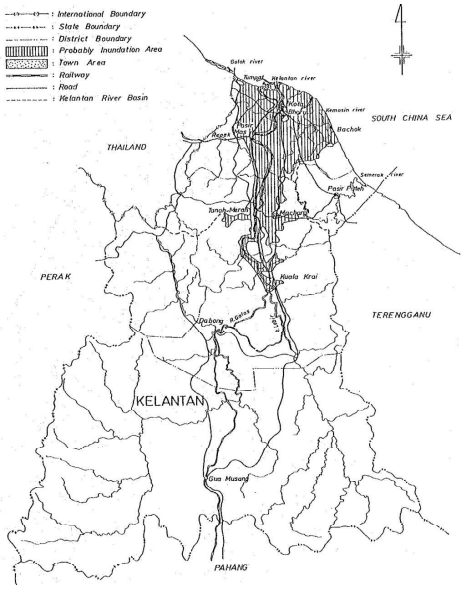

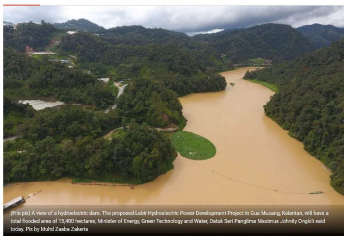

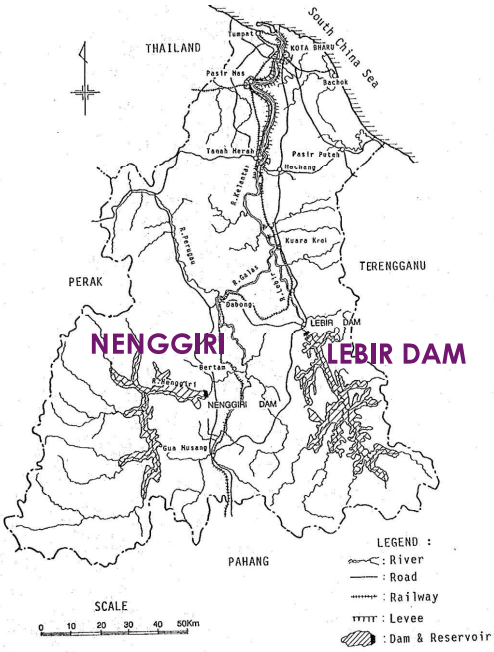

Projected Changes in Flood Areal Extent for the Selected 15 Flood Prone Basins in Peninsular Malaysia

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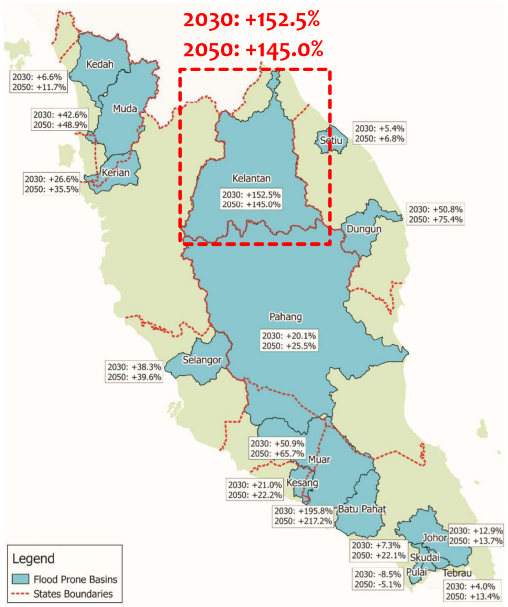
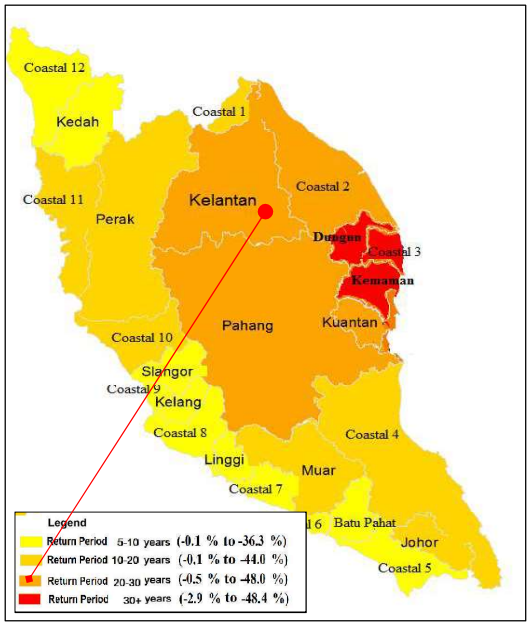


Source: NAHRIM & Malaysia 3rd National Communication and 2nd Biennial Update Report to UNFCCC (2018)

Projected Severe Dry Spell in Peninsular Malaysia (2025-2035)



[2] CLIMATE CHANGE IMPACTS STUDY

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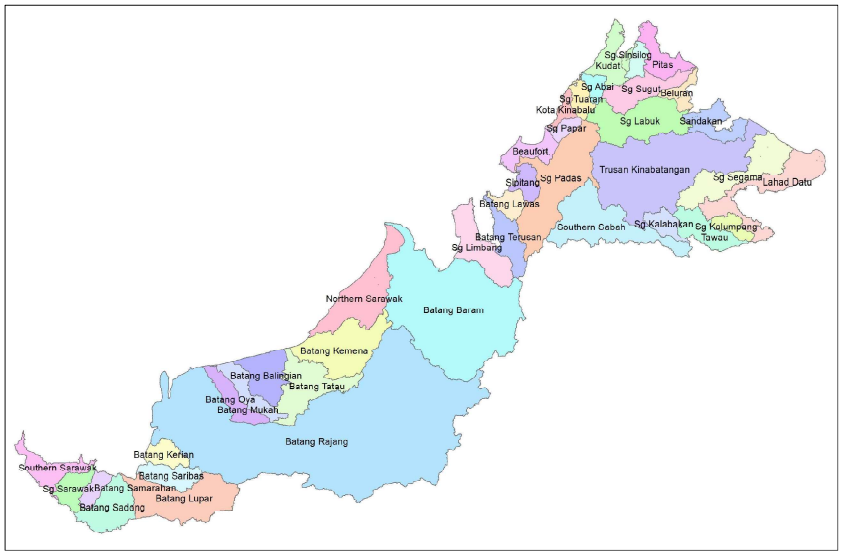
List of future projections for four Representative Concentration Pathways greenhouse gas emission scenarios

GCM	Scenario	Realization	Period
CCSM4	RCP4.5	r6i1p1	2006-2100
	RCP8.5	r6i1p1	2006-2100
MIROC5	RCP2.6	r1i1p1	2006-2100
	RCP4.5	r1i1p1	2006-2100
	RCP6.0	r1i1p1	2006-2100
	RCP8.5	r1i1p1	2006-2100
MRI-CGCM3	RCP4.5	r1i1p1	2006-2100
	RCP8.5	r1i1p1	2006-2100
GFDL-ESM2M	RCP2.6	r1i1p1	2006-2100
	RCP4.5	r1i1p1	2006-2100
	RCP6.0	r1i1p1	2006-2100
	RCP8.5	r1i1p1	2006-2100
IPSL-CM5A-MR	RCP2.6	r1i1p1	2006-2100
	RCP4.5	r1i1p1	2006-2100
	RCP6.0	r1i1p1	2006-2100
	RCP8.5	r1i1p1	2006-2100

16 future climate projections by **5 GCMs - CCSM4, MIROC5, MRI-CGCM3, GFDL-ESM2M, and IPSL-CM5A-MR)** and **4 RCPs** at **6 km spatial resolution** for the duration of 2006-2100 over Peninsular Malaysia and Sabah-Sarawak



Peninsular Malaysia : **13 river basins**
Sabah – Sarawak : **25 river basins**

6km x 6km spatial resolution grid

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CHAPTER

4

ASSESSMENT OF VULNERABILITY AND ADAPTATION

MALAYSIA

THIRD NATIONAL COMMUNICATION AND ECOND BIENNIAL UPDATE REPORT TO THE UNFCCC

THANK YOU

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