Progress and Results of Hydrological Assessment

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Outline of the Presentation

1. Overview
2. Hydrological assessment
3. Conclusions
4. Addressing uncertainties
5. Issues for the countries to consider

1.Overview

Scenario Considered

No.	Short Title	Full Title	Development Period	Interventions/Projects
Baseline situation				
1	BS	Baseline scenario		Year 2000 infrastructure including existing HEP dams
Definite future situation				
2	2015-UMD	Upper Mekong dam scenario	2000 - 2015	Baseline extended to include the full HEP cascade on the Lancang
3	2015-DF	Definite future scenario	2000 - 2015	2015-UMD plus 25 additional HEP dams in LMB and 2008 irrigation and flood measures
Foreseeable future situation				
4	2030-20Y	LMB 20-year plan scenario	2010 - 2030	2015 DF plus 11 LMB mainstream dams and planned tributary dams, irrigation, and water supply
5	2030-20Y-w/o MD	LMB 20-year plan scenario without mainstream dams	2010 - 2030	As above, excluding 11 LMB mainstream dams
6.1	2030-20Y-w/o LMD	LMB 20-year plan with 6 mainstream dams in Northern Lao PDR	2010 - 2030	As above plus 6 LMB mainstream dams in upper LMB
6.2	2030-20Y-w/o TMD	LMB 20-year plan with 9 mainstream dams	2010 - 2030	2030-20Y, excluding the two Thai mainstream dams
7	2030 – 20Y Flood	Mekong delta flood management scenario	2010 - 2030	Baseline plus 3 options for flood control in Cambodia and Vietnam Delta
Long term future situation				
8	2060-LTD	LMB long-term development scenario	2030-2060	2030-20Y plus all feasible infrastructure developments in LMB
9	2060–VHD	LMB very high development scenario	2030-2060	As above, extended to full potential infrastructure developments

Climate Change and Sea Level rise Scenarios

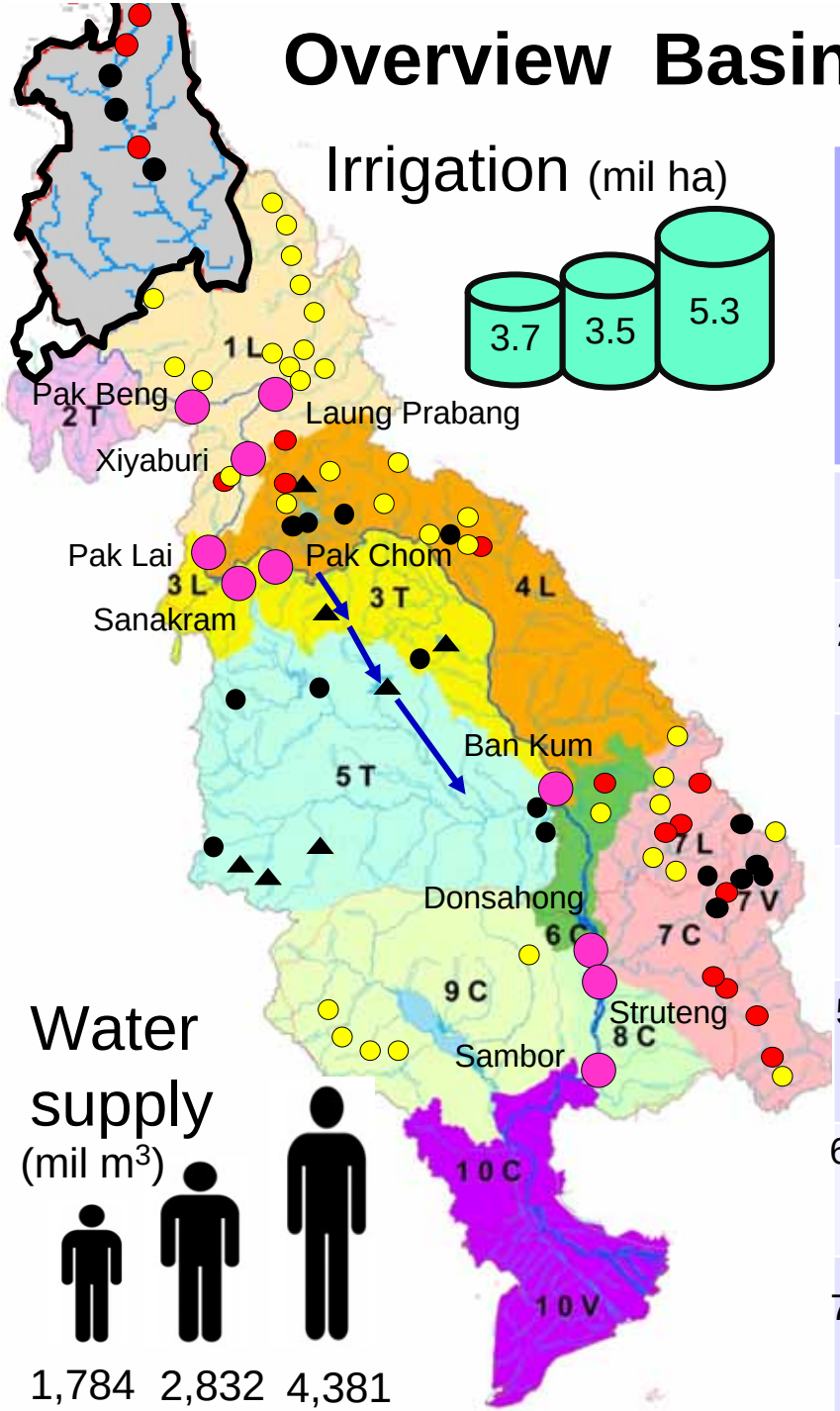
Key achievements (Oct-Jan)

No	Achievement	Time
1	Completed 7 scenario runs up to Foreseeable future situation	End Nov
2	Quality assured model setup	End Dec
3	Post data analyzed ➢Hydrological assessment ➢Input to initial economic, environmental and social assessment	End Jan
4	Prepared daft summary report on main findings from hydrological assessment	End Jan

Progress in modelling

Scenario	Upper Kratie	Lower Kratie
Without Climate Change		
1.Baseline	Completed	Completed
2.Upper Mekong Dams	Completed	Completed
3.Definite Future	Completed	Completed
4.LMB 20-Year Plan	Completed	Completed
5. LMB 20-Year Plan without Mainstream Dams	Completed	Completed
6. LMB 20-Year Plan with Different Configurations of Mainstream Dams	Completed	Completed
7. Mekong Delta Flood Management	Completed (FMMP C2)	Completed (FMMP C2)
8. LMB Long-Term Development	Progressing	End Feb
9. LMB Very High Development	Mid Mar	End Mar
With Climate Change		
Climate change and sea level rise scenarios + LMB 20-Year Plan	Reviewing input data	Mid Mar
Climate change and sea level rise scenarios + Long-Term Development	End Mar	Mid Apr

Overview Basin-Wide Scenario Formulation



Scenarios	Install Capacity (MW) Storage (MCM)	Wet Irrigated area (10^6 ha)	Water supply (10^6 m3)
1) Baseline 2000	1,586 (9,649)	3.7	1,784
2) Upper Mekong Dams	17,036 (32,842)	3.7	1,784
3) Definite Future	19,918 (44,415)	3.5	2,832
4) LMB 20-Year Plan	39,511 (69,825)	5.3	4,381
5) LMB 20-Year Plan without mainstream dams	24,814 (64,599)	5.3	4,381
6) LMB 20-Year Plan with 6 mainstream dams in north LMB	32,313 (66,707)	5.3	4,381
7) LMB 20-Year Plan without Thai mainstream dams	36,560 (69,205)	5.3	4,381

2.Hydrological Assessment

Recap of 7th RTWG key comments

- Further more analyze impact of floodplains downstream of Vientiane and take into account flood frequency analysis
- Provide more details on extreme values such as max-min or specific time periods to serve country discussion
- Provide implication picture of hydrological changes to environment, social and economic
- Verify input data from SA study or add more information to make comprehensive picture
- Selection of Climate Change and Sea level rise scenarios

Main findings (1)

- **Dry season flows:** All scenarios increase the dry season flows above the baseline, with most of this arising from the Definite Future scenario and further addition from the Foreseeable Future Scenario in next 20 Year. The additional increases in April are shown below.

Station	Definite Future vs Baseline		Foreseeable Future vs Definite Future	
	m^3/s	m	m^3/s	m
Chiang Sean	686	0.95	45	0.05
Vientiane	702	1.20	250	0.36
Stung Treng	833	0.27	598	0.18
Tan Chau	793	0.09	553	0.06

Main findings (2)

- **Wet season flows:** All scenarios reduce average flow and peak water levels in the wet season. In the peak month of September, the reductions of flow and water level are given below.

Station	Definite Future vs Baseline		Foreseeable Future vs Definite Future	
	m^3/s	m	m^3/s	m
Chiang Sean	-641	-0.46	-69	-0.05
Vientiane	-775	-0.42	-98	-0.05
Stung Treng	-1191	-0.17	-632	-0.09
Tan Chau	-546	-0.13	-399	-0.10

Main findings (3)

- **Reverse flow to Tonle Sap:** Flow reversal in the Tonle Sap river is still maintained in all scenarios but occurs a few days starting reverse flow earlier (average 3-8 days). The volume of reverse flow slightly reduce by 7% (-2518 mcm) in Definite Future scenario and further reduce by 5% (-1747 mcm) in 20Y Plan scenario. According to above results, the average maximum water level at Kampong Luong in August (peak month) reduce 0.24 m and further more 0.20 m, respectively.
- Dry season water level in Tonle Sap: The average minimum water level in April (driest month) at Kampong Luong increase 0.08 m in Definite Future scenario and further additional increase 0.07 m in 20Y Plan scenario.

Main findings (4)

- **Flooding:** All scenarios reduce the extent of wet season flooding. Total annual flooded areas in average year which connected to Mekong mainstream river mainly reduce by 6% of LMB in Definite Future scenario and marginally decrease in Foreseeable Future scenario by typically 1%

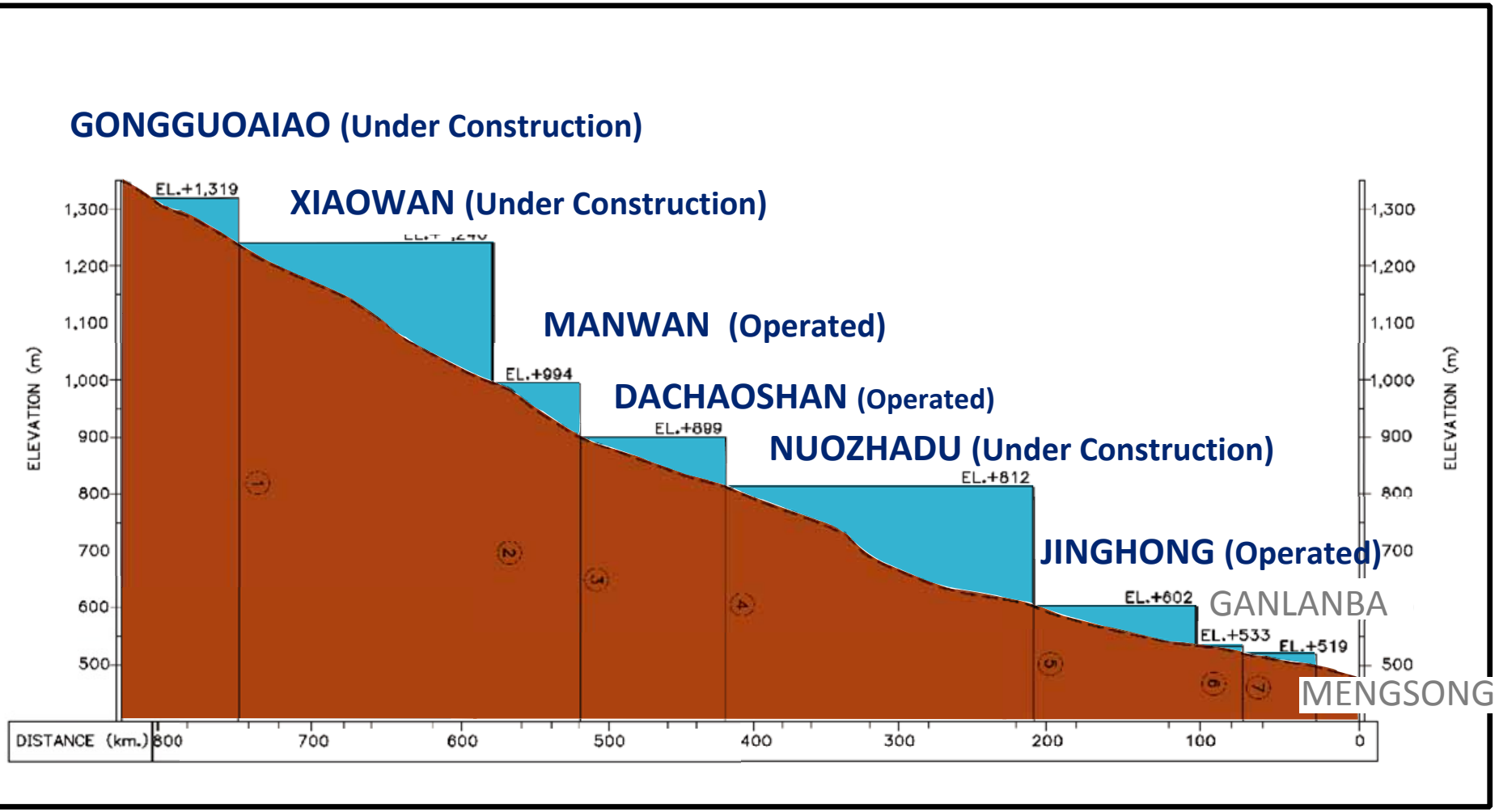
Country	Definite Future vs Baseline		Foreseeable Future vs Definite Future	
	km2	%	km2	%
Lao PDR	-632	-16.0	-31	-0.8
Thailand	-668	-18.4	-92	-2.5
Cambodia	-1034	-4.8	-383	-1.8
Viet Nam	-180	-1.0	-73	-0.4

Main findings (5)

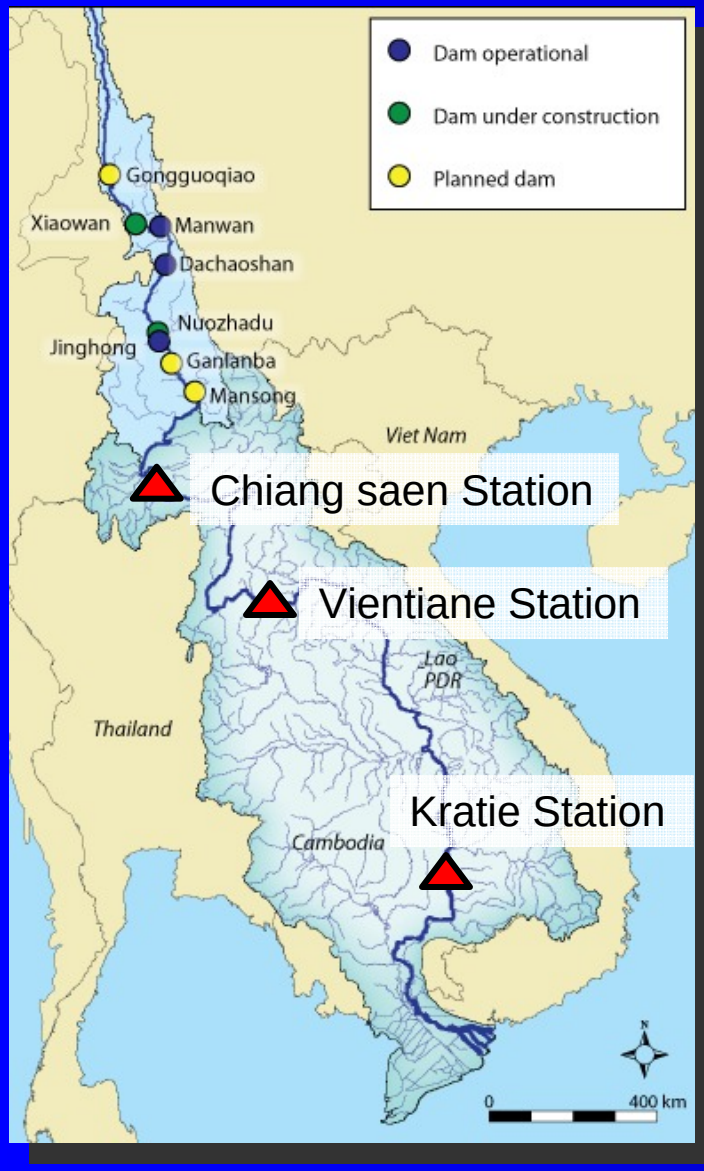
- **Saline intrusion**: All scenarios reduce the extent of dry season saline intrusion. the extent of salinity intrusion will reduce by some 5-10km and that the reduction area potentially affected by salinity levels in excess of 1.3g/l in average, dry and wet years are presented below.

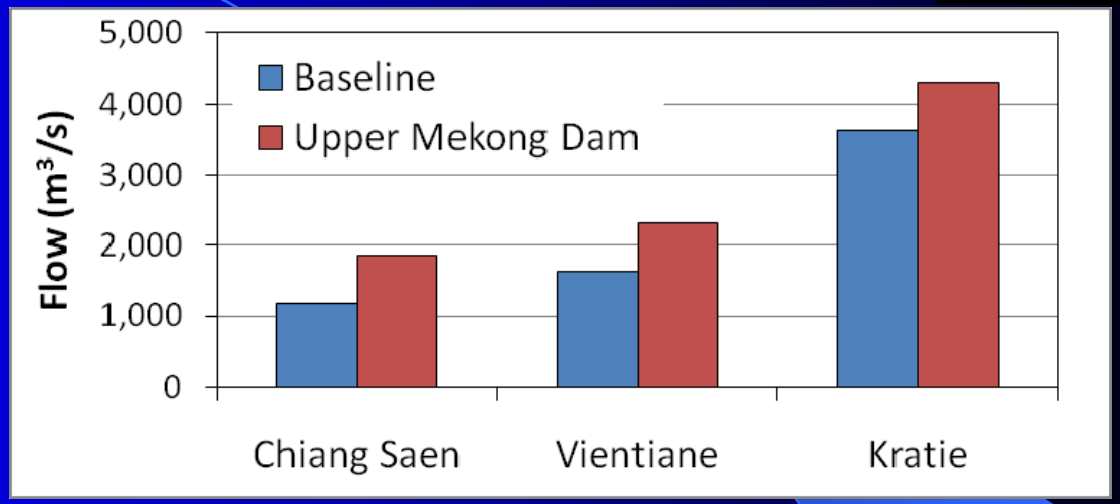
Year	Definite Future vs Baseline		Foreseeable Future vs Definite Future	
	km2	%	km2	%
Average	-2719	-15.0	-366	-2.0
Dry	-1416	-7.3	389	+2.0
Wet	-960	-6.1	-27	-0.2

Impact of Upper Mekong Dams

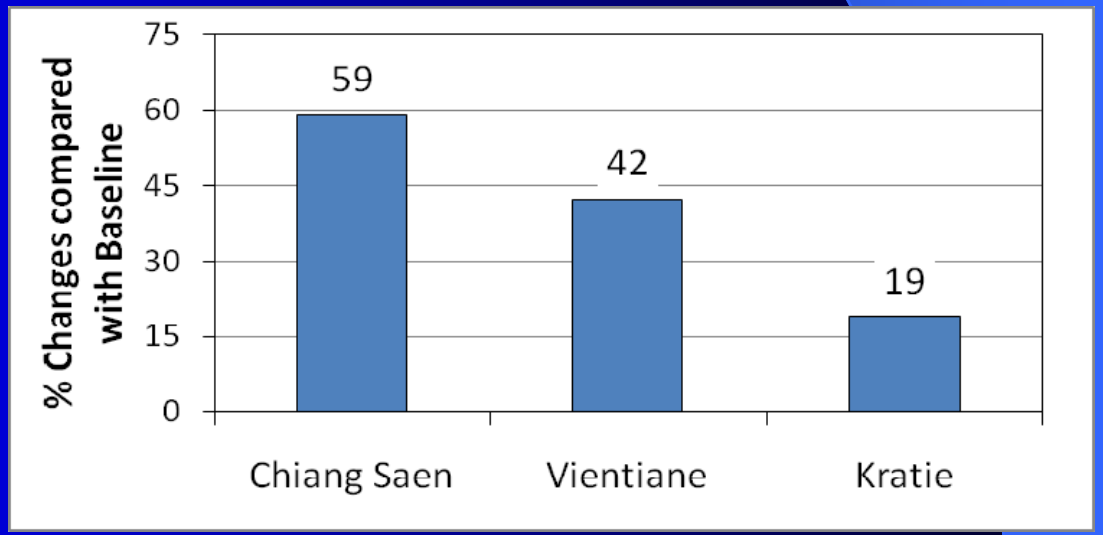


Change in average dry season flows

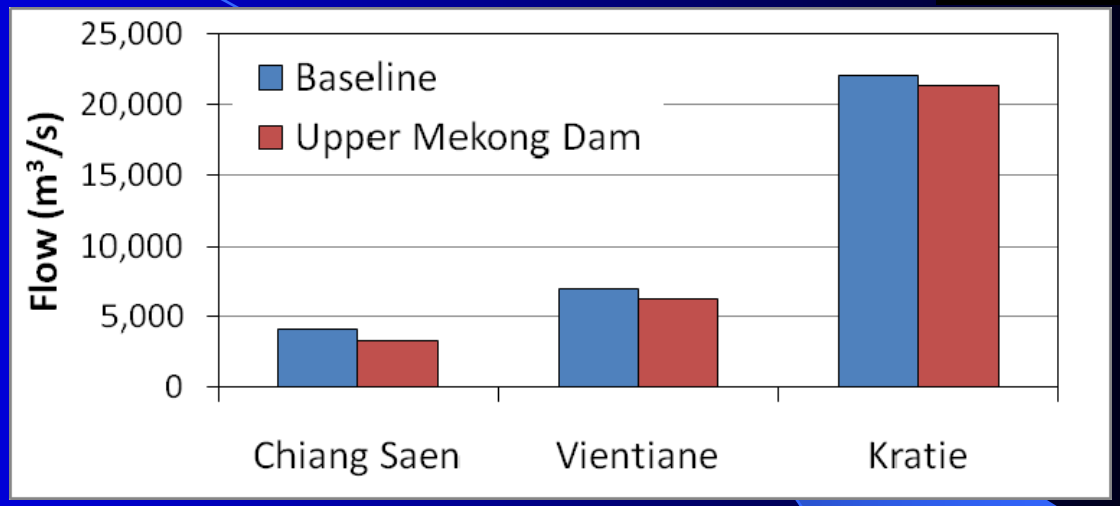




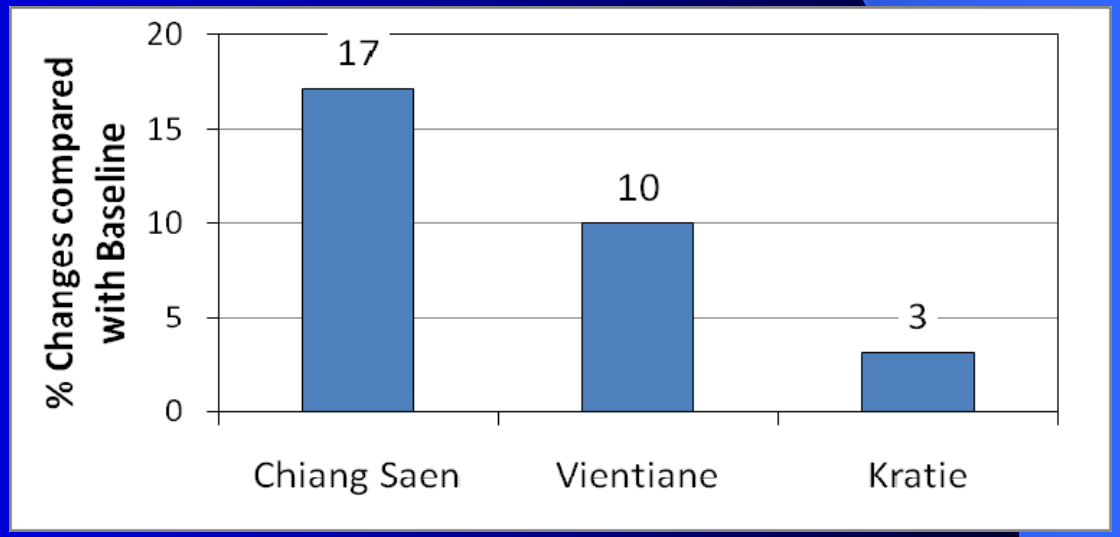
Dry season flow will increases ~ 690 m³/s



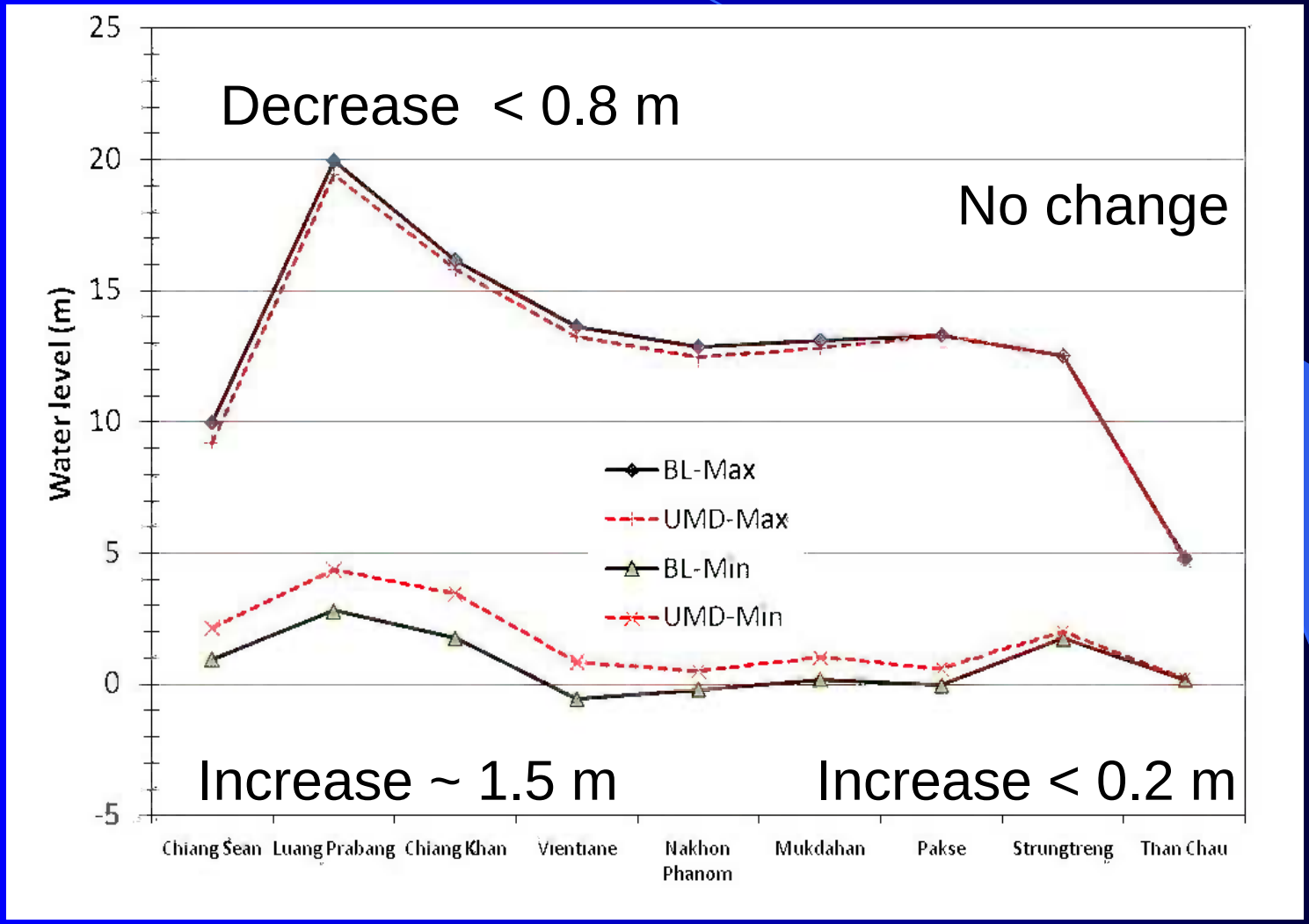
Change in average wet season flows



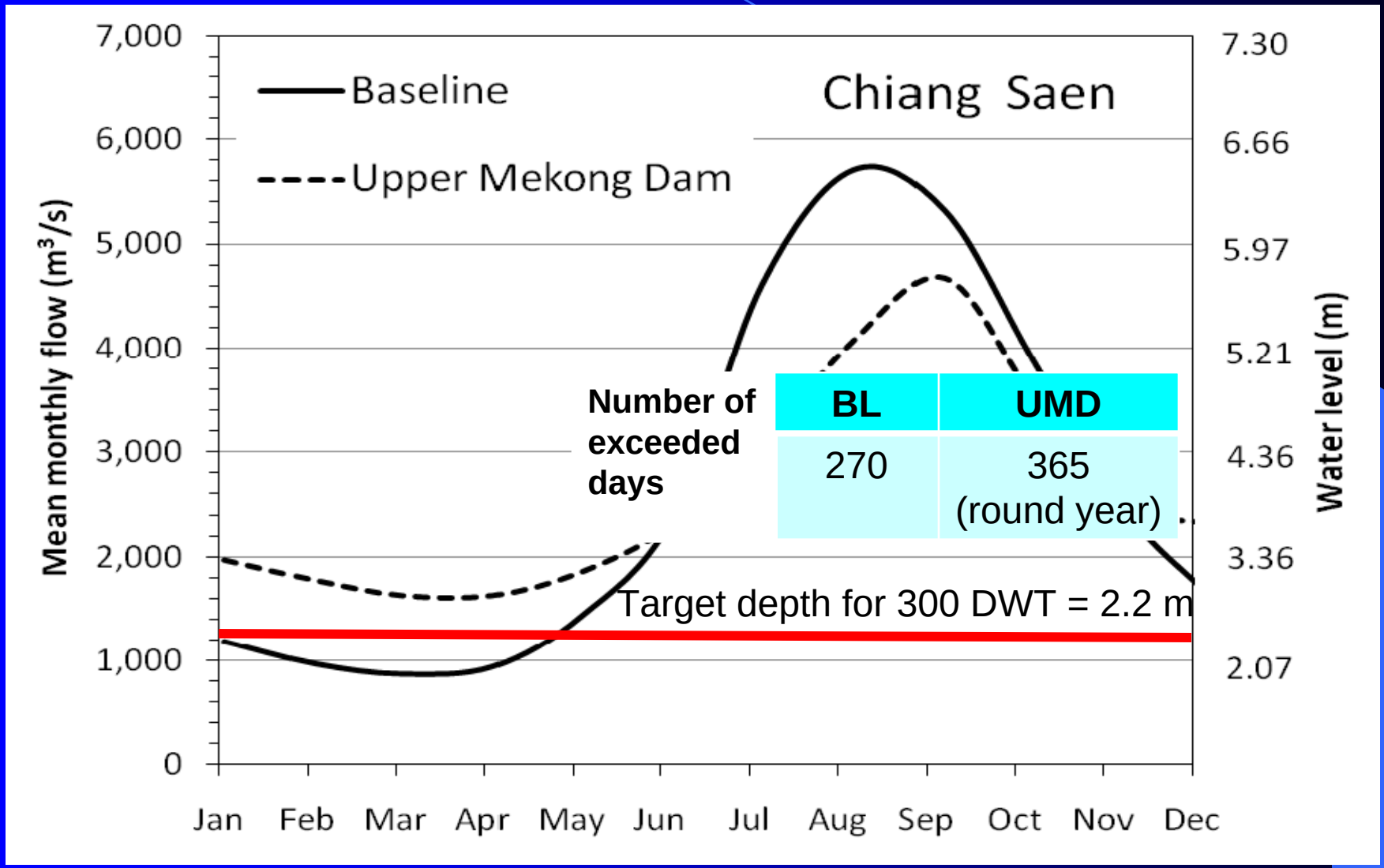
Wet season flow will decreases ~ 700 m³/s



Change in highest and lowest daily WL

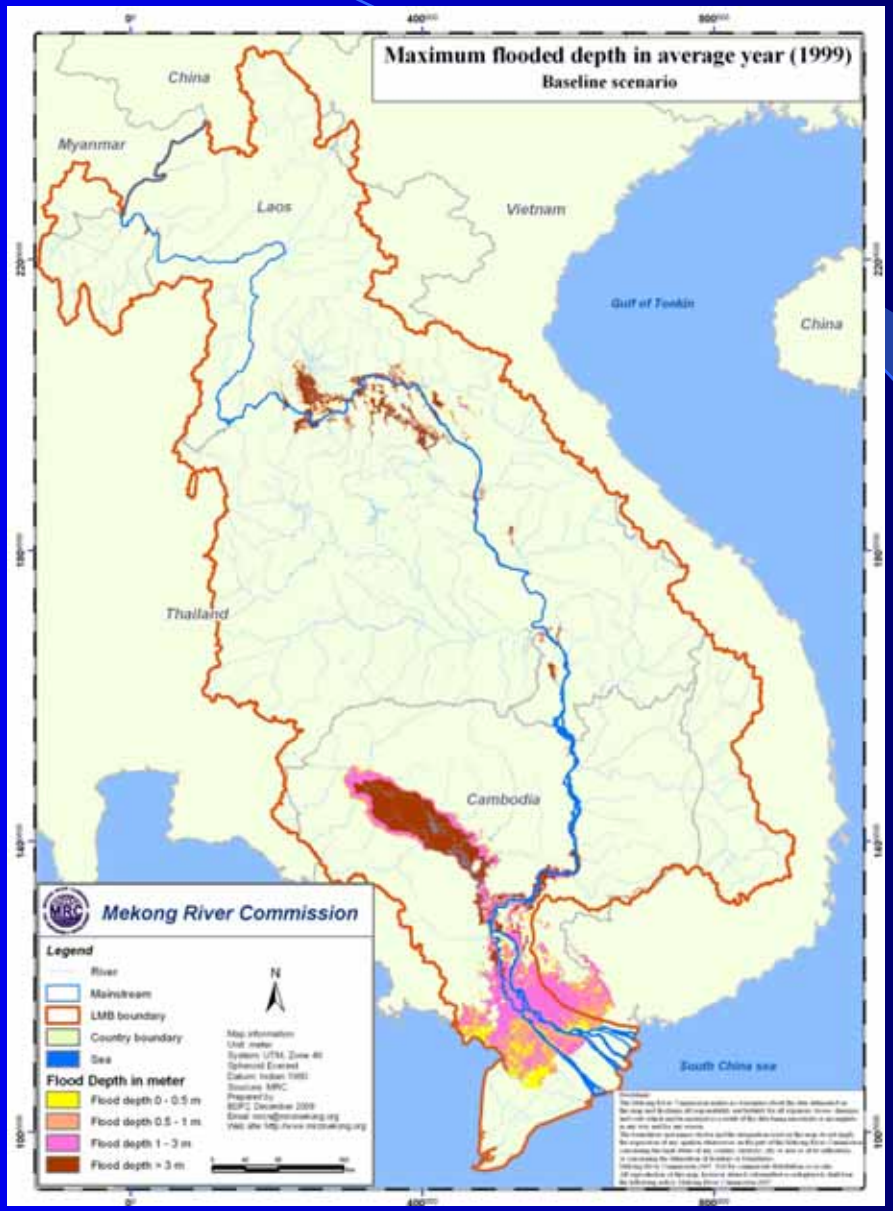


Change in WL duration for navigation target depth



Change in flooded areas

Thailand	ha
BL	362,781
UMD	301,228
%Change	-16.97

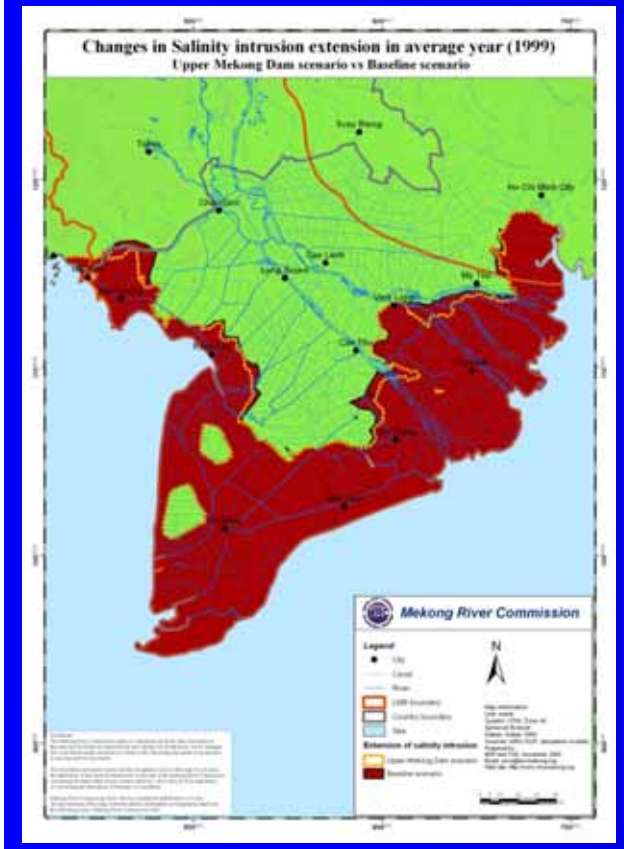


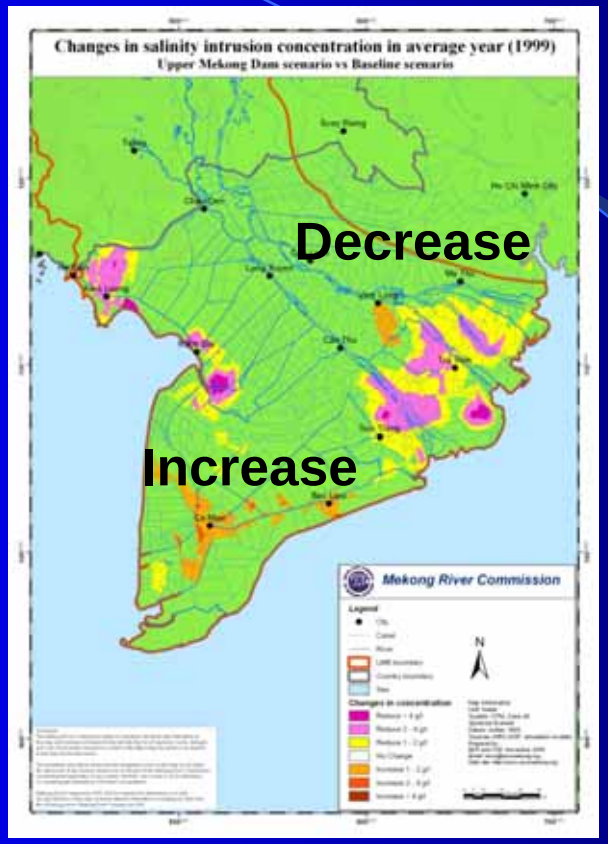
Lao PDR	ha
BL	395,035
UMD	339,090
%Change	-14.16

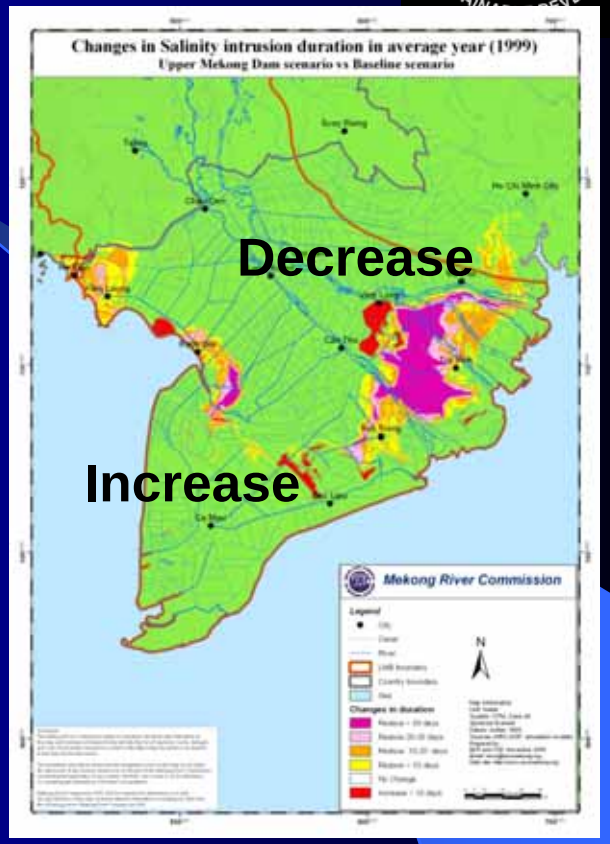
Cambodia	ha
BL	2,132,686
UMD	2,093,243
%Change	-1.85

Viet Nam	ha
BL	1,773,495
UMD	1,756,011
%Change	-0.99

Change in salinity intrusions

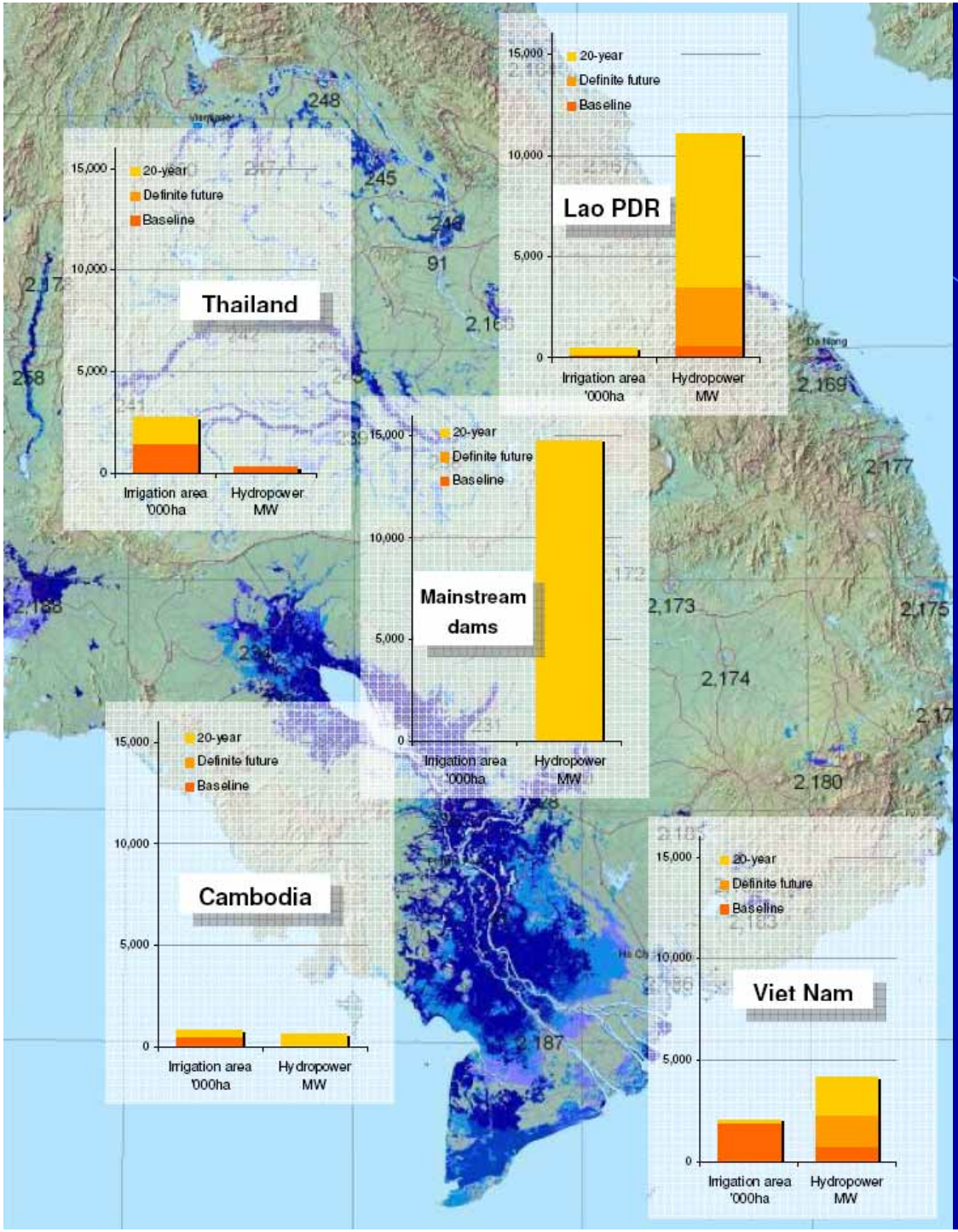






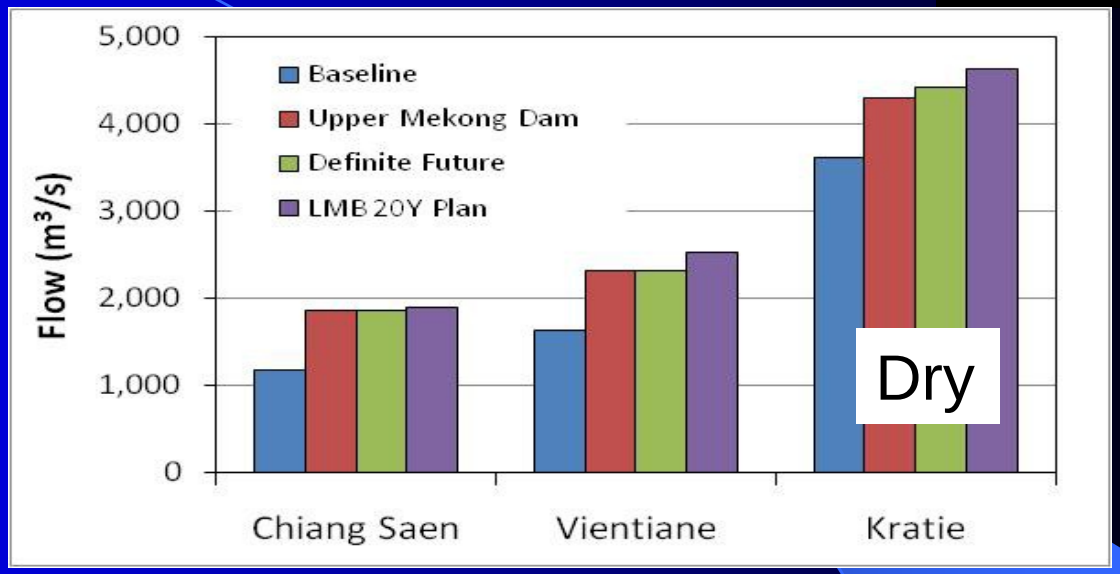
Extended area **Concentration** **Duration**

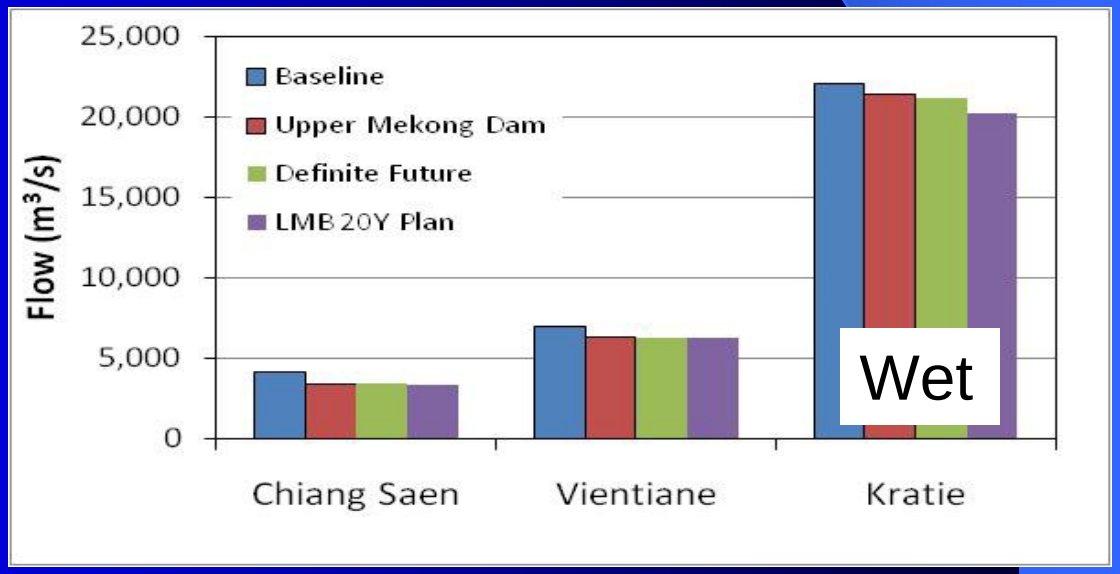
Country	BL	Decrease area		Increase area	
	ha	ha	%	ha	%
Cambodia	82,716	5,901	7.13	520	0.63
Viet Nam	3,948,307	873,270	22.1	258,472	6.5



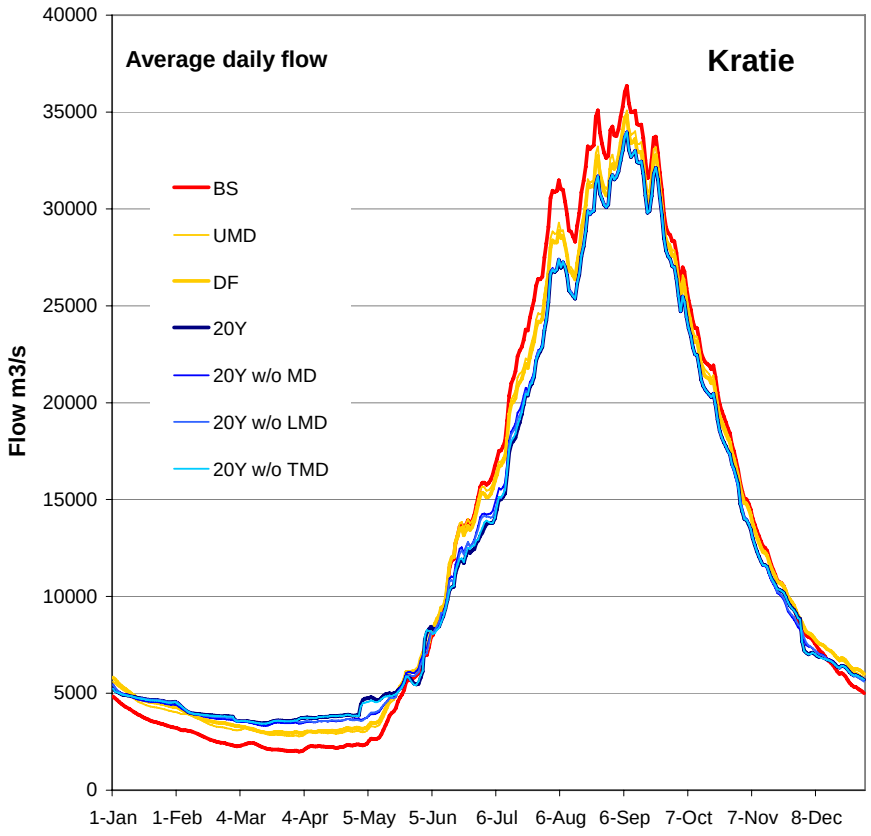
Impact of Lower Mekong development

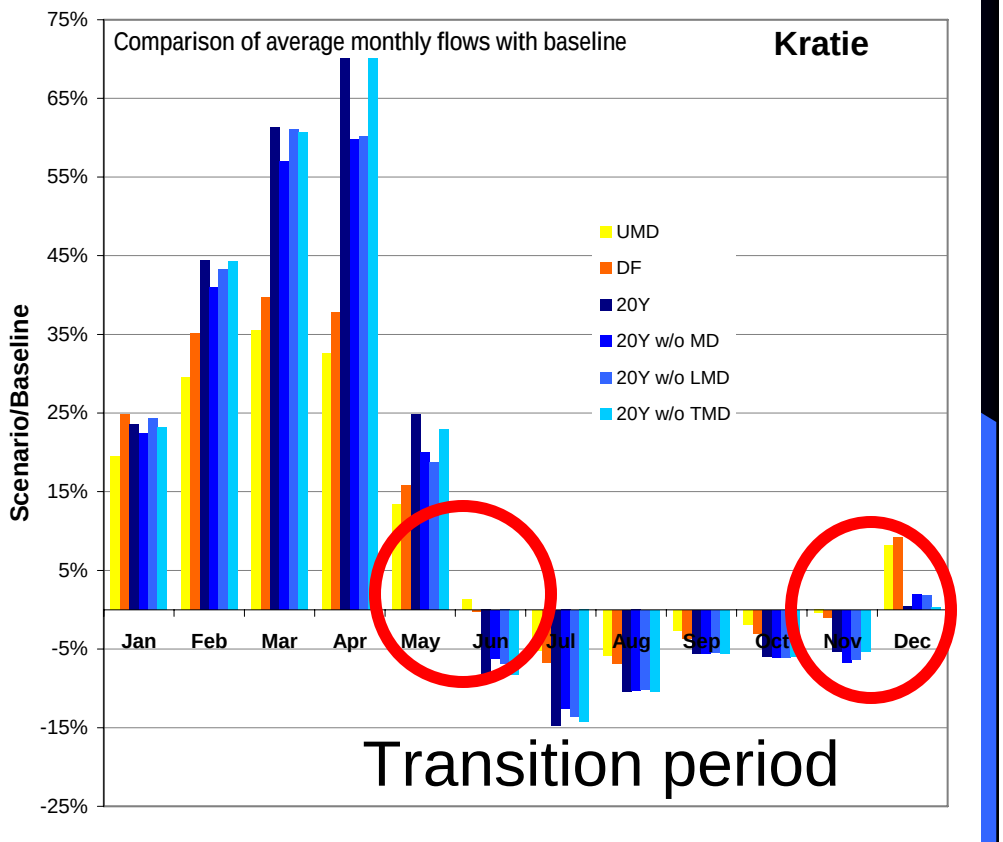
Change in average dry/wet season flows





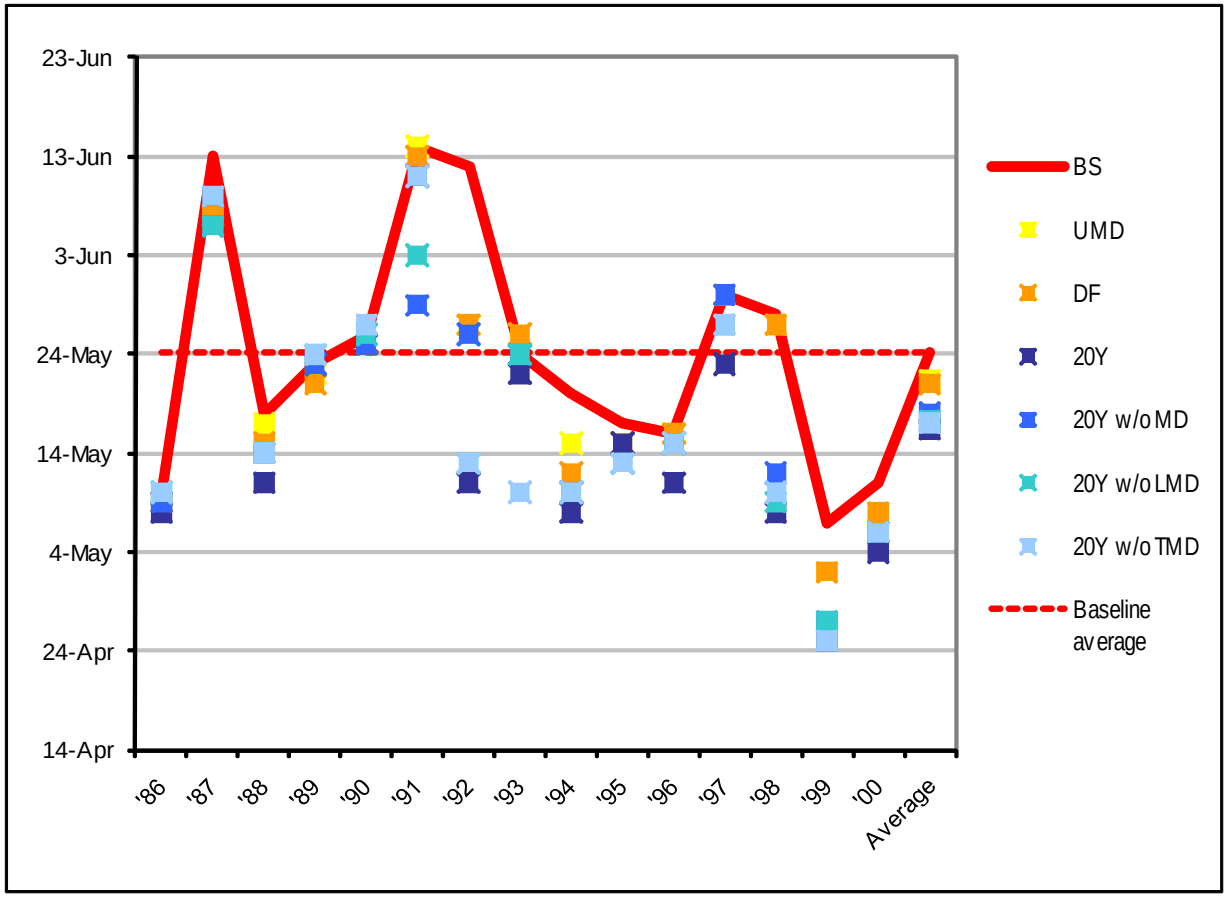
Change in average daily/monthly flows





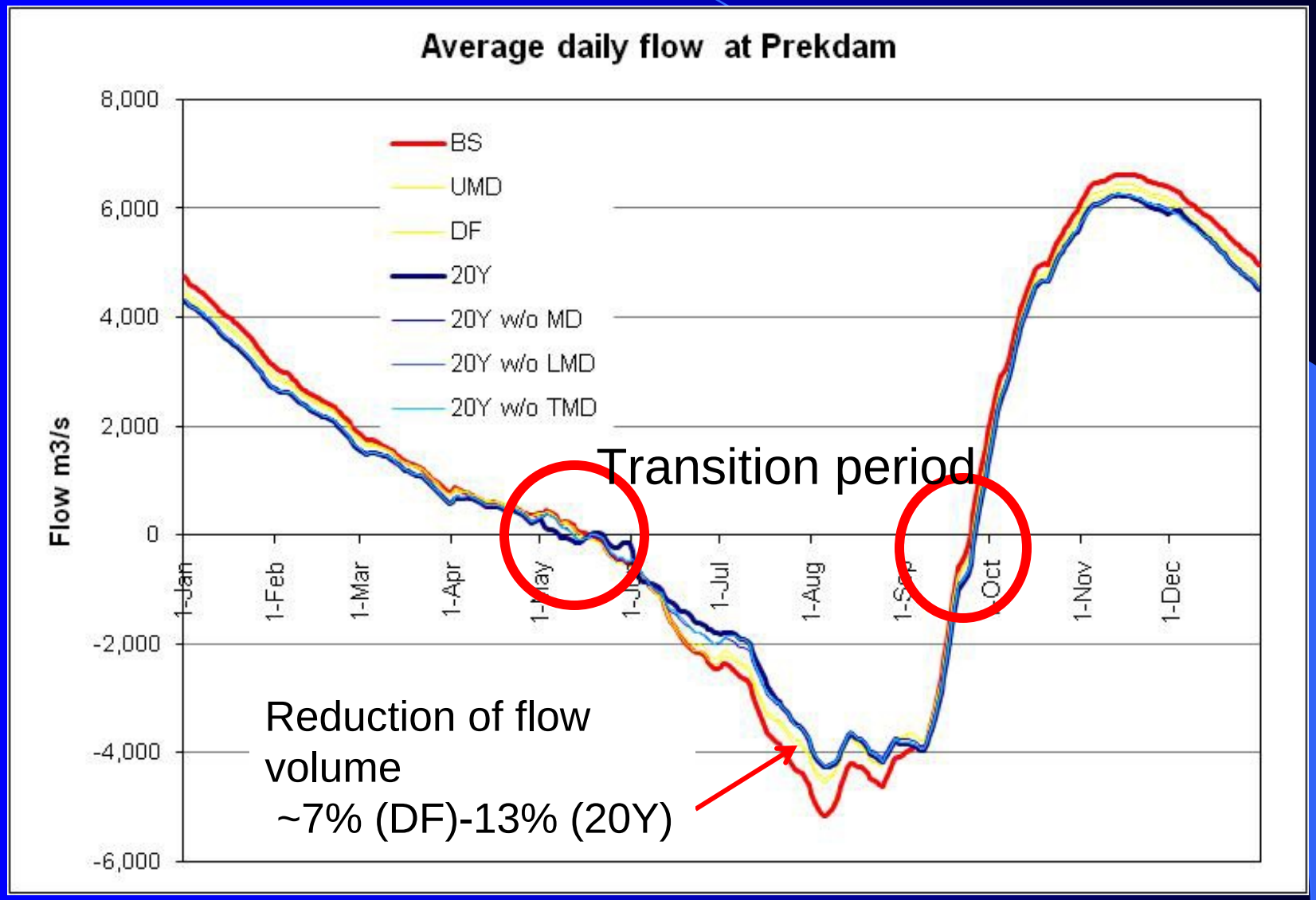
Change in reverse flows to Tonle Sap

Start date for flow reversal



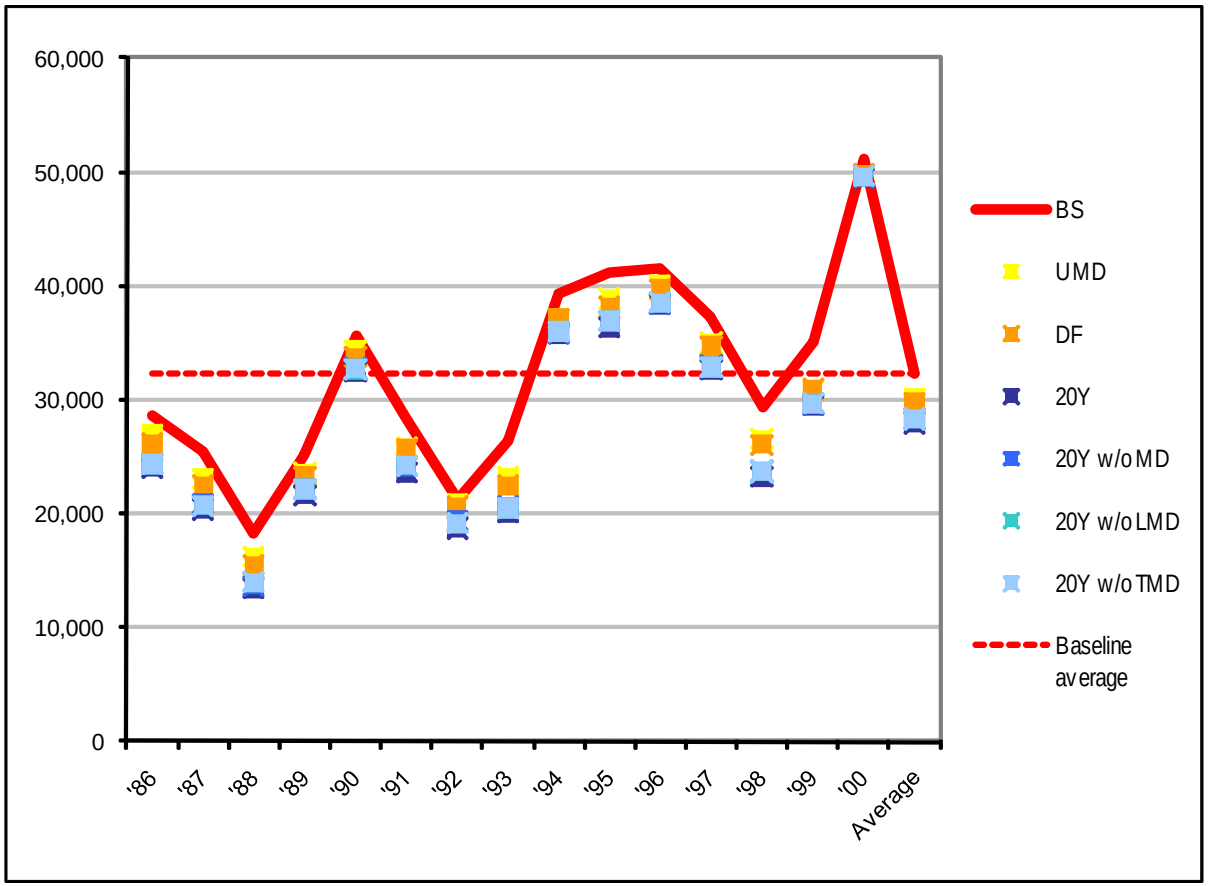
	BS	UMD	DF	20Y	20Y w/o MD	20Y w/o LMD	20Y w/o TMD
Average start date	24-May	21-May	21-May	16-May	18-May	17-May	17-May
Days earlier	0	3	3	8	6	7	7
Max-min start date	38	43	42	47	40	40	47
Range increase (days)	0	5	4	9	2	2	9

Change in reverse flows to Tonle Sap



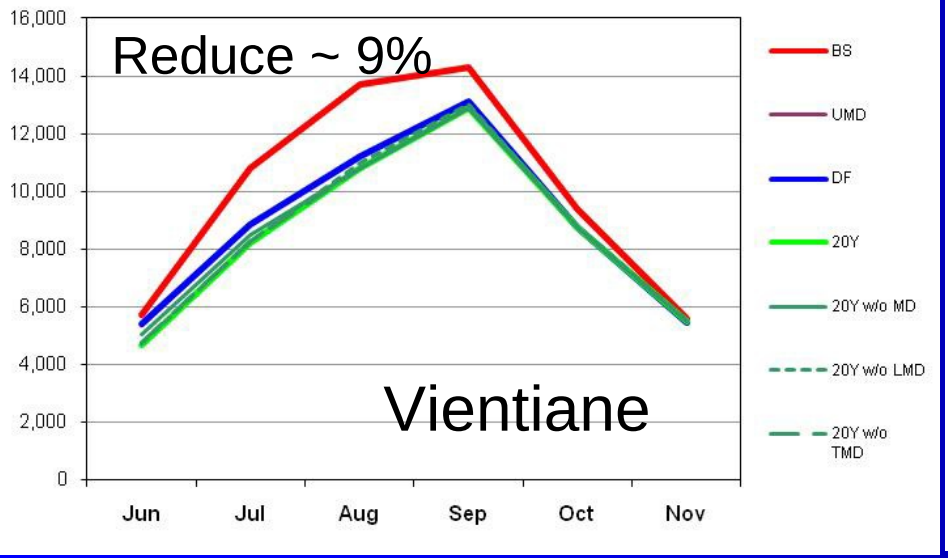
Change in reverse flows to Tonle Sap

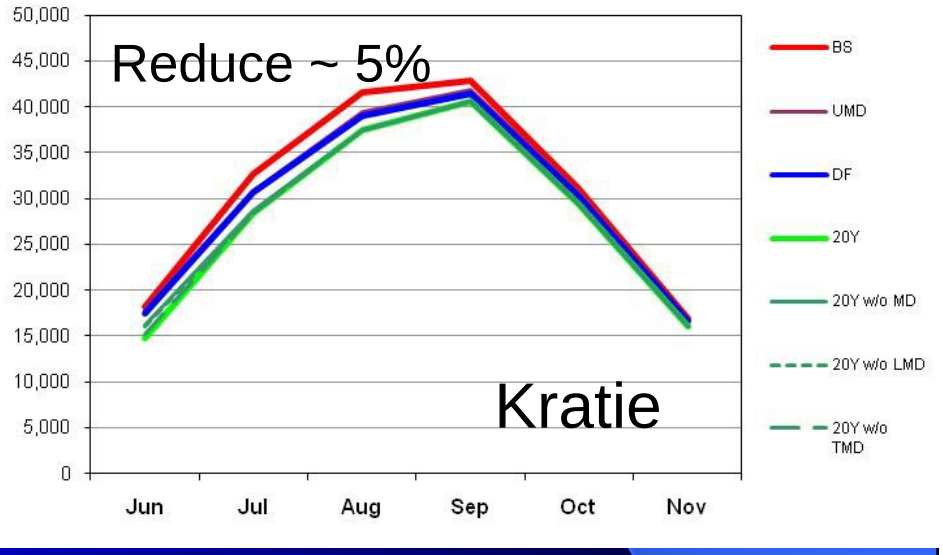
Volume of flow reversal MCM



	BS	UMD	DF	20Y	20Y w/o MD	20Y w/o LMD	20Y w/o TMD
Average volume	32,259	30,145	29,740	27,993	28,358	28,339	28,340
Change from BS	0%	-7%	-8%	-13%	-12%	-12%	-12%
Max-min volume	32,950	33,530	34,286	36,065	35,833	35,633	35,631
Range increase (MCM)	0%	2%	4%	9%	9%	8%	8%

Change in flood peaks/flood frequencies





Vientiane — Unit: m3/s

Return Period	BL	UMD	DF	20Y	20Y-WMD	20Y-LMD	20Y-TMD
100	23,469	25,022	25,024	25,081	25,083	25,549	25,081
50	22,831	23,437	23,434	23,422	23,419	23,849	23,422
20	21,781	21,179	21,169	21,069	21,061	21,436	21,069
10	20,752	19,290	19,276	19,110	19,102	19,427	19,110
5	19,378	17,146	17,128	16,897	16,893	17,158	16,897

Kratie — Unit: m3/s

Return Period	BL	UMD	DF	20Y	20Y-WMD	20Y-LMD	20Y-TMD
100	86447	87171	87125	87506	87652	87708	87506
50	79190	79099	79065	78946	79064	79141	78946
20	69557	68571	68510	67767	67853	67949	67767
10	62180	60694	60573	59390	59453	59556	59389
5	54621	52849	52618	51030	51074	51174	51029

Change in flooded areas in average year (1999)

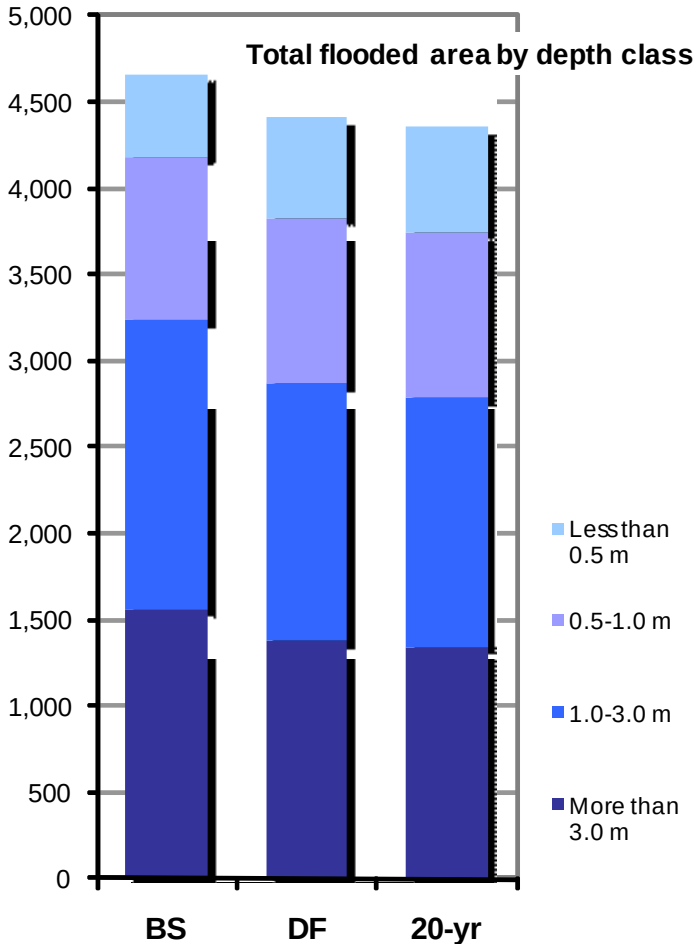
Flooded area assessments

'000 ha

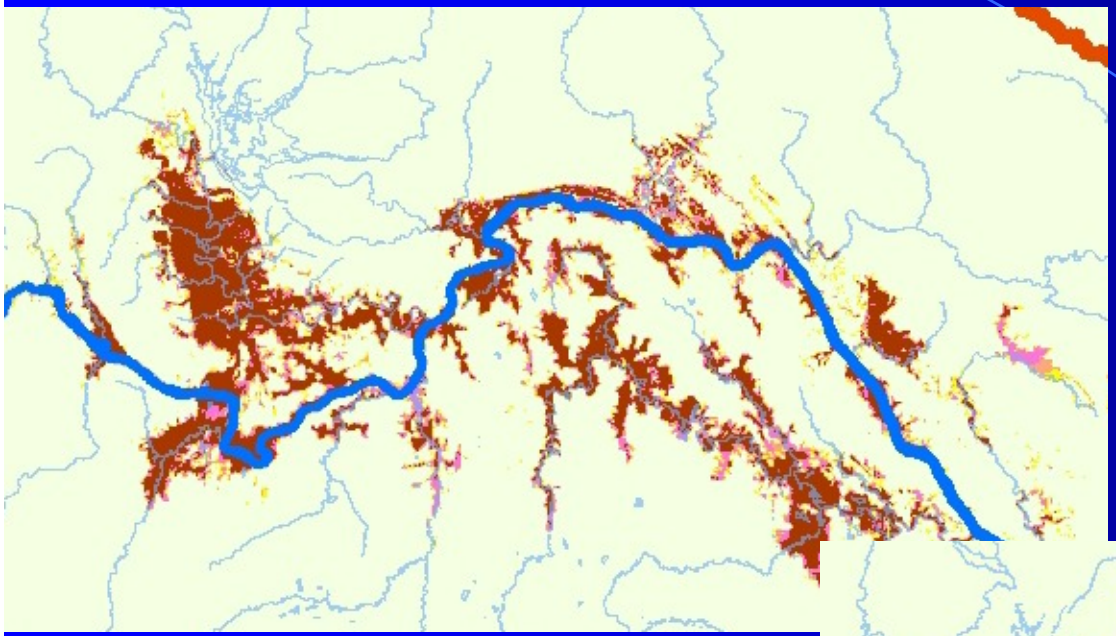
Baseline	Lao	Thailand	Cambodia	Vietnam	Total
Less than 0.5 m	18	17	142	307	484
0.5-1.0 m	25	24	228	668	945
1.0-3.0 m	82	89	708	794	1,673
More than 3.0 m	270	232	1,055	5	1,562
Totals	**395**	**363**	**2,133**	**1,773**	**4,664**

Definite Future Scenario	Lao	Thailand	Cambodia	Vietnam	Total
Less than 0.5 m	17	18	175	374	584
0.5-1.0 m	20	22	205	712	959
1.0-3.0 m	72	79	673	666	1,490
More than 3.0 m	224	177	977	3	1,380
Totals	**332**	**296**	**2,029**	**1,756**	**4,413**
Reductions from baseline	16%	18%	5%	1%	5%

20-year Foreseeable Future	Lao	Thailand	Cambodia	Vietnam	Total
Less than 0.5 m	18	19	177	395	609
0.5-1.0 m	18	21	208	717	963
1.0-3.0 m	69	77	664	634	1,444
More than 3.0 m	223	170	943	3	1,339
Totals	**329**	**287**	**1,991**	**1,748**	**4,355**
Reductions from baseline	17%	21%	7%	1%	7%
Change from Definite Future	**-1%**	**-3%**	**-2%**	**0%**	**-1%**

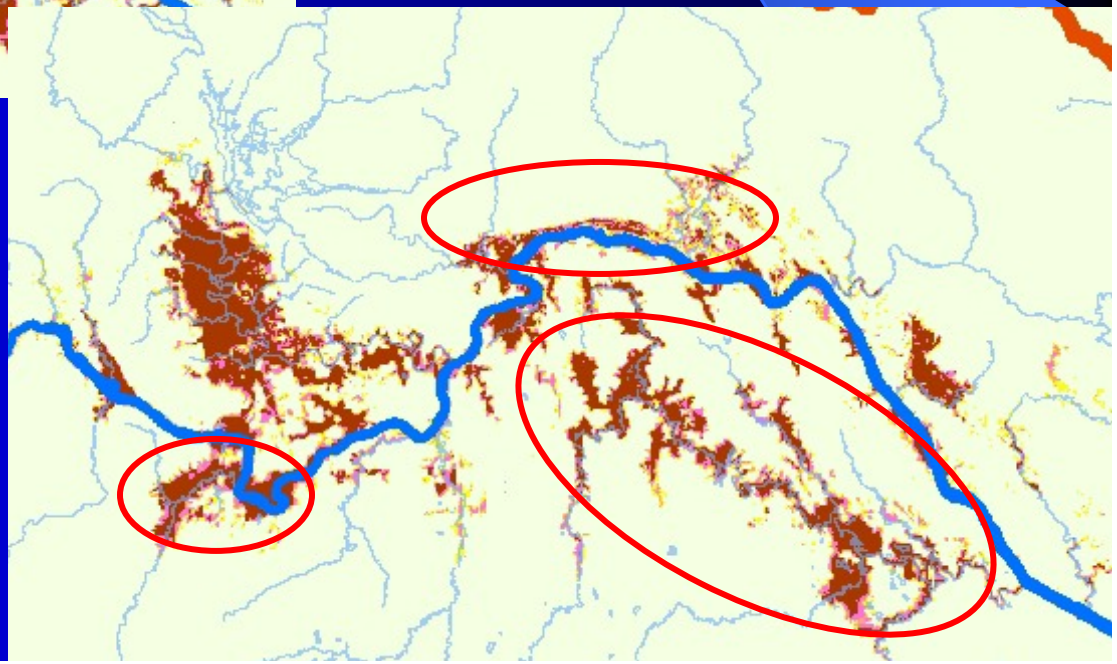


Change in flooded areas below Vientiane in average year (1999)

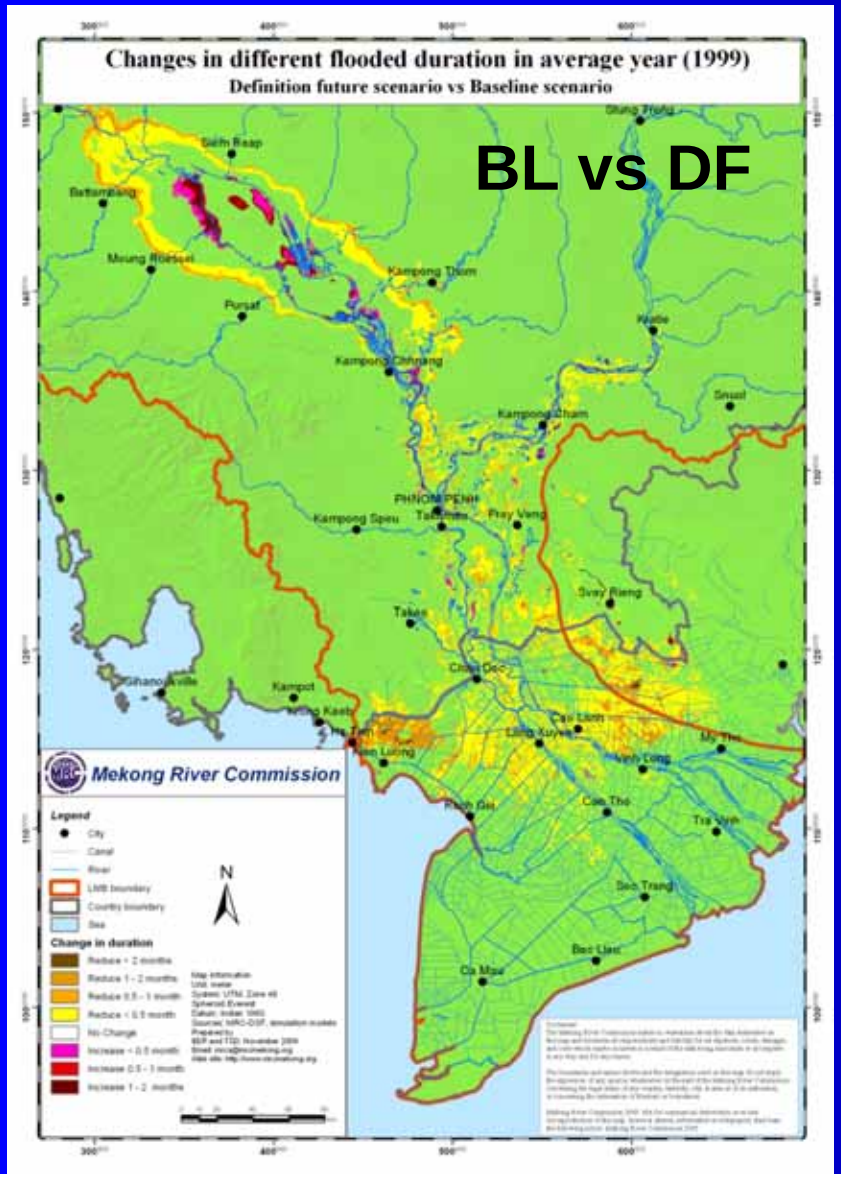


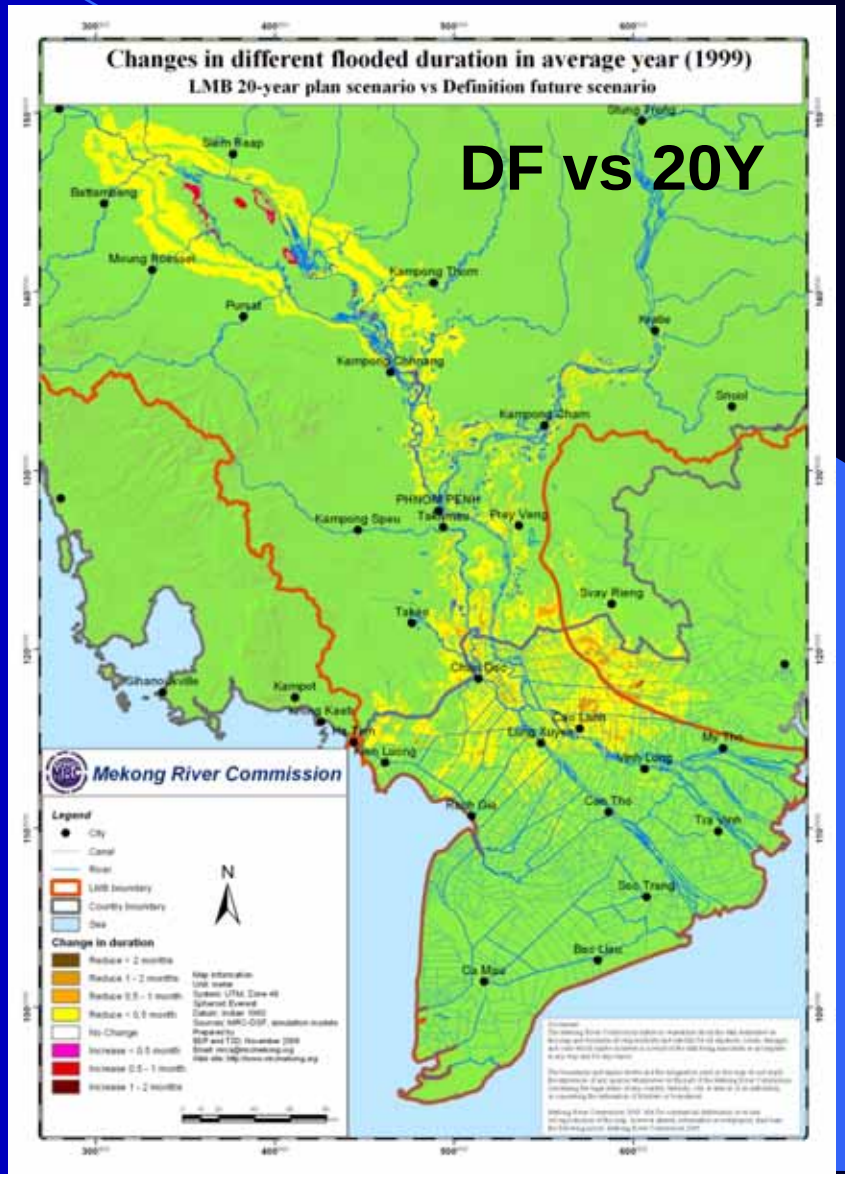
Baseline

LMB 20Y-Plan



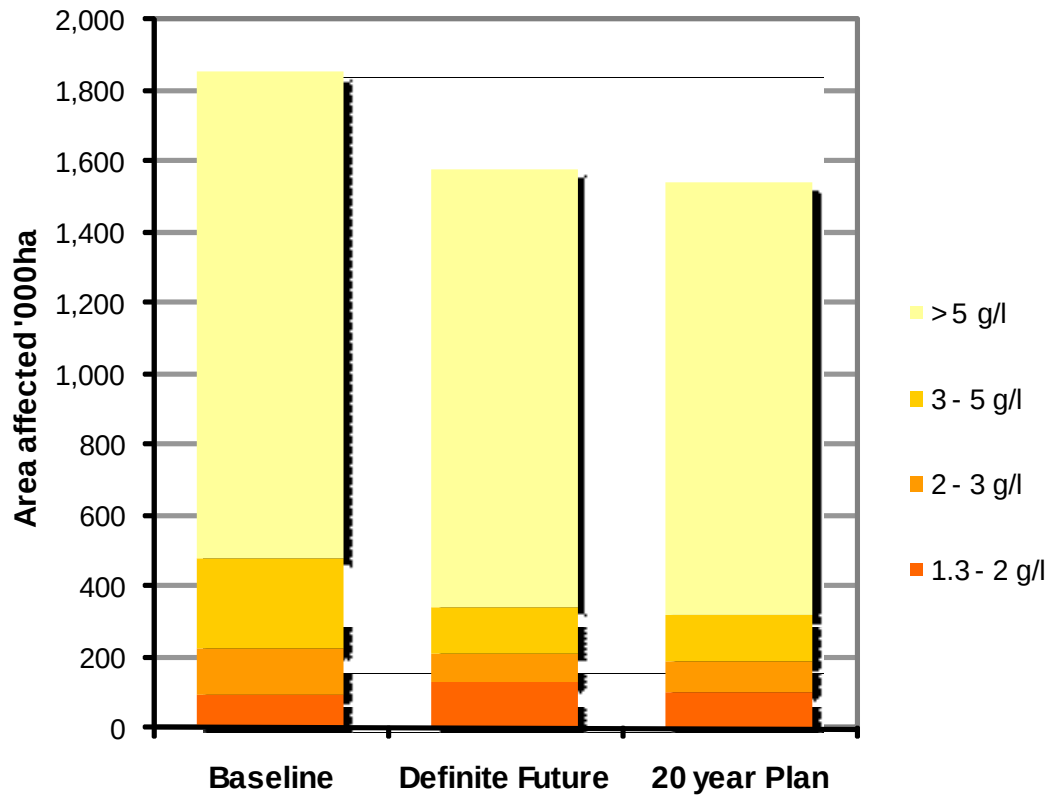
Change in flood duration in Mekong Delta in average year (1999)



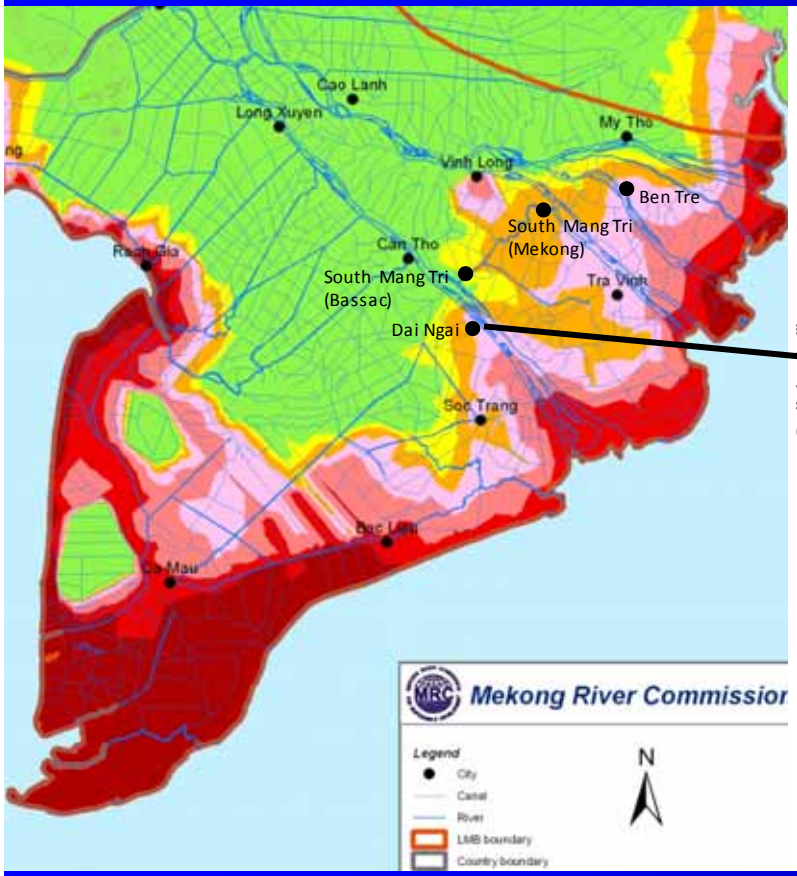


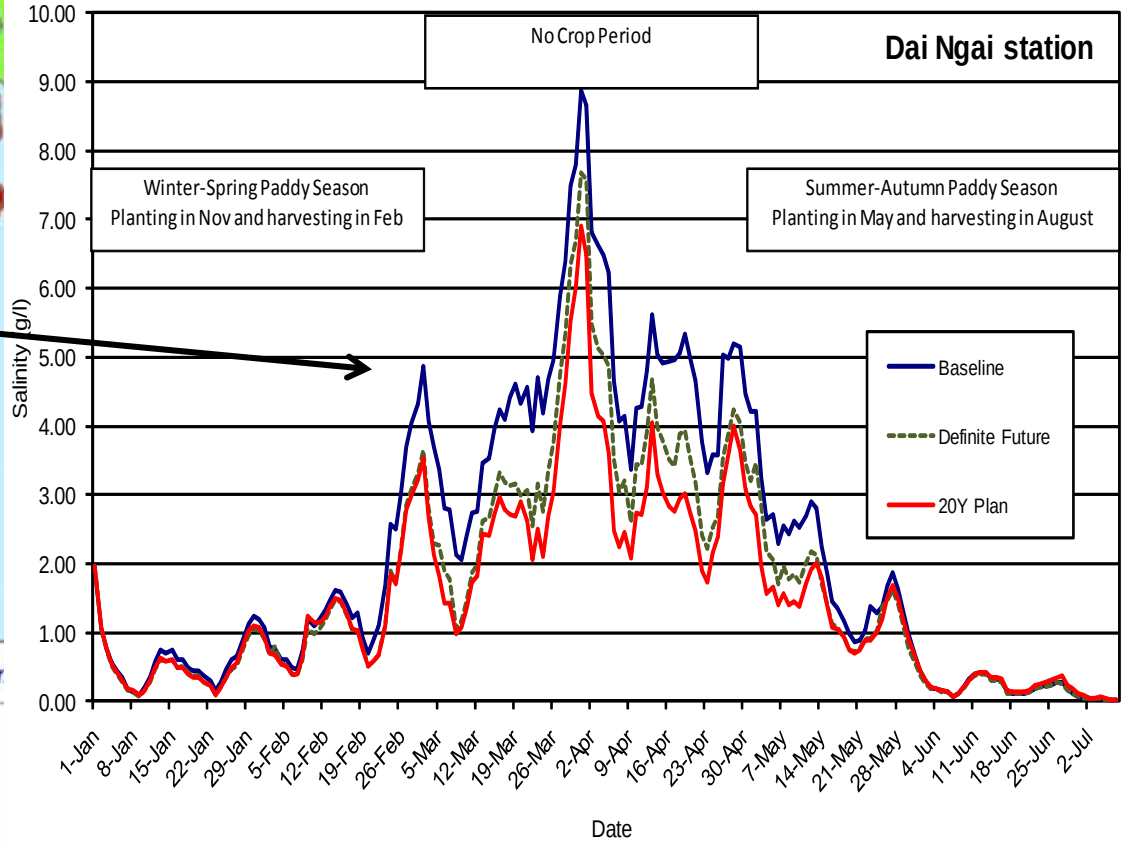
Change in salinity intrusion concentration in average year (1999)

	Salinity concentrations				Total area	'000ha Percent change
	1.3 - 2 g/l	2 - 3 g/l	3 - 5 g/l	> 5 g/l		
Baseline	94	129	257	1,372	1,851	0%
Definite Future	128	87	131	1,234	1,579	15%
20 year Plan	105	82	131	1,225	1,543	17%

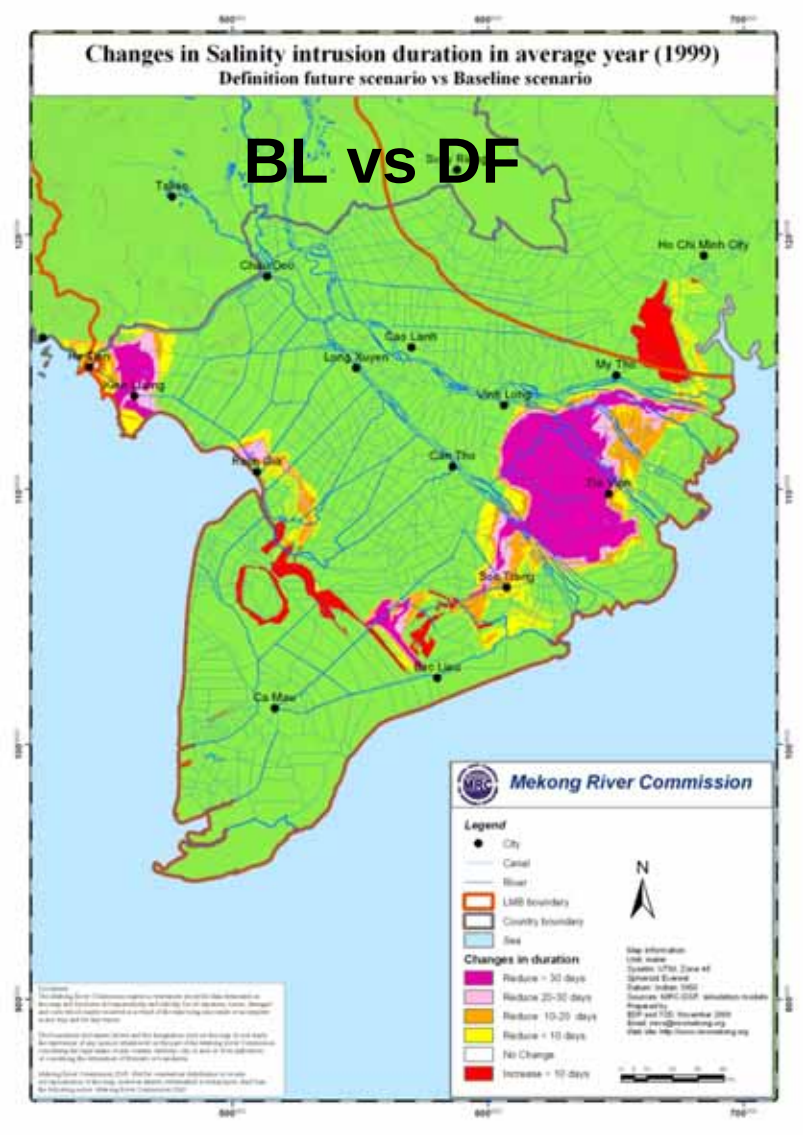


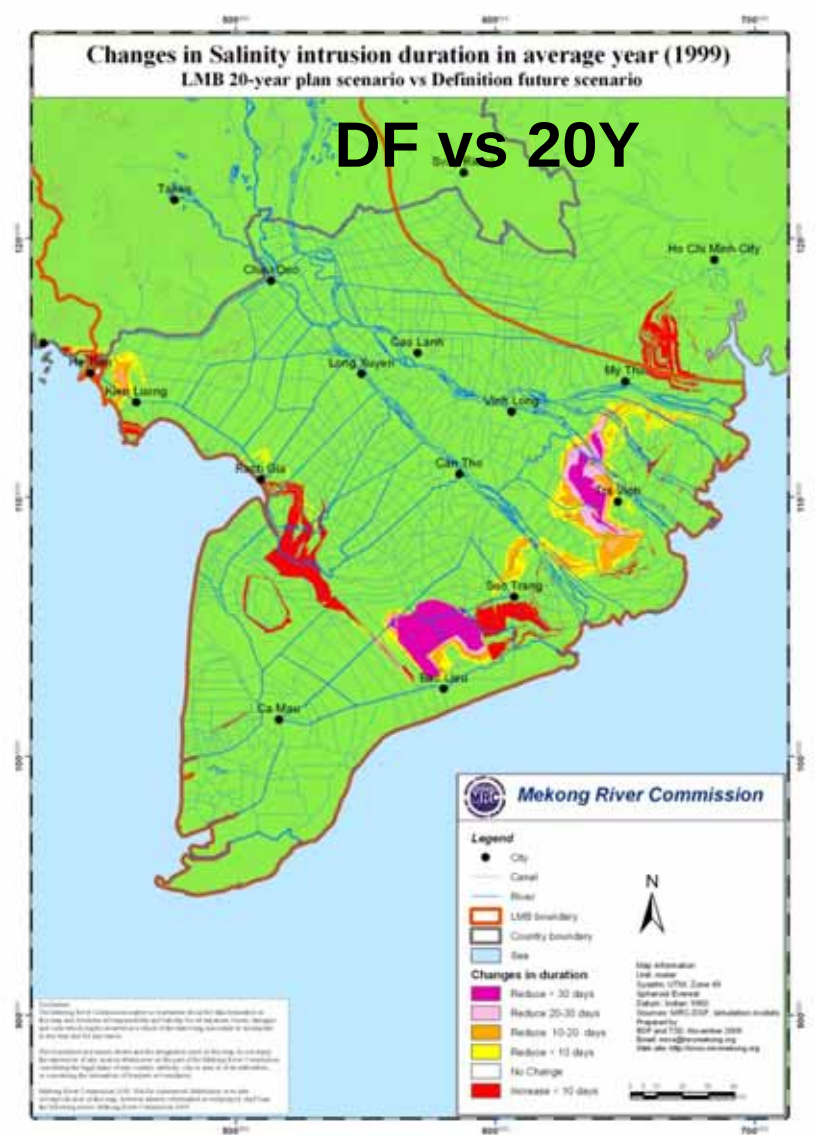
Change in daily salinity intrusion concentration in average year (1999)





Change in salinity intrusion duration in average year (1999)





3.Conclusions

In conclusions (1)

- **Impacts of Definite Future Scenario**: The impacts of the Definite Future Scenario, when compared to those of other scenarios, demonstrate that the construction of dams currently under implementation especially the two large storage dams in China will have a substantial effect on the natural flow regimes of the mainstream by increasing dry season flows and decreasing flood flows and salinity intrusion. By their nature as “firm” projects, these changes will be irreversible.

In conclusions (2)

- **Impacts of Foreseeable Future Scenarios**: The impacts of the foreseeable future scenarios, both with and without mainstream dams, are broadly similar and represent only a small further changes from the Definite Future Scenario. Under the Foreseeable Future Scenarios, the presence of mainstream dams causes only very small further changes to the overall flow patterns at a regional scale.
- Overall, the assessments demonstrate that the increased storage within the basin currently under implementation together with that planned within the 20-year Foreseeable Future Scenario will compensate for the increased abstractions planned over this same period.

In conclusions (3)

- In addition, the assessments demonstrate that the impact of the mainstream dams under consideration in LMB, at a regional scale, have only very minor incremental impact on the mainstream flow regime. However, the impacts may increase significantly at a local scale (project site) such as increase of hourly flow fluctuation

4. Addressing Uncertainties

- **Climate change and sea level rise**

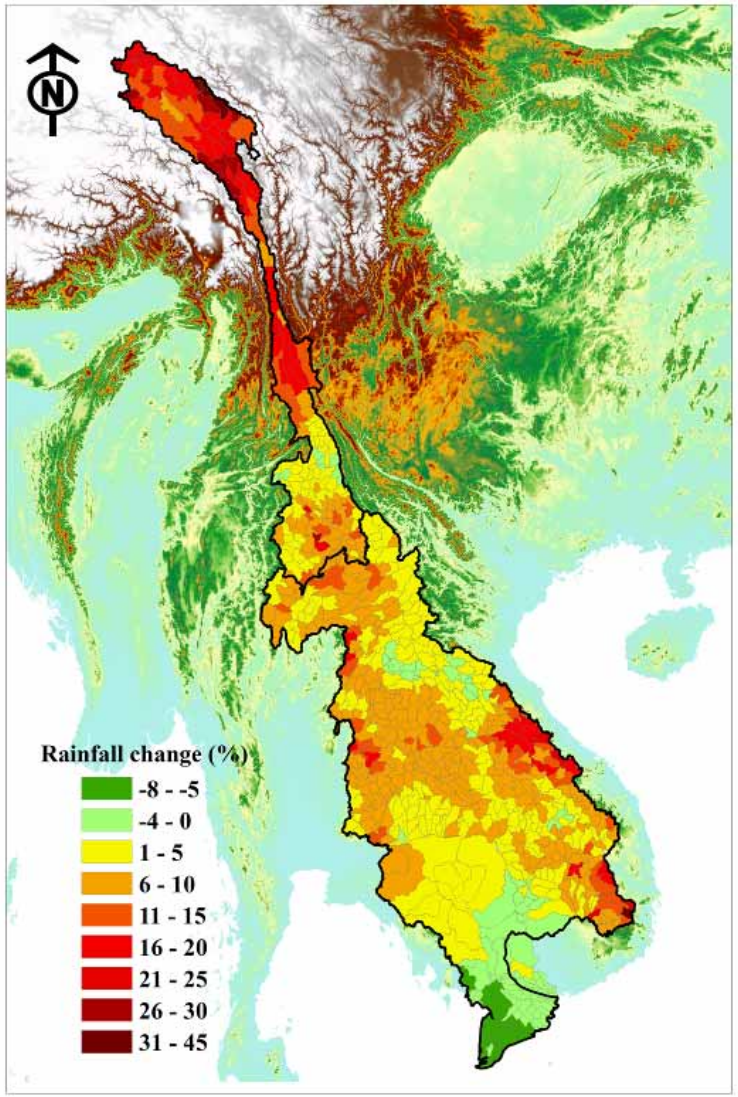
  - Climate change scenarios A2 and B2 of IPCC are available in MRC under EP programme for period 2010-2050
  - Sea level rise scenarios for Viet Nam are available at Ministry of Natural Resources and Environment

Table 7. Sea Level Rise (cm) relative to period of 1980 - 1999

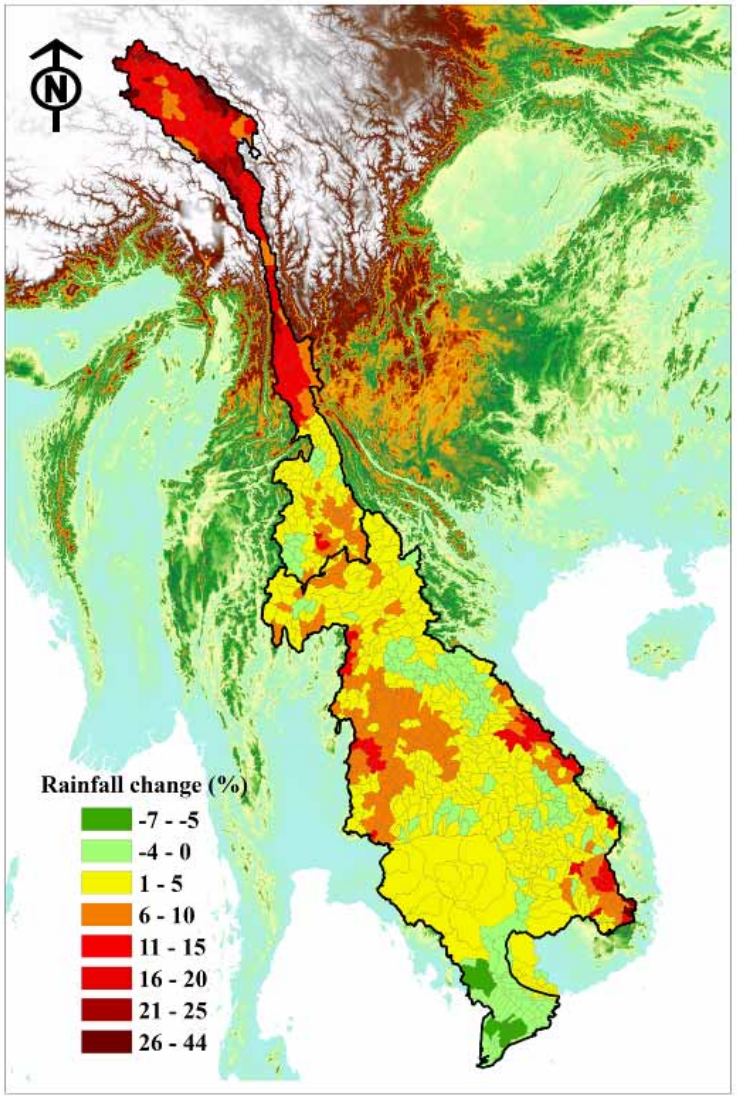
Scenarios	Decades in the 21 Century								
	2020	2030	2040	2050	2060	2070	2080	2090	2100
Low emission scenario (B1)	11	17	23	**28**	35	42	50	57	**65**
Medium emission scenario (B2)	12	17	23	**30**	37	46	54	64	**75**
High emission scenario (A1FI)	12	17	24	**33**	44	57	71	86	**100**

Change in mean annual subbasin precipitation (%) during 2010–2050 compared to 1985–2000

A2 Scenario



B2 Scenario



4. Addressing Uncertainties

- **Operation of hydropower in the Upper Mekong Basin**
  - Based on discussion with The Ecosystem Study Commission for International Rivers (ESCIR) , China through MRC SEA activity in Nov 2009, The dry season flow is possible increase up to 1,000 m3/s

- **Hydropower development in the Lower Mekong Basin**
  - New projects in 20Y Plan scenario will contribute 19,523 MCM of useful seasonal water transfer, all of it in projects in tributary rivers. This transfer drops to 5,876 MCM if only those projects with acceptable financial performance are counted indicating that the most promising projects in terms of storage are also the less financially attractive.

5. Issues for the countries to consider

- Main findings and conclusions
- Selection of climate change and sea level rise scenarios
- Selection of flood management scenarios in Mekong Delta for Long-Term and Very High development scenarios
- National consultation on the results (approach/date/venue)

Thank You