The MRC Regional Stakeholder Forum

14th – 15th December 2017

Vientiane, Lao PDR

MRC Council Study - Results of Irrigation and Agriculture Land Use Thematic Areas

Agriculture and Irrigation Team
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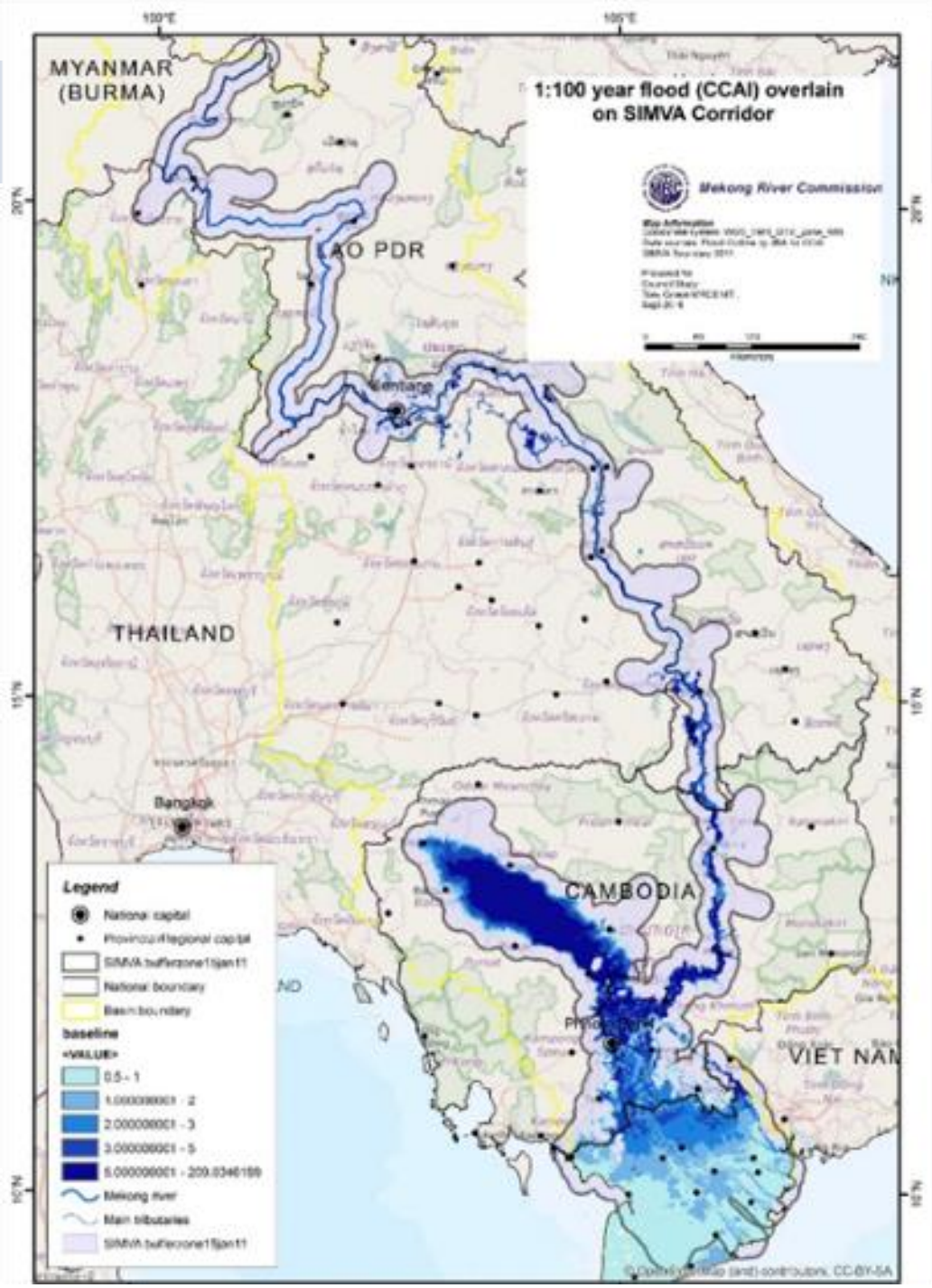
Outlines of Presentation

1. **Overview**
   - Scope of Assessment, Indicators, Methodology, Scenario development
2. **Key Findings/Results**
   - ***Irrigation:***
     - Timeline of Irrigated area in wet and dry seasons
     - Rate of irrigation expansion (%)
     - Irrigation water demand,
     - Impacts of irrigation on flow and sediments, and
   - ***Agriculture:***
     - Timeline of land use change (forest and rainfed agriculture areas)
     - Changes in flow and sediments
     - Impacts of ALU changes on flow and sediments, and
   - ***Impacts of scenarios development on irrigated and rainfed rice production***
3. **Socio-economic, macro-economic and ecological findings**
4. **Key conclusions**

1. OVERVIEW

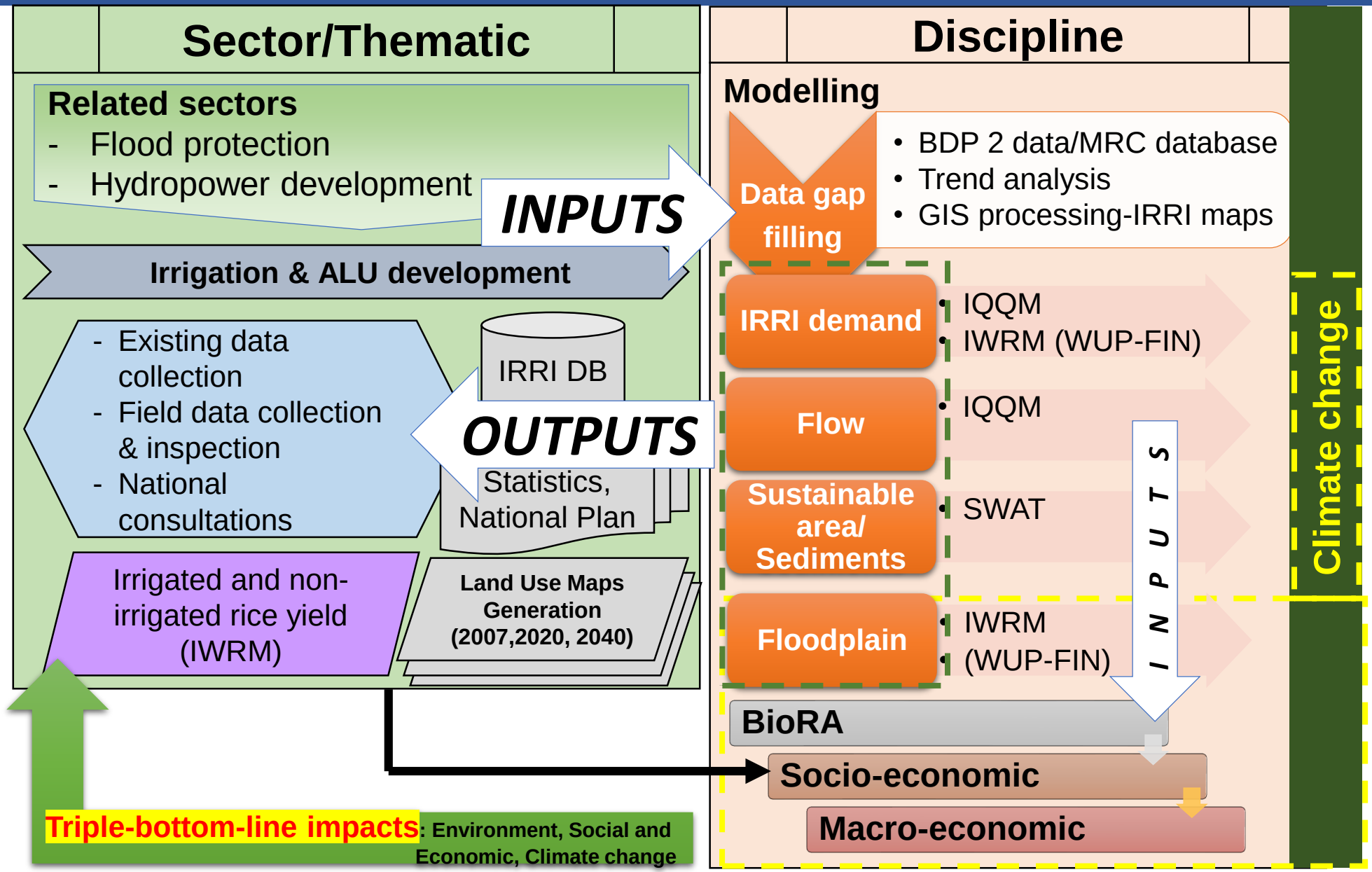
Scope of the assessment



Council Study impact assessment corridor

- **Areas 15 km. along the Mekong mainstream**

Methodology



Scenario development

	Scenario	Level of Development for water-related sectors						Climate	Flood-plain
		ALU	DIW	FPF	HPP	IRR	NAV		
M1	Early Development Scenario 2007	2007	2007	2007	2007	2007	2007	No climate change	2007
M2	Development Future Scenario 2020	2020	2020	2020	2020	2020	2020	No climate change	2020
M3	Planned Development Scenario 2040	2040	2040	2040	2040	2040	2040	No climate change	2040
M3CC	Planned Development Scenario 2040	2040	2040	2040	2040	2040	2040	Mean warmer & wetter	2040
I1	Planned Development 2040 without IRR	2040	2040	2040	2040	**2007**	2040	Mean warmer & wetter	2040
I2	High level IRR implementation	2040	2040	2040	2040	**HIGH**	2040	Mean warmer & wetter	2040

Scenario development

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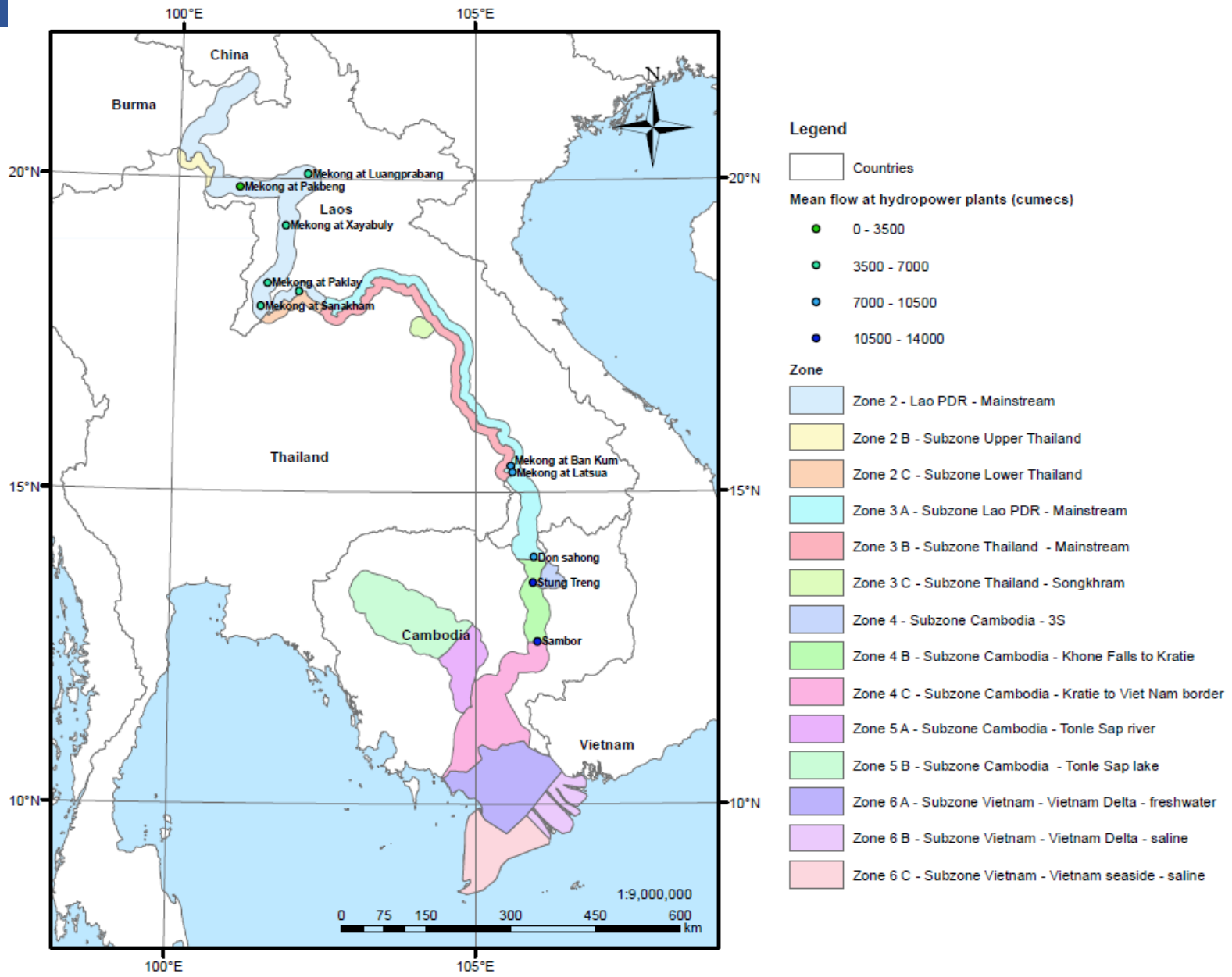
M1	Early Development Scenario 2007	2007	2007	2007	2007	2007	2007	No climate change	2007
M2	Development Future Scenario 2020	2020	2020	2020	2020	2020	2020	No climate change	2020
M3	Planned Development Scenario 2040	2040	2040	2040	2040	2040	2040	No climate change	2040
M3CC	Planned Development Scenario 2040	2040	2040	2040	2040	2040	2040	Mean warmer & wetter	2040
A1	Planned Development 2040 without ALU	**2007**	2040	2040	2040	2040	2040	Mean warmer & wetter	2040
A2	High level ALU implementation	**HIGH**	2040	2040	2040	2040	2040	Mean warmer & wetter	2040

MODEL OUTPUT AREAS FOR ANALYSIS

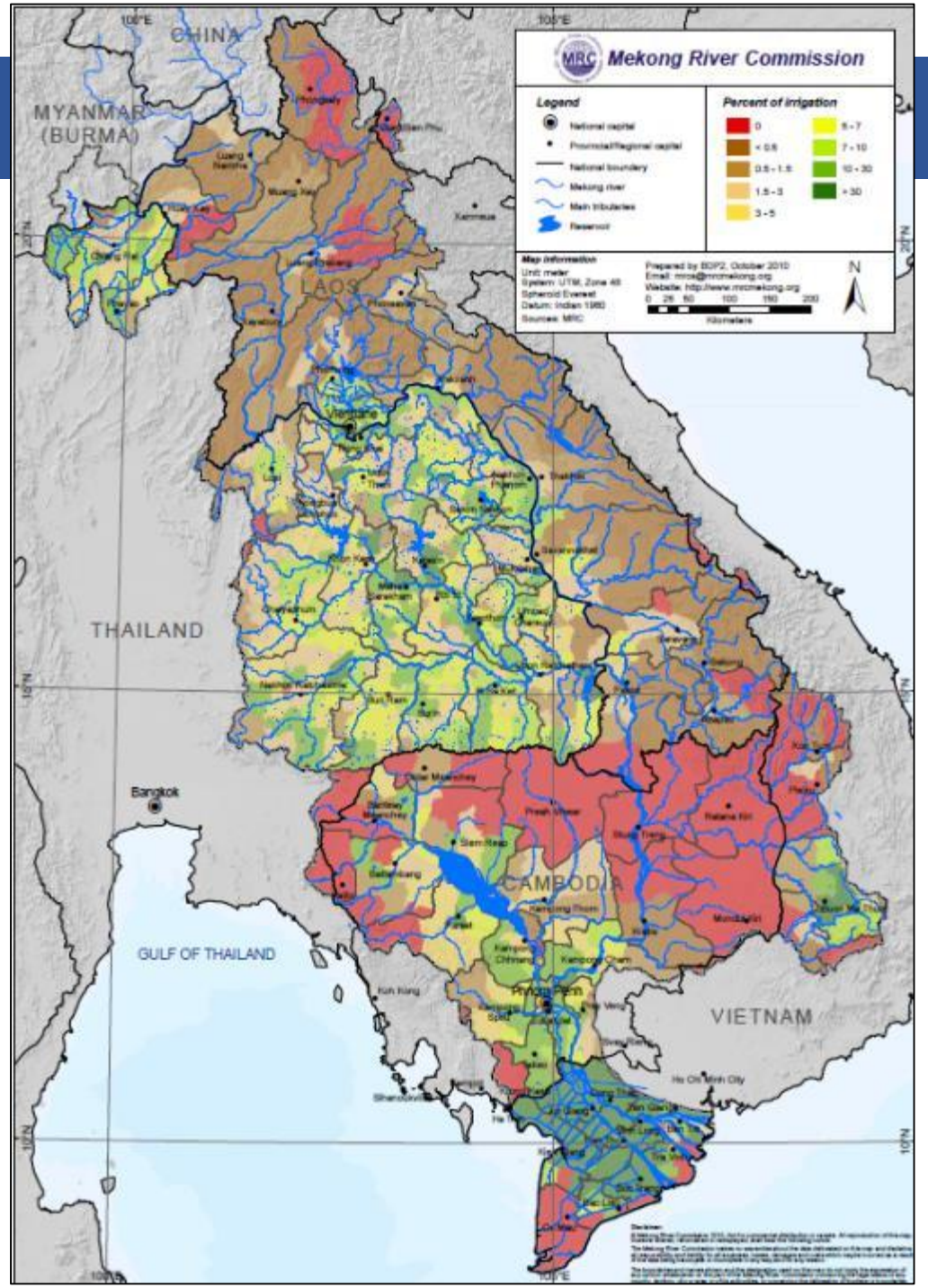


2. KEY FINDINGS/RESULTS


Irrigation in the LMB

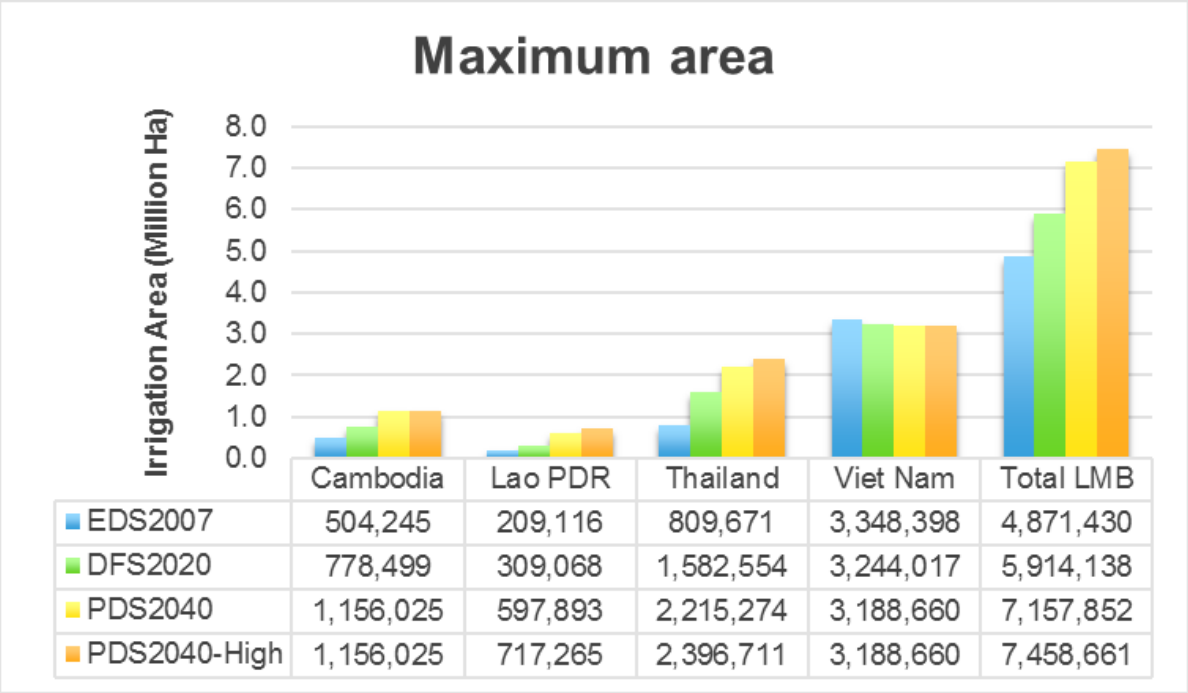
Percentage of land area irrigated (Baseline 2007)

- Dominated by wet season irrigation **Northeastern Thailand, the Great Lake, and Mekong Delta.**
- Irrigated in **Cambodia upstream of Kratie** to the border of Vietnam **and Laos** is quite small.



Key findings/results

Timeline of irrigated area for wet and dry season



	Cambodia	Lao PDR	Thailand	Viet Nam	Total LMB
EDS2007	504,245	209,116	809,671	3,348,398	4,871,430
DFS2020	778,499	309,068	1,582,554	3,244,017	5,914,138
PDS2040	1,156,025	597,893	2,215,274	3,188,660	7,157,852
PDS2040-High	1,156,025	717,265	2,396,711	3,188,660	7,458,661

- **Cambodia and Laos:** increase 50% by 2020 and triples by 2040
- **Thailand:** doubles in 2020 and in PDS2040, will increase 50% of 2020 *in case that the Mekong irrigation water diversion (Ph.1) is fully operated.*
- **Viet Nam:** slightly decreasing trend (3-5% compared to 2007)

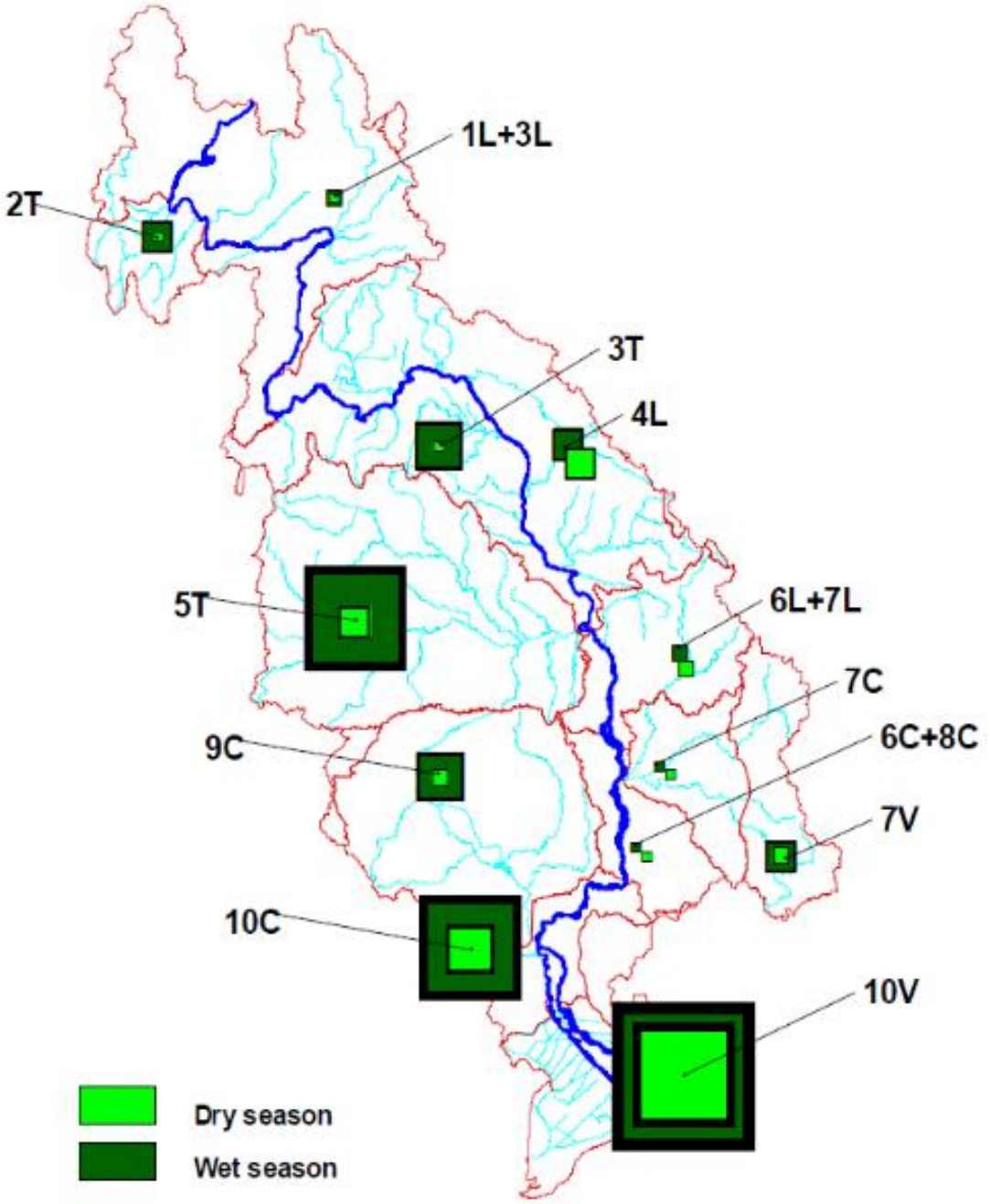
Irrigation distribution

Wet season:

- Total irrigated area is similar in **Cambodia, Thailand, Vietnam,** **but much smaller in Laos.**
- **Cambodia: In the highest flood months (Sep – Nov), around 5-10% of the total irrigated areas.**

Dry season:

- The **most developed in the Vietnam Delta** as it has abundance of *water available*, *branching natural river channels* and *well-developed irrigation channel network*.
- **Thailand** has relatively **small** irrigated area due to **dryer climate and poorer water availability.**

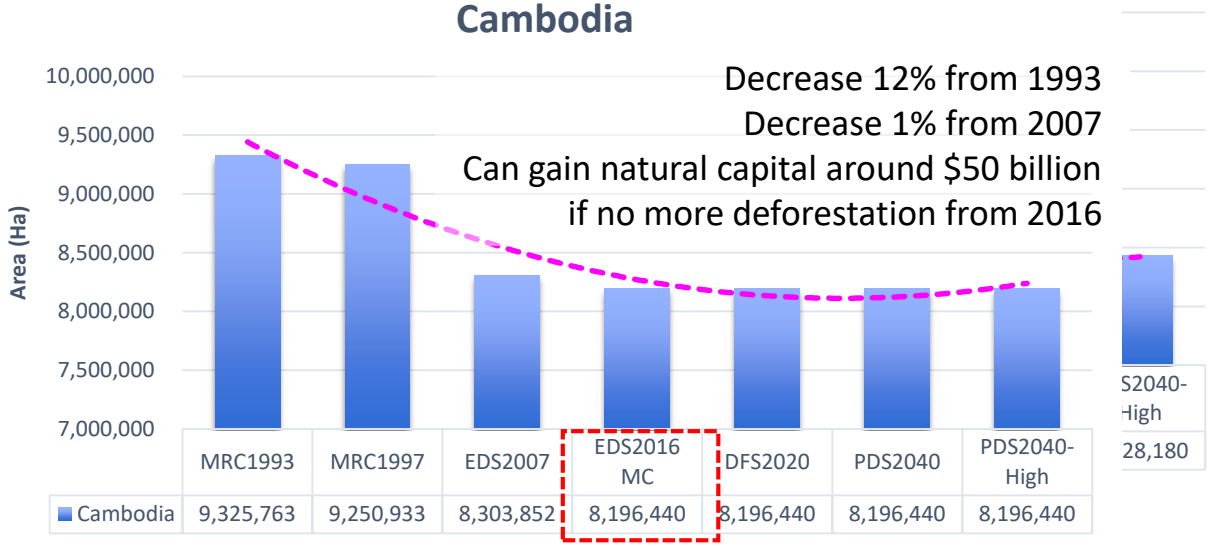


TIMELINES OF ALU AREA DEVELOPMENT

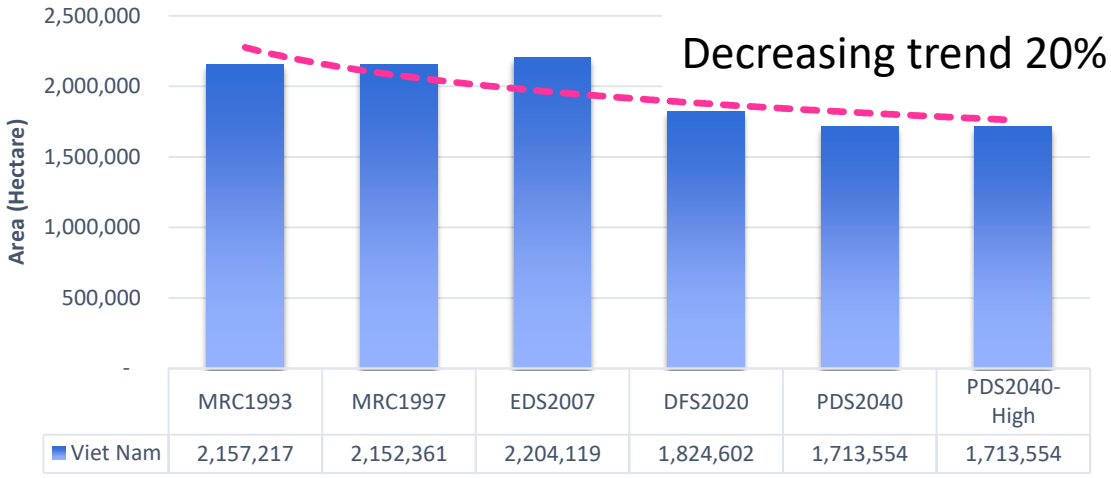
(FOREST AND AGRICULTURE)

Key findings/results

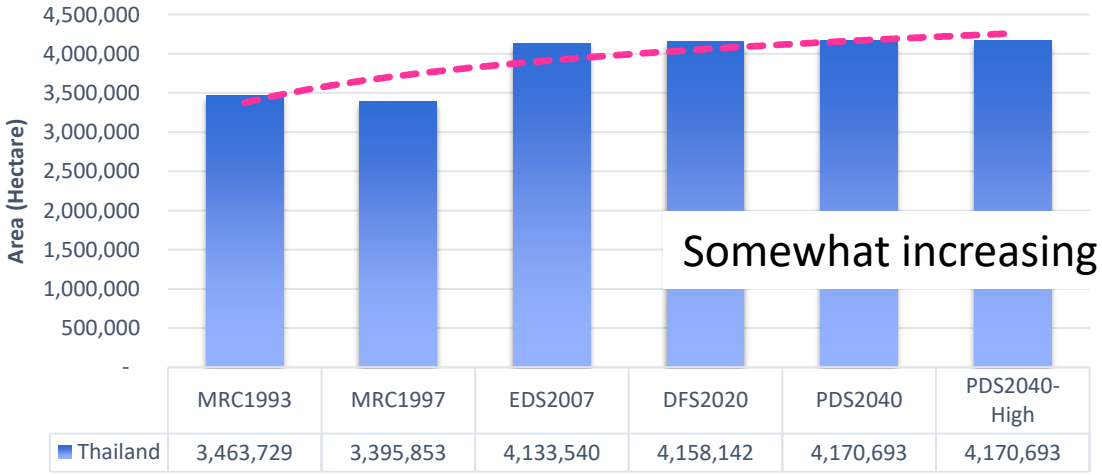
Cambodia



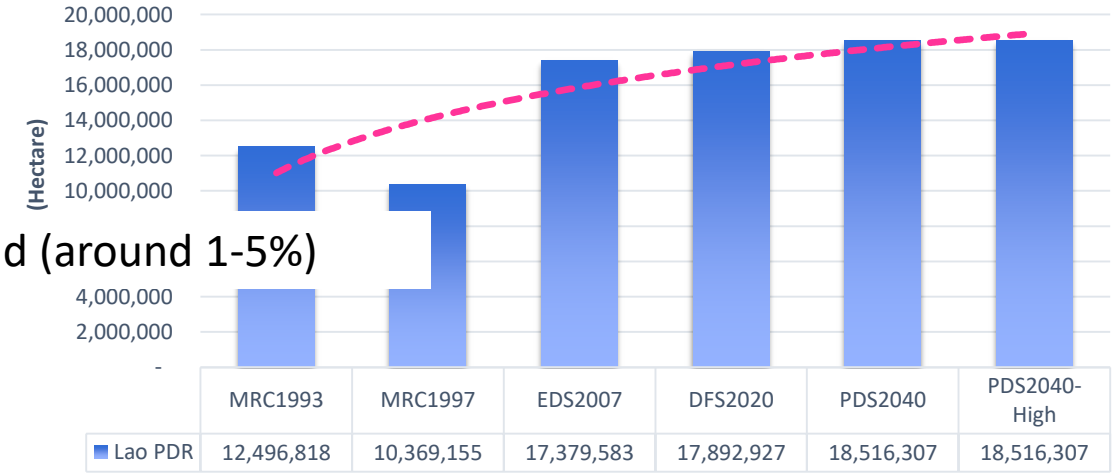
Forest-Viet Nam



Forest-Thailand

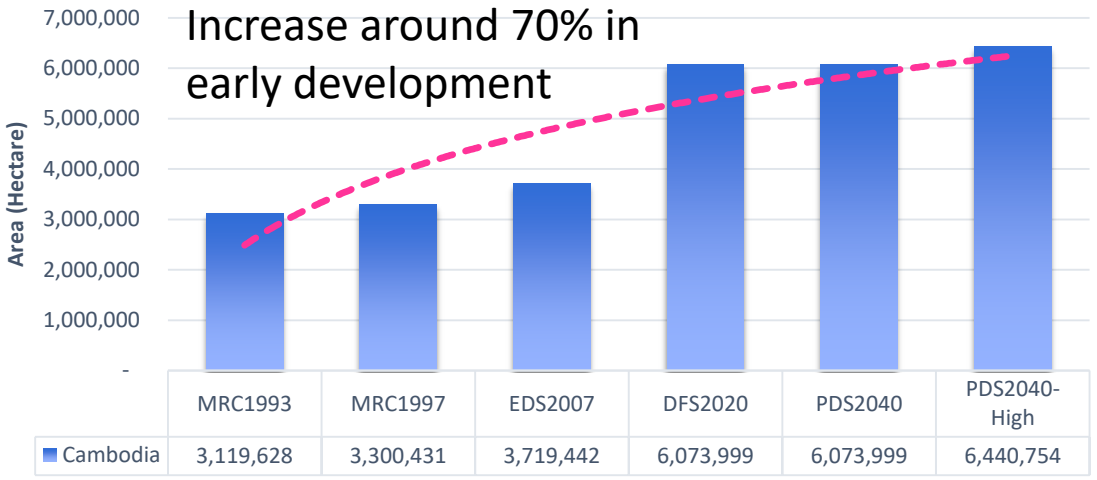


Forest-Lao PDR



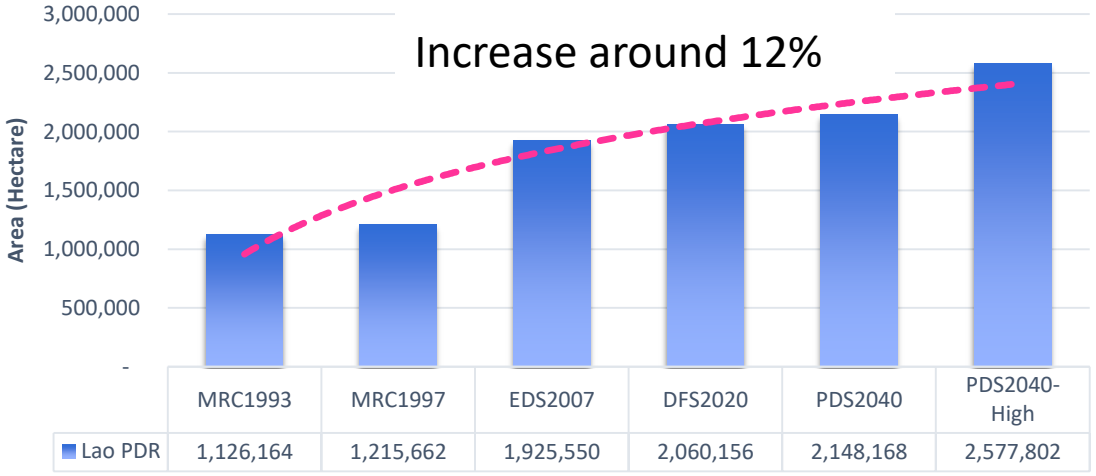
Key findings/results

Agriculture-Cambodia



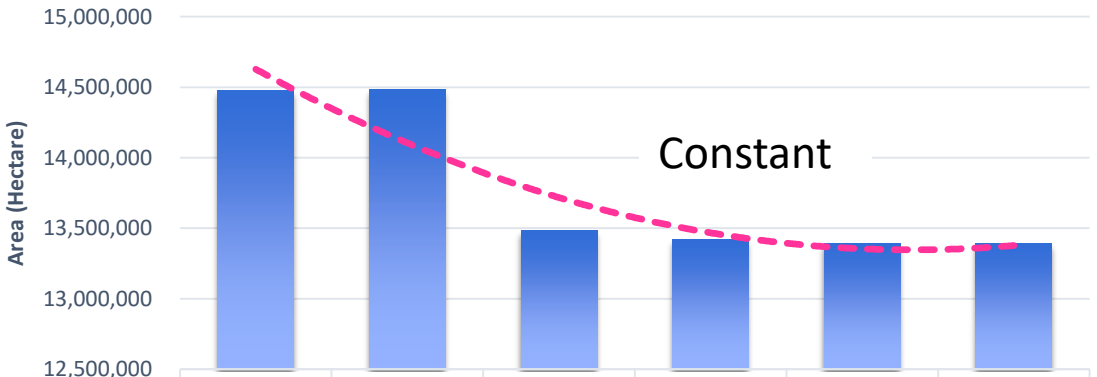
	MRC1993	MRC1997	EDS2007	DFS2020	PDS2040	PDS2040-High
Cambodia	3,119,628	3,300,431	3,719,442	6,073,999	6,073,999	6,440,754

Agriculture-Lao PDR



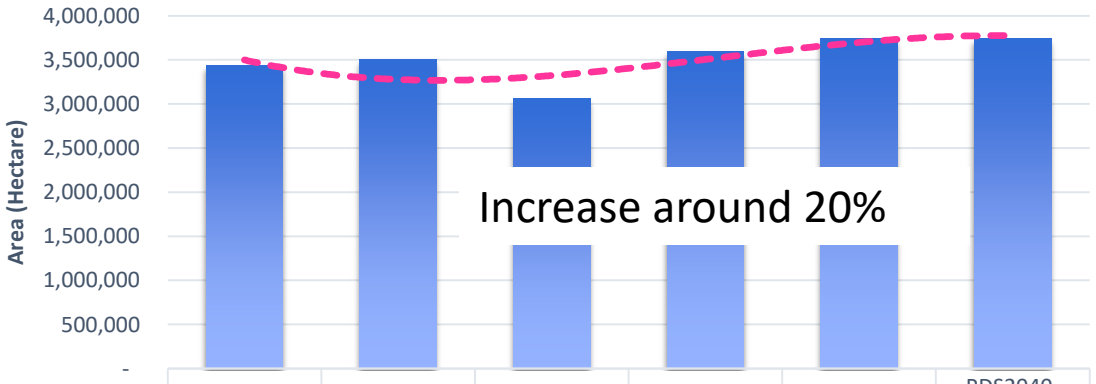
	MRC1993	MRC1997	EDS2007	DFS2020	PDS2040	PDS2040-High
Lao PDR	1,126,164	1,215,662	1,925,550	2,060,156	2,148,168	2,577,802

Agriculture-Thailand



	MRC1993	MRC1997	EDS2007	DFS2020	PDS2040	PDS2040-High
Thailand	14,474,804	14,483,036	13,484,104	13,423,818	13,391,904	13,391,904

Agriculture-Viet Nam



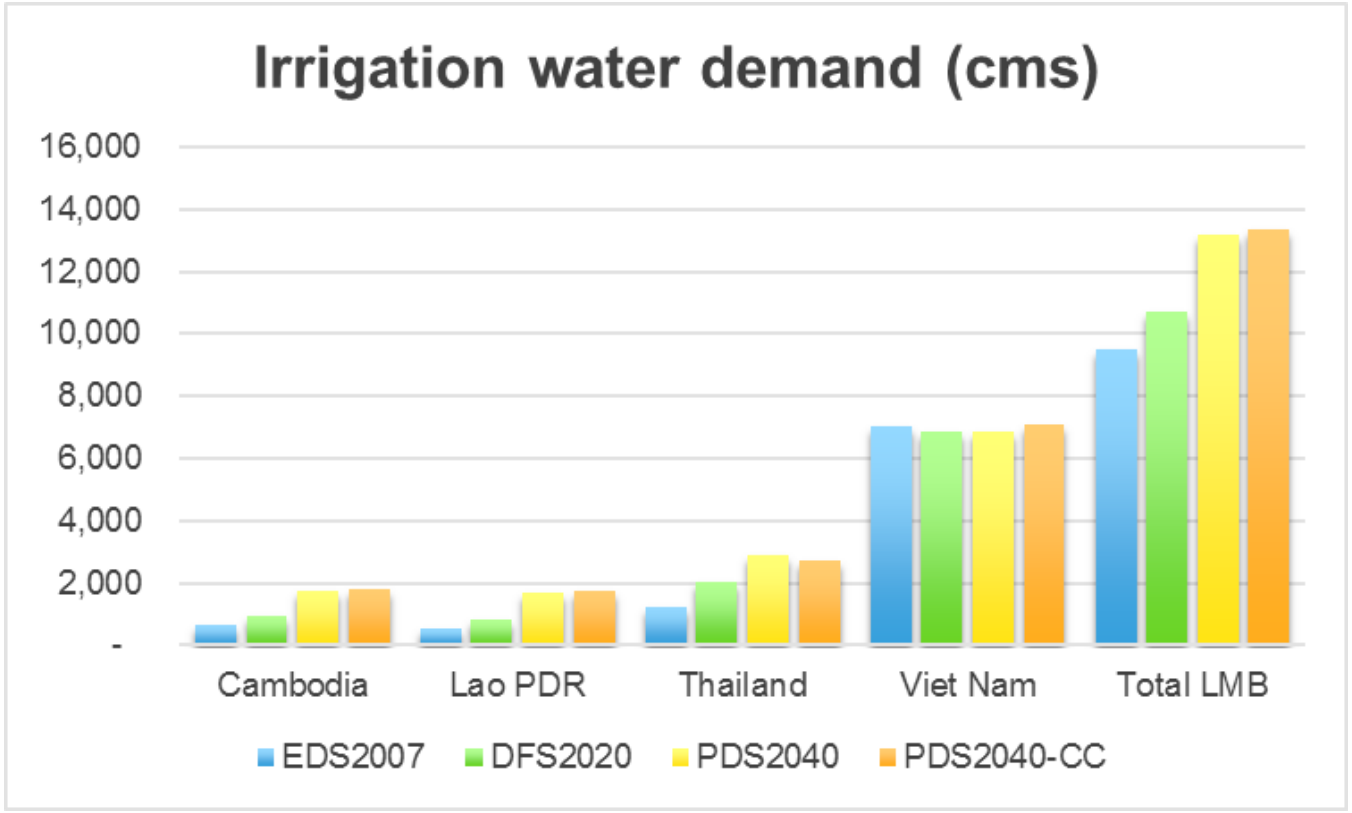
	MRC1993	MRC1997	EDS2007	DFS2020	PDS2040	PDS2040-High
Viet Nam	3,436,587	3,499,808	3,057,032	3,590,710	3,745,498	3,745,498

IRRIGATION WATER DEMAND

Key findings/results

Irrigation water demand

	Scenario : EDS 2007_M1			Scenario : Dev 2020_M2			Scenario : Dev 2040_M3			Scenario : Dev 2040_M3CC		
Country	Wet (May -Oct)	Dry (Nov - Apr)	Annual	Wet (May -Oct)	Dry (Nov - Apr)	Annual	Wet (May -Oct)	Dry (Nov - Apr)	Annual	Wet (May -Oct)	Dry (Nov - Apr)	Annual
Cambodia	160	525	685	251	685	936	638	1,104	1,742	668	1,117	1,785
Laos	187	367	554	271	587	859	511	1,211	1,721	495	1,282	1,777
Thailand	838	369	1,208	1,383	659	2,042	1,801	1,073	2,873	1,608	1,123	2,731
Vietnam	974	6,061	7,035	922	5,957	6,879	962	5,906	6,868	966	6,118	7,085
Total	2,159	7,323	9,482	2,827	7,889	10,716	3,912	9,294	13,205	3,737	9,641	13,378



Key findings/results

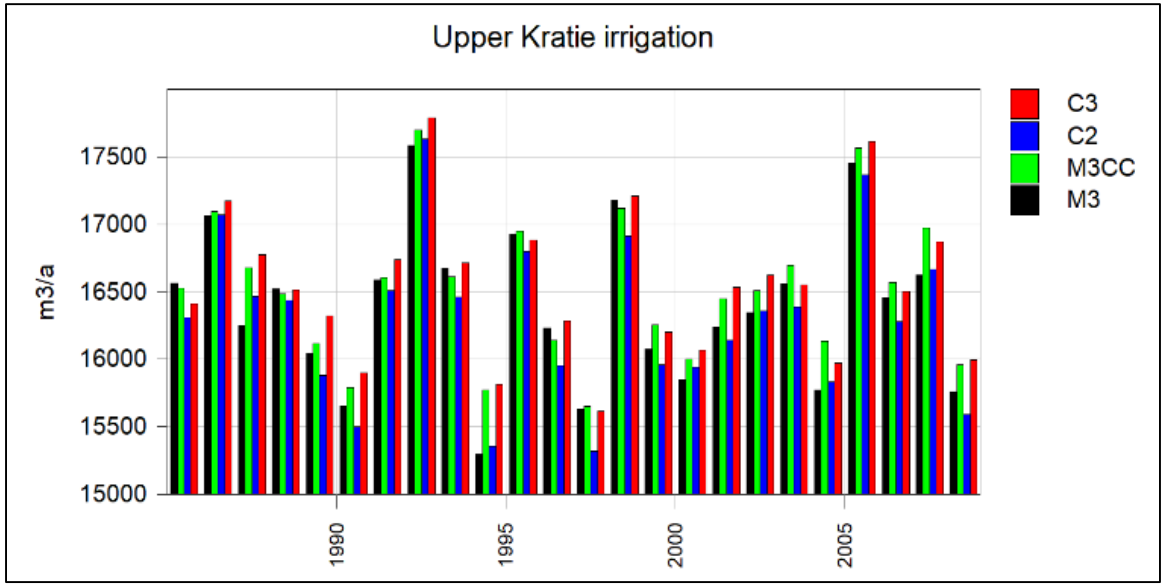
Irrigation water demand and availability

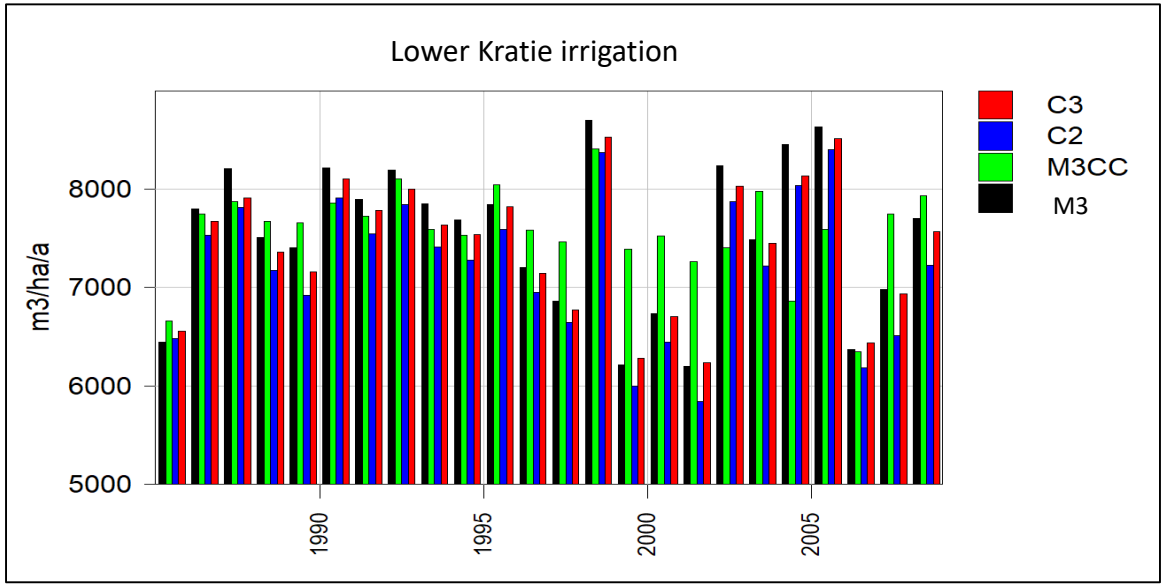
- **Cambodia: increases 40%** by 2020 and almost **triples** in 2040
- **Lao PDR and Thailand:** also has increasing. Around **60-70% increase** in 2020 and **triples** in 2040.
- **Viet Nam: Slightly decreasing** trend of the demand.
- High irrigation demand is during **Nov-Feb** (**4-5 times higher** demand **in dry season**)
- **Climate change** has affected on more irrigation water demand **2-5% change** of water demand in 2040 with CC.
- Due to the hydropower development, **average *dry season* water availability will improve** in the mainstream.
- ***Wet season*** water availability will **decrease slightly** in the mainstream but this has small impact on water security.

Key findings/results

Irrigation water demand

- **The climate change scenarios don't have large impact on average irrigation demands** in the **upper Kratie** compared to inter-annual demand variation.
- **M3CC** (more seasonal) and **C3** (drier condition) **increase** irrigation demand **max 400 m^3/ha**.
- **C2** (more wet) **decreases** irrigation demand **max 300 m^3 /ha**.

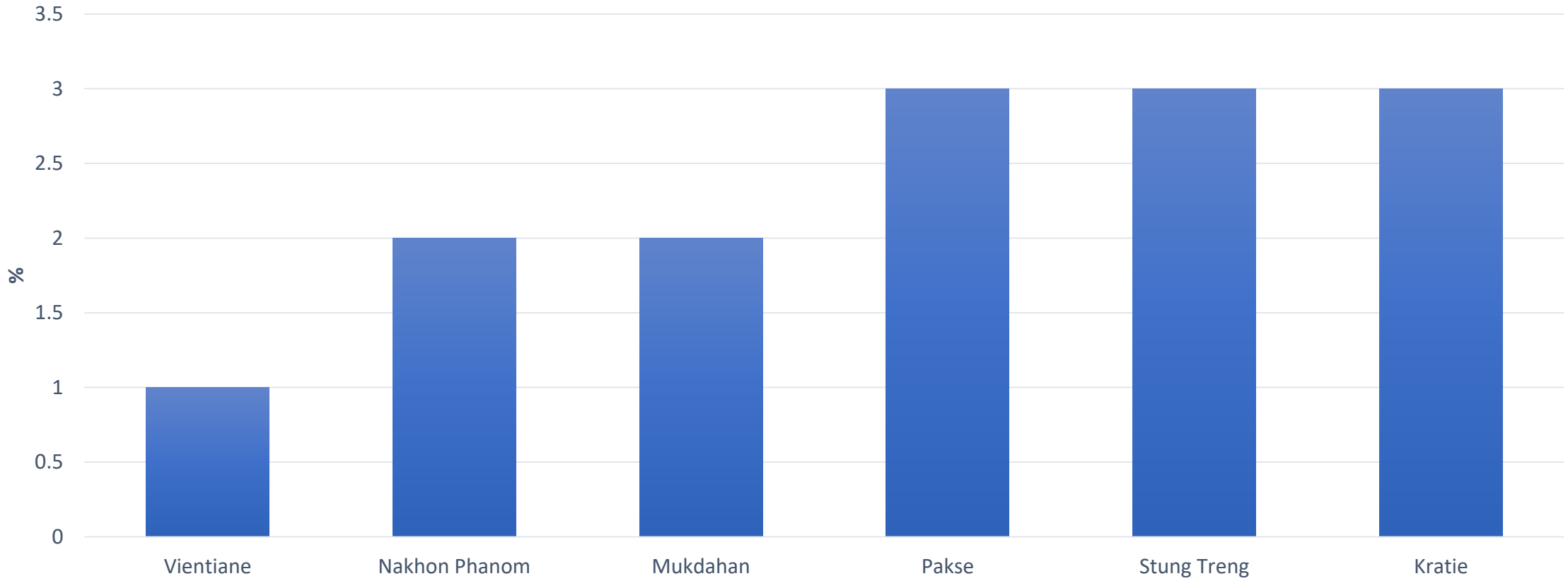




IRRIGATION IMPACTS ON FLOW AND SEDIMENT

I2 scenario impact on flow

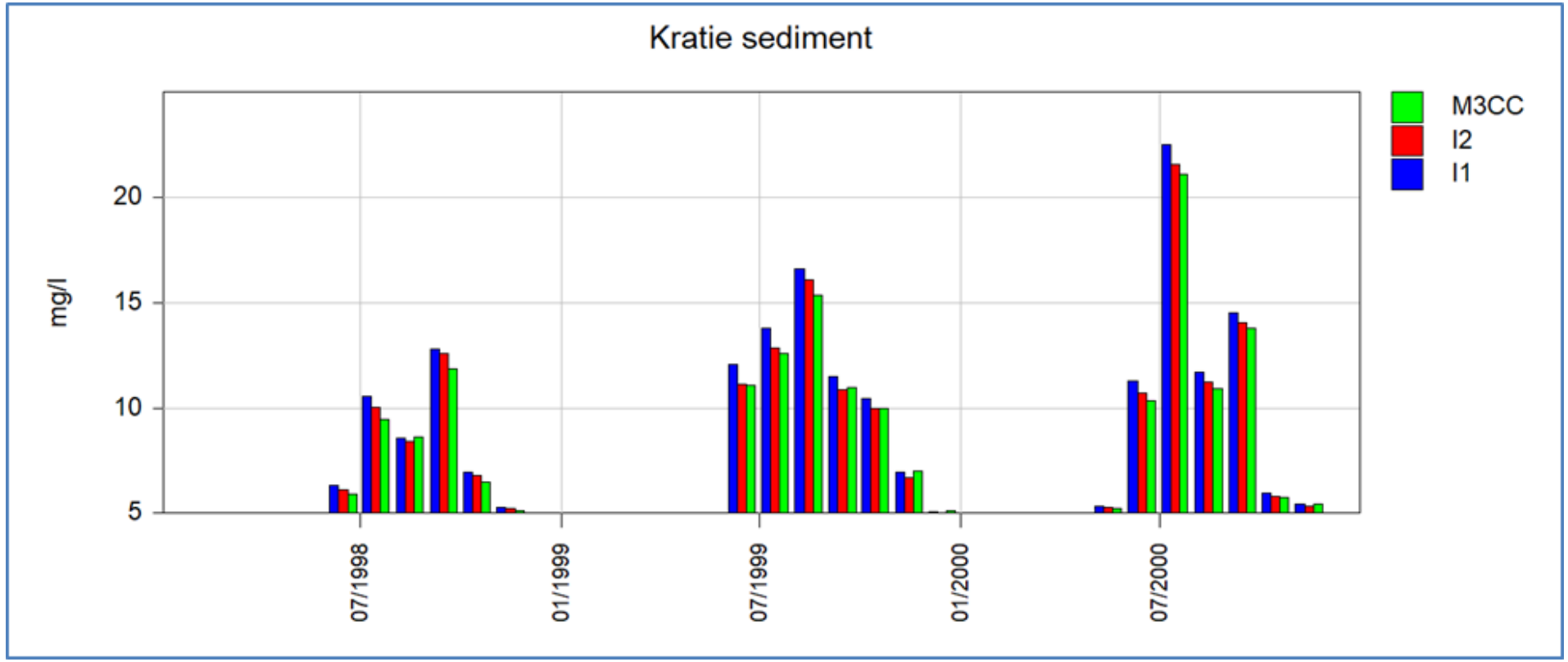
- Irrigation impact on **wet season flow** is **very small.**
- Difference between the M3CC and I2 scenarios is shown in the graph; it shows **small increase in dry season flow**



Key findings/results

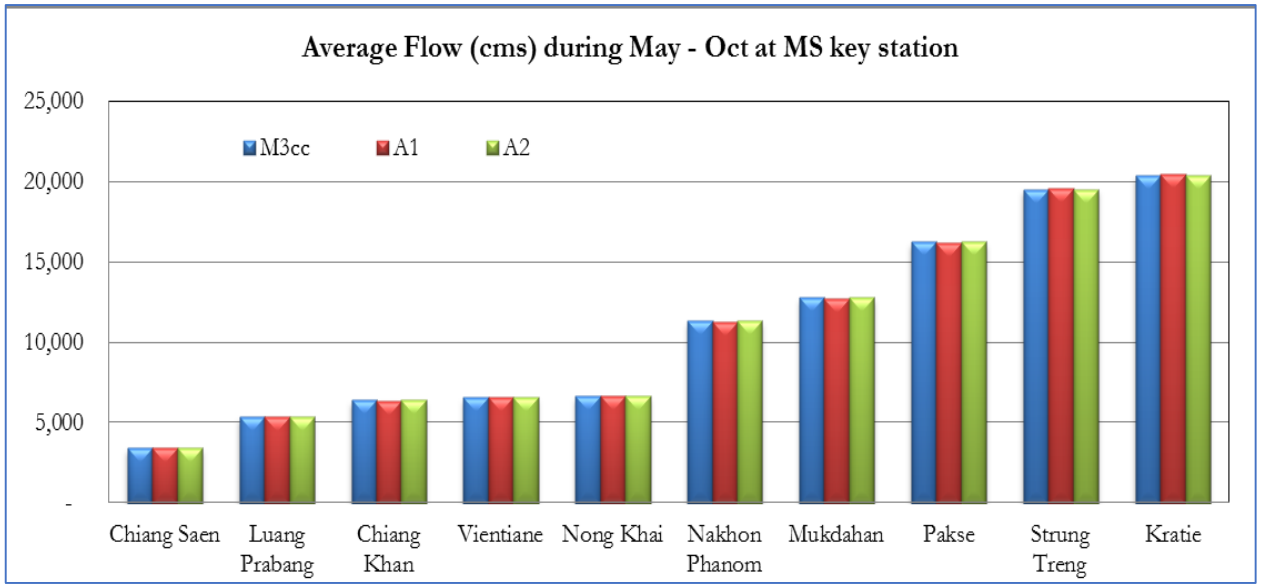
Sediment

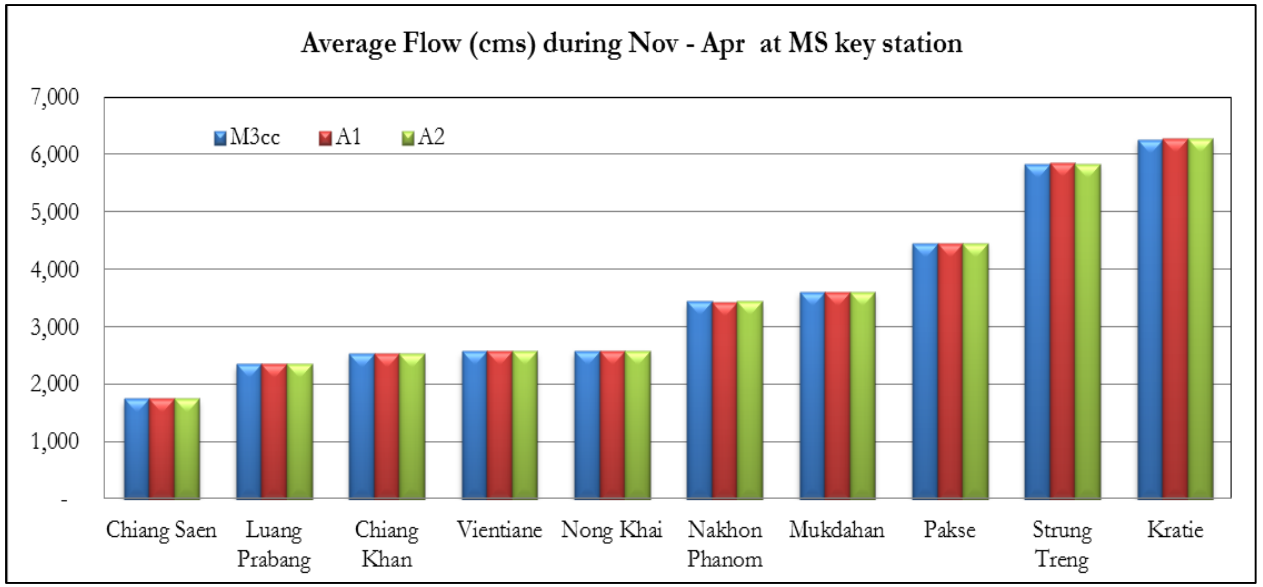
- **Irrigation slightly decreases sediment loads** as can be seen from the graph below showing M3CC monthly average concentration M3CC compared to irrigation development at baseline (I1) and intensive irrigation (I2)



ALU SCENARIO IMPACTS ON FLOW AND SEDIMENT

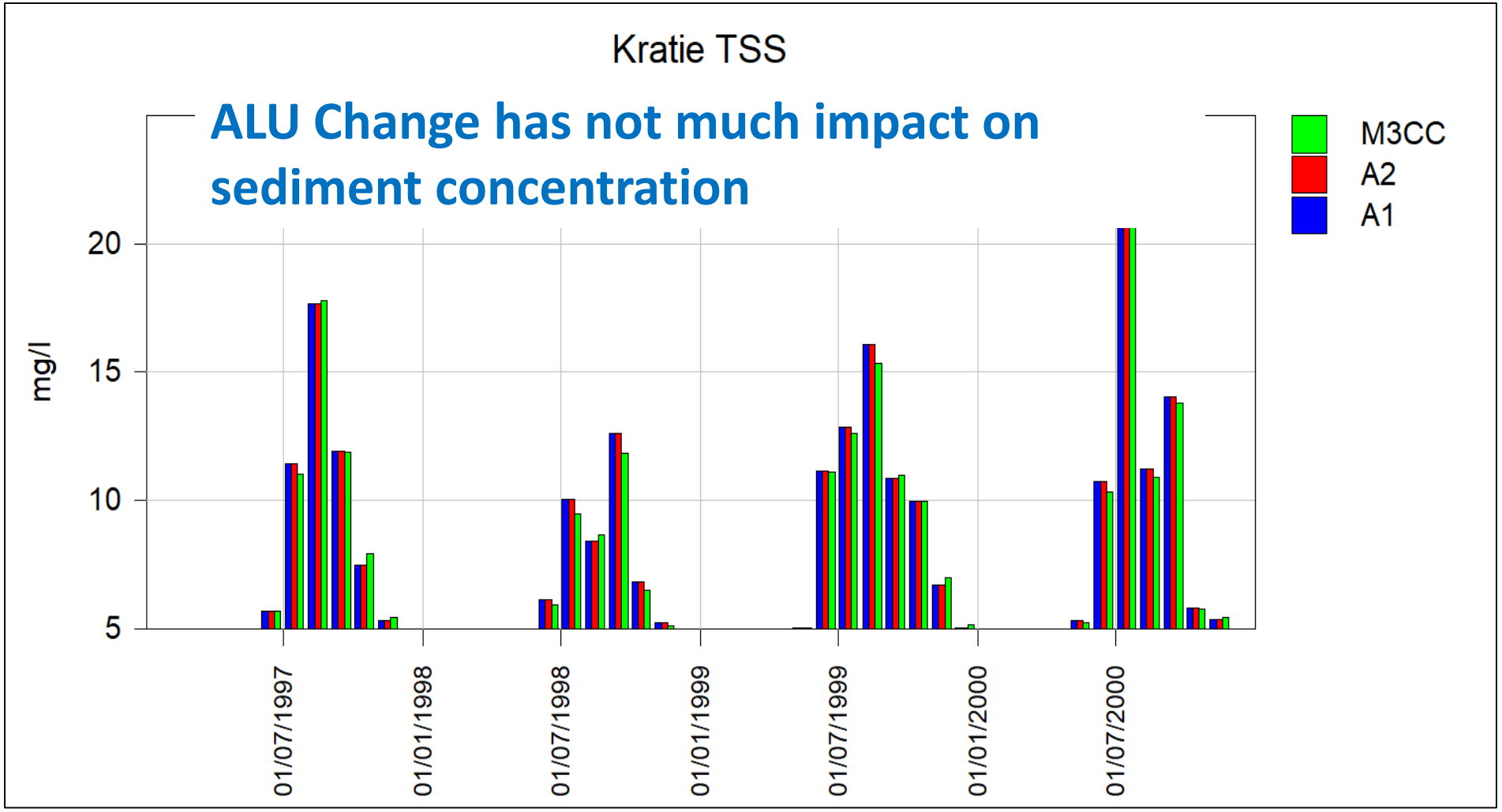
Flow



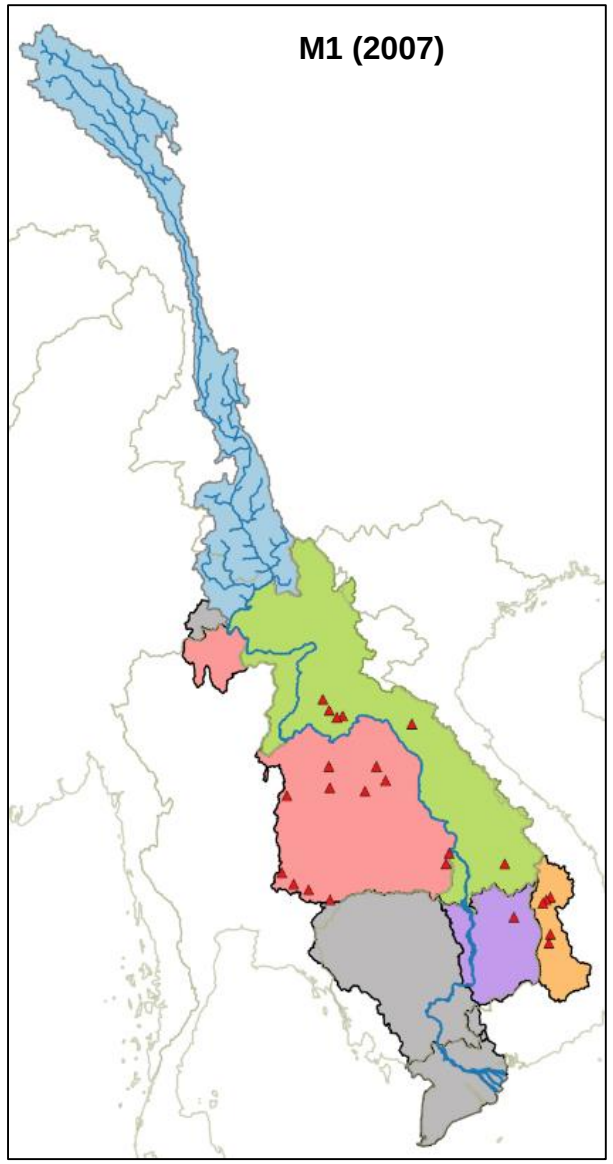


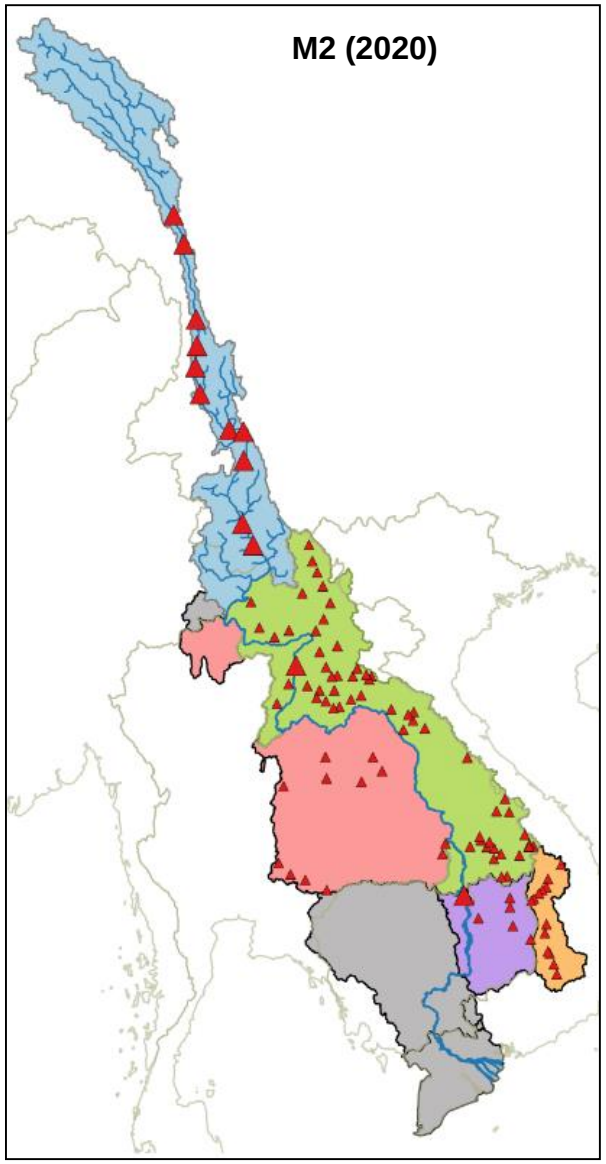
- From sub-scenario results, the **expansion of agricultural areas**, focusing on rainfed rice areas, **and decrease of forest areas** have **small impact on flow changes**, which are slightly changed **(0.0 – 0.5%)**
- **Other developments induce more impacts than ALU sector.**

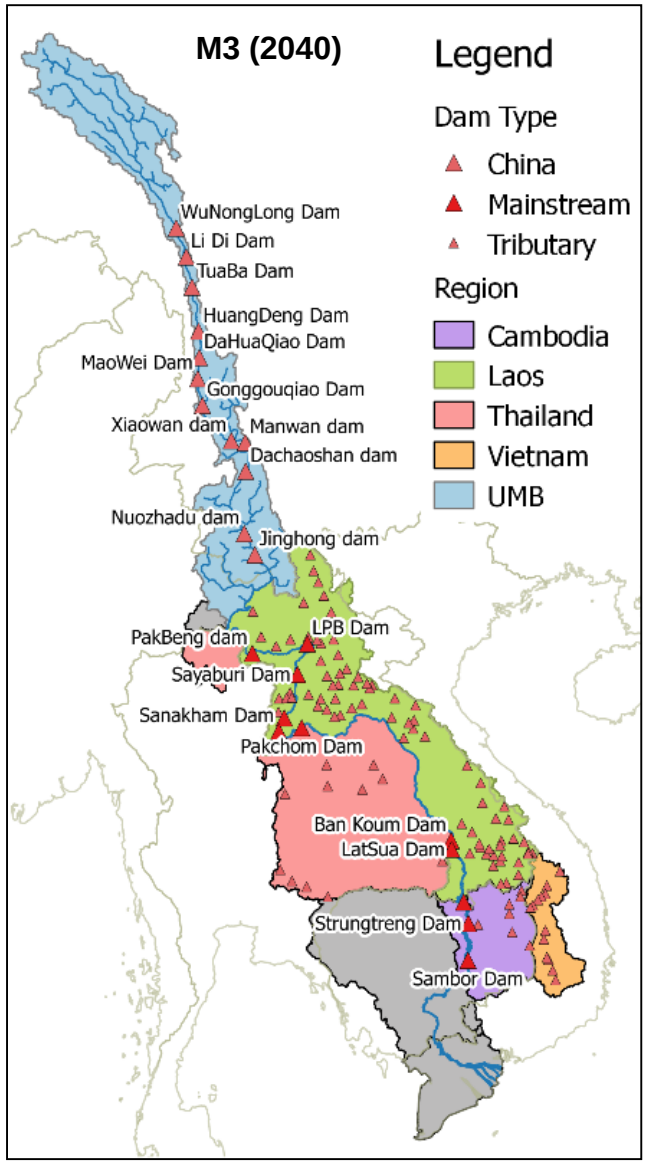
ALU scenario impacts on monthly average sediment concentration



SCENARIOS DEVELOPMENT IMPACT ON RICE PRODUCTION







Hydropower reservoir locations in the Mekong Basin for the 2007, 2020 and 2040 scenarios.

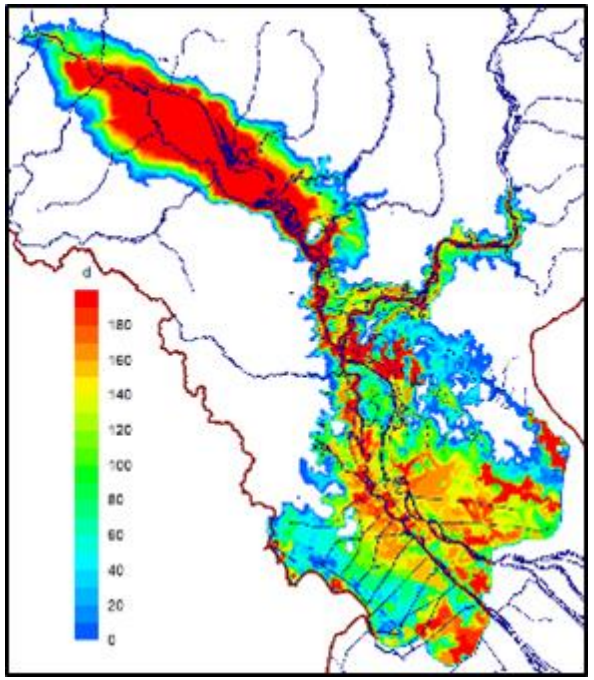
Key findings/results

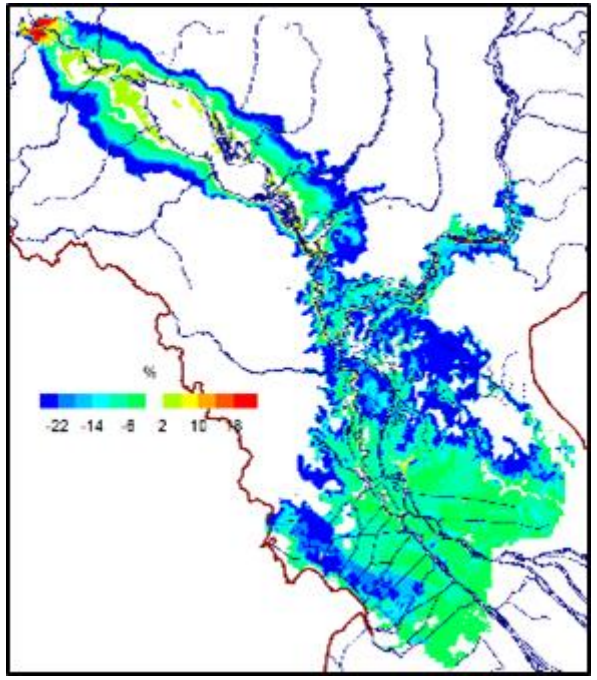
Flooding

- **Flood duration** **decreases** in the future development.
- Hydropower development reduces flood peaks and extreme flood events

Average flood duration

Baseline ***2040***



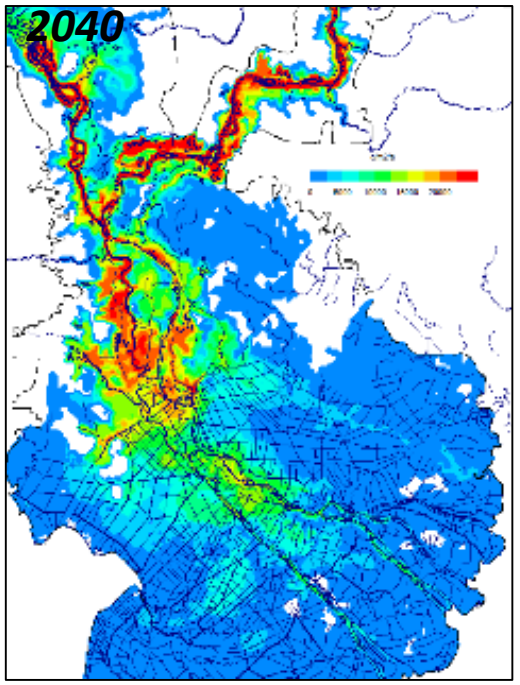


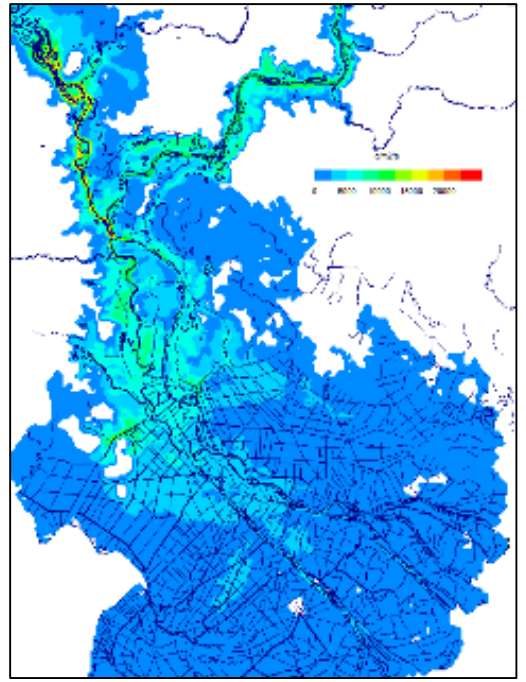
Sedimentation

- **Sedimentation is reduced** in the M2 and M3 scenarios.
- In M2 sedimentation is third of the baseline and in M3 sedimentation is one tenth of that in M2.

BL

2040

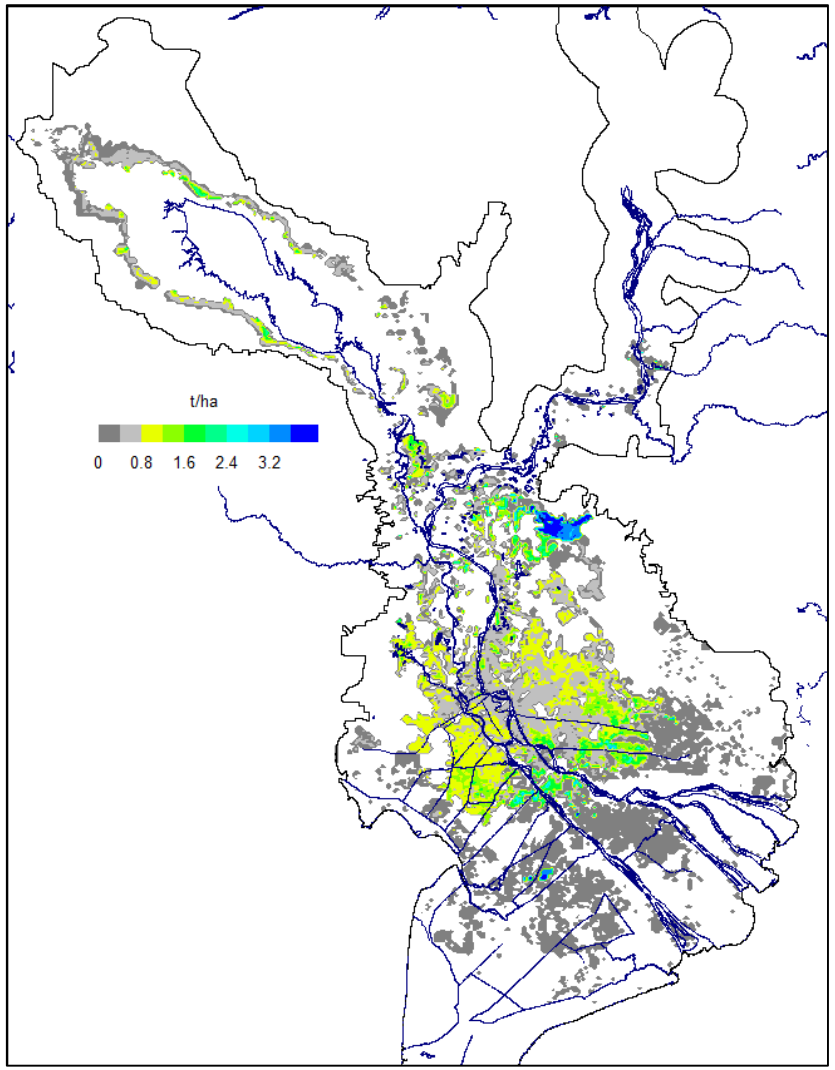




IRRIGATED RICE PRODUCTION

Key findings/results

Flood impact on irrigated rice yields



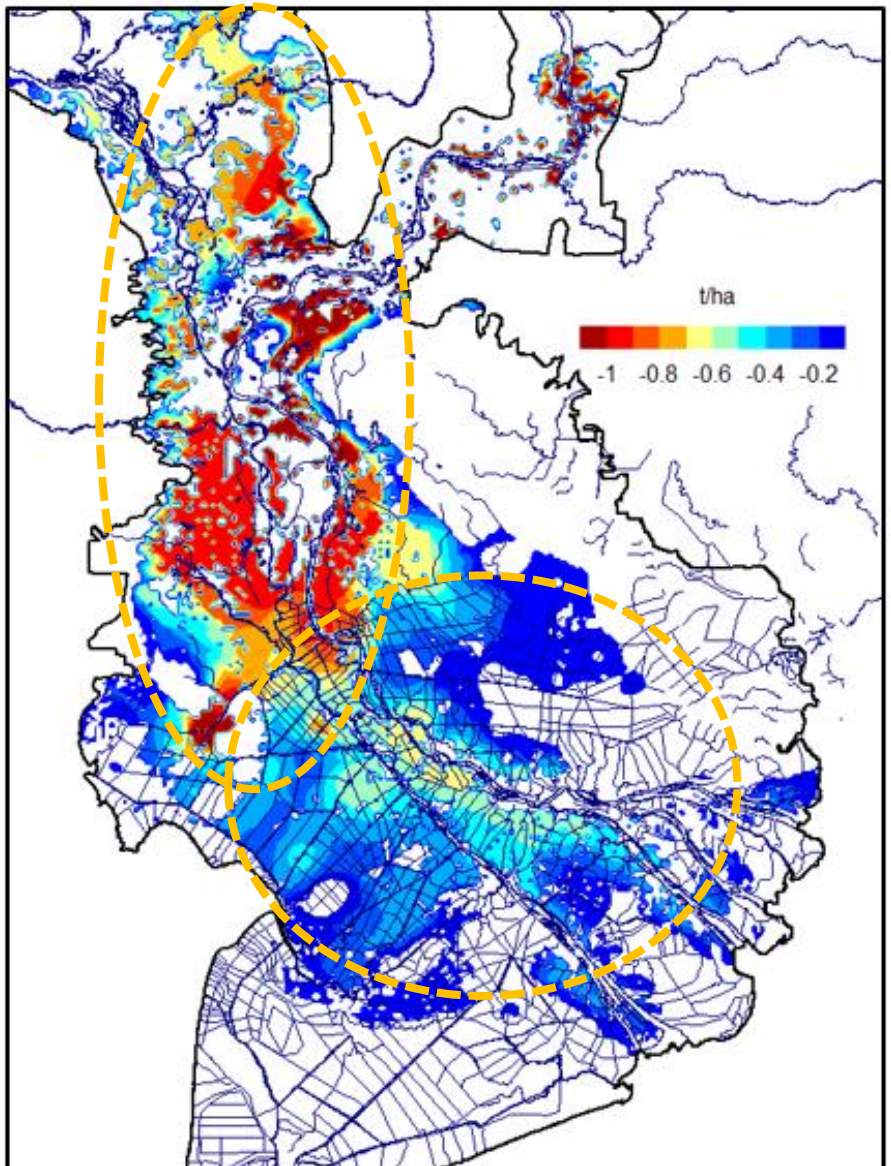
Rice planted mid-June:
Yield increase in the M3 scenario.

- Flooding is beneficial for rice production in providing **fertile soil** to paddies, **flushing harmful substance** from soils and **recharging soil water**.
- **On the other hand** too much flooding can **slow down rice growth or damage it** through long submersion.
- **Hydropower development** in M3 and other scenarios **reduces flooding duration and flood peaks, and increases yields for wet season rice**.

Remarks: example of figures showing only in the lower part for clear visual for presentation, but the model applied for the assessment areas

Key findings/results

Sediment impact on irrigated rice production

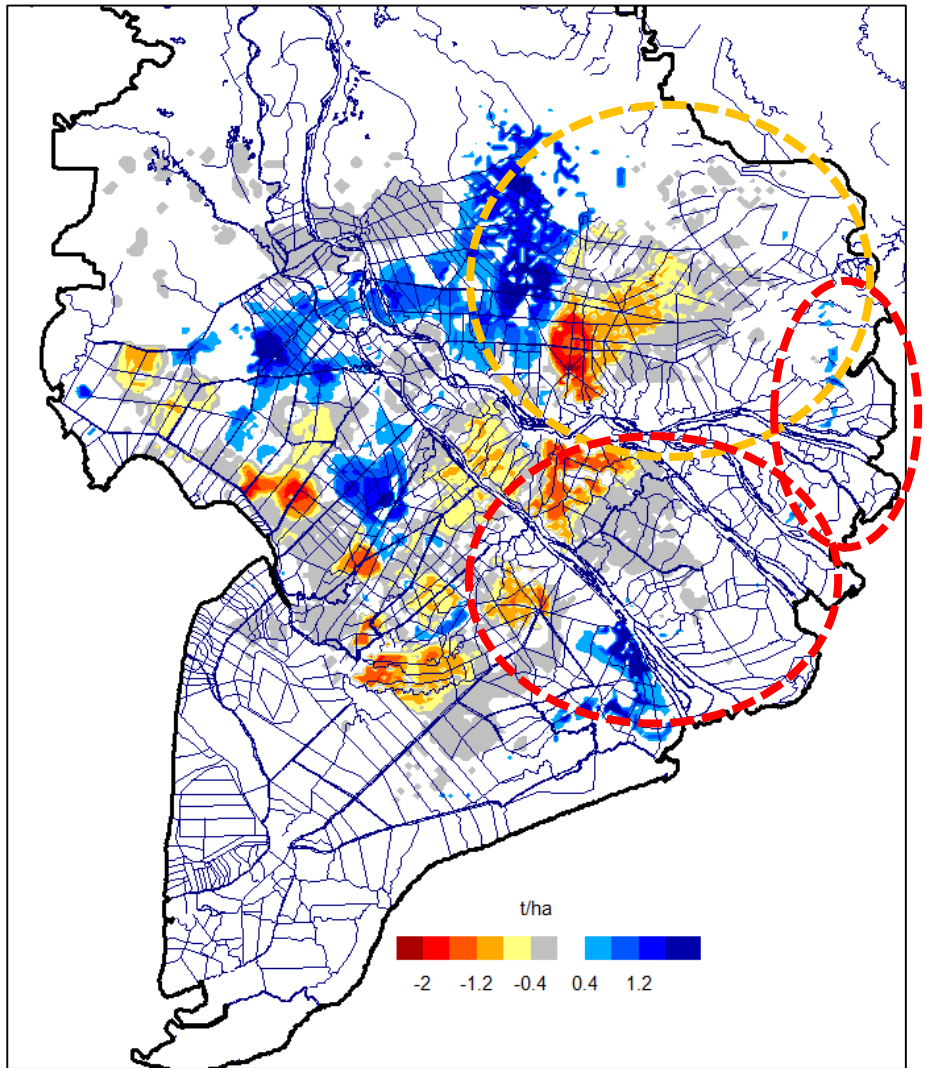


Decrease of rice production in scenario M3.
(No flooding impact included)

- ***Near*** the Mekong ***mainstream*** where sediment loads and sedimentation are largest, **crop yields are decreased about 20%.**
- Further ***out from the mainstream*** crop yield **decrease is about 5% – 10%.**

Key findings/results

Future development impact on irrigated rice production

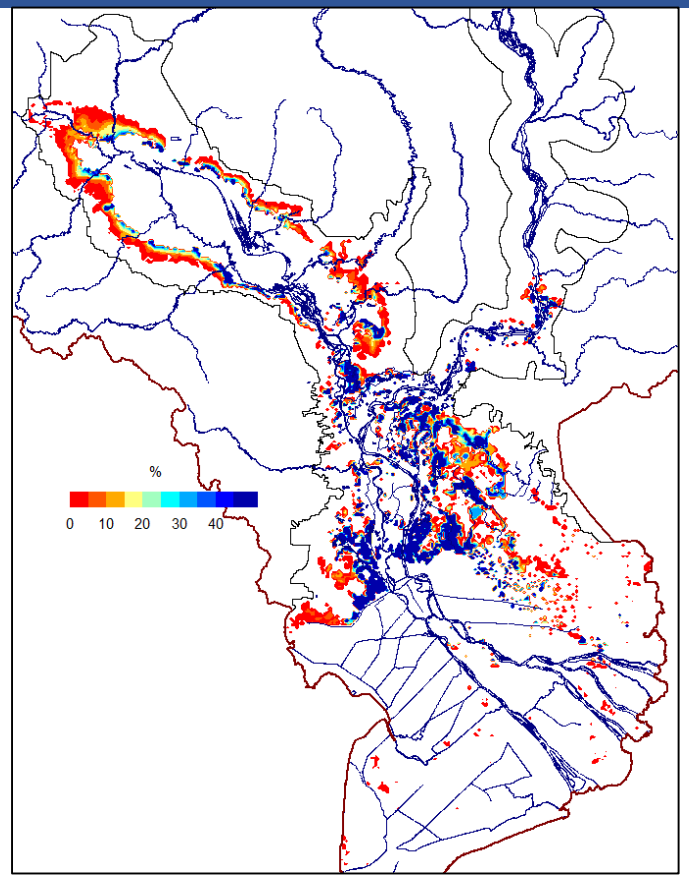


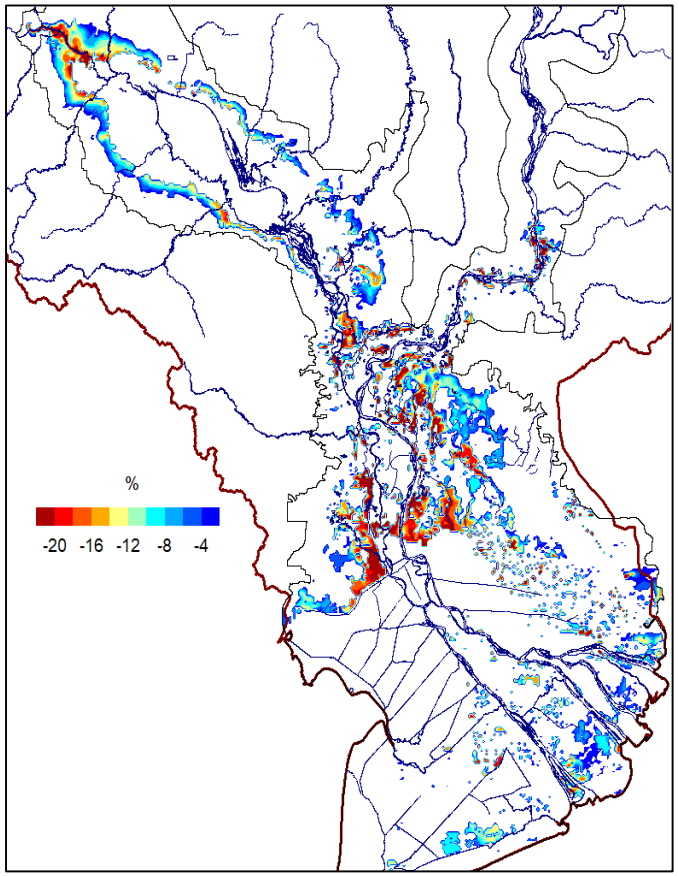
Irrigated rice production change in M3 scenario

- Salinity intrusion **changes due to hydropower (flow), sea level rise and water regulation (more dykes and gates with operation for flood protection).**
- Due to **increased dry season flow** and **decreased salinity intrusion**, there is **small increase in dry season rice** production in number of areas.
- Some small areas experience **decrease of production** because of the **complexity of flow and in 2040 sea level rise.**

NON-IRRIGATED RICE PRODUCTION

Key Findings





2040 scenario reduced flooding

- **Increases yields 0%–50%** compared to the baseline for rain-fed rice planted mid-June

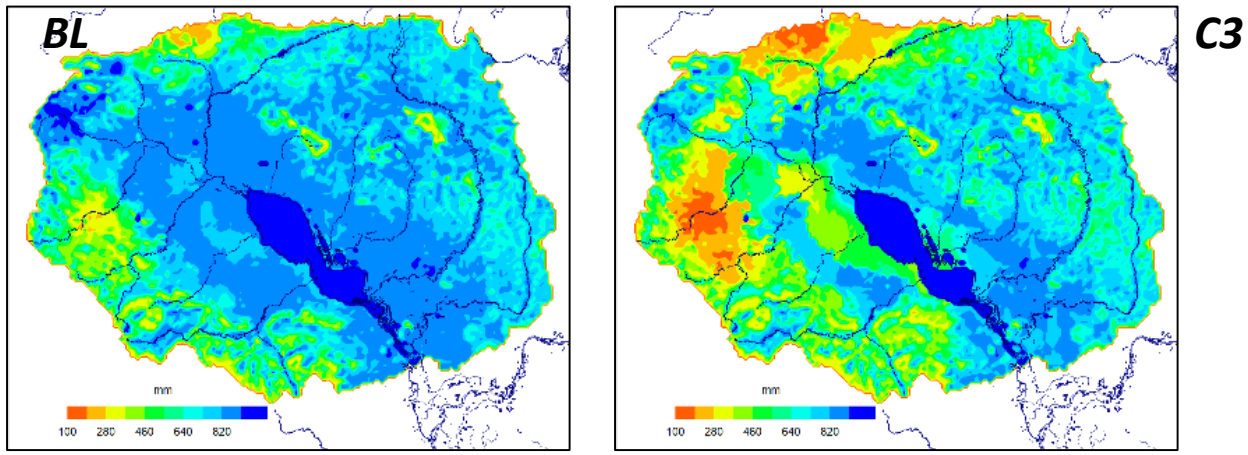
2040 scenario reduced alluvium input

- **The non-irrigated rice yields can be reduced up to 20%** near the Mekong.
- This loss can be compensated by fertilization and soil management.

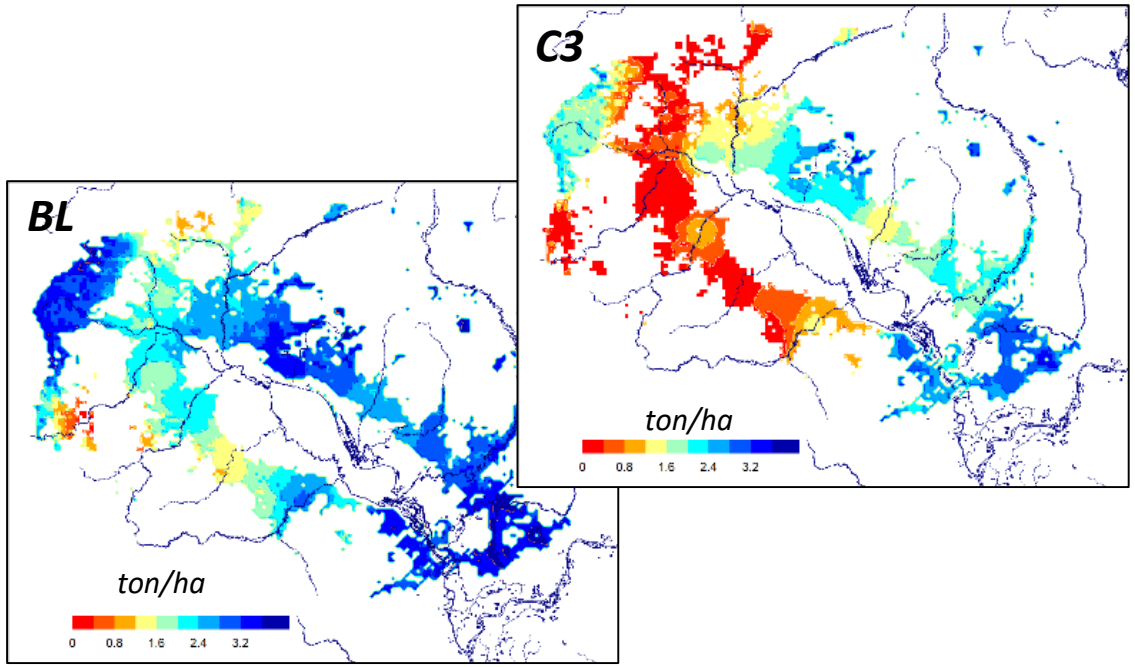
CLIMATE CHANGE IMPACTS

Tonle Sap CC impacts on wet rice production

- Special focus is on **scenario C3.**
- Decreased rainfall, hotter temperatures and increased evaporation **affect the water security in the Tonle Sap watershed.**
- **Dry season** model soil layer (0.2 m – 3 m) **water content.**
- The soil in scenario C3 is **up to 50% drier than** in the baseline.



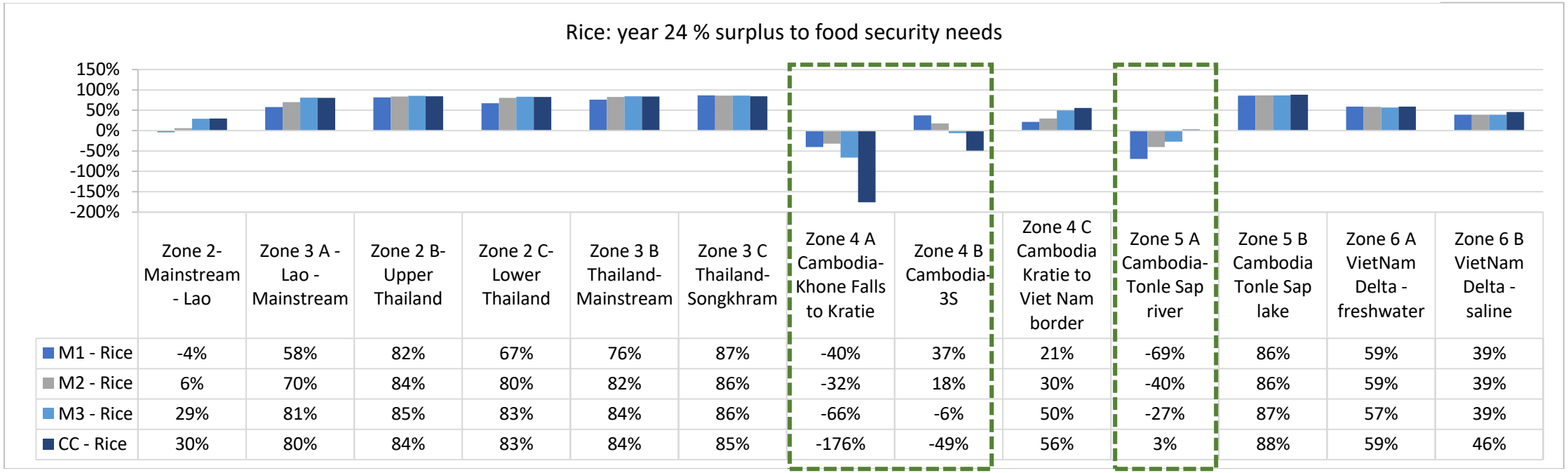
- The **production decrease** is pronounced and most critical **in the South-Western part** of the basin.



3. SOCIO-ECONOMIC, MACRO-ECONOMIC AND ECOLOGICAL FINDINGS

Socio-economic key findings

- **Expansion of agricultural areas + irrigation** capacity can **increase rice production**.



	Zone 2- Mainstream - Lao	Zone 3 A - Lao - Mainstream	Zone 2 B- Upper Thailand	Zone 2 C- Lower Thailand	Zone 3 B Thailand- Mainstream	Zone 3 C Thailand- Songkhram	Zone 4 A Cambodia- Khone Falls to Kratie	Zone 4 B Cambodia- 3S	Zone 4 C Cambodia Kratie to Viet Nam border	Zone 5 A Cambodia- Tonle Sap river	Zone 5 B Cambodia Tonle Sap lake	Zone 6 A VietNam Delta - freshwater	Zone 6 B VietNam Delta - saline
M1 - Rice	-4%	58%	82%	67%	76%	87%	-40%	37%	21%	-69%	86%	59%	39%
M2 - Rice	6%	70%	84%	80%	82%	86%	-32%	18%	30%	-40%	86%	59%	39%
M3 - Rice	29%	81%	85%	83%	84%	86%	-66%	-6%	50%	-27%	87%	57%	39%
CC - Rice	30%	80%	84%	83%	84%	85%	-176%	-49%	56%	3%	88%	59%	46%

- *Considering the food surplus*, **every country can meet the food security needs** to serve population growth in the future.
- The food security **need awareness** in the *Kratie to the Vietnam border, the Khone Falls and 3S zones*, due to the **sensitivity of the areas to climate change conditions** for both flood and drought.

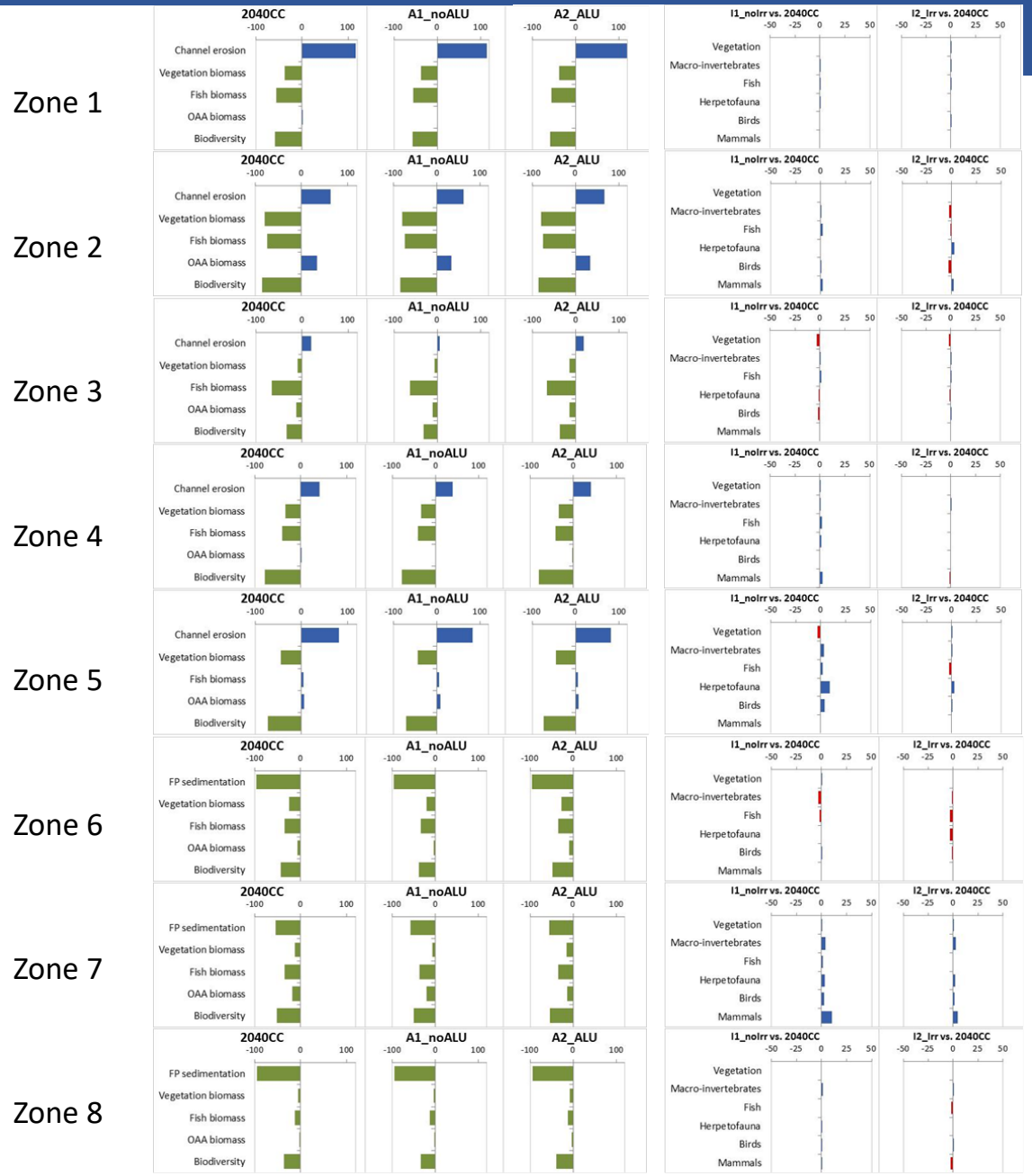
Macro-economic key findings

	A1 Difference		A2 Difference		I1 Difference		I2 Difference	
	B$	%	B$	%	B$	%	B$	%
Cambodia	-$70.0	-54.1%	+10.1	+7.8%	-$7.5	-5.8%	0.0	0.0%
Lao PDR	-$5.9	-12.3%	+15.3	+31.8%	-$5.9	-12.2%	+0.2	+0.5%
Thailand	-$9.9	-6.3%	0.0	0.0%	-$9.6	-6.1%	+2.4	+1.5%
Viet Nam	-$25.3	-20.2%	0.0	0.0%	$3.1	2.5%	0.0	0.0%
LMB	-$111.2	-24.1%	+25.4	+5.5%	-$19.8	-4.3%	+2.7	+0.6%

Economic benefit changes in % of agriculture sector income compared to M3CC

- **Irrigation expansion is expected to bring significant economic benefits to Cambodia, Lao PDR and Thailand.**
- For Vietnam, **avoiding these investments** translates into a gain, which suggests that the costs of irrigation expansion are likely to outweigh the economic benefits by $3.1 billion in net present value.
- Further gains beyond the M3 scenario (I2) seem to be uncertain, except for **Thailand that shows potential for further increasing economic**. ***However, these results are highly sensitive to the assumptions on costs for installing new irrigation areas.***
- **Additional agricultural expansion would largely eventuate in Lao PDR and Cambodia** and would facilitate an **increase in net present value** of $15.3 billion and $10.1 billion, respectively.
- The **agriculture sector-specific advantages can create a macro-economic barrier to economic growth due to the labour demands** that would not be available to ***secondary and tertiary sectors.***

Bio-Resources: Biological findings



- The effects of IRR and ALU sub-scenario **do not affect overall ecosystem health in the LMB.**
- **Other developments are the drivers of ecosystem change** predicted in the scenarios.
  - much of the riparian zone had already been **converted to agriculture by 2007**, and/or
  - the **effects of herbicide and pesticide use are not considered** and/or
  - **not distinguish the impacts of flood protection.**

4. Key conclusions

- *Hydropower development could reduce the risk of floods and droughts and contribute to enhanced agricultural productivity.*
- *Vietnam has higher irrigation sustainability than the other member countries. But salinity intrusion expands due to decreased Mekong flows and sea level rise, reducing rice production.*
- *Results show that drier climate change would reduce rice production in Cambodia, Lao PDR, and Thailand. Increased climate variability and sea level rise would reduce rice production in Vietnam.*
- *The agricultural sector is likely to cause slightly poorer ecosystem conditions. However, the cumulative effects of herbicides and pesticides on aquatic ecosystems need to be analysed.*

4. Key conclusions

- *The expansion of agricultural areas in combination with increased irrigation capacity would increase inter-annual reliability of agricultural production.*
- *For more benefit in terms of economic values, it is recommended to put investment in the increase and improve existing agriculture lands capacity and irrigation facilities, rehabilitation rather than expansion of irrigation and agricultural areas.*

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Thank you