8th Meeting of the Regional Technical Working Group
1-2 February 2010
Vang Vieng City, Lao PDR

Basin Development Plan Programme Phase 2

Environmental impacts of Basin Development Plan scenarios

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Recap of assessment methodology

Environmental objectives of the BDP

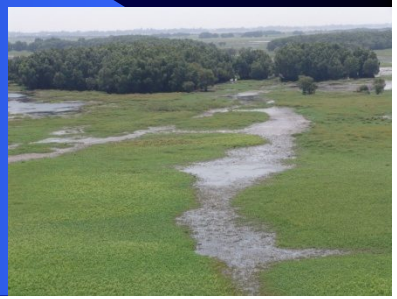
- Maintain water quality and acceptable flow conditions
- Maintain wetland productivity and ecosystem services
- Manage salinity intrusion the Mekong Delta
- Minimize channel effects on bank erosion
- Conservation of biodiversity

Primary Objectives	Assessment Criteria: Specific development objective	Issue	Indicator Description
1 Economic development	1.1 Increase irrigated agricultural production	Irrigable area, production tonnage and value	Incremental area
			Incremental crop production
			Net incremental economic value
	1.2 Increase hydropower production	Hydropower capacity, power generated and value	Incremental installed capacity
			Incremental power generated
			Net incremental economic value
	1.3 Improve navigation	River transport	Incremental navigable days by class
			Net incremental economic value
	1.4 Decrease damages by floods	Extent and duration of annual flooding by class	Average area flooded annually to max 0.5-0.9m depth
			Average area flooded annually > max 0.9m depth
			Incremental net economic value of flood damage
	1.5 Maintain productivity of fishery sector	Capture fisheries and aquaculture production	Incremental annual average capture fish availability
			Incremental annual average aquaculture production
			Net incremental economic value
		Impact of flow and sediment transport changes on deep pools	Sediment loads at specified locations on mainstream
			Water levels at specified locations on mainstream
			Net incremental economic values
2. Environmental protection (triple bottom line)	2.1 Maintain water quality and acceptable flow conditions	Water quality	Water quality incl. sediment in transport in mainstream
		Flow characteristics	Key flow characteristics (to be defined)
		Protection of forests around Tonle Sap	Forest flooded for specified depth duration at Tonle Sap
			Net incremental economic values
	2.2 Maintain wetland productivity and ecosystem services	Productivity of wetland ecosystems	Incremental wetlands with required depth-duration
			Net incremental economic value
	2.3 Manage salinity intrusion in the Mekong delta	Impact of salinity intrusion on land use potential	Area within delta within thresholds of salinity levels
			Net incremental economic value
	2.4 Minimize channel effects on bank erosion	River bank erosion	Incremental area at risk to erosion
			Vulnerability to bank erosion
			Net incremental economic values
	2.5 Conservation of biodiversity	Impacts of flow management changes on endangered species	Incremental area of suitable habitats
			Estimated number of species affected
			Incremental net economic value of habitat areas
3. Social development	3.1 Maintain livelihoods of vulnerable resource-users	health, food and income security	No. of people affected
			Severity of impact on health, food and income security
	3.4 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in:
			Agriculture
			Fisheries
			Water-related service industries
			Tourism
4 Equitable development	4.1 Ensure that all four LMB countries benefit from the development of water and related resources	Aggregate benefits by country	Summation of incremental net economic benefits
			Summary of non-quantifiable impacts

Ecosystem based approach

There are important/valuable ecosystems:

- River channels, Mekong and largest low gradient tributaries
  - Main river channels
  - Deep pools, rapids
  - Small islands and riverine sand bars
- Permanent and seasonally inundated floodplain wetlands
  - Seasonally inundated forest
  - Mashes, small pools and seasonal wetlands in the lowland plains
  - Inundated grasslands
  - Rice fields
- Delta formations and
- the Plain of Reeds
  - Lowland forests
  - Inundated grasslands
  - Mangroves
  - Rice fields

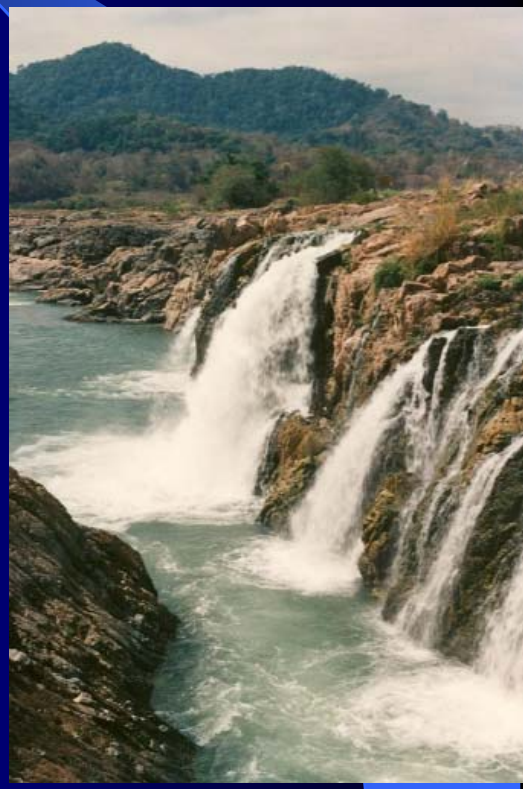


'Hotspot' approach

Special attention is given to 'hotspots', rare and endangered species & flagship species:

- Ramsar sites (wetlands of International Important)
- World heritage sites & Biosphere reserves
- Protected areas

- Irrawaddy Dolphin, Mekong Giant Catfish, Eastern Sarus Crane, Siamese Crocodile



Environmental impacts on ecosystems

(Mainly) related to changes in flooding pattern and water quality (including sediments)

- Changes in ecosystem productivity
- Changes in environmental services
- Changes in biodiversity, flora and fauna

Map overlay approach

Many of the impacts are spatially distributed, and assessment are made by overlaying GIS maps

Overlays of the important ecosystem/ habitat map with the flood maps (area, depth, duration), for each scenario and for an average, a dry and a wet years result in:

- Changes in area of the ecosystems
- Changes in ecosystem conditions

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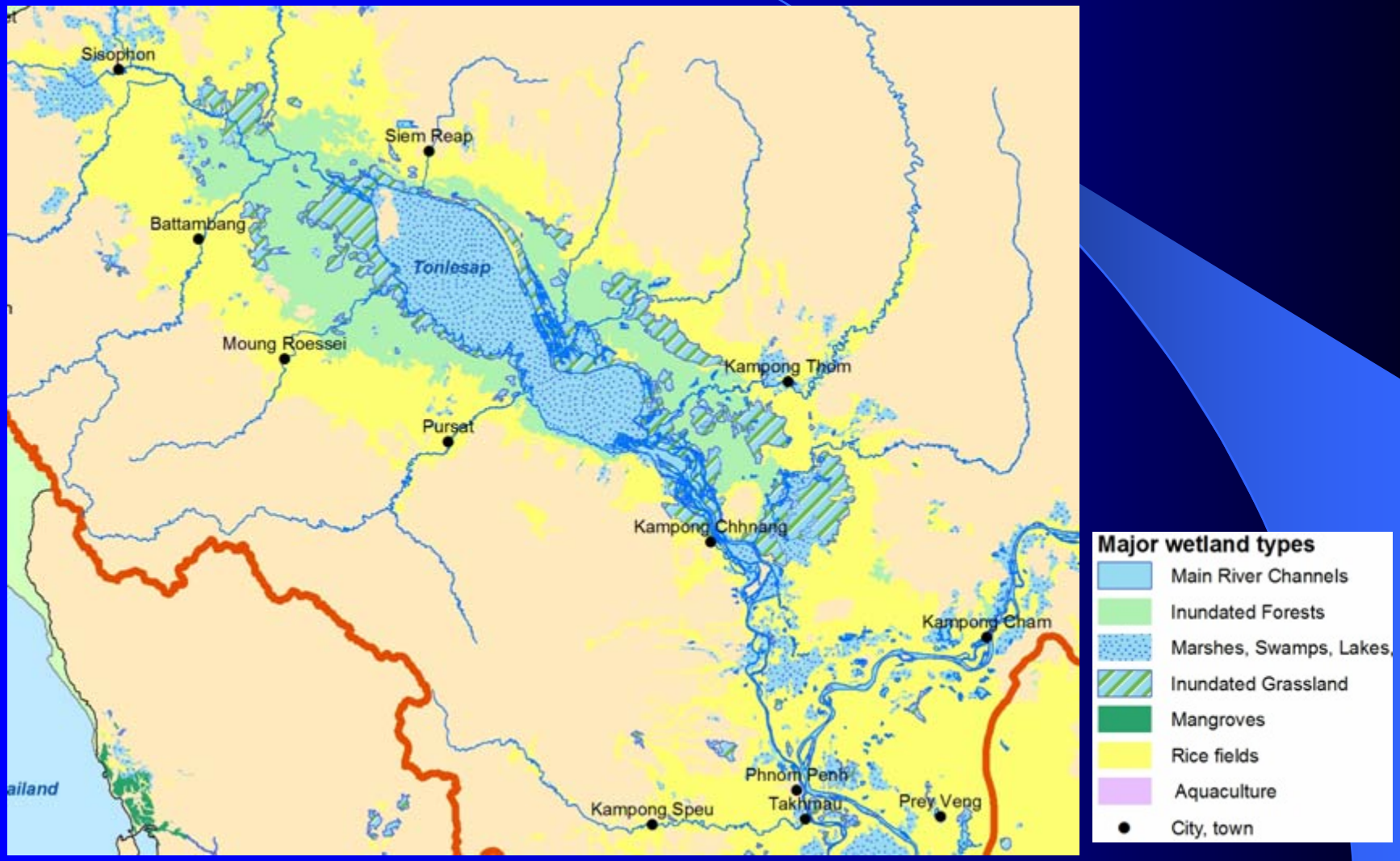
Draft results

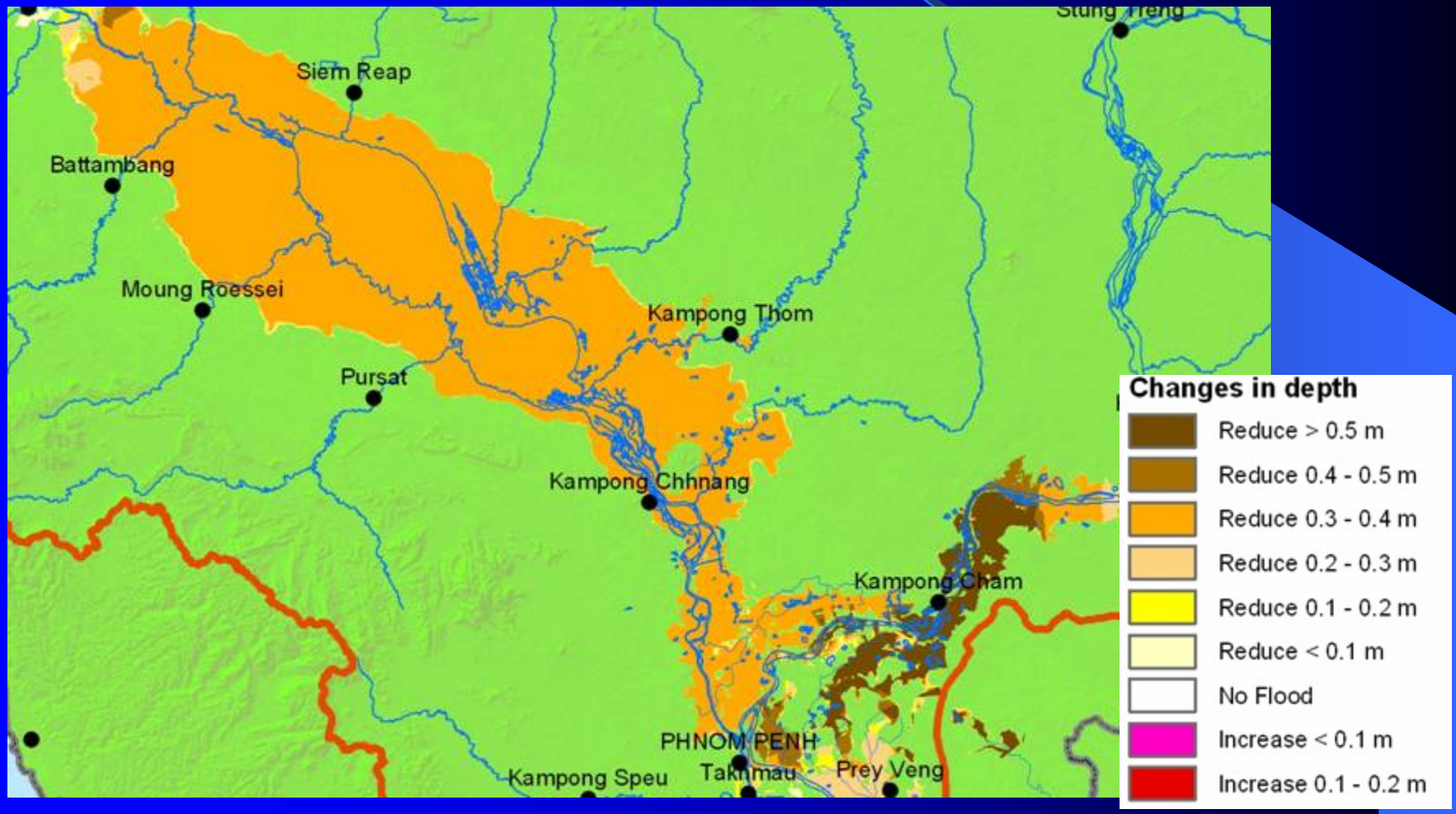
Draft results: analysis sofar

- The identified valuable ecosystems/habitats have been mapped
- 'Hotspots' have been identified and described
- Maps with flooded areas, flood depth and flood duration for each of the scenarios have been made for an average, a wet and a dry year, as well as maps showing differences between scenarios
- Results have been tabulated
- First analysis has been made for an average year, the Baseline scenario, the Definite Future scenario and the 20 Year plan scenario (worst case)

Example of a wetland map



Example of a floodmap (flood depth change)



Draft results: impacts on deep pools

Very limited under the Definite Future scenario:

- With decreasing sediment input into the systems deep pools may become more flushed out
- Increased dry season flow will not result in higher rates of infilling

However, under the 20 Year Plan scenario 60% of the river channel between Kratie (km 575) and Houei Xai will become impounded and nearly all deep pools will start to fill in

Draft results: impacts on rapids

Very limited under the Definite Future scenario

- Rapids will not become submerged by increased flows in the low flow season
- Increases in water depths and velocities probably less than 5%
- No change in availability of suitable habitat

Under the 20 Year Plan scenario most of the rapids will drown due to impoundment by mainstream dams

Draft results: Impacts on small islands and sandbars

As a result of changing flow conditions and reduced sediment inflow in the river:

- Upstream Vientiane: notecable decrease in area (presently 2,900 ha) within 20 years, disappearance within 50 years
- Downstream of Vientiane and Kratie: loss of sandbars within the next 20 year over the first 20 - 30 km
- Downstream of the 3 Ss confluence, notecable loss of sandbar area (reduced sediment inflow)

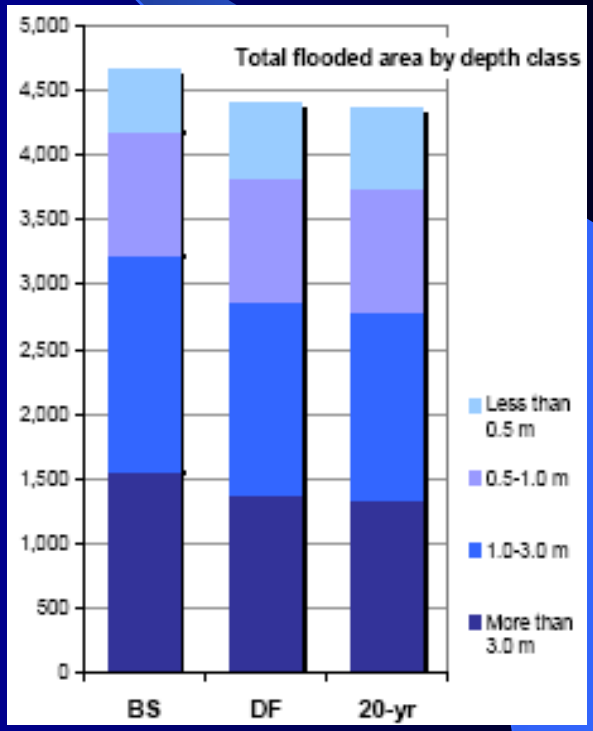
Construction of the mainstream dams will result in drowning of most of the sandbanks

Draft results: impacts on wetlands

Loss of total flooded area in an average year:

- 20% in Lao PDR and Thailand
- 7% in Cambodia
- 1% in Vietnam

Basin wide: 7%



Consequences for biodiversity

The loss of deep pools, rapids and sandbars under the 20 year plan scenario will have very significant impacts on biodiversity:

A large number of rare and endangered species are dependent on these habitats and may become extinct in the region

Fish and water birds will be affected most

Draft results: impacts on wetlands: loss of flooded forest

Inundated forest	Lao PDR	Thailand	Cambodia	Vietnam	LMB
Baseline	0	0	451,799	45,770	497,569
Definite Future	0	0	449,062	45,551	494,613
Change from baseline (ha)	0	0	-2,737	-219	-2,956
Change from baseline (%)	*0.0*	*0.0*	*-0.6*	*-0.5*	*-0.6*
20 Year plan	0	0	446,794	45,362	492,155
Change from Definite Future (ha)	0	0	-2,269	-189	-2,458
Change from Definite Future (%)	*0.0*	*0.0*	*-0.5*	*-0.4*	*-0.5*
Change from baseline (ha)	0	0	-5,006	-408	-5,414
Change from baseline (%)	*0.0*	*0.0*	*-1.1*	*-0.9*	*-1.1*

Draft results: impacts on wetlands: loss of seasonal mashes

Inundated marshes	Lao PDR	Thailand	Cambodia	Vietnam	LMB
Baseline	7,944	11,771	506,580	0	526,295
Definite Future	6,286	9,882	493,062	0	509,230
Change from baseline (ha)	-1,658	-1,889	-13,518	0	-17,065
Change from baseline (%)	*-20.9*	*-16.0*	*-2.7*	*0.0*	*-3.2*
20 Year plan	6,475	9,623	488,499	0	504,597
Change from Definite Future (ha)	189	-259	-4,563	0	-4,633
Change from Definite Future (%)	*3.0*	*-2.6*	*-0.9*	*0.0*	*-0.9*
Change from baseline (ha)	-1,469	-2,148	-18,081	0	-21,698
Change from baseline (%)	*-18.5*	*-18.2*	*-3.6*	*0.0*	*-4.1*

Draft results: impacts on wetlands: loss of inundated grasslands

Inundated grassland	Lao PDR	Thailand	Cambodia	Vietnam	LMB
Baseline	8,989	49,315	315,057	54,775	428,136
Definite Future	5,297	41,816	307,691	54,715	409,519
Change from baseline (ha)	-3,692	-7,499	-7,366	-60	-18,617
Change from baseline (%)	*-41.1*	*-15.2*	*-2.3*	*-0.1*	*-4.3*
20 Year plan	4,664	40,659	303,731	54,691	403,745
Change from Definite Future (ha)	-633	-1,157	-3,960	-24	-5,774
Change from Definite Future (%)	*-12.0*	*-2.8*	*-1.3*	*0.0*	*-1.4*
Change from baseline (ha)	-4,325	-8,656	-11,326	-84	-24,391
Change from baseline (%)	*-48.1*	*-17.6*	*-3.6*	*-0.2*	*-5.7*

Draft results: impacts on wetlands

Loss of areas mainly due to changes already taking place under the Definite Future scenario

Not only areas change, changes in depth and duration of flooding affect habitat quality

Cosequences on impacts on wetlands

Considerabel loss of area and reduction in flood depth and duration will reduce wetland productivity and biodiversity significantly and in Lao PDR and Thailand will

In Cambodia the situation is more grave a larger areas are lost, the more so of the very important inundated grasslands

Impacts in Vietnam will be less significant since the flooded area is only limited affected

Draft results: Tonle Sap: area of major concern

Expected changes in the Tonle Sap area:

- Reduction of the flooded area with 60,000 ha (4.5 %) in an average year, and as much as 100,000 ha (9%) in a dry year;
- Reduction of the area of flooded forest with 5,000 ha (1.1%) in an average year to 23,000 ha (5.3 %) in a dry year;
- Reduction of the area of inundated grasslands with 8,500 ha (3.2%) in an average year to 25,000 ha (10 %) in a dry year;
- Reduction of the area of flooded marshes with 3,000 ha (1.0%) in an average year to 5,500 ha (1.8 %) in a dry year;
- Reduction of the area of flooded ricefields of 41,000 ha (18%) in an average year and 48,000 ha (28 %) in a dry year;

Draft results: Tonle Sap: area of major concern

- Reduction of flood depth of just over 0.5 m in an average and dry year;
- Reduction of flood duration of the flooded forest area with generally less than 2 weeks in an average year, but up to 1 month in a dry year;
- Reduction in flood duration with generally less than 1 month in an average year in 70% of the inundated grassland area, but an increase of flood duration with up to 1 month in 25% of the area. A similar pattern is to be seen in dry years, even with a bit more pronounced increase;
- A reduction of the reverse flow with 8 (Definite Future) to 13% (20 Year Plan)

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

Draft results: Tonle Sap: area of major concern

- Increase of the water level in the dry season with about 20 cm, resulting in a volume increase of 520 MCM, or an increase with some 30%;
- Shift of the flow reversal date of 3 to 8 days (earlier);
- Reduction of sediment inflow in the system of at least 8 to 13%;
- An overall increase in nutrient (and other agro-chemical) inflow into the lake; and
- Blockage of the migration paths (by mainstream dams under the 20 Year Plan scenario) of a large number of ecologically and commercially important fish species.

Draft results: Tonle Sap: area of major concern

Consequences of the changes:

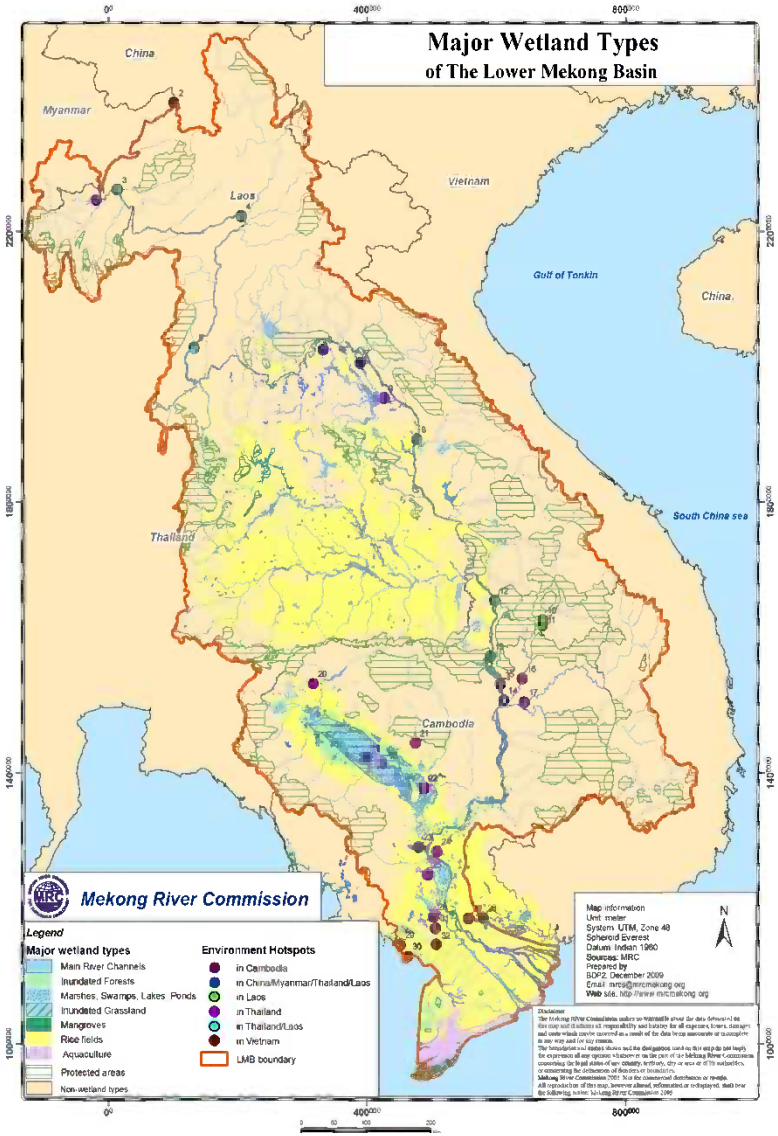
- Considerable reduction in primary production: 20 to 30%
- Severe impact on the biodiversity
- Loss of up to 50% of the white fish production
- Loss of timber and non timber wetland products, negatively affecting local people

Flagship species

Flagship species	Baseline	Definite Future	20-year Plan
Mekong River Dolphin, Irrawaddy Dolphin ***Orcaella brevirostris*** **(CR)**	High	High	Extinct
Mekong Giant Catfish ***Pangasianodon gigas*** **(CR)**	High	High	Extinct
Siamese Crocodile ***Crocodylus siamensis*** **(CR)**	Moderate	Moderate	Moderate
Eastern Sarus Crane ***Grus antigone sharpie*** **(VU)**	Low	Low	Moderate

Environmental Hotspots

32 environmental hotspots identified: Ramsar sites, Biosphere reserves, Protected areas, Important Bird Areas (IBA's)



Environmental Hotspots

	No of impacted Hotspots		
	Minor	Moderate	High
Definite Future scenario	22	9	1
20 Year Plan scenario	11	9	12

Summary of findings

- **Sandbars, deep pools and rapids** will be heavily affected under the 20 Year Plan scenario, when most of these valuable habitats will drown. Consequences for biodiversity are high

- **Wetland areas** reduced 6% in DF and by further 1% in FS, **Flooded Forest areas** reduced by 1%, **Flooded marshes** by 4% and **Inundated graslands** by 6%, flood duration and depth less favorable for the ecosystems. Consequences: loss of productivity and species diversity, impact on fisheries

- **Tonle Sap area:** affected considerably by a series of environmental changes that may lead to a reduction primary productivity of 20 to 30%, a considerable loss of species, a 50% lss of the white fish production and loss of harvestable timber and non-timber wetland products.

- **Flagship** Two of four flagships species threatened by mainstream dams and generally considerable negative impact

- **Environmental Hotspots:** 9 out of 32 moderately affected under the Definite Future scenario and 1 highly affected, under the 20 Year Plan scenario: 9 moderately affected, 12 highly affected

Main conclusions

- Changes in flow regime result in considerable wetland loss in Lao PDR and Thailand (20%)
- Area loss in Cambodia is moderate (7%), in Vietnam low (1%)
- Most of the changes already result from the Definite Future scenario
- Impacts on biodiversity and fish are considerable
- Construction of mainstream dams changes a large proportion of the free flowing river to impoundments, resulting is a severe loss of habitats and biodiversity
- A series of environmental changes in the Tonle Sap area will result in a considerable change of the systems functioning with severe consequences for productivity, biodiversity, fisheries and other wetland functions.