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# The Council Study

**Study on the sustainable management and development of the Mekong River, including impacts of mainstream hydropower projects**

## Macro-economic Assessment Report

**(Final)**

26. December 2017

# Content

# Document History

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# 1 <u>Executive Summary</u>

All lower Mekong countries have committed to *sustainable* development. Sustainability, however is challenging as large investments come with a multitude of side effects or trade-offs that could lead to unsustainable outcomes. The integrated assessment of development strategies is a critical step towards evidence-based planning processes as it reveals likely impacts on a wide variety of economic, social, hydrological and ecological indicators. Based on the improved understanding of trade-offs, unsustainable development strategies can be reconsidered and sustainable options designed to further improve development outcomes.

This report summarises the macro-economic assessment of scenarios as defined by the MRC council study. These scenarios place at the forefront three main scenarios that combine investments in hydropower, irrigation, agriculture, and navigation:

- Main scenario M1: Early development situation of 2007, defines the baseline.
- Main scenario M2: Definite future as planned for 2020; including projects under construction.
- Main scenario M3: Planned development scenario that includes investments planned for 2040.
- Main scenario M3CC: M3 plus projected climate change, assuming more seasonal climate.

These *main* scenarios combine bundles of investments to assess the combined effect of all interventions, which has the advantage of considering synergistic effects. Synergies are critical where the combined effect differs from the sum of effects individual interventions would have. Many scientific studies have emphasised the relevance of synergies. However, the downside is that the assessment of larger bundles of investments prevents clear attribution of outcomes to individual investments. Therefore, the council study considers in addition to these main scenarios thirteen sub-scenarios to assess the sector-specific variation of main scenario 3 (as planned for 2040). The design is focused on the comparison of the third main scenario that includes projected climate change (M3CC) with all sub-scenarios to reveals sector-specific impacts. However, within each sector considered in this study, up to a hundred projects or more (e.g. hydropower dams) are being considered as a bundle. This assessment does not allow for a project-specific attribution of impacts, only for a sector-specific assessment. Such an additional disaggregation would require a project-by-project assessment approach and would allow the effective design of sustainable development strategies.

This report presents the macro-economic assessment and should be consulted in combination with other disciplinary and thematic reports. Many changes might appear positive from an economic perspective but could lead to unacceptable outcomes for other indicators, for instance food security or biodiversity. The acceptability needs to be defined by policy makers in the lower Mekong basin. This study aims to support the discourse by providing evidence and recommendations.

The macro-economic assessment is based on widely applied methodology. It utilises bio-physical input information provided by other disciplinary and thematic teams and adds economic values relevant for each unit, thereby quantifying annual economic benefits and costs. Annual benefits between now and 2040 are being discounted employing hyperbolic discounting. Discounting assumes that profits and costs in the future have a lower value to people than the same profits or costs would have today. Hyperbolic means that people do not value profits or costs differently between two different years in the far future. In other words, this report adds all annual discounted values for the period until 2040, while discounting decreases over time. The combined (discounted) value of all benefits and costs in today's terms is referred to as the net present value.

***This assessment is structured into three tiers.*** In a first tier, the net present value is calculated at the sector level, considering investments in hydropower, fisheries, agriculture and irrigation, and navigation. The comparison of results for these sectors identifies sector-specific gains and highlight the (changing) relevance of sectors. This tier is very narrow as it excludes wider macro-economic effects. Hence, in a second tier, sector effects are embedded in a macro-economic perspective to assess impacts on GDP. Conventionally, this type of assessment requires appropriate economic modelling as changes in one sector are likely to affect other sectors. Sectors are linked because they require similar production factors as inputs (e.g. labour, capital, natural resources) and compete for the same household (or public) budget. Time and resource constraints precluded development of economic models capable of accounting for factor interdependence. Instead, for this second assessment tier, Input-Output data, household survey data, and population growth projections are combined with the sector specific assessment results (assessment tier 1) to estimate ranges of possible GDP trajectories. The second tier revealed unexpected side-effects resulting from sector-specific investments for the macro-economic growth of lower Mekong countries. However, assessment tiers 1 and 2 only capture processes that are represented in existing and functioning economic markets and fail to consider impacts on factors that can be understood as the foundation of future economic activities. A third tier included in the assessment introduces the economic values of non-market processes to improve understanding of natural resource trade-offs and eventual incorporation into the economic calculus. The third tier takes a wider sustainability-focused perspective and includes effects on input factors to assess the long-term viability of development strategies. The assessment tier is focused on impacts on natural capital that are not represented on economic markets, an approach widely applied to qualify the sustainability of economic development as these changes affect future growth potential.

***The first tier*** is focused on agriculture, hydropower and navigation. The macro-economic results confirm that investments planned for the lower Mekong basin are likely to have profound impacts on the development of the basin and basin sustainability. Scenario M2 (2020 development plans) is likely to increase the combined net present value of the four foci sectors by 34% and M3 (2040 development plans) by 68%. Agriculture is dominating the effects of M2 due to substantial expansion plans in Cambodia. The viability of these plans from a macro-economic and sustainability perspectives is discussed under tier 2 and 3. Hydropower has the largest impact in M3 and reveals that the main beneficiary of mainstream hydropower investment in Lao PDR is likely to be Thailand and the main beneficiary of mainstream hydropower investments in Cambodia is likely to be Vietnam. This is due to Thai investments in Lao PDR hydropower and the subsequent import of electricity at costs that are substantially below Thailand's domestic retail tariff, generating substantial profit margins in Thailand and increases in Thailand's GDP. The same benefit transfer unfolds in Vietnam, based on hydropower investments in Cambodia, and subsequent benefit transfers. A third substantial beneficiary of Mekong mainstream hydropower are investors from outside the lower Mekong basin (e.g. China, South Korea, Malaysia). Their profits from hydropower in the lower Mekong contributes to GDP in their respective countries. Within the boundaries of tariff estimate uncertainties it is likely that both host countries (Lao PDR and Cambodia) would be able to convert 15-30% of hydropower profits into net present value for their national economies.

The fisheries sectors are likely to decline substantially in all four lower Mekong countries. Scenario M2 would trigger a decline of the net present value of the fisheries sector by $16.5 billion, while M3 would trigger a decline of $22.6 billion if compared with M1. Sub-scenario H1a quantifies that the combined effect of all planned and existing hydropower in the lower Mekong basin causes a loss in fisheries of about $19.4 billion in net present value. This is about 12% of the net present value of all planned and existing hydropower. Sub-scenario H1b distinguishes between mainstream hydropower and tributary dams, enabling quantification of the fisheries related losses due to mainstream dams at about $8.6 billion in net present value, which is 5.4% of the net present value of the hydropower sector. The majority of economic gains in the fisheries sector for these hydropower-focused sub-scenarios would eventuate in Lao PDR and Thailand. Under M3, fisheries would lose its economic relevance in both countries and solutions would need to be found for the loss in related livelihoods and food security.

Analyses of the full range of sub-scenarios indicates that the second most relevant driver for fisheries (after hydropower) is climate change. Drier climate change would decrease the net present value of fisheries by nearly 10%. The majority of losses occur in Cambodia.

Navigation has a surprisingly large economic potential, particularly for Vietnam and Cambodia. The net present value of navigation expansion in Vietnam in scenario M3 is about $55.5 billion and nearly as high as the combined effect of hydropower and agriculture. Cambodia ranks second in navigation related benefits, associated with an estimated increase in net present value of $8.5 billion. This considers only navigation specific revenue and costs and does not include the value of cargo or revenue from passenger transport (see the navigation report for a detailed assessment). Typically, improved infrastructure for trade multiplies with increasing value-add of exported goods. However, expected gains demand complementary investments in secondary (and tertiary) sectors, which leads to the second tier of this assessment.

***The second tier*** embeds the narrow sector assessment into a macro-economic perspective. This reveals if sector investments have negative impacts on one or multiple other sectors. Two elements have already been raised above, the impacts of hydropower on fisheries and the trade-related potential. In addition to these two important effects, a critical aspect emerges from linking agricultural expansion, population growth and macro-economic growth. Substantial investments in agriculture increase the demand in labour. If this demand outpaces workforce growth and productivity gains, other sectors will face increasing constraints in meeting labour requirements. Typically, salaries in secondary and tertiary sectors increase and workers move over time away from agricultural production, which would potentially leave newly developed farmland unproductive. The northeast of Thailand is an example for such effects. Mechanisation and farm consolidation are not always possible, which leaves large areas unproductive. This means that either agricultural production will increase as planned but the demand for labour will reduce the overall growth of the national economies. Or workers will move into secondary (and tertiary) employment, which would leave new investments in agriculture under-utilised or stranded. Agricultural expansion plans in Cambodia and Lao PDR (and to a much lesser extent in Vietnam) are likely to face this macro-economic dilemma. As a corollary, large portions of the predicted increase in net present value of agriculture in, for instance Cambodia ($65.3 billion for M2 and $67.3 billion in M3) may not eventuate. The risk of this development strategy will be amplified if the climate becomes drier than expected as economic gains would substantially decline. It seems highly beneficial to disaggregate the bundle of proposed agricultural expansion projects and undertake a risk assessment of individual projects and how they perform against workforce and climate change related risks.

A third assessment dimension is the relevance of ecosystem services as explained under the third assessment tier further below.

The net present value derived from hydropower is also likely to benefit from a more disaggregated assessment. This study identifies a few hydropower projects that have low or negative benefits. If this coincides with negative externalities (=side-effects) for other sectors, underperforming projects could be cancelled and investment re-focussed on the most cost effective projects, where cost effectiveness includes the benefits and costs of inter-sector side effects or externalities. This would require a project-by-project assessment approach to provide planning with a disaggregated, evidence based prioritisation process. External effects within and between the economies of the lower Mekong basin are likely to be substantial. But not all projects are likely to trigger the same level of externalities. Eliminating the worst performing projects in hydropower and any other sector is likely to substantially improve the macro-economic development gains in the lower Mekong basin.

This study projects ranges for possible GDP growth in the absence of appropriate socio-economic modelling. Table 1 summarises GDP results for all 16 scenarios. For each country, only areas are considered that are within the basin, which required the disaggregation of data for Vietnam and Thailand. For each country and for the lower Mekong basin, GDP values are provided as an upper range and a lower range of a potential growth trajectory, depending on how much of the workforce will remain in the agricultural sector. The greater the increase of labour transitions to secondary and tertiary sectors, the more realistic the upper bound becomes. The upper bound assumes that everybody in the workforce would find employment in secondary and tertiary sectors if leaving the agricultural sector, which is clearly too optimistic. However, long-term investments in education and effective development of innovative industries that meet national sustainability objectives would prepare the economic system towards this benchmark. This assessment tier aims to illustrate how macro-economic growth potential changes for the selected development strategies for the four lower Mekong basin countries.

Important considerations for interpreting Table 1 correctly are:

- these projections are largely based on workforce changes while other input factors such as the availability of energy or capital could not be factored into these calculations;
- consequently, the results for H1a are likely to exaggerate GDP because it assumes substantial expansion of secondary and tertiary sectors, which implies the availability of energy (if provided by generating sources other than hydropower this would become more realistic);
- the upper bound requires full employment of labour not employed in agriculture, which is likely to be an overestimation of realistic GDP, hence 'upper bound'; and
- the lower bound 'forces' labour to meet the full utilisation of agricultural land, which is likely to lead to an underestimation of GDP.

**Table 1 GDP ranges for 2040 under the various development scenarios for the lower Mekong basin**

| GDP in billion US$ (deflated to 2017 dollar) | | M1 (2007) | M2 (2020) | M3 (2040) | M3CC (2040) | A1 (2007) | A2 (2020) | C2 (Wet) | C3 (Dry) | I1 (no IRR) | I2 (IRR) | F1 (no FPI) | F2 (FPI) | F3 (FPI) | H1a (noHPP) | H1b (noMain) | H3 (HPP) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cambodia | Upper bound | $50.3 | $45.6 | $46.5 | $47.7 | $50.5 | $46.7 | $46.3 | $46.2 | $46.6 | $46.0 | $46.8 | $47.2 | $46.8 | $48.5 | $47.6 | $47.4 |
| | Average | $48.3 | $41.8 | $39.5 | $38.5 | **$48.0** | $40.8 | $40.6 | $40.7 | $40.8 | $40.3 | $39.4 | $39.4 | $39.6 | $40.2 | $39.6 | $39.5 |
| | Lower bound | $46.2 | $38.0 | $32.6 | $29.3 | $45.4 | $34.8 | $35.0 | $35.3 | $35.1 | $34.6 | $32.0 | $31.7 | $32.3 | $31.8 | $31.5 | $31.5 |
| Lao PDR | Upper bound | $42.0 | $40.4 | $40.0 | $39.7 | $39.1 | $40.0 | $39.7 | $39.9 | $40.0 | $39.8 | $39.9 | $39.9 | $39.9 | **$43.4** | $41.6 | $39.8 |
| | Average | $39.2 | $35.1 | $30.3 | $30.3 | **$36.3** | $30.2 | $30.7 | $30.7 | $30.3 | $30.1 | $30.5 | $30.5 | $30.5 | $32.5 | $30.9 | $30.4 |
| | Lower bound | $36.3 | $29.8 | $20.5 | $21.0 | $33.5 | $20.5 | $21.6 | $21.6 | $20.6 | $20.4 | $21.0 | $21.0 | $21.0 | $21.6 | $20.3 | $21.0 |
| Thailand | Upper bound | $98.0 | $101.6 | $98.4 | $98.2 | $97.9 | $98.4 | $98.1 | $98.4 | $98.4 | $98.3 | $98.2 | $98.4 | $98.3 | **$103.9** | $102.6 | $97.9 |
| | Average | $79.8 | $73.7 | $68.9 | $70.5 | **$78.3** | $69.0 | $71.2 | $71.0 | $69.0 | $69.0 | $70.4 | $70.5 | $70.5 | $73.2 | $72.1 | $70.3 |
| | Lower bound | $61.5 | $45.9 | $39.5 | $42.7 | $58.6 | $39.6 | $44.3 | $43.6 | $39.5 | $39.7 | $42.7 | $42.7 | $42.7 | $42.5 | $41.5 | $42.8 |
| Vietnam | Upper bound | $92.3 | $93.6 | $92.9 | $92.9 | $93.3 | $92.8 | $92.4 | $92.5 | $92.5 | $92.5 | $92.6 | $92.8 | $92.6 | **$94.3** | $93.6 | $93.0 |
| | Average | $82.3 | $82.7 | $82.5 | $81.3 | **$84.4** | $84.1 | $83.8 | $83.9 | $83.8 | $83.8 | $82.7 | $82.9 | $82.9 | $83.9 | $84.0 | $82.1 |
| | Lower bound | $72.2 | $71.7 | $72.0 | $69.7 | $75.6 | $75.4 | $75.1 | $75.3 | $75.1 | $75.2 | $72.8 | $73.0 | $73.1 | $73.5 | $74.4 | $71.3 |
| LMB | Upper bound | $282.6 | $281.2 | $277.9 | $278.5 | $280.8 | $277.9 | $276.5 | $276.9 | $277.4 | $276.5 | $277.6 | $278.3 | $277.6 | **$290.2** | $285.5 | $278.1 |
| | Average | $249.5 | $233.3 | $221.2 | $220.6 | **$247.0** | $224.1 | $226.2 | $226.3 | $223.9 | $223.3 | $223.1 | $223.3 | $223.4 | $229.8 | $226.6 | $222.3 |
| | Lower bound | $216.3 | $185.3 | $164.6 | $162.7 | $213.1 | $170.3 | $176.0 | $175.8 | $170.3 | $170.0 | $168.6 | $168.4 | $169.1 | $169.4 | $167.7 | $166.5 |

A few key insights emerge from Table 1:

- The comparison of M2, M3, A1 and H1a suggests that the macro-economic optimum requires
    - lower agricultural expansion than assumed for M2;
    - some hydropower but

        - fewer hydropower projects than assumed for M3; and
        - fewer mainstream dams than assumed for M2.
- The upper bound for GDP growth in M3 is lower than for M2 for all countries but Cambodia. However, Cambodia's lower bound decreases substantially when stepping from the M2 to M3 development scenarios. This indicates that a macro-economic optimum is likely to be closer to M2 than M3.
- If alternate energy generation could be developed other than hydropower, growth potential would outpace all scenarios considered in this study. It is highly recommended to assess emerging energy technologies, including third generation biomass, off-shore wind-farms, tidal turbines, fusion, or transparent photovoltaic. However, any other power generation technology could also trigger negative externalities, which also needs to be assessed.
- Flood protection projects benefit Vietnam and Cambodia more than Lao PDR and Thailand.
- Hydropower mitigation measures (comparing H3 and M3CC) are likely to create benefits of over $1.7 billion per year.

The main text of Section 7 (see Table 26) compares the 2040 scenario with 13 sub-scenarios and confirms that under M3CC conditions, over-investing in agriculture is likely to be cause the largest economic reductions.

The analyses are based on simple calculations that combine Input-Output data, household survey data, population trends and sector specific valuation results. The approach neglects some key economic dynamics, as already mentioned. For instance, labour availability, mobility and migration patterns emerges as important aspects, which could realistically translate into increasing salaries with the strongest increase in sectors with the highest labour productivity. It is critical for the macro-economic development to capture sector-specific effects of relative price changes. Also, fish impacts are likely to be substantial, which means that fish prices are very likely to increase substantially. This means that there will be an increasing incentive to change land use and increase the development of aquaculture. National estimates of annual aquaculture increase over the projection horizon were held constant for of the Council Study development scenarios. Expanding aquaculture is likely to affect water demands and water quality. These ripple effects are fundamental to designing sustainable development strategies. Due to the methodological constraints, the analytical interpretation focused on principle patterns and the relative comparison of scenarios instead of the absolute values.

Future scenario assessments with socio-economic modelling that accounts for these complexities is a principle recommendation emerging from the macro-economic assessment.

***The third tier*** of this assessment places the economic system into the wider social-ecological system to identify important dependencies and the long-term viability of development strategies. One critical dependency is the need to sustain the functional integrity of natural resources as inputs for economic and social processes. The loss of natural capital (for instance in form of ecosystem services) would lead to a loss of economic growth potential. For instance, a continued investment in forestry would suddenly face negative growth rates if deforestation exceeds regrowth. This applies to all natural resources, even if it is a non-consumptive use, such a water for power plant cooling.

The economic valuation of natural resources functions and services relied on an assessment of over 500 economic valuation studies conducted in the lower Mekong basin over the past 20 years and applies these results as value ranges for each hectare of evergreen forest or each hectare of wetlands. Land use change is at the core of the value transfer approach. It is recommended to broaden this approach toward an Inclusive Wealth approach, which would add human capital, built capital and financial capital. However, natural capital changes are potentially the most immediate and relevant for the water resource focus of the MRC and the Member Countries. The results suggest that main scenario M2 would coincide with a mean loss of net present value of natural capital of $55 billion. M3 would increase this loss to a mean value of $79 billion. This is about a quarter of the combined annual economic gains from hydropower, fisheries, agriculture, and navigation.