Mekong River Commission
Cambodia • Lao PDR • Thailand • Viet Nam
For sustainable development

Summary note

Review Report on Joint Environmental Monitoring (JEM) Activities and Recommendations for Mekong Mainstream Hydropower Projects

Draft

In an effort to communicate openly with broader stakeholders of the Mekong River Commission (MRC) and to help them participate in MRC's regional stakeholder forums more meaningfully, the MRC Secretariat has prepared this summary report to present key and substantive points from selected on-going technical work of the MRC which is in the process of development and finalization in consultation with its member countries.

10 September 2018

Contents

1. Background

Hydropower is a significant growth area in the rapid development of the Lower Mekong River and surrounding basins. However, without careful planning, hydropower dams have the potential to cause severe negative socio-environmental consequences. A joint basin-scale environmental monitoring programme would provide robust environmental information to inform decisions, enabling issues to be mitigated and prevented, and make hydropower more sustainable.

A basin wide approach to sustainability calls for effective, collaborative environmental monitoring and impact assessment. The MRC provides an important role in coordinating the monitoring of the Lower Mekong Basin (LMB) and making information available to inform hydropower projects and enhance cooperation between all involved parties. However, environmental monitoring in the basin has not been designed with the purpose of the monitoring and assessment of Mekong mainstream hydropower dams and thus does not effectively capture impacts and changes through time.

Undertaking Prior Consultation reviews (PNPCA) for the hydropower developments; viz Xayaburi hydropower project (2011), Don Sahong hydropower project (2015) and Pak Beng hydropower project (2017), highlighted the need for a robust scientific environmental monitoring programme for proper assessment of the impacts of Mekong mainstream hydropower dam projects. In July 2016, the 44th Meeting of the MRC Joint Committee requested the MRC secretariat to develop 'Joint Environmental Monitoring (JEM)' for Mekong mainstream hydropower projects, which now features in the Strategic Plan for 2016-2020.

Once developed, the JEM programme will be piloted on the existing dam developments, Xayaburi and Don Sahong, and then adjusted based on the findings to inform a joint action plan for Pak Beng, as well as aiding in the development of standardised procedures and methodologies for future dam developments in the LMB.

1.1 Purpose of the Joint Environmental Monitoring Programme

As an initial stage of establishing a Joint Environmental Monitoring programme, all current environmental monitoring efforts conducted by the MRC and in connection with the Don Sahong, Xayaburi, Pak Beng projects, as well as all the relevant MRC documents (ISH 11 and 0306, PDG 2009 and DG 2018) and monitoring activities in other regions have been reviewed and compiled into a Review Report, as summarised in this document. From this, recommendations for a replicable, cost-effective monitoring programme to assess impacts of Mekong hydropower projects on the environment have been provided. The review intends to form the basis of a strategy to JEM with the following purposes:

1. Developing a common, standardized and scientifically robust joint programme for monitoring the effects of Mekong mainstream hydropower projects on key environmental indicators.

2. Supporting Mekong mainstream hydropower project proponents to collect sufficient environmental data to inform project planning and design, construction and operation (i.e. effective mitigation measures).

3. Supporting Member Countries (MCs) to monitor and report the transboundary environmental impacts of Mekong mainstream hydropower projects during construction and operation to inform mitigation and management measures.

4. Supporting the MCs to establish formal coordination mechanisms for information sharing to enable adaptive management of the operation of Mekong hydropower projects and avoid, minimize and mitigate both local/national and transboundary impacts.

The JEM project intends to align monitoring activities with monitoring needs by providing impact assessment for all Mekong mainstream hydropower projects. This will be done considering the following environmental variables:

1) Hydrology and hydraulics
2) Sediments and geomorphology
3) Water quality
4) Aquatic ecology
5) Fish biodiversity and fisheries

2. Review and Recommendations for a Joint Environmental Monitoring programme of Mekong Mainstream Hydropower projects

Introduction

This Summary Note on the '*Review of Joint Environmental Monitoring Activities on Mekong Mainstream Hydropower Projects*' is made available to stakeholders with the intention of providing information on the status, progress and intent of the Joint Environmental Monitoring (JEM) programme for Mekong Mainstream Hydropower projects.

The Review assesses all current monitoring efforts already established in the Mekong and, drawing on the knowledge and application of procedures of developments in other regions, as well as lessons learnt from current developments in the Mekong region and relevant MRC documents, determines the monitoring needs to be able to provide a robust environmental assessment for hydropower development projects in order to support sustainable hydropower development in the LMB. The information gathered, and the subsequent recommendations will be used to form the basis of the Joint Environmental Monitoring programme. The focus of the JEM programme and therefore the review is the utilisation of 5 key environmental indicators: (1) hydrology and hydraulics, (2) sediments and geomorphology, (3) water quality, (4) aquatic ecology, and (5) fish and fisheries. For each environmental factor, the importance of monitoring is established in terms of potential effects of Hydropower projects, current monitoring activities are described, and recommendations are made on adaptions to effectively measure and therefore mitigate against any environmental impacts of hydropower projects.

2.1 Hydrology and Hydraulics

Importance and potential impacts of hydropower projects

Through flow alterations, hydropower developments influence sediment transport, water quality and as a result ecosystem functioning and associated socio-economic consequences. Therefore, hydrological and hydraulic monitoring provides important information on the sustainability of hydropower projects. Data on hydrology and hydraulics also provide information on water availability to optimise power generation and dam operations.

Existing hydrology and hydraulics monitoring activities

Collection of hydro-meteorological data has been a core activity of MRC since its establishment in 1957, which have been used to support both regional and national decision making in a range of sectors. The original MRC monitoring system, established in 2005 was upgraded to the Hydrological Cycle Observing System (HYCOS) telemetry network in 2012, with real-time accessible hydro-meteorological data. Presently 53 stations across the LMB are connected to HYCOS, including 19 on the mainstream. However, some of the stations are not fully operational due to lack of allocation of maintenance funding by countries, and some other relevant stations (e.g. at tributaries, dam sites) are not connected to the HYCOS. Also relevant discharge measurements at these stations for rating curves have not been updated the past years. HYCOS stations measure water levels and rainfall. Other Hydraulic indicators are generally only monitored when measuring other parameters such as in water quality monitoring surveys.

Recommendations

It was established that the hydro-meteorological network must be tailored to monitor specific hydrological processes and be made adaptable to future changes and events (e.g. flooding) The monitoring network should be suitable to support a project over its full life cycle with the number and position of monitoring sites based on the data needs.

Based on the 'ISH 11' study for "Improved Environmental and Socio-Economic Baseline Information for Hydropower Planning" to "Improve the Sustainability of Hydropower Development", the best approach for monitoring hydrological impacts in terms of both energy production and the formulation and assessment of Impact mitigation, uses a combination of a detailed hydrological monitoring network and hydrological modelling. It also stated that the number of stations needs to be increased integrating locally installed stations with the existing network. These measurements could also be integrated with the wealth of remotely-sensed data available. With some datasets spanning long periods, the data can be used to form the basis for hydrological modelling.

There was lack of specific guidance in the 'PDG 2009' "Preliminary Design Guidance" on monitoring the hydrological and hydraulic impacts of hydropower dams. This has subsequently been addressed in the 'DG 2018' "Design Guidance" with a section dedicated to hydrology and hydraulics in terms of pre-project assessments and post-project monitoring for adaptive management. This includes assessing the baseline conditions prior to project initiation as well

as the quantification of any potential hydrological and hydraulic changes using a combined modelling and monitoring approach. It is recommended to follow the monitoring guidelines set out by the World Meteorological Organisation (WMO) on the monitoring and quality management of hydrological data and quality assurance procedures should be followed with appropriate analysis in a standardised and uniform way for the entire basin.

2.2. Sediment

Importance and potential impacts of hydropower projects

Sediment transport controls the river channel, floodplain characteristics and the distribution of ecological habitats and is therefore an essential component of river functioning, which is controlled by the hydrology and hydraulics of a river. Hydropower developments pose many geomorphic risks including alteration of the morphological balance of the Mekong river; trapping sediment in the impoundment; reducing sediment load downstream of the dame site; causing water level fluctuations downstream leading to increased erosion and increased land disturbance and sediment generation during construction.

Current Discharge Sediment Monitoring Programme (DSMP)

Another core function of the MRC already is the Discharge Sediment Monitoring Programme (DSMP), initiated in 2009 in the LMB, but has not been implemented since 2015. As designed, the programme includes 13 sites along the Mekong mainstream, two sites on the Bassac, one site on the Tonle Sap and one site in the lower 3S River. Parameters measured include discharge, suspended sediment concentrations, suspended sediment grainsize analysis, bedload and bed material. However, a greater understanding of the following processes is required to guide sustainable hydropower development in the LMB:

- Sediment movement through and trapping within impoundments, including what grain-sizes are trapped over what time-frames;
- The impacts of sediment trapping on the geomorphology of the impoundment, and of river bed erosion in downstream channel;
- The potential risks and rate of change associated with the geomorphic impacts which may occur well downstream of a hydropower project.

Recommendations

The number of monitoring sites should be increased as recommended by ISH11 to include stations upstream of the dam in the reservoir and backwater reaches at the dam site and in the river downstream of the dam site to determine sediment transport in these locations. With respect to site selection, stations are recommended to be established downstream of the Xayaburi dam site and upstream of the existing Stung Treng site above the 3S confluence. Any new monitoring activities should be compatible with the current DSMP to allow flawless integration. Furthermore, continuous DSMP monitoring should be introduced and the monitoring of bedload and grainsize should be performed at every monitoring station. New technology will be trialled to look for cost-effective solutions to meet these monitoring demands. Repeat bathymetric profile monitoring should be carried out to document change

related to hydropower projects. A baseline survey of sediment features should be carried out before the initiation of the development and sediment monitoring should be undertaken, both during the construction period and throughout the rest of HPP life cycle, recording changes after the dam construction, particularly to the river banks, flood level lines, mid-channel islands and sediment deposits at tributary junctions. The status of sediment transport and geomorphology within the LMB would be better assessed if data management and analysis was improved to ensure that up to date information can be provided, involving the MRC, MCs and developers. All existing data should be collated into one dataset, analysed and integrated with the existing 2009-2015 time-series.

2.3. Water quality

Importance and potential impacts of hydropower projects

Hydropower dams have the potential to cause detrimental effects to water quality. Hydropower reservoirs can encourage the proliferation of algae blooms due to both the accumulation of nutrient from other sources (e.g. agricultural runoff, industrial inputs) and increased light penetration caused by decreased turbidity. Reservoir stratification can also occur which has many negative effects: decreasing dissolved oxygen (DO) in bottom water, causing a high concentration of metals such as iron, manganese and mercury and lowering pH causing hydropower infrastructure to corrode. Water quality can also be affected as a direct result of pollution from dam construction, as well as rapid flow changes during operation and altered water temperatures. All these impacts can have substantial effects on the river ecosystem.

Existing Water Quality Monitoring Network (WQN)

The current water quality monitoring network (WQN) has 48 sites, including 22 on the Mekong mainstream to detect large scale, long-term changes in physicochemical water quality. Appropriate data management and analysis procedures are in force including quality assurance procedures. However, programmes have not been designed to assess the impact of individual mainstream Mekong dams, which would require water quality monitoring within the reservoir and upstream and downstream of the development.

Recommendations

It is suggested that the established water quality monitoring network should be supplemented to assess the impacts of individual dams by detecting issues in the reservoir (e.g. stratification, algae blooms) and downstream. Additional monitoring locations should be established for water quality upstream and downstream of the dam site and some tributaries and multiple samples should be collected on each sampling occasion. The parameters currently included in the MRC water quality monitoring programme and chlorophyll should be monitored during the pre-project stage and thereafter. Additional parameters are warranted during construction and operations.

High frequency monitoring of all parameters included the MRC WQN should be performed in downstream water to detect changes due to hydropeaking, sediment flushing and other

processes. This includes such parameters as temperature, dissolved oxygen (DO) and turbidity and it is also recommended that chlorophyll measurements are taken in addition. At least monthly measurements of these parameters should be included in the MRC WQN.

2.4. Ecological health

Importance and potential impacts of hydropower projects

Apart from its importance to life in and around rivers, the ecosystem reflects the ecological health of the river. It responds to a whole variety of environmental factors including water quality, flow regime, channel morphology, the harvesting of aquatic plants and animals and invasive species.

Because the aquatic ecosystem responds to so many environmental factors, there are many potential risks. Creation of an impoundment eliminates the flowing water environment replacing it with a still water, lentic, environment which will have a different flora and fauna. That environment may be susceptible to risk from invasive organisms or algal blooms. Downstream of the impoundment there will be some alterations to flows, which may be minor or major depending on the impoundment and the operating rules, and there will be changes to water quality both of which will influence the aquatic ecosystem. In addition, channel changes may occur downstream of the dam, and a result of sediment deposition within the dam, which will also impact the biota downstream.

Current Ecological Health Monitoring Activities

Assessments were conducted annually from 2002 to 2008 and are now conducted every 2 years at 41 sites across the LMB to assess ecological health using indicator species. However, assessments of aquatic ecology in impact assessments for dams have been inadequate. There are problems associated with maintaining standardisation across the four separate country teams, as well as ensuring accurate and consistent identification of aquatic organisms and quality assurance procedures for the documents produced.

Recommendations

Pre and post-project sampling and monitoring would allow comparison of the ecological health before and after the hydropower development and therefore understanding of impacts. Baseline conditions must be sufficiently established to do this effectively. Monitoring should be carried out at locations upstream, within the impoundment and downstream of dam site. The MRC bioassessment protocols and indices, which have been designed specifically for the Mekong region and have proven effective, should be used in the river upstream and downstream. The existing MRC bioindicators (littoral macroinvertebrates, benthic diatoms, zooplankton and benthic macroinvertebrates) should be used, with the addition of chlorophyll to measure phytoplankton, and multiple samples should be collected. In the ISH 11 and 306, the use of macrophytes, amphibians and fish were also suggested. Monitoring should be established within the impoundment, including monthly sampling of chlorophyll and faecal coliform bacteria as well as annual surveys for pest species including both aquatic plants and animals.

2.5. Fish biodiversity and Fisheries

Importance and potential impacts of hydropower projects

There is acute concern over the impact of dams on the basin's fisheries, both in terms of individual developments on a local and basin-wide scale and the cumulative impact of multiple schemes. The impacts of damming, whether for hydropower, irrigation or flood control are numerous and can be summarized in terms of upstream and downstream effects, as well potential harm caused as fish bypass the dam and hydropower infrastructure.

Existing MRC fisheries monitoring programme

The MRC fisheries monitoring programme has been tracking the status and trends of fisheries in the LMB since 1994 but was not fully implemented until 2007. The programme is split into a number of different components: Fish Abundance and Diversity Monitoring Program, Fish Larvae Density Monitoring Program, Dai Fishery Monitoring Program, and the Lee Trap Monitoring Program.

However, inadequate monitoring of baseline status and absence of discourse on socio-economic aspects of fisheries means that it is inappropriate for monitoring impacts of Mekong hydropower dam projects.

Recommendations

It was suggested monitoring for fisheries should be standardised and align with data collected on hydrology, sediments, water quality and aquatic ecology to facilitate interpretation of the causes of variation in fisheries parameters. Establish comprehensive monitoring programs that monitor before, during and after dam construction. The scope of assessment needs to be widened beyond the immediate impacts of the dam. Additional monitoring sites should be established as recommended by ISH11 and FADM. The locations of the addition sites should be determined in relation to the monitoring required for the HPP schemes under construction and future developments. It is necessary to monitor the status within, upstream and downstream of impoundments and link all assessments to habitat and environmental variables. It has also been suggested to utilise telemetry tracking to study the effectiveness of fish pass design and functioning to enable improvement in passage efficiency and reduce mortality. Genetic studies may be necessary to understand fish migration patterns and trophic interactions. A food security and livelihoods study needs to be conducted in conjunction with fishing activities in the region to ensure socio-economic impacts are fully recognised. Monitoring should be implemented and continued indefinitely without interruption. Any monitoring included in the JEM should be compatible with the existing monitoring by the MRC, line agencies and developers to allow flawless integration. Data management and availability should be a high priority, with all available results by both developers and MRC programmes, plus external research outputs, collated in one data set. Capacity building / knowledge sharing workshops should be developed that allow developers to share their experiences in the monitoring of fisheries and OAAs at the project level, and the MRC and MCs to provide overviews of the monitoring results and trends in the LMB. Annual (where feasible) workshops

should be held where hydropower operators, the MCs and the MRC can present and discuss fisheries monitoring results.

3. Conclusion

A joint environmental management plan is needed in the LMB to ensure that the environmental impacts of dams are properly assessed and therefore prevent environmental damage.

The approach will involve the comprehensive monitoring of five key environmental variables (Hydrology and Hydraulics, Sediment, Water Quality, Ecological Health, Fish Diversity and Fisheries), which will be monitored and assessed for change as a result of specific dam projects.

Standard methods and procedures will be compiled in the project guidelines, which will use the information gathered in the Review document from relevant MRC documents, existing hydropower projects on the Mekong and approaches from other regions. The guidelines aim to support Member Countries and hydropower proponents to ensure the effective use of environmental data to report, mitigate and prevent any detrimental impacts as a result of hydropower dam projects.

Key Recommendations from the Review:

Hydrology

- Increase number of monitoring stations and integrate locally installed stations with the existing monitoring network.
- Integrate the wealth of remote-sensing data, into existing hydrological monitoring.
- Assess baseline hydrological conditions prior to project initiation.
- Use a combined modelling and monitoring approach to quantify any potential hydrological and hydraulic changes.

Sediment

- Increase the number of monitoring sites that determine sediment transport immediately upstream and downstream of impoundments.
- Include bedload and grainsize monitoring at every monitoring station.
- Repeat bathymetric profile monitoring regularly to document change, as well as improved data management and analysis.

Water quality

- Add to the established water quality monitoring network using multiple samples to assess the impact of individual dams and detect issues in the reservoir (e.g. stratification, algae blooms) and downstream.
- Ensure high frequency monitoring of temperature, dissolved oxygen (DO) and turbidity in downstream water to detect changes due to hydropeaking, sediment flushing etc. Include at least monthly measurements of all parameters in the MRC WQN.

Ecological health

- Establish monitoring sites upstream and downstream of dam sites using the existing MRC EHM methods.
- Monitoring for assessment of impoundments should be conducted annually for potential pest species.
- Adequate training must be provided, along with quality assurance procedures.

Fisheries

- Establish comprehensive standardised monitoring programmes that monitor fisheries and fish biodiversity before, during and after dam construction.
- The scope of assessment needs to be widened beyond the immediate impacts of the dam.
- Monitor the fisheries status within, upstream and downstream of impoundments and link all assessments to habitat and environmental variables.
- Invest in studies to assess the effectiveness of fish passes to improve mitigation measures.
- Conduct a food security and livelihoods study associated with fishing activities in the region to ensure socio-economic impacts are fully recognised.

MRC Secretariat
184 Fa Ngoum Road, P.O.Box 6101, Vientiane, Lao PDR
Tel: +856 21 263 263
Fax: +856 21 263 264
e-mail: mrcs@mrcmekong.org
www.mrcmekong.org