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BUILDING RESERVOIR SEDIMENT MODELING CAPABILITIES WITH THE LAO PDR MINISTRY OF ENERGY AND MINES

BY JOHN SHELLEY, PAUL BOYD, STANFORD GIBSON, DANIEL PRIDAL AND TRAVIS DAHL

Background

Over the past several years the Mekong River Basin has experienced rapid development of new hydropower dams. Eleven (11) proposed dams on the main-stem of the Lower Mekong River (six are wholly within the Lao People's Democratic Republic (Lao PDR), two are on the Lao PDR-Thailand shared border, one on the Lao PDR-Cambodia border, and two are wholly within Cambodia), and numerous additional dams on tributaries, have the potential to significantly reduce the sediment input to the downstream channel (Figure 1). The sediment continuity in the Mekong basin is vital to maintaining the fisheries that over 50 million residents rely on according to National Geographic. There is an increased need to understand and minimize the impacts of reservoir sedimentation.

In 2013, the Government of Lao PDR requested, through the U.S. Embassy in Vientiane, specific assistance in hydraulic and sediment transport modeling for several key dam projects. Since 2014, reservoir sedimentation experts from the U.S. Army Corps of Engineers (USACE) have interfaced in a series of technical exchanges with the Ministry of Energy and Mines Department of Energy Policy and Planning (MEM-DEPP). The overall goal of these exchanges is to equip MEM with the technical oversight and review skills to improve the environmental and social sustainability of hydropower development in the Mekong River Basin. Proper planning and oversight can limit the impacts of dam building on the aquatic ecosystem of the lower Mekong River and increase the long-term sustainability of all reservoir benefits, including hydropower dams in Lao PDR.

Sediment Properties and Transport Analysis Workshops

Since 2014, USACE experts have held several workshops on topics such as sediment properties, river geomorphology, watershed

management, and dam safety considerations. A set of three workshops in 2015 in Luang Prabang, Paksan, and Pakse, introduced nearly 80 MEM-DEPP engineers and technical staff to the physical processes that transport and deposit sediment in reservoirs, and methods to estimate the volume of sediment that has or would deposit in a reservoir (Figures 2 and 3). In 2016, a subsequent pair of workshops intro-

duced river and reservoir sediment management methods as well as an initial exposure to sediment transport numerical modeling.

Collaborative Numerical Modeling Workshops

In 2017, USACE personnel held a hands-on reservoir sediment modeling workshop with

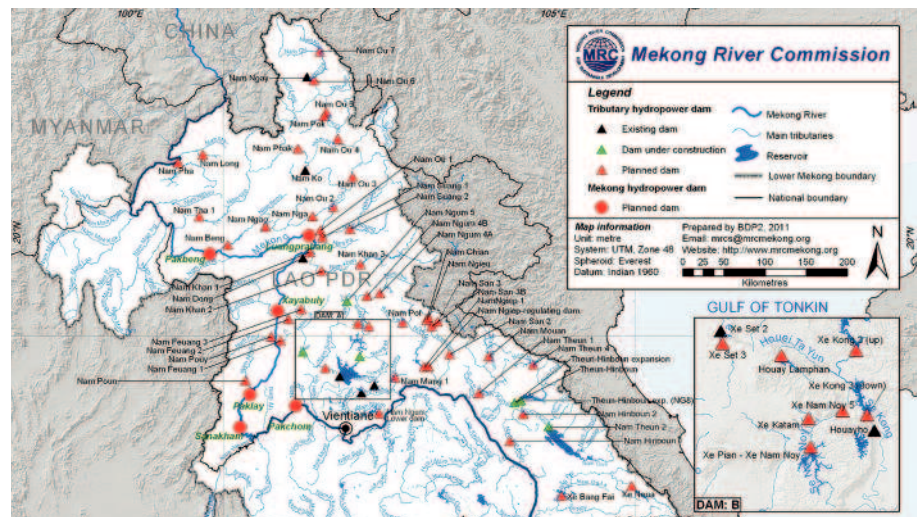


Figure 1. Excerpt from "Existing and Planned Hydropower Projects in Lao PDR"^[2]



Figure 2. Dr. Paul Boyd and Mr. Daniel Pridal with MEM-DEPP engineers at Nam Khan 3 dam site



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MEM-DEPP engineers. The workshop included presentations by USACE experts interspersed with hands-on collaborative modeling exercises conducted jointly by USACE and Lao PDR engineers. These modeling exercises utilized the Hydrologic Engineering Center River Analysis System (HEC-RAS) version 5.0.3^[1], which combines hydraulic modeling, sediment modeling, and reservoir gate operations. During

the workshop, MEM-DEPP engineers built models using data from Lao watersheds and existing or proposed dams. These models allow for evaluating changes in management and infrastructure, and how those can affect the projected reservoir sedimentation. MEM-DEPP engineers modeled changes in reservoir pool level management that resulted in increased sediment transport to the river below the dams. Also tested was the effectiveness of drawdown flushing with and without low-level outlets. Over time these actions can reduce the environmental impact of dams on the downstream channel and prolong the useful life of the dams and hydropower infrastructure.

The workshop also included a visit to the Nam Mang 1 dam (Figure 4). The original construction of the dam included a sediment bypass tunnel. In most years, the heavily-forested watershed does not contribute significant quantities of sediment. However, wildfires,

landslides, major storms, and other disturbances have the potential to introduce significant quantities of sediment in a short time frame. The inclusion of the sediment bypass tunnel allows flexibility in future operations to handle these eventualities.

Not all current designs for dams include active sediment management infrastructure. MEM intends to use the sediment modeling skillset to ensure that the current and future designs meet the sustainability goals that the Government of Lao PDR has set forth for hydropower development.

Future

USACE is continually expanding the sustainable reservoir management knowledge base, and will hold future workshops with MEM under a train-the-trainer framework. In the future, MEM-DEPP engineers who have developed the sediment modeling skillset will partner in delivering workshops to a larger group of MEM engineers, ensuring that knowledge effectively transfers to MEM staff located in provincial offices. Future workshops will use HEC-RAS v.5.0.5, which will bring increased geospatial functionality and independence without the need for integration with licensed software.

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Figure 3. Mr. Vithounlabandid THOUMMABOUT leads a team of MEM-DEPP engineers learning to estimate bed material size with a gravelometer (March 2015)



Figure 4. Nam Mang 1 Outlet Channel and Sediment Bypass Tunnel