

Supporting Information for

Drastic decline of floodpulse in the Cambodian floodplains (the Mekong River and the Tonle Sap system)

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Contents of this file

Tables S1 to S4

Introduction

Tables presented in this document are additional information that have been referenced in the main text. See main text for more information on their materials and methods.

Table S1. *Non-comprehensive list of irrigation schemes in Cambodia*

| Project Name | Duration | Partner |
|---|-----------|------------|
| Tonle Sap Lowlands Rural Development Project | 2008-2015 | |
| Uplands Irrigation and Water Resources Management Sector Project | 2015-2019 | ADB |
| Greater Mekong Subregion Flood and Drought Mitigation and Management Sector Project | 2012-2017 | |
| North West Irrigation Sector Project | 2005-2014 | ADB /AFD |
| Stung Chinit Irrigation and Rural Infrastructure Project | 2000–2008 | ADB/AFD |
| Water Resources Management Sector Development Program | 2010–2016 | ADB/DFAT |
| Cambodia Agricultural Value Chain Program (CAVAC) Phase 1 and 2 | 2010–2021 | DFAT |
| Rehabilitation of Prey Nup Polders | 1997–2008 | |
| Water Resources Management & Agricultural Transition for Cambodia, Phase 1 and 2 | 2014–2025 | AFD |
| Kanghot Irrigation Development, Phase 1 and 2 | 2010–2016 | |
| Multi-purpose Dam Development | 2012–2017 | |
| Prek Stung Keo Water Resources Development | 2011–2015 | PRC |
| Stung Chikreng Water Resources Development, Phase 1 | 2014–2019 | |
| Design and Build of Stung Pursat Dam | 2011–2015 | |
| Stung Sreng Water Resources Development 1 and 2 | 2011–2017 | |
| Vaico Irrigation Development Phase 1 | 2012–2017 | |
| Approximately 22 small-scale rehabilitation projects | 2009–2016 | |
| Technical Services Centre for Irrigation Systems, Phases 1 and 2 | 2001–2009 | |
| River Basin Water Resources Utilization in Cambodia | 2014–2019 | JICA |
| Southwest Phnom Penh Irrigation and Drainage Rehabilitation and Improvement project | 2014–2026 | |
| West Tonle Sap Irrigation and Drainage Rehabilitation and Improvement Project | 2011–2016 | |
| Dauntri Dam Development Project | 2014–2019 | |
| Krang Ponley River Basin development (multi-dams) | 2006–2012 | KOICA |
| Mongkol Borey Dam Project | 2011–2015 | |
| Sala Ta Orn Irrigation | 2013–2017 | |
| Mekong Integrated Water Resources Management Project | 2017–2021 | World Bank |

Note: ADB = Asian Development Bank, AFD= Agence Française de Développement, DFAT = Government of Australia, JICA= Japan International Cooperation Agency, KOICA, Korean International Cooperation Agency, PRC, People’s Republic of China. Source: (Asian Development Bank, 2019)

Table S2. Floodpulse variables at Stung Treng, Kratie, Kompong Cham, Chaktomuk, Neak Luong and Prek Kdam from 1960-2019.

| | | Pre-dam 1960-1991 | Growth 1992-2009 | Change | Mega-dam 2010-2019 | Change |
|--------------|------------------------------------|----------------------|---------------------|-------------|-----------------------|------------|
| Stung Treng | <i>MIN_{annual}/m</i> | 1.80 | 2.03 | +0.23m * | 2.40 | +0.60m * |
| | <i>MAX_{annual}/m</i> | 10.23 | 10.47 | +0.24m | 10.43 | +0.21m |
| | <i>AMPLITUDE/m</i> | 8.42 | 8.44 | +0.2% | 8.03 | -4.7% |
| | <i>START DATE</i> | 6/6 | 3/6 | -3 days | 7/6 | +1 day |
| | <i>PEAK DATE</i> | 28/8 | 25/8 | -3 days | 5/9 | +8 days |
| | <i>END DATE</i> | 5/12 | 7/12 | +2 days | 30/11 | -5 days |
| | <i>DURATION/days</i> | 182 | 186 | +4 days | 182 | No change |
| | <i>RISE RATE/mday⁻¹</i> | 0.087 | 0.088 | +1.8% | 0.087 | -0.04% |
| | <i>FALL RATE/mday⁻¹</i> | 0.071 | 0.077 | +9.0% | 0.083 | +17.6% |
| Kratie | <i>MIN_{annual}/m</i> | 5.28 | 6.13 | +0.85m * | 6.83 | +1.55m * |
| | <i>MAX_{annual}/m</i> | 20.87 | 21.23 | +0.36m | 21.19 | +0.32m |
| | <i>AMPLITUDE/m</i> | 15.59 | 15.10 | -3.2% | 14.36 | -7.9% * |
| | <i>START DATE</i> | 10/6 | 1/6 | -9 days * | 8/6 | -2 days |
| | <i>PEAK DATE</i> | 3/9 | 31/8 | -3 days | 6/9 | +3 days |
| | <i>END DATE</i> | 6/12 | 12/12 | +6 days | 10/12 | +4 days |
| | <i>DURATION/days</i> | 175 | 193 | +18 days * | 187 | +12 days |
| | <i>RISE RATE/mday⁻¹</i> | 0.163 | 0.146 | -10.5% | 0.150 | -7.8% |
| | <i>FALL RATE/mday⁻¹</i> | 0.134 | 0.131 | -1.9% | 0.139 | +3.9% |
| Kompong Cham | <i>MIN_{annual}/m</i> | 2.05 | 2.26 | +0.22m * | 2.65 | +0.60m * |
| | <i>MAX_{annual}/m</i> | 14.72 | 14.94 | +0.23m | 14.61 | -0.10m |
| | <i>AMPLITUDE/m</i> | 12.67 | 12.68 | +0.08% | 11.96 | -5.6% |
| | <i>START DATE</i> | 12/6 | 19/6 | +7 days | 21/6 | +9 days |
| | <i>PEAK DATE</i> | 6/9 | 11/9 | +5 days | 6/9 | No change |
| | <i>END DATE</i> | 14/12 | 7/12 | -7 days | 26/11 | -18 days |
| | <i>DURATION/days</i> | 188 | 187 | -1 day | 162 | -26 days * |
| | <i>RISE RATE/mday⁻¹</i> | 0.117 | 0.121 | +3.6% | 0.143 | +22.6% |
| | <i>FALL RATE/mday⁻¹</i> | 0.090 | 0.100 | +10.8% | 0.111 | +23.8% |
| Neak Luong | <i>MIN_{annual}/m</i> | 1.04 | 1.00 | -0.03m | 1.14 | +0.10m * |
| | <i>MAX_{annual}/m</i> | 7.22 | 7.14 | -0.08m | 6.67 | -0.55m |
| | <i>AMPLITUDE/m</i> | 6.19 | 6.13 | -1.0% | 5.53 | -10.6% * |
| | <i>START DATE</i> | 24/6 | 5/7 | +11 days | 9/7 | +15 days * |
| | <i>PEAK DATE</i> | 24/9 | 24/9 | No change | 19/9 | -5 days |
| | <i>END DATE</i> | 2/1 | 31/12 | -2 days | 15/12 | -18 days* |
| | <i>DURATION/days</i> | 191 | 188 | -3 days | 155 | -36 days * |
| | <i>RISE RATE/mday⁻¹</i> | 0.051 | 0.051 | -1.0% | 0.067 | +31.0% |
| | <i>FALL RATE/mday⁻¹</i> | 0.044 | 0.044 | +1.1% | 0.046 | +5.4% |
| Chaktomuk | <i>MIN_{annual}/m</i> | 1.79 | 1.74 | -0.05m | 1.74 | -0.05m |
| | <i>MAX_{annual}/m</i> | 9.91 | 9.91 | -0.00m | 9.15 | -0.76m |
| | <i>AMPLITUDE/m</i> | 8.13 | 8.17 | +0.5% | 7.40 | -8.9% |
| | <i>START DATE</i> | 29/6 | 3/7/2020 | +4 days | 10/7 | +11 days * |
| | <i>PEAK DATE</i> | 27/9 | 29/9/2020 | +2 days | 18/9 | -9 days |
| | <i>END DATE</i> | 7/1 | 2/1/2021 | -5 days | 13/12 | -25 days * |
| | <i>DURATION/days</i> | 193 | 192 | -1 day | 153 | -40 days * |
| | <i>RISE RATE/mday⁻¹</i> | 0.062 | 0.061 | -2.1% | 0.096 | +53.8% |
| | <i>FALL RATE/mday⁻¹</i> | 0.060 | 0.061 | +2.6% | 0.063 | +6.5% |
| Prek Kdam | <i>MIN_{annual}/m</i> | 0.65 | 0.81 | +0.16m * | 0.90 | +0.25m * |
| | <i>MAX_{annual}/m</i> | 8.92 | 8.93 | +0.01m | 8.13 | -0.79m |
| | <i>AMPLITUDE/m</i> | 8.27 | 8.11 | -2.0% | 7.20 | -12.9% * |
| | <i>START DATE</i> | 25/6 | 5/7 | +10 days | 10/7 | +15 days * |
| | <i>PEAK DATE</i> | 28/9 | 1/10 | +3 days | 5/10 | +7 days |
| | <i>END DATE</i> | 30/12 | 9/1 | +10 days | 26/12 | -4 days |
| | <i>DURATION/days</i> | 183 | 199 | + 16 days * | 163 | -20 days |
| | <i>RISE RATE/mday⁻¹</i> | 0.062 | 0.059 | -4.6% | 0.070 | +13.3% |
| | <i>FALL RATE/mday⁻¹</i> | 0.064 | 0.055 | -14.2% * | 0.057 | -10.6% |

(*) denotes statistically significant changes (p<0.05)

Table S3. Reverse flow variables at Prek Kdam (Tonle Sap River) during 1962-1972 and 1995-2018.

| | | Pre-dam 1962-1972 | Growth 1995-2009 | Change | Mega-dam 2010-2018 | Change | |
|-----------|-------------------------|---------------------------|---------------------|--------|-----------------------|--------|----------|
| Prek Kdam | Reverse Flow (RF) Phase | ANNUAL RF/km ³ | 49.67 | 37.75 | -24.0% * | 31.74 | -56.5% * |
| | | MAX _{RF} /cms | 9764 | 8393 | -14.0% * | 8312 | -17.5 * |
| | | START DATE | 01/06 | 29/05 | -3 days | 23/05 | -9 days |
| | | PEAK DATE | 16/08 | 16/08 | No Change | 09/08 | -7 days |
| | | END DATE | 22/09 | 01/10 | 9 days | 23/09 | 1 day |
| | | DURATION/days | 125 | 121 | -4 days | 112 | -13 days |
| | Transition Phase | DURATION/days | 41 | 6 | -35 days | 19 | -23 days |
| | Normal Flow (NF) Phase | ANNUAL NF/km ³ | 74.54 | 72.28 | -3.0% | 62.81 | -18.7% |

(*) denotes statistically significant changes (p<0.05)

Table S4. Floodpulse variables at Kompong Luang (Tonle Sap Lake) from 1996-2019.

| | | Growth 1996-2009 | Mega-dam 2010-2019 | Change |
|-----------------------------------|------------------------------------|---------------------|-----------------------|------------|
| Kompong Luang (Tonle Sap Lake) | <i>MIN_{annual}/m</i> | 0.70 | 0.60 | -0.10m |
| | <i>MAX_{annual}/m</i> | 8.58 | 7.52 | -1.05m* |
| | <i>AMPLITUDE/m</i> | 7.91 | 6.93 | -12.4%* |
| | <i>START DATE</i> | 25/07 | 25/07 | No change |
| | <i>PEAK DATE</i> | 14/10 | 15/10 | +1 day |
| | <i>END DATE</i> | 31/01 | 18/01 | -13 days * |
| | <i>DURATION/days</i> | 198 | 163 | -35 days* |
| | <i>RISE RATE/mday⁻¹</i> | 0.06 | 0.06 | -1.5% |
| | <i>FALL RATE/mday⁻¹</i> | -0.05 | -0.05 | -4.9% |

(*) denotes statistically significant changes (p<0.05)

References for Supporting Information

Asian Development Bank. (2019). *Irrigated Agriculture Improvement Project: Report and Recommendation of the President.*