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Supplement of

Quantifying human impacts on hydrological drought using a combined modelling approach in a tropical river basin in central Vietnam

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| Flow of the Vu Gia (m ³ s ⁻¹) | | Diversion |
|--|-----------------|-----------|
| Before Quang Hue | After Quang Hue | Rate (%) |
| 100.0 | 65.4 | 34.6 |
| 90.0 | 58.3 | 35.2 |
| 80.0 | 51.0 | 36.2 |
| 70.0 | 44.4 | 36.6 |
| 60.0 | 37.4 | 37.7 |
| 50.0 | 30.8 | 38.4 |
| 40.0 | 24.3 | 39.2 |
| 30.0 | 17.9 | 40.3 |
| 20.0 | 11.4 | 43.0 |

Table S1. The water diversion rules at the Quang Hue river from Vu Gia to Thu Bon. Before Quang Hue represent the actual flow of Vu Gia before the diversion. After Quang Hue, represent the remaining water that is continuing to flow to the Vu Gia through the Ai Nghia station. The Diversion Rate (%) represents the amount which diverted from the Vu Gia to Thu Bon river and flows over Giao Thuy Station.

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(a) A Vuong (MOIT, 2011a)

| Month | Flood Control | Upper Zone | Normal Zone | Lower Zone | Dead Level |
|-------|---------------|------------|-------------|------------|------------|
| Jan | 380 | 380 | 380 | 376 | 340 |
| Feb | 380 | 380 | 375 | 376 | 340 |
| Mar | 380 | 378 | 372 | 374.1 | 340 |
| Apr | 380 | 374.2 | 370 | 371 | 340 |
| May | 380 | 369.5 | 361 | 366 | 340 |
| Jun | 380 | 365.7 | 352 | 361.1 | 340 |
| Jul | 380 | 362.3 | 349 | 354.7 | 340 |
| Aug | 380 | 357.2 | 342 | 347.4 | 340 |
| Sep | 380 | 352.2 | 342 | 340 | 340 |
| Oct | 380 | 353 | 349 | 350 | 340 |
| Nov | 380 | 369 | 369 | 364 | 340 |
| Dec | 380 | 378 | 373 | 364 | 340 |

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(b) Dak Mi 4 (MOIT, 2011b)

| Month | Flood Control | Upper Zone | Normal Zone | Dead Level |
|-------|---------------|------------|-------------|------------|
| Jan | 258 | 258 | 255 | 240 |
| Feb | 258 | 258 | 256 | 240 |
| Mar | 258 | 258 | 255 | 240 |
| Apr | 258 | 256 | 253 | 240 |
| May | 258 | 252.7 | 249 | 240 |
| Jun | 258 | 251 | 248 | 240 |
| Jul | 258 | 249.7 | 246 | 240 |
| Aug | 258 | 244 | 241 | 240 |
| Sep | 258 | 240.3 | 240 | 240 |
| Oct | 258 | 240 | 240 | 240 |
| Nov | 258 | 244.5 | 240.2 | 240 |
| Dec | 258 | 253 | 247 | 240 |

(c) Song Bung 4 (MOIT, 2013)

| Month | Flood Control | Upper Zone | Normal Zone | Dead Level |
|-------|---------------|------------|-------------|------------|
| Jan | 222.6 | 222.5 | 216.9 | 205 |
| Feb | 222.6 | 222.5 | 215.3 | 205 |
| Mar | 222.6 | 222.5 | 212.4 | 205 |

| | | | | |
|-----|-------|-------|-------|-----|
| Apr | 222.6 | 222.5 | 208.7 | 205 |
| May | 222.6 | 222.5 | 206.9 | 205 |
| Jun | 222.6 | 222.5 | 205.7 | 205 |
| Jul | 222.6 | 219.4 | 205.3 | 205 |
| Aug | 222.6 | 215.5 | 205 | 205 |
| Sep | 222.6 | 218 | 205 | 205 |
| Oct | 222.6 | 220 | 205 | 205 |
| Nov | 222.6 | 222.5 | 213.8 | 205 |
| Dec | 222.6 | 222.5 | 216.8 | 205 |

(d) Song Bung 5 (MOIT, 2012b)

| Month | Flood Control | Normal Zone | Dead Level |
|-------|---------------|-------------|------------|
| Jan | 60 | 60 | 58.5 |
| Feb | 60 | 60 | 58.5 |
| Mar | 60 | 60 | 58.5 |
| Apr | 60 | 60 | 58.5 |
| May | 60 | 60 | 58.5 |
| Jun | 60 | 60 | 58.5 |
| Jul | 60 | 60 | 58.5 |
| Aug | 60 | 60 | 58.5 |
| Sep | 60 | 60 | 58.5 |
| Oct | 60 | 60 | 58.5 |
| Nov | 60 | 60 | 58.5 |
| Dec | 60 | 60 | 58.5 |

(e) Song Bung 6 (MOIT, 2012a)

| Month | Flood Control | Normal Zone | Dead Level |
|-------|---------------|-------------|------------|
| Jan | 34 | 34 | 31.8 |
| Feb | 34 | 34 | 31.8 |
| Mar | 34 | 34 | 31.8 |
| Apr | 34 | 34 | 31.8 |
| May | 34 | 34 | 31.8 |
| Jun | 34 | 34 | 31.8 |
| Jul | 34 | 34 | 31.8 |
| Aug | 34 | 34 | 31.8 |
| Sep | 34 | 34 | 31.8 |
| Oct | 34 | 34 | 31.8 |

| | | | |
|-----|----|----|------|
| Nov | 34 | 34 | 31.8 |
| Dec | 34 | 34 | 31.8 |

(f) Song Tranh 2 (MOIT, 2012c)

| Month | Flood Control | Normal Zone | Dead Level |
|-------|---------------|-------------|------------|
| Jan | 175 | 174.24 | 138 |
| Feb | 175 | 173.85 | 138 |
| Mar | 175 | 168.48 | 138 |
| Apr | 175 | 155.31 | 138 |
| May | 175 | 153.33 | 138 |
| Jun | 175 | 140.82 | 138 |
| Jul | 175 | 139.51 | 138 |
| Aug | 175 | 142.44 | 138 |
| Sep | 175 | 150.44 | 138 |
| Oct | 175 | 165.92 | 138 |
| Nov | 175 | 174.31 | 138 |
| Dec | 175 | 174.73 | 138 |

(g) Song Con (MOIT, 2008)

| Month | Flood Control | Upper Zone | Normal Zone | Dead Level |
|-------|---------------|------------|-------------|------------|
| Jan | 340 | 340 | 334.52 | 319 |
| Feb | 340 | 340 | 331.76 | 319 |
| Mar | 340 | 337.45 | 328.45 | 319 |
| Apr | 340 | 335.42 | 322.86 | 319 |
| May | 340 | 334.74 | 321.36 | 319 |
| Jun | 340 | 330 | 320.37 | 319 |
| Jul | 340 | 325.77 | 319.00 | 319 |
| Aug | 340 | 319 | 319.00 | 319 |
| Sep | 340 | 340 | 319.00 | 319 |
| Oct | 340 | 340 | 319.40 | 319 |
| Nov | 340 | 340 | 334.02 | 319 |
| Dec | 340 | 340 | 336.17 | 319 |

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Table S2- Operation Rules of the hydropower operation of the VGTB; (a) A Vuong, (b) Dak Mi 4, (c) Song Bung 4, (d) Song Bung 5, (e) Song Bung 6, (f) Song Tranh 2, (g) Song Con

| Calibrated parameters | Short description | calibrated Value | Range |
|-----------------------|--|------------------|----------|
| soilMaxDPS | Maximum depression storage capacity | 2 | 1.0 - 5 |
| soilMaxInfSummer | Maximum infiltration in summer | 40 | 1 -200 |
| soilMaxInfWinter | Maximum infiltration in winter | 100 | 1 -200 |
| soilDistMPSLPS | MPS/LPS distribution coefficient | 0.68 | 0 - 1 |
| soilDiffMPSLPS | MPS/LPS diffusion coefficient | 0.4 | 0 - 1 |
| soilConcRD1 | Recession coefficient for overland flow | 1.2 | 1.0 -3.0 |
| soilConcRD2 | Recession coefficient for interflow | 3.5 | 2.0 - 10 |
| soilPolRed | Potential reduction coeffiecient for aET computation | 3 | 1.0 - 10 |
| soilMaxPerc | Maximum percolation rate | 20 | 1.0 - 20 |
| gwRG1Fact | Adaptation of the fast groundwater outflow | 1 | 0.1 - 10 |
| gwRG2Fact | Adaptation of the baseflow | 0.4 | 0.1 - 10 |
| gwRG1RG2dist | RG1-RG2 distribution coefficient | 0.5 | 0 - 1 |
| flowRouteTA | River routing coefficient | 10 | 1 -100 |

Table S3. Parameters selected for the model calibration (other parameters of the model were left to default values during calibration)

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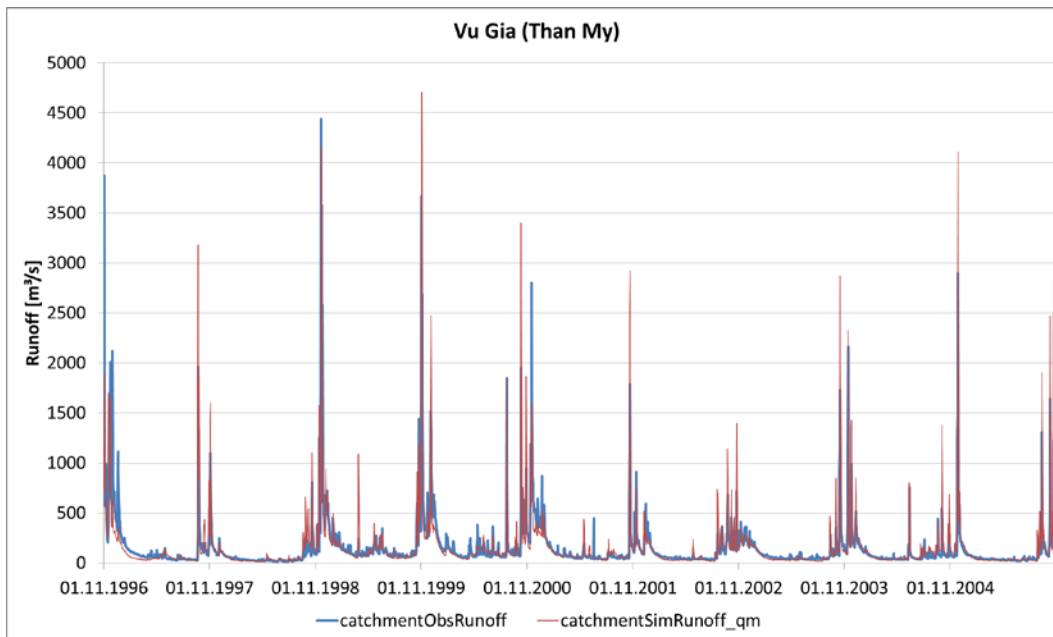
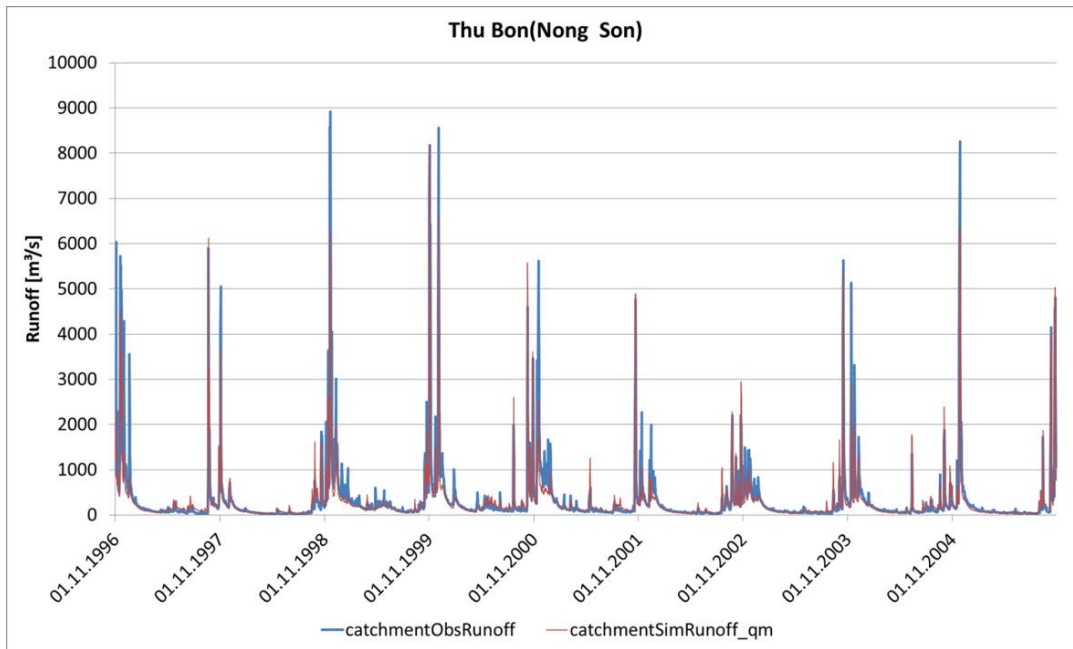


Figure S4. J2000 Hydrograph simulation compared to observed discharge (1996-2005) for the Thu Bon at Nong Son and Vu Gia river at Thanh My station.

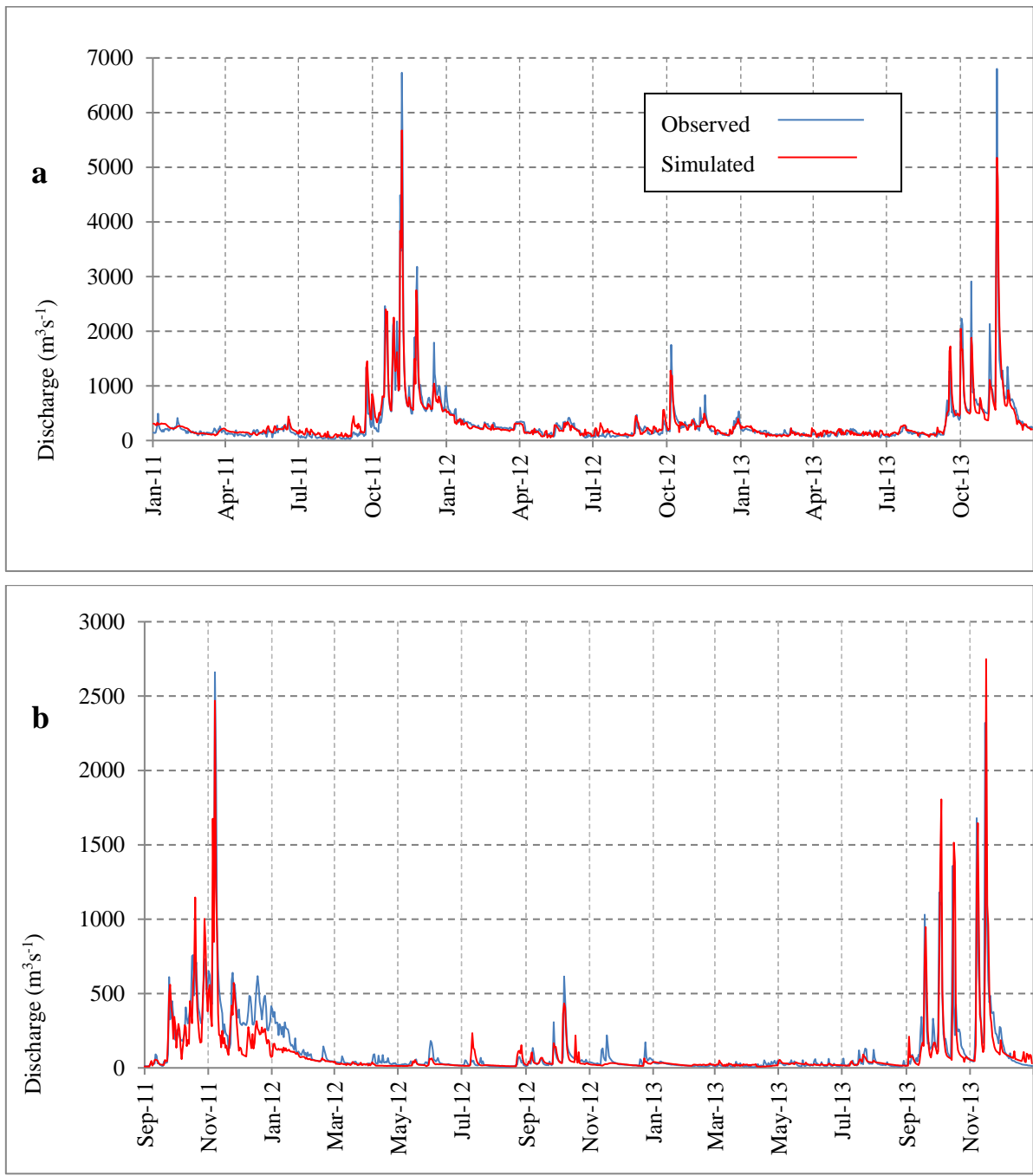


Figure- S5. Simulated reconstructed model output (Reservoir Simulation) compared to observed discharge from 2011 to 2013, for a) Thu Bon at Nong Son station, b) Vu Gia at Thanh My Station.

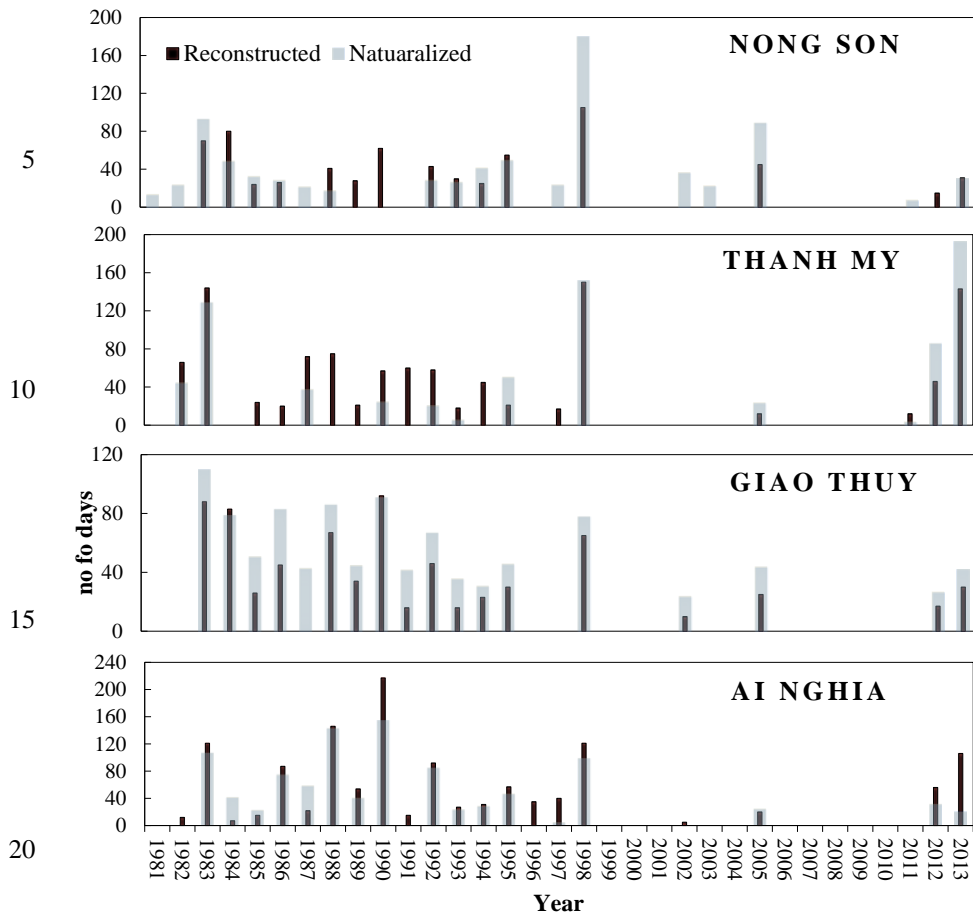


Figure S6. Number of hydrological drought days at four stations for both naturalized and reconstructed condition.

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Output uncertainty Plot

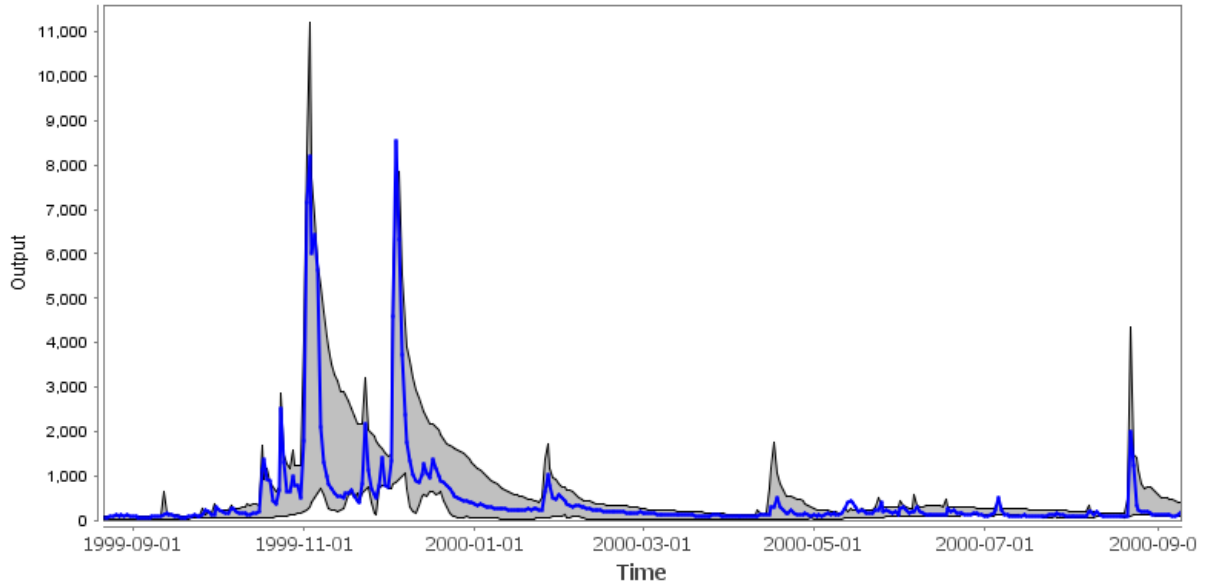


Figure S7. 5% best simulations (range grey shaded) versus observed discharge (blue line) at Nong Son.

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5 References

- MOIT: Decision Number 5538/QD-BCT, Decision on Song Con 1 and Song Con 2 Operation, Hanoi, 15.10.2008, Ministry of Investment and Trade (MOIT), Hanoi, Viet Nam, 2008.
- MOIT: Decision Number 6801/QD-BCT, Decision on Dak Mi 4 Reservoir Operation,, Ministry of Investment and Trade, Socialist Republic of Vietnam, Hanoi, Viet Nam, 2011a.
- 10 MOIT: Decision Number 6801/QD-BCT, Decision on Dak Mi 4 Reservoir Operation, Hanoi, 23.12.2011, Ministry of Investment and Trade (MOIT), Hanoi, Viet Nam, 2011b.
- MOIT: Decision Number 3711/QD-BCT, Decision on Song Bung 5 Reservoir Operation, Hanoi, 29.06.2012, Ministry of Investment and Trade (MOIT), 2012a.
- 15 MOIT: Decision Number 4537/QD-BCT, Decision on Song Bung 5 Reservoir Operation, Hanoi, 07.08.2012, Ministry of Investment and Trade (MOIT), Hanoi, Viet Nam, 2012b.
- MOIT: Ministry of Investment and Trade (MOIT), Decision Number 7878/QD-BCT, Decision on Song Tranh 2 Operation, Hanoi, 24.12.2012, Ministry of Investment and Trade (MOIT), Hanoi, Viet Nam, 2012c.
- MOIT: Decision Number 2093/QD-BCT, Decision on Song Bung 4 Reservoir Operation, Hanoi, 04.04.2013, Ministry of Investment and Trade (MOIT), Hanoi, Viet Nam, 2013.