Impacts of climate variability and water resources development on river flows and water balance of Huai Luang Watershed, Thailand

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Study area

- Watershed area: 4,122 km²
- Monthly temp: 16.3-36.3°C
- Annual rainfall: 1,145–2,174 mm
- Land-use:
  - 68% agriculture
  - 14% forest
  - 6% urban area
- Stakeholders in the basin have highlighted that changing rainfall pattern/variation and impacts of water resources development are the most critical concerns
River Profile

Flood in 2011

Mekong River

Flood level

Distance (km)
An increasing trend of annual rainfall during 32 year-period from 1982–2013

The variation of annual rainfall has double from ± 250 mm during 1982–1993 to ± 500 mm during 1998–2013
Rainfall analysis: spatial distribution

(a) Annual Rainfall Distribution Huai Luang Sub-basin 1982-1997

(b) Annual Rainfall Distribution Huai Luang Sub-basin 1998-2013

Statistics:
- Minimum value: 972 mm
- Maximum value: 1,757 mm
- Mean value: 1,405 mm
- Standard deviation: 170 mm

Statistics:
- Minimum value: 1,334 mm
- Maximum value: 2,024 mm
- Mean value: 1,672 mm
- Standard deviation: 188 mm
Water resources development plan

- Increase irrigation area
  - 315,195 rai (127,557 ha)
  - 200,000 rai (80,938 ha)

- Reduce water shortage for irrigation

- Reduce flood area 54,390 rai (22,011 ha)

- Increase water supply for domestic and industrial use
Modelling Tools

Rainfall-Runoff model

Water allocation model

Hydrodynamic and flood model
SWAT Model Setup

Topo/weather  Land cover  Soil  SWAT Subbasin
SWAT Model Calibration and Validation

### Daily flows

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Cal</th>
<th>Val</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R^2$</td>
<td>0.74</td>
<td>0.76</td>
</tr>
<tr>
<td>NSE</td>
<td>0.69</td>
<td>0.70</td>
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</table>

Satisfactory

### Monthly flows

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Cal</th>
<th>Val</th>
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</thead>
<tbody>
<tr>
<td>$R^2$</td>
<td>0.81</td>
<td>0.91</td>
</tr>
<tr>
<td>NSE</td>
<td>0.79</td>
<td>0.84</td>
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</table>
Global Sensitivity Analysis

Most sensitive parameters

P-Value

t-Stat

10:R__CH_N2.rte
6:R__SOL_AWC(...).scl
5:V__ESCO.bsn
4:V__GWQMN.gw
3:V__GW_DELAY.gw
7:V__GW_REJAP.gw
9:R__SOL_K(...).scl
2:V__ALPHA_RF.gw
6:V__RCHRG_DP.gw
1:R__CN2.mat
Simulated Flow Analysis

An increasing trend of annual flows at the outlet during 30 year-period from 1983–2012
WEAP Model Setup

- Irrigation water demand
- Domestic water demand

- Reservoir operation
- Water allocation and water balance
Water Demand Estimation

Irrigation water demand (million m³)

1983-1997: 200
1998-2012: 340

Domestic water demand (million m³)

1983-1997: 10
1998-2012: 15


45% increase in domestic water demand from 1983-1997 to 1998-2012.
Percentage of water supply coverage

Domestic water use

Irrigation water use
Next step: Flood Modelling

Flood in 2010 during Sep-Oct

Mike Flood (M11+M21)  Field Survey
Next step: Impacts of Climate Change

- Climate change projection database
- 1x1 km resolution
- Contain 4 RCPs and 40 GCMs from the CMIP5
- Generate monthly change factors (rainfall, temperature, humidity, solar radiation) for the SWAT model
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THANK YOU