Impact of oil palm expansion on water quantity and Nitrate load in Merangin Tembesi Watershed, Jambi Province, Indonesia

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Introduction

- Oil palm distribution in Indonesia
  - Year 2014: 10 millions ha,
  - Year 2025: 20 millions ha

- Widespread perception:
  - Oil palm affects significantly water quantity and quality

- Scientific researches on these issues are still scarce
Distribution of oil palm in Indonesia
Hotspots of Indonesia’s recent oil palm boom

Merangin Tembesi watershed

Legend

- Baseline 2010
- Land use
  - Agroforest
  - Bareland
  - Dryland farming
  - Forest
  - Lake
  - Mangrove
  - Oil palm
  - Rubber
  - Sawah
  - Shrublands
  - Settlements
  - Swamps
  - Water body
Research objective: Predicting impact of oil palm expansion on water quantity and quality using SWAT
Methodology – SWAT parameterization

Field measurement of specific hydrological characteristics in oil palm

Bulk density  Infiltration  Canopy Interception

Nitrate in surface runoff

Parameterization of SWAT Model

Impact of oil palm expansion on Water yield, water quality

Baseline  Scenario
Result and Discussion

Oil palm Canopy Interception

![Chart showing Canopy interception (%) of rainfall for Oil palm, Rubber, and Forest, with labels 'a', 'ab', and 'b'.]
Result and Discussion

Oil palm soil infiltration

HSG → CN2
Result and Discussion

Overland flow

[HSG → CN2]

OV_n
Result and Discussion

Nitrate load

Fertilizer: 6.75 kg NPK/tree/year (oil palm: 143 trees/ha)

Management operations

![Graph showing nitrate load for different land use types: Oil palm, Rubber, Forest. The graph indicates higher nitrate load in oil palm compared to rubber and forest.]
Table 2. The SWAT input parameters in different land use types obtained from the plot experiment.

<table>
<thead>
<tr>
<th>SWAT input parameters</th>
<th>Units</th>
<th>Oil palm</th>
<th>Rubber</th>
<th>Agroforest</th>
<th>Secondary Forest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum canopy storage (CANMX)</td>
<td>mm</td>
<td>4.0</td>
<td>2.7</td>
<td>4.3</td>
<td>5.8</td>
</tr>
<tr>
<td>Hydrologic soil groups (HSG)</td>
<td>D</td>
<td>D</td>
<td>C</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>Curve Number (CN2)*</td>
<td></td>
<td>88</td>
<td>85</td>
<td>76</td>
<td>55</td>
</tr>
<tr>
<td>Bulk density (SOL_BD)</td>
<td>gcm⁻³</td>
<td>1.24</td>
<td>1.30</td>
<td>1.22</td>
<td>1.14</td>
</tr>
</tbody>
</table>

* CN2 value for each land use type was adapted from SCS Engineering Division (1986) and Natural Resources Conservation Service (2007)
Model Calibration and Validation

Water Quantity

Nitrate load

NS = 0.6
Scenario 1

Baseline (Disbun -2010)

Water yield

Scenario 2

Future conversion of left over forest production

Nitrate load

Result and Discussion

Water yield

Nitrate load
On-going: Testing effectiveness of soil conservation measures in Oil Palm (silt–pit) plantation using SWAT

Silt Pit (20x15 ha=300 silt pit)
Oil palm expansion affect significantly water quantity and water quality in watershed scale

SWAT model can be used to test effectiveness of mitigation option