Status of Indonesian Soil Resources

Fahmuddin Agus\textsuperscript{1,2)}, Wiratno\textsuperscript{1)}, and Suwardi\textsuperscript{2,3)}

1) \textit{Indonesian Agency for Agricultural Research and Development}
2) \textit{Indonesian Society of Soil Science}
3) \textit{Bogor Agricultural University}
\texttt{f_agus@litbang.pertanian.go.id}

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Coverage

- Introduction (Indonesian Soils)
- Status of soil resources in the country (Land uses, management and land use changes):
  - Main issues and soil threats
- Technology options for sustainable soil management
Indonesian Soils
## Dominance of high rainfall areas (>2000 mm/annum)

<table>
<thead>
<tr>
<th>Island</th>
<th>&gt;5000</th>
<th>3,500-5,000</th>
<th>2,000-3,500</th>
<th>1,000-2,000</th>
<th>&lt;1,000</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sumatra</td>
<td>0.8</td>
<td>21.5</td>
<td>71.5</td>
<td>6.2</td>
<td>-</td>
<td>21.5</td>
</tr>
<tr>
<td>Java</td>
<td>1.9</td>
<td>12.6</td>
<td>56.0</td>
<td>29.5</td>
<td>-</td>
<td>23.7</td>
</tr>
<tr>
<td>Bali, NTB, NTT</td>
<td>-</td>
<td>2.1</td>
<td>16.3</td>
<td>69.6</td>
<td>12.0</td>
<td>71.9</td>
</tr>
<tr>
<td>Kalimantan</td>
<td>-</td>
<td>29.0</td>
<td>66.3</td>
<td>4.7</td>
<td>-</td>
<td>30.9</td>
</tr>
<tr>
<td>Sulawesi</td>
<td>-</td>
<td>23.0</td>
<td>66.1</td>
<td>30.9</td>
<td>0.8</td>
<td>26.4</td>
</tr>
<tr>
<td>Maluku</td>
<td>-</td>
<td>1.7</td>
<td>71.9</td>
<td>26.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Papua</td>
<td>10.3</td>
<td>33.7</td>
<td>40.3</td>
<td>15.7</td>
<td></td>
<td>43.3</td>
</tr>
<tr>
<td>Total</td>
<td>2.6</td>
<td>20.5</td>
<td>59.7</td>
<td>16.2</td>
<td>1.0</td>
<td>100</td>
</tr>
</tbody>
</table>
## Steep slopes

<table>
<thead>
<tr>
<th>Slopes</th>
<th>Slope (%)</th>
<th>Area (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mountainous (very steep)</td>
<td>&gt;30</td>
<td>27</td>
</tr>
<tr>
<td>Hilly (moderately steep)</td>
<td>15-30</td>
<td>20</td>
</tr>
<tr>
<td>Undulating (strongly sloping)</td>
<td>8-15</td>
<td>13</td>
</tr>
<tr>
<td>Flat-sloping</td>
<td>0-8</td>
<td>39</td>
</tr>
</tbody>
</table>
Indonesian Soil Resources
188 Mha

- **Upland**
  - Acid soil: 107.4 Mha
  - Semi-arid: 10.7 Mha
  - Others: 26.4 Mha

- **Wetland / Aquic**
  - Tidal: 8.4 Mha
  - Freshwater: 11.6 Mha
  - Peat (Organic): 14.9 Mha

- **Swampland**
  - 34.9 Mha

- **Others**
  - 26.4 Mha

- Current agricultural land ~ 53 Mha
- Suitable for future expansion ~ 35 Mha
- Conservation and environ. services ~ 100 Mha
MAIN ISSUES AND SOIL THREATS

- Land pressure (LULUC)
- Soil degradation
- Climate change
- Socio-economic and Land tenure issues
Land use and land use change

Area (Mha)

Mineral soil

2006
2011

Primary forest
Secondary forest
Mangrove forest
Shrub+Bareland+Grassland
Forest plantation
Other tree based agric.
Annual crop and paddy
Others

Forest
Idle
Production area
Land use and land use change

Peat soil

Area (Mha)

Primary forest
Secondary forest
Mangrove/Forest
Shrub+Bareland
Grassland
Forest plantation
Other tree based agric.
Annual crop and pasture
Others

2006
2011
Sumber: BPS (1986-2013)
Causes of land degradation

- **Natural factor:** slope, rainfall
- **Anthropogenic:**
  - Imbalanced fertilization: overuse, too little and imbalance
  - Intensive steep slope agriculture
  - Open mining
  - Industrial wastes
  - Over-draining (in case of peatland)
N fertilizer rates in Java do not ensure high yield

- High residue
- Unbalance use

Source: Buresh et al. (2014)
$\text{P}_2\text{O}_5$ rates are not strongly related to rice yield (Buresh et al. 2014)
### Change of soil P status in lowland rice (West Java and Banten Provinces)

<table>
<thead>
<tr>
<th>Status of Soil P</th>
<th>Map of 2000</th>
<th>Updated map in 2010</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ha</td>
<td>%</td>
<td>Ha</td>
</tr>
<tr>
<td>Low</td>
<td>235,621</td>
<td>19</td>
<td>64,084</td>
</tr>
<tr>
<td>Middle</td>
<td>454,396</td>
<td>38</td>
<td>304,681</td>
</tr>
<tr>
<td>High</td>
<td>523,348</td>
<td>43</td>
<td>755,520</td>
</tr>
<tr>
<td>Total</td>
<td>1,213,365</td>
<td>100</td>
<td>1,124,285</td>
</tr>
</tbody>
</table>
Good response to additional manure and P on maize grain yield (Husnain et al.)

A: Rock Phosphate (RP)  B: Chicken Manure (CM)  C: RP+CM
Intensive agriculture on steep slopes

- Erosion
- Siltation
- Mass wasting
- Agrochemical transport
Climate change effects on soil

• Higher temperature $\rightarrow$ Higher ET $\rightarrow$ soil dryness
• Unpredictable and extreme weather
  o Extremely high rainfalls $\rightarrow$ Water saturation and inundation, Soil erosion and mass movement, Nutrient leaching and soil acidification
  o Low rainfall and long dry season $\rightarrow$ Drought, Salinization
• Sea level rise and salt water intrusion $\rightarrow$ Inundation, salinization
Adaptation approaches
Adaptation approaches to the harsher climate events?

<table>
<thead>
<tr>
<th>Effects on soil condition</th>
<th>Soil management approaches</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Soil dryness</strong></td>
<td>• Irrigation</td>
</tr>
<tr>
<td></td>
<td>• Water harvesting</td>
</tr>
<tr>
<td></td>
<td>• Increase water holding capacity</td>
</tr>
<tr>
<td></td>
<td>o Mulching</td>
</tr>
<tr>
<td></td>
<td>o Application of organic matter</td>
</tr>
<tr>
<td><strong>Water saturation and inundation</strong></td>
<td>• Improvement of drainage system</td>
</tr>
<tr>
<td></td>
<td>• Increase infiltration</td>
</tr>
<tr>
<td></td>
<td>• Cover crops</td>
</tr>
<tr>
<td><strong>Soil erosion</strong></td>
<td>• Increase infiltration</td>
</tr>
<tr>
<td></td>
<td>• Reduce slope steepness and length ➔ terracing</td>
</tr>
<tr>
<td></td>
<td>• Cover crops</td>
</tr>
<tr>
<td><strong>Mass movement</strong></td>
<td>• Reduce soil burden</td>
</tr>
<tr>
<td></td>
<td>• Improve drainage system</td>
</tr>
</tbody>
</table>
### How should we manage the soil (cont.)?

<table>
<thead>
<tr>
<th>Effects on soil condition</th>
<th>Management techniques and practices</th>
</tr>
</thead>
</table>
| Nutrient leaching and acidification | • Increase soil CEC  
• Increase water holding capacity  
• Increase soil organic matter  
• Split application of leachable nutrients  
• Cover crops |
| Salinization               | • Leaching with fresh water         |
| Inundation, salinization   | • Drainage, leaching                |
Mulches

- Reduce transpiration
- Control erosion
- Regulate soil temperature
- Reduce weeds

Recycles plant residues and nutrients
Life mulch and circle weeding of *Arachis pintoi* under pepper (*Piper nigrum*)

- Runoff water almost totally filtered
- N-fixing system
- *Arachis pintoi* attracts snails
- Good source of protein for ducks
Bench terrace on very steep slope: paddy and secondary crops rotation with advantages and disadvantages.
Sediment and litter pits under coffee plantation
Conservation tillage

- Ridge tillage
- Minimum tillage
- No tillage

Herbicide use becomes important under no tillage practice. Avoid excessive use.
Ameliorants

- Lime
- Organic matter
- Steel slag: Si, Ca
- Peat fertilizers: Ca, Mg, P
- Biochar
Soil test kit for balanced fertilization
The case of peat soil

- Carbon storage
- High CO$_2$ emissions when drain
- Rapid subsidence

- Keep water table high (close to soil surface)
- Avoid using peat forest
- Increase productivity of existing agriculture on peatland
National Priorities

• Attainment of food security (rice, maize, soybean)
  o Subsidies and improvement of fertilizer distribution
  o Improvement of irrigation networks
  o Support on farm machineries, esp. for tillage and harvesting

• Extension and capacity building
  o Cropping calendar
  o Fertilizer recommendation
  o Soil conservation
Bottom-up planning to discuss: Designs, materials, costs, supporting institutions

Build up from existing practices
Lucrative vegetable farming

Thank you

ขอบคุณ

Terima kasih