Constructed Wetlands in the Water-Energy-Waste Nexus

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What is wrong with this picture
Research Questions

How can we at the same time provide:

• adequate sanitation in developing countries
• fuel supplies for household needs
• fertilizer and organic material for crop production

➢ Assess potential of low-technology, low-maintenance wastewater treatment approaches, from which resources can be recovered

➢ Can biomass recovery from constructed wetlands help close the Water-Soil-Waste Nexus?
Wetlands to Treat Wastewater
What did we do?

► +400 publications reviewed
► 800 observations for biomass density in +20 countries
► for 4 wetland plants: Phragmites spp. (common reed), Typha spp. (cattail), A. donax (giant reed), and C. papyrus (papyrus)
Wetlands to Treat Wastewater

Wetland Plants

- *A. donax* – Giant reed
- *Phragmites* – Common reed
- *Cyperus* – Papyrus
- *Typha* – Cattail

Source: Barbagallo, et al., 2013
Biomass Yield
Energy from Direct Combustion

Wetland biomass can provide up to 55% of the energy needs of a small community.

Heat Yield (MJ/kg)

<table>
<thead>
<tr>
<th>Material</th>
<th>Heat Yield (MJ/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wetland plants</td>
<td>18</td>
</tr>
<tr>
<td>Acacia firewood</td>
<td>19</td>
</tr>
<tr>
<td>Charcoal briquette</td>
<td>24</td>
</tr>
<tr>
<td>Anthracite coal</td>
<td>32</td>
</tr>
</tbody>
</table>

Biomass briquettes from *Cyperus* (Morrison, et al., 2013).
Energy from Biogas Generation

Biogas for a Community of 60 Persons (12 families)

Biogas yield, A. *donax* = 2,800 L/d

One meal for a family of five = 1,000 L

Biogas can supply about 30% of cooking needs for one meal/day for each family

Biogas production can be greatly increased by adding other household organic matter

Water Reuse Potential

- Level of evapotranspiration:
  - Phragmites spp. > A. donax > C. papyrus
  - Typha spp. > C. papyrus
- Careful balancing of water portfolios necessary in arid regions

From the wetland effluent up to 1,040 kg of maize could be produced on 3300 m$^2$ of irrigated land over the course of one growing season in a small community.
Maybe this is better?
Constraints & Preconditions

CWs can be effective as a NEXUS solution if

• Wastewater is produced and can be collected (as opposed to latrines or similar)

• Centralized collection is not necessary; decentralized or household solutions can be effective

• Population centres and agricultural areas are in close proximity

• Water is sufficiently available to support wetlands
Thank you for your attention.

Danke für Ihre Aufmerksamkeit.

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