Waste Management in Brazil/
Rio de Janeiro City:
Focus on the Organic Fraction

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Important characteristic for waste management planning:

- In Brazil, almost half of 191 million inhabitants live in urban areas;

- 73% of 5,564 municipalities have not more than 20 thousand inhabitants.

Ministério das Cidades (2015) based on data from 2013
Waste Management Hierarchy

1. Avoidance
2. Source Reduction
3. Reuse
4. Recycling
5. Energy Recovery
6. Treatment
7. Disposal


Sustainability
NATIONAL LAW Nº 12.305 (AUG 2010)
Establishing the National Policy on Solid Waste

Brazilian Waste Management Hierarchy

NO GENERATION
GENERATION REDUCTION
RECYCLING
"TREATMENT"
(WITH OR WITHOUT ENERGY RECOVERY ??)
FINAL DISPOSAL "RESIDUES" (rejeitos)
Included in the LAW Nº 12.305/2010

HOUSEHOLD + PUBLIC WASTE = URBAN WASTE;

COMMERCIAL WASTE;

SOLID WASTE FROM SANITATION SERVICES;

MEDICAL WASTE;

INDUSTRIAL WASTE;

CONSTRUCTION / DEMOLITION WASTE;

AGRICULTURE WASTE;

TRANSPORT WASTE;

MINING WASTE.
Important improvements brought by the Law

• IMPLEMENTATION OF **WASTE MANAGEMENT PLANS** AT NATIONAL, STATE, MICROREGION, INTERMUNICIPALITY, METROPOLITAN AND MUNICIPAL LEVELS;

• STRATEGIES TO PROMOTE **SEPARATION AT THE SOURCE AND RECYCLING**;

• **SCAVANGER** COMMUNITIES IN THE **REVERSE LOGISTICS AND SEPARATION AT THE SOURCE** STRATEGIES;

• HELPS TO REACH THE **RECYCLING RATE OF 20% BY 2015** (IN ACCORDANCE TO THE CLIMATE CHANGE CONTROL POLICY);

**GOAL IMPOSSIBLE TO ACHIEVE:**

• OPEN DUMPS SHALL BE CLOSED **BY AUGUST/2014** (STILL WORKING ON IT IN 2016..........................)
Scavengers
AVAILABLE INSTRUCTION MANUALS:

• SOLID WASTE MANAGEMENT PLANS
• INTEGRATED MANAGEMENT PLANS FOR PUBLIC CONSORTIUMS
• APROPRIATION AND RECOVERY OF COSTS FROM PRIORITY CONSORTIUMS
• SEPARATION AND THE SOURCE AND COMPOSTING FOR CONSORTIUMS
• CONSTRUCTION SECTOR IN PUBLIC CONSORTIUMS
• INFORMATION SYSTEM IN PUBLIC CONSORTIUMS
Plano Municipal de Gestão Integrada de Resíduos Sólidos - PMGIRS da Cidade do Rio de Janeiro

AGOSTO 2012 – AGOSTO 2016
<table>
<thead>
<tr>
<th>PLANNING AREAS</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inhabitants</td>
<td>208,267</td>
<td>8,784</td>
<td>2,198,528</td>
<td>893,852</td>
<td>1,814,510</td>
<td>5,993,557</td>
</tr>
<tr>
<td>% of Population</td>
<td>3</td>
<td>15</td>
<td>37</td>
<td>15</td>
<td>30</td>
<td>100</td>
</tr>
<tr>
<td>Generation (ton/day)</td>
<td>734</td>
<td>1,526</td>
<td>3,480</td>
<td>1,494</td>
<td>2,432</td>
<td>9,666</td>
</tr>
<tr>
<td>% Solid Waste</td>
<td>8</td>
<td>16</td>
<td>36</td>
<td>15</td>
<td>25</td>
<td>100</td>
</tr>
<tr>
<td>Generation (kg per capita and day)</td>
<td>3.96</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1.62</td>
</tr>
</tbody>
</table>

SOURCE: COMLURB, 2012
HOUSEHOLD WASTE (0.79 kg/capita and day) (EU 1.2 kg) | 4,777
PUBLIC WASTE (0.52 kg/capita and day) | 3,129
MEDICAL WASTE, EMERGENCY, OTHERS | 795
TOTAL UNDER MUNICIPAL RESPONSIBILITY | 8,511
LARGE GENERATORS | 1,156
COMPOSITION OF HOUSEHOLD WASTE IN RIO

- ORGANIC: 53%
- PAPER: 41%
- METALS: 4.1%
- GLASS: 7.8%
- PLASTIC: 47%
- OTHERS: 6%

2,532 TON/DAY

COMPOSITION OF RECYCLABLES

- RECYCLABLES: 41%
Art. 9º:

§ 1º Technologies for energy recovery from urban solid waste can be applied as long as they have been proved to be environmentally and technically feasible and a monitoring program to control the emission of toxic gases is approved by the environmental agency.

ORGANIC FRACTION OF URBAN SOLID WASTE IN RIO CITY ≈ 53%
2,532 ton/day

Source: COMLURB, 2012

AEROBIC DIGESTION (COMPOSTING)
ANAEROBIC DIGESTION (BIOGAS)
THERMAL TREATMENT
What is normally done with the MSW in Brazilian cities?
Separation of biodegradable from non-biodegradable fractions

Composting

Anaerobic digestion

BIOGAS
$\text{CH}_4, \text{CO}_2, \text{N}_2, \text{H}_2, \text{H}_2\text{S}$

Landfills/Open Dumps
GENERATION

COMMINGLED WASTES

TRANSFER STATIONS

SEPARATION AT THE SOURCE – 2 OR MORE FRACTIONS

RECYCLING INDUSTRY

ENERGY

CHEMICAL INDUSTRY

PURIFICATION

RESIDUE

BIOGAS

ANAEROBIC DIGESTION

COMPOSTING

THERMAL?

FUTURE?

SANITARY LANDFILLS
BIOGAS PLANT IN GRAMACHO
7 Transfer Stations (Cajú, Jacarepaguá, Irajá) + 4 ATT Missões
3 Landfills (Gramacho-closed, Seropédica, Gericinó)
RESEARCH AREAS:

- Environmental Monitoring, Diagnosis and Modelling - MONIT

- Environmental Pollution and Contamination Treatment Technologies - TREAT

- Environmental/Natural Resources Management, Public Policies Towards Sustainability - SUST
Faculdade de Engenharia
Departamento de Engenharia Sanitária e de Meio Ambiente
DOUTORADO EM ENGENHARIA AMBIENTAL - DEAMB

1. DIAGNÓSTICO,
MONITORAMENTO E
MODELAGEM AMBIENTAL

- Caracterização física, química, microbiológica de matrizes ambientais
- Membranas filtrantes
- Nanotecnologias
- Ecotecnologias (Ecossistemas Engenheirados, Wetlands construídos, Biofiltros, Telhados Verdes, Biorremediação, Fitorremediação)

2. TECNOLOGIAS
DE TRATAMENTO

- Produção Mais Limpa P+I
- Energia a partir de resíduos
- Metais tóxicos
- Xenobióticos de origem industrial

3. MODELOS DE GESTÃO
SUSTENTABILIDADE

- Sustentabilidade nos negócios
- Micropoluentes emergentes
- Disruptores Endócrinos
- Produtos Farmacêuticos e de Uso Pessoal PPCPs
- Segurança & Prevenção
- Gerenciamento de Recursos Hídricos
- Políticas setoriais
- Gestão de Bacias

LINHA 1
- LCA
- Ciclo de Vida do Produto
- Reatores de bancada, Ensaios de tratabilidade

LINHA 2
- Charaterização física, química, microbiológica de matriz ambientais
- Membranas filtrantes
- Nanotecnologias
- Ecotecnologias (Ecossistemas Engenheirados, Wetlands construídos, Biofiltros, Telhados Verdes, Biorremediação, Fitorremediação)

LINHA 3
- Gestão de áreas contaminadas
- Auditoria Ambiental
- Economia Circular
- Gestão de resíduos
RESEARCH TOPICS WITH POTENTIAL TO INCLUDE BIOCHAR:

SOIL & LANDFILL
• Bioremediation and Phytoremediation of Contaminated Sites;
• Mitigation of soil contamination by waste: protection barriers and cover layers;
• Reduction of greenhouse gases emissions in landfills;

WATER & WASTEWATER
• Treatment of leachate from sanitary landfills;
• Sorption processes (non-conventional adsorbent, nanomaterial) for removal of organic and inorganic compounds from sewage and industrial wastewater treatment;
• Removal of pharmaceuticals and xenobiotic compounds from water/wastewater with sorption processes.
Review

A review of biochars' potential role in the remediation, revegetation and restoration of contaminated soils

Luke Beesley a,*, Eduardo Moreno-Jiménez b, Jose L. Gomez-Eyles c, Eva Harris d, Brett Robinson d, Tom Sizmur e

DOI 10.1007/s11356-013-1659-0

Using biochar for remediation of soils contaminated with heavy metals and organic pollutants

Xiaokai Zhang · Hailong Wang · Lizhi He · Koupie Lu · Ajit Sarmah · Jianwu Li · Nanthi S. Bolan · Jianchuan Pei · Huagang Huang
Biochar pyrolytically produced from municipal solid wastes for aqueous As(V) removal: Adsorption property and its improvement with KOH activation

Hongmei Jin\textsuperscript{a,b,c}, Sergio Capareda\textsuperscript{c}, Zhizhou Chang\textsuperscript{a,b,*}, Jun Gao\textsuperscript{d}, Yueding Xu\textsuperscript{a,b}, Jianying Zhang\textsuperscript{a,b}

Chemosphere 144 (2016) 122–130

Stability, nutrient availability and hydrophobicity of biochars derived from manure, crop residues, and municipal solid waste for their use as soil amendments

R. Zornoza\textsuperscript{*}, F. Moreno-Barriga, J.A. Acosta, M.A. Muñoz, A. Faz
THANK YOU

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