KATIA GONÇALVES GUTIERREZ

MATHEUS AUGUSTO DE OLIVEIRA FERNANDES

CARLOS AUGUSTO DE LEMOS CHERNICHARO

Modeling of a sanitary landfill for developing countries to improve the reliability of Life Cycle Assessment studies
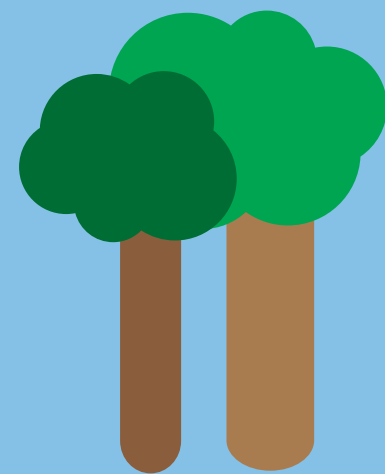
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DEPT. OF SANITARY AND ENVIROMENTAL ENGENEERING, FEDERAL UNIVERSITY OF MINAS GERAIS – UFMG – BRAZIL
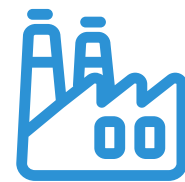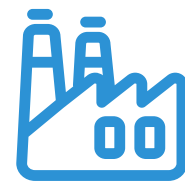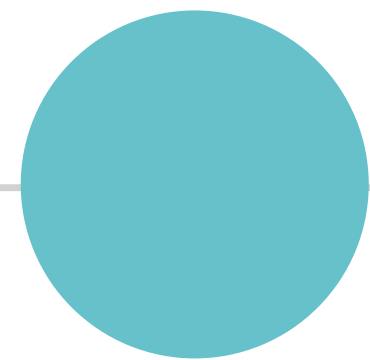
INTRODUCTION

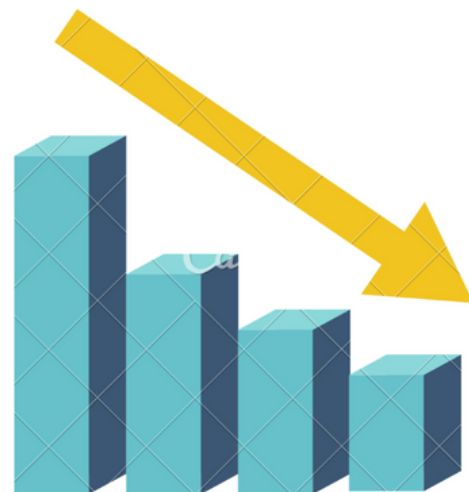SUSTAINABLE
ENVIRONMENT

WASTE
MANAGEMENT

SUSTAINABLE
CITIES

INTRODUCTION

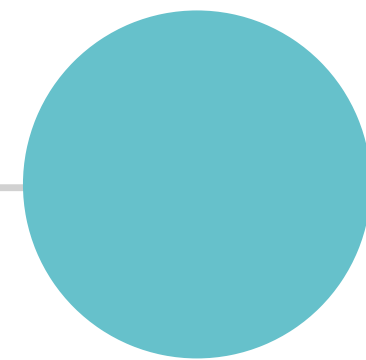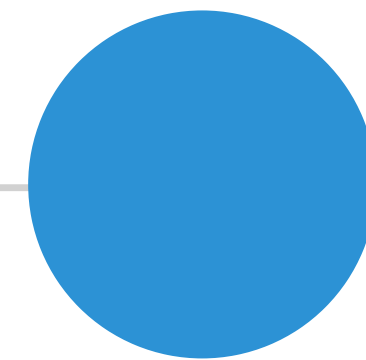## NATIONAL SOLID WASTE POLICY (2010)

68% (2000)
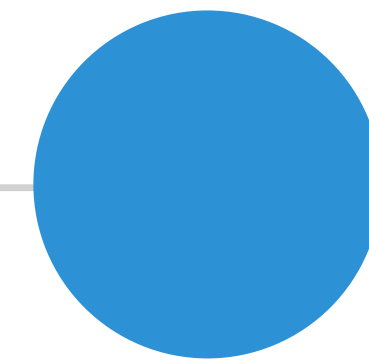
Open Dumps
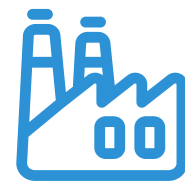
Sanitary Landfills

40% (2017)

28% (2018)
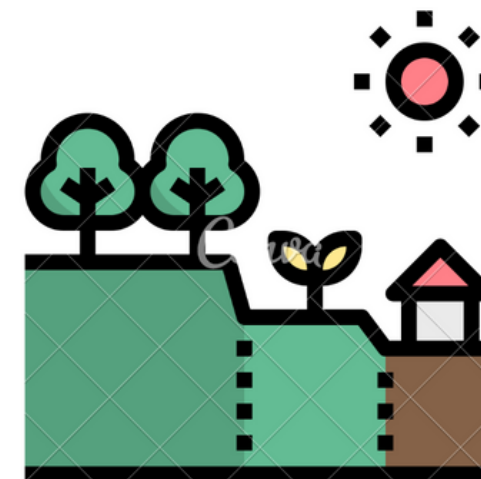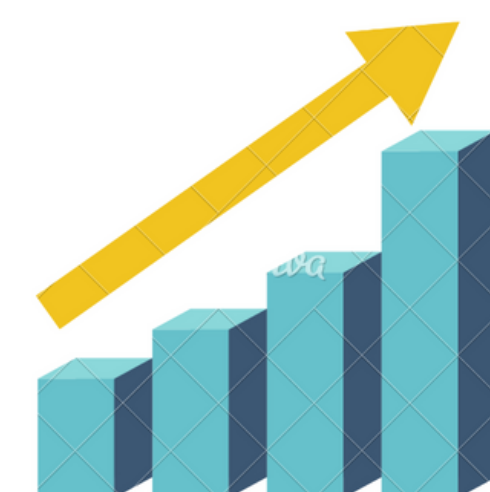
17% (2000)

LIFE CYCLE ASSESSMENT
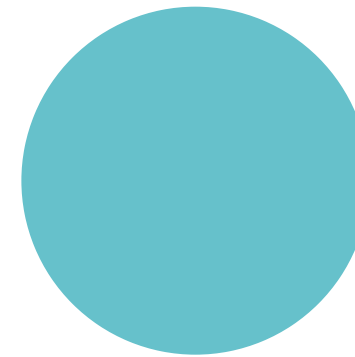
Need for a representative landfill model
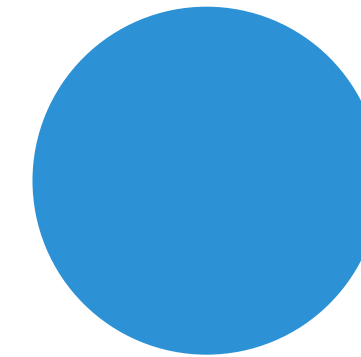
Most studies used european data

Technologies that are not used in small municipalities

Focus on only a few stages of waste degradation

INTRODUCTION

5570 MUNICIPALITIES - 2239 LANDFILLS

EMISSION QUANTIFICATION
METHODOLOGY TO BE REPORTED IN
LCA SOFTWARES

Life Cycle Inventory

Based on the characteristics of landfills located in small Brazilian cities

Usable on developing countries

Consideration of the full operation

METHODOLOGY

Legend

☐ Process

🟢 Ressource

🔵 Emission

🟠 Byproduct

Direct emissions

Flaring emissions

Flaring (50% efficiency)

Related emissions

Diesel

Atmospheric emissions

Biogas

Atmospheric emissions

Solid waste

Leachate

Treated leachate

Transport to landfill → Landfilling → Treatment in stabilization ponds

METHODOLOGY

Legend

Process

Ressource

Emission

Byproduct

Related emissions

Atmospheric emissions

Diesel

Solid waste

Transport to landfill

Landfilling

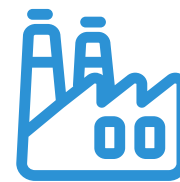Trucks (3.5 tonnes of load capacity)

15km way-and-back distance

Diesel based on the average use of a 25,000 inh. city

Emissions due to diesel burning in the damp truck and bulldozers

METHODOLOGY

Legend

□ Process

● Ressource

● Emission

● Byproduct

Direct emissions

Flaring emissions

Direct emissions, biogas characterization and flaring emissions calculated using literature data

Flaring (50% efficiency)

Biogas production based on the average characteristics of the brazilian msw: 50% organic matter, 60% moisture

Considered a 60% destruction of volatile solids (0,25 m^3 CH4.kgVS-1)

Biogas

METHODOLOGY

Atmospheric emissions

Leachate

Treatment in stabilization ponds

Treated leachate

Legend

Process

Ressource

Emission
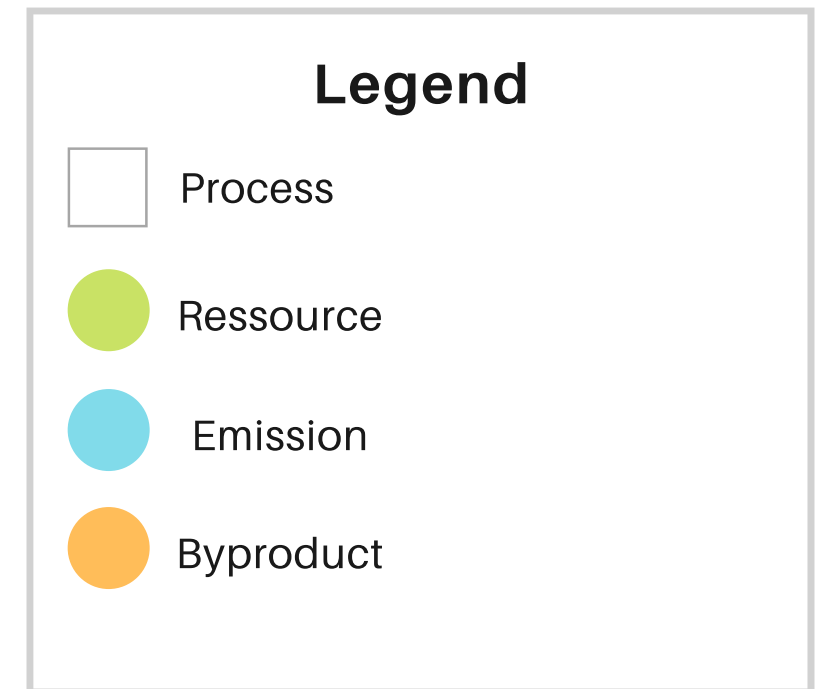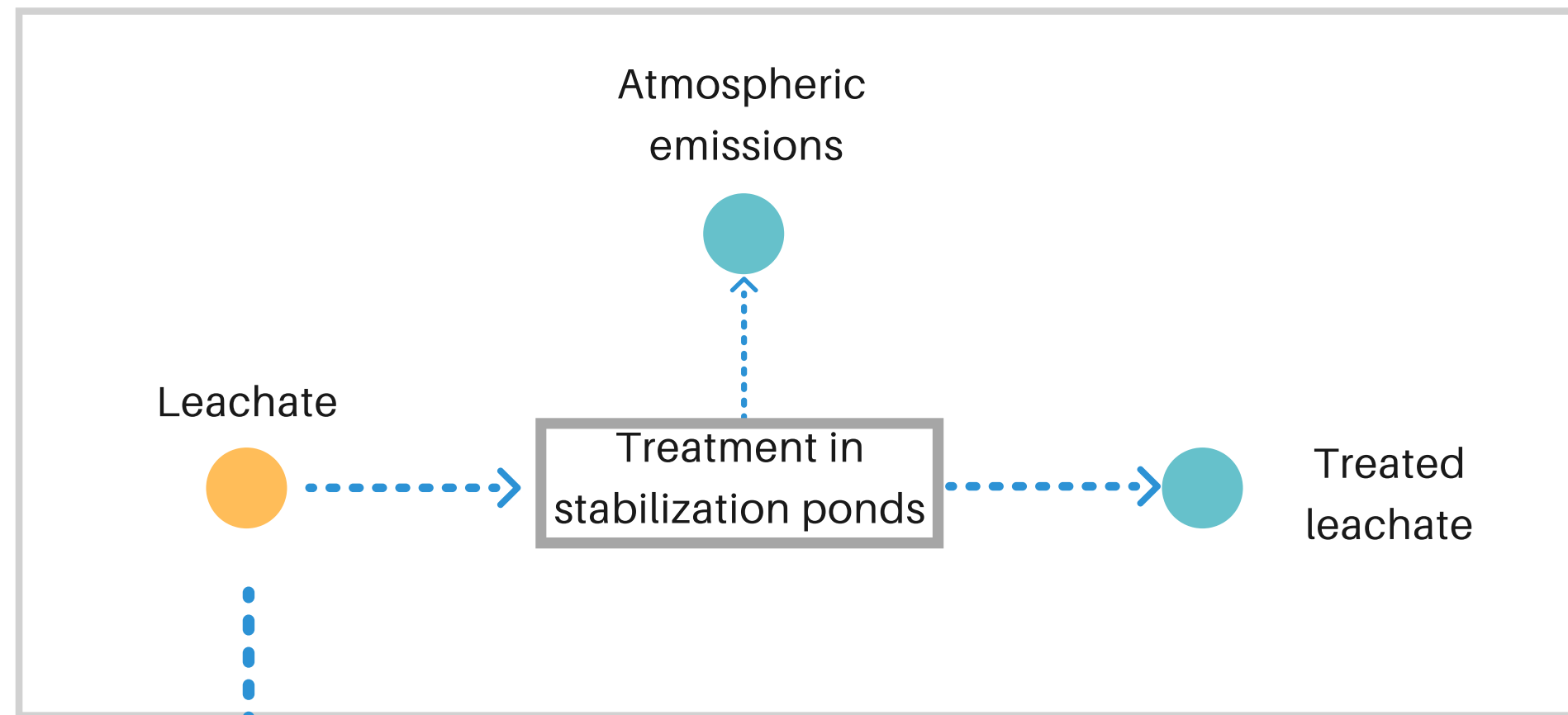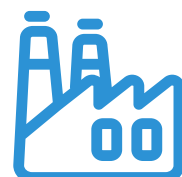
Byproduct

Leachate production: 25% of the precipitation – in accordance to the swiss method

The area was based in the methodology presented in the environmental company of São Paulo

Leachate treatment used the Australian Lagoon System, based on a real experience in the state of Minas Gerais

Atmospheric emissions based on the IPCC

METHODOLOGY

SANITARY LANDFILL		
Waste Mass (t)	1	
% VS	50%	
% degradation in landfill	60%	
Annual precipitation (mm)	1500	
Landfill operation (spreading, compactation, covering)		
Diesel usage (kWh)	4,32	
Air emissions (t)	CO	3,59E-06
	NOx	7,78E-06
	Particulate matter	7,78E-08
Methane and biogas generation		
CH_4 generation (m³)	75,00	
Biogas generation (m³)	136,36	
Biogas management emissions		
	CH_4	4,54E-02
	N_2	1,65E-03
	NH_3	4,13E-04
	CO	8,25E-05

Spreadsheet where you can adapt the methodology to your case study
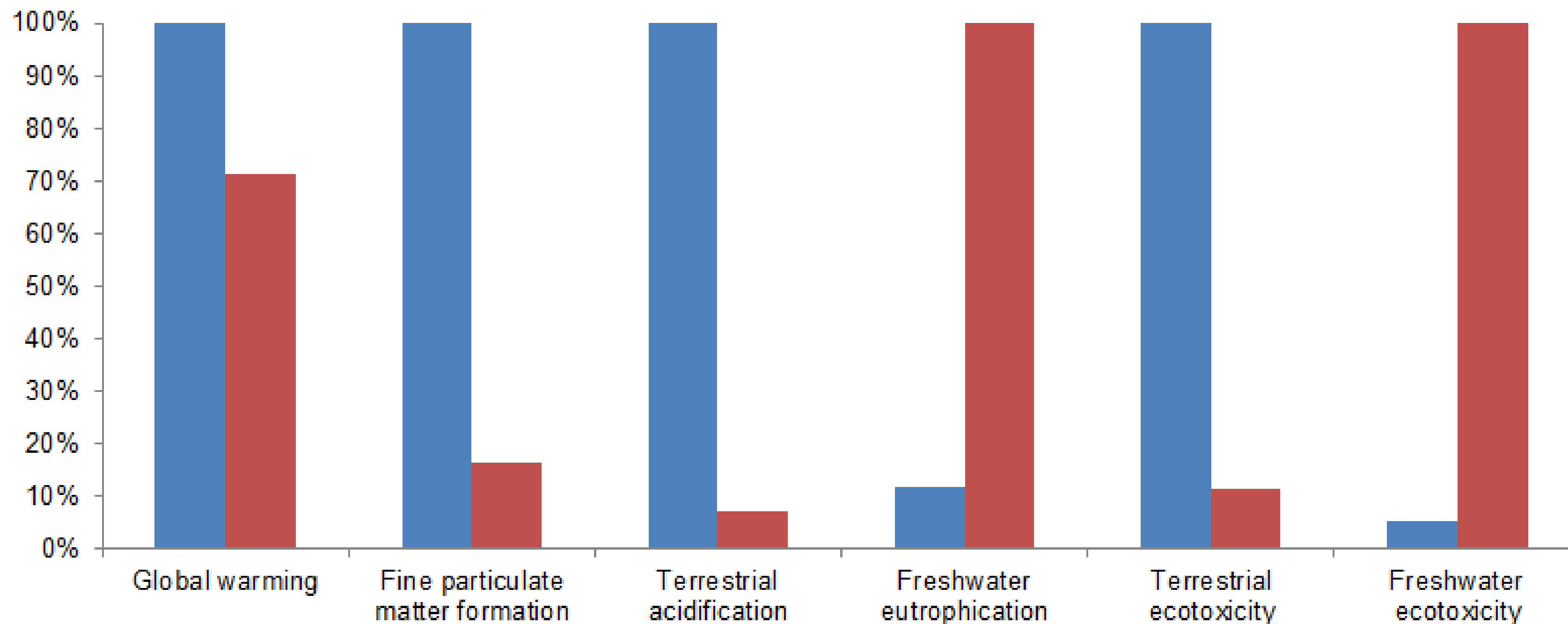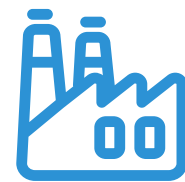
MODEL ANALYSIS
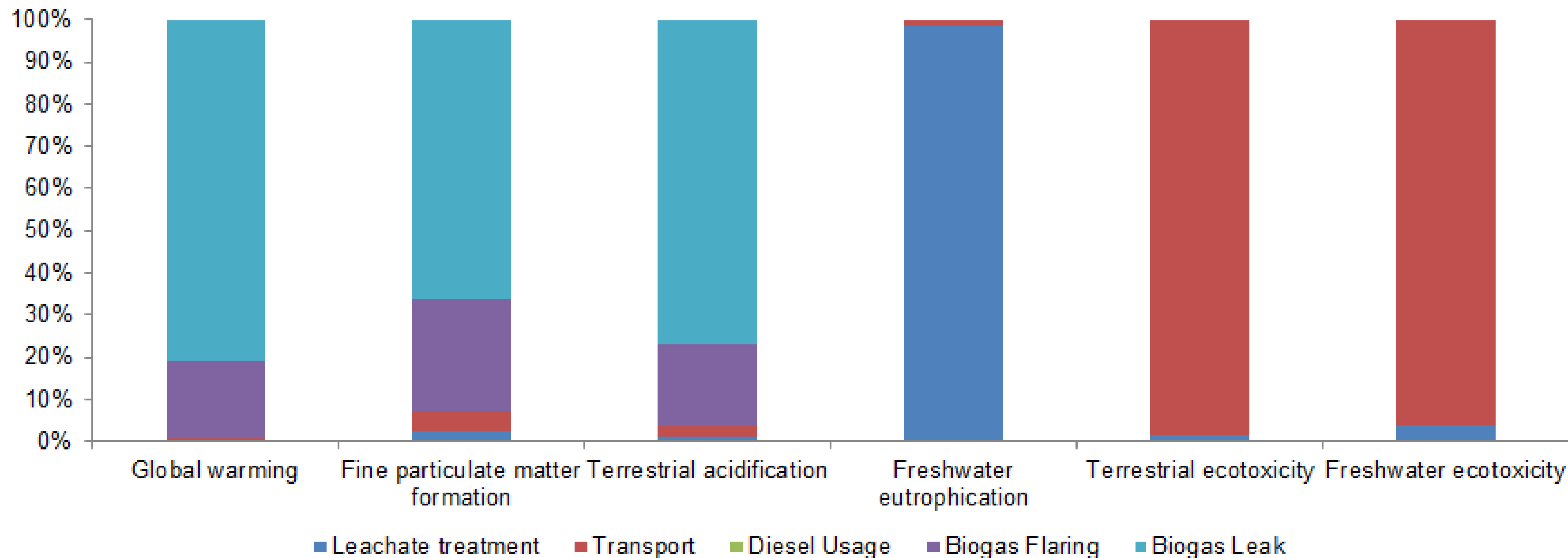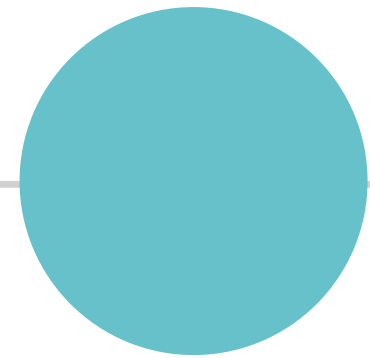
COMPARATIVE ANALYSIS

Legend:
- Sanitary Landfill modeled
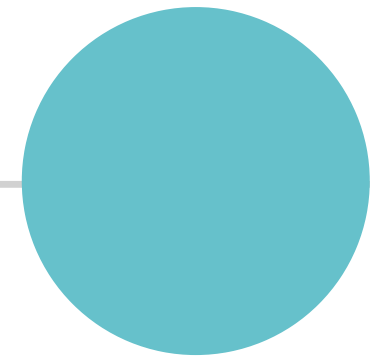- Municipal solid waste {RoW}| treatment of, sanitary landfill | APOS, U

Technology available in Switzerland in 2000: Includes gas and sludge incinerations and leachate emissions due to lining failure
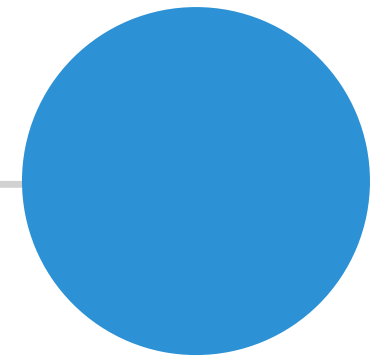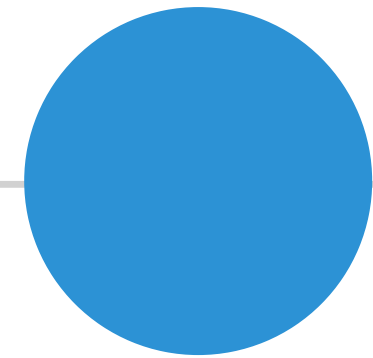
CONCLUSIONS

The model is based on Brazilian small municipalities and can correspond better to the reality of developing countries than European models

The methodology presented is adaptable to case studies

When compared to a landfill available in the LCA database Ecoinvent v.3, based on European data, differences between up to 80% the two could be observed.

These observations reaffirm the need of a representative model to estimate the environmental impacts of such technologies

Thank you

ANY QUESTIONS?

MATHEUS FERNANDES

maof@live.com