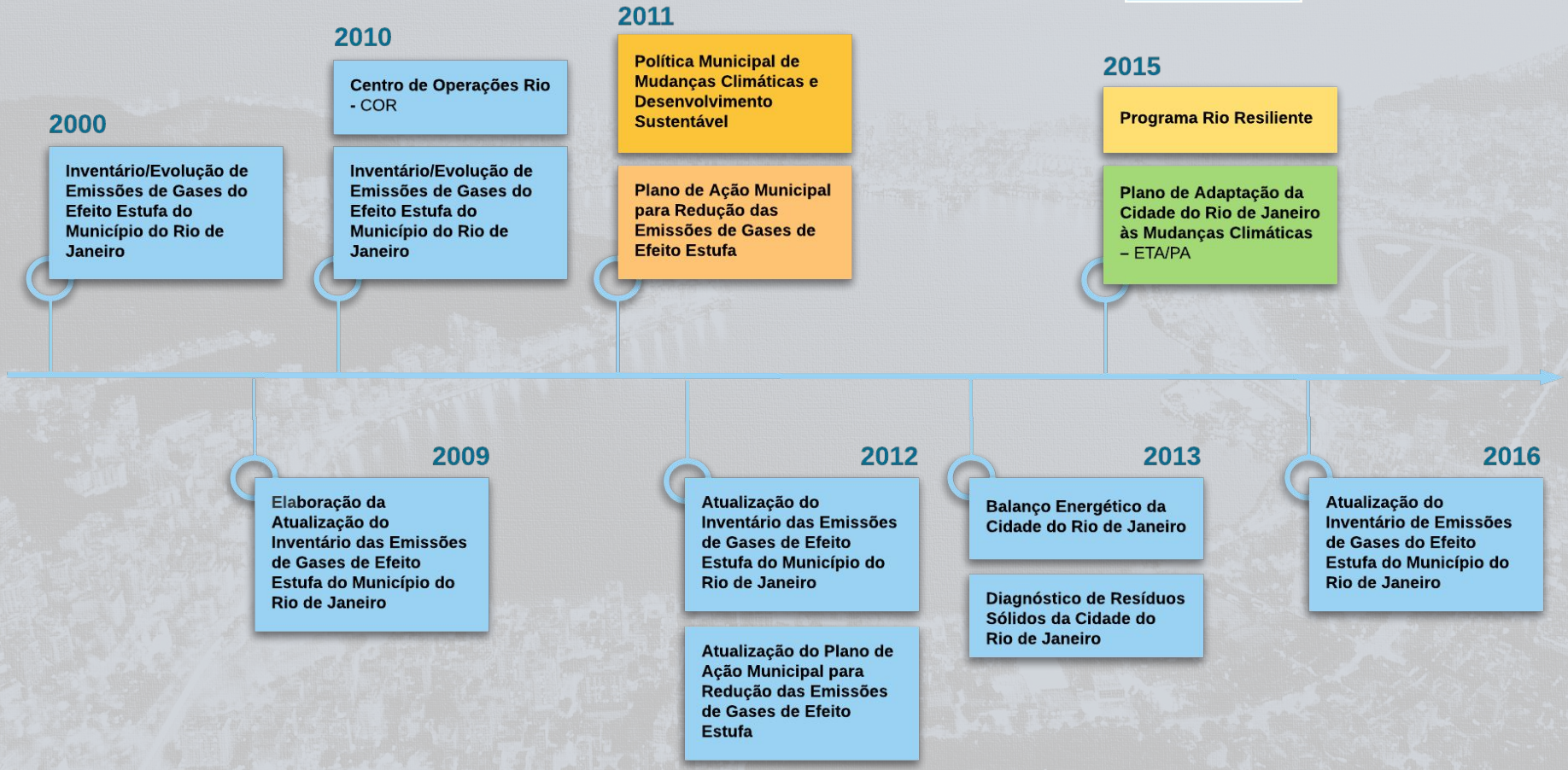
Centro Clima
CENTRO DE ESTUDOS INTEGRADOS SOBRE MEIO AMBIENTE E MUDANÇAS CLIMÁTICAS

MITIGATION ACTIONS AND INVESTMENT OPPORTUNITIES IN CITIES: THE CASE OF RIO DE JANEIRO

Prof. Emilio Lèbre La Rovere
Centro Clima / COPPE /UFRJ

MITIGAÇÃO e ADAPTAÇÃO



Centro Clima
CENTRO DE ESTUDOS INTEGRADOS SOBRE MEIO AMBIENTE E MUDANÇAS CLIMÁTICAS

Rio de Janeiro GHG Emissions Inventory, 2005 - Scopes 1, 2 and 3

	Scope 1 (Gg CO2e)	Scope 2 (Gg CO2e)	Scope 3 (Gg CO2e)	Total (GgCO2e)
Stationary Combustion	2,269.6	472.5	-	2,742.0
Residential	620.2	175.3	-	795.6
Services	172.0	147.1	-	319.2
Public and others	136.9	74.1	-	210.9
Industry	1,340.4	76.0	-	1,416.4
Mobile Combustion	5,344.6	10.1	123.5	5,478.2
Road	4,267.8	-	123.5	4,391.3
Aviation	1,062.9	-	-	1,062.9
Rail	3.3	10.1	-	13.4
Water-Bourne	10.6	-	-	10.6
Industrial Processes	409.8	-	-	409.8
Fugitive Emissions	53.6	-	-	53.6
Refining	75.0	-	-	75.0
Waste	1190.6	-	1,181.9	2,372.5
AFOLU	220.6	-	-	220.6
Total	**9,563.7**	**482.6**	**1,305.4**	**11,351.7**
Bunkers	-	-	-	531.1

Mitigation targets set by the City Law on Climate Change and Sustainable Development (January, 2011):

GHG avoided emissions in the city of Rio de Janeiro by 2016, compared to the 2005 baseline year:

By 2012: 8% of 2005 GHG emissions (11.4 Mt CO_2e) = 0.9 M ton CO_2e

By 2016: 16% = 1.8 M ton CO_2e

By 2020: 20% = 2.3 M ton CO_2e

Centro Clima
CENTRO DE ESTUDOS INTEGRADOS SOBRE MEIO AMBIENTE E MUDANÇAS CLIMÁTICAS

Rio de Janeiro Emissions in 2012 Scopes 1, 2 and 3 (Gg CO_2e)

	Scope 1 (Gg CO2e)	Scope 2 (Gg CO2e)	Scope 3 (Gg CO2e)	Total (GgCO2e)
Stationary Combustion	5655	924	-	6580
Residential	1575	315	-	1890
Commercial & Services	1283	344	-	1627
Public sector	436	126	-	563
Industry	2361	139	-	2500
Transport	7049	20	-316	6754
Road	5301	-	-316	4986
Aviation	1665	-	-	1665
Rail	73	20	-	93
Water-Bourne	10	-	-	10
Energy sector consumption	2702	470		3172
Fugitive Emissions	1254	-	182	1437
IPPU	2355	-	-	2355
Waste	634	-	1696	2331
AFOLU	9	-	-	9
Total	**19345**	**1413**	**1563**	**22637**

GHG Emissions, GDP and Population in Rio de Janeiro: 2005 and 2012

	2005	2012	2012/2005 Increase (%)
Total emissions (million tons CO_2e)	11.61	22.64	95%
GDP (billion Reais at 2012 prices)*	167.00	242.50	45%
Population (million inhabitants)	6.10	6.32	4%
Total emissions/GDP (t CO_2e/million 2012 Reais)	69.54	93.35	34%
Total emissions per capita (t CO_2e/inhabitant)	1.90	3.58	88%

Estimated avoided emissions in the City of Rio de Janeiro, 2012 and 2016 (thousand tons CO_2e)

Reduced emissions	2012	2016
Energy – stationary sources	**0.7**	**0.7**
Energy – fugitive emissions Replacing gas distribution network	**5.7**	**17**
Energy – transports	**79.6**	**525**
BRTs (1 in 2012. 4 in 2016)	*7.7*	*211.1*
Copacabana BRS	*17.6*	*17.6*
Subway expansion	*51.1*	*289.9*
Expansion of bicycle lanes network (300km)	*3.2*	*6.4*
Agriculture. Forests and Land Use	36.3	49.7
Urban Solid Wastes	**243.8**	**1.240**
Capture and burning of biogas in Gramacho Landfill	*235.1*	*329*
Capture and burning of biogas in Seropédica Landfill	*8.7*	*911*
Liquid effluents	**11.9**	**–**
Total Emissions Reductions	***378.00***	***1.832.40***
City Mitigation Targets	***929***	***1.858***

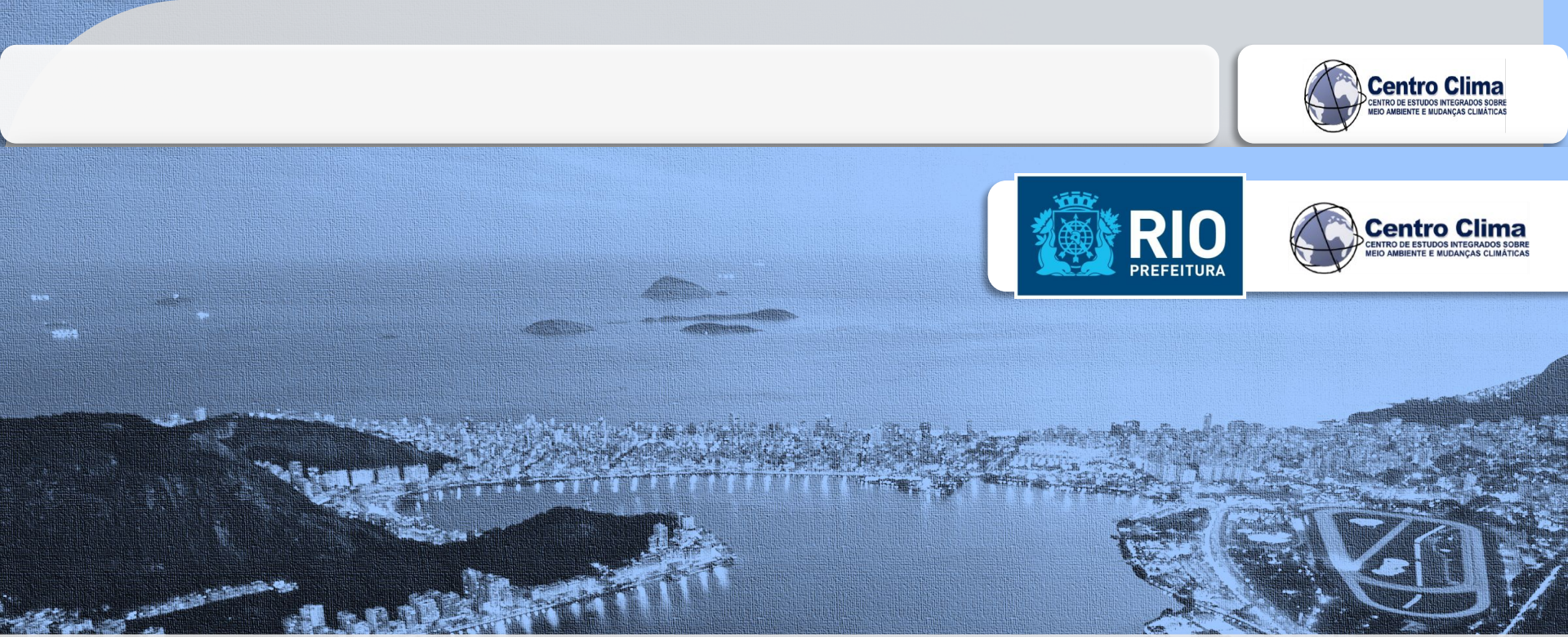
Centro Clima
CENTRO DE ESTUDOS INTEGRADOS SOBRE MEIO AMBIENTE E MUDANÇAS CLIMÁTICAS

Estimates of GHG avoided emissions

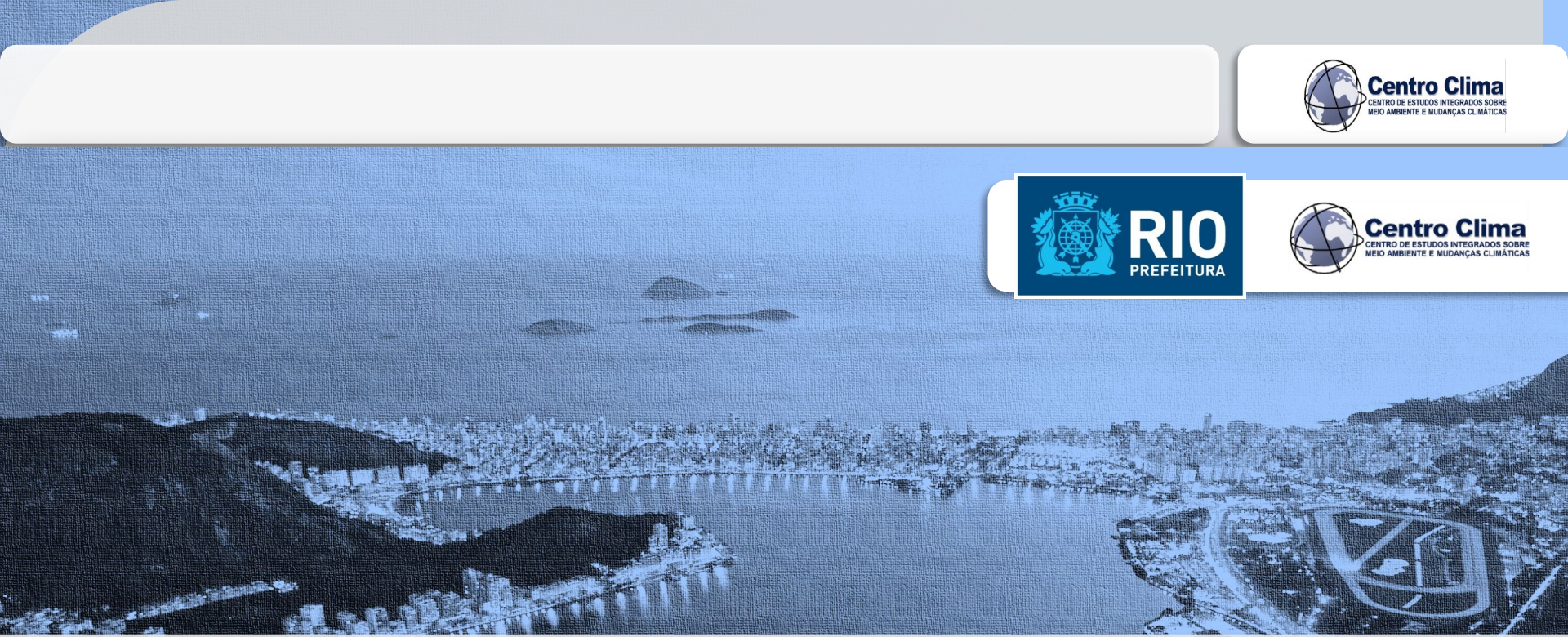
In $GgCO_2e$ = thousand tons CO_2e

Setor	2005 (emissão)	2012 (mitigação)	2016 (mitigação)	2017 (mitigação)	2018 (mitigação)	2019 (mitigação)	2020 (mitigação)
	GgCO2e						
Energia	8.545	160	278	339	418	471	502
Transporte		150	278	339	418	471	502
Outros*		10					
Resíduos	2.227	295	855	1.030	1.153	1.279	1.350
Sólidos		283	855	1.030	1.153	1.279	1.350
Efluentes		12					
AFOLU	221	215	218	218	218	218	218
IPPU	410						
TOTAL	**11.402**	**669**	**1.351**	**1.588**	**1.789**	**1.968**	**2.070**
% em relação a 2005		**5,9%**	**11,8%**	**13,9%**	**15,7%**	**17,3%**	**18,2%**

*Inclui fontes fixas. ciclovias e emissões fugitivas da rede de distribuição de gás no valor total de 10 Gg CO2e

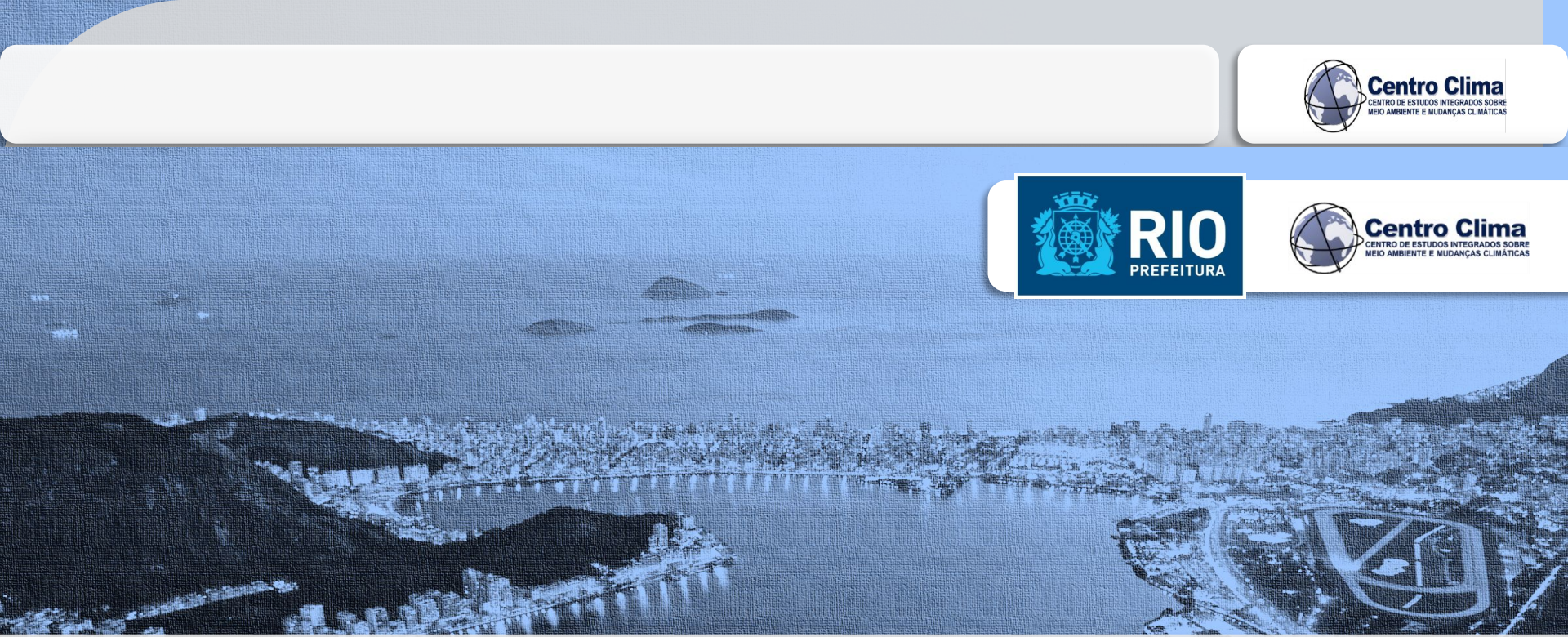


ASSESSMENT OF VULNERABILITY TO CC

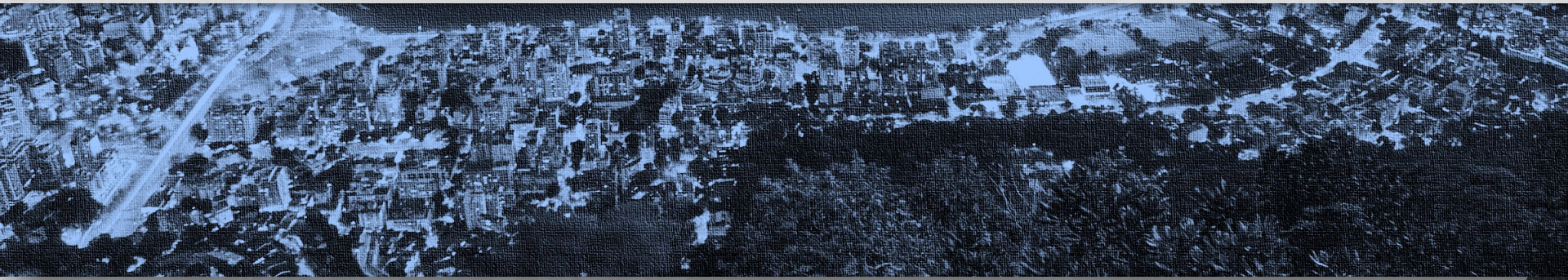


ASSESSMENT OF EXPOSURE OF

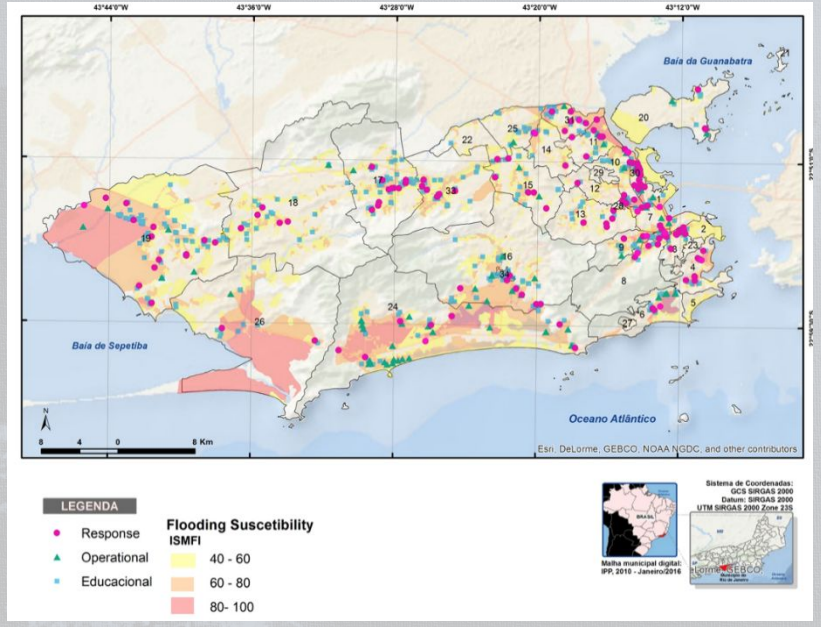
STRATEGIC INFRAESTRUCTURE

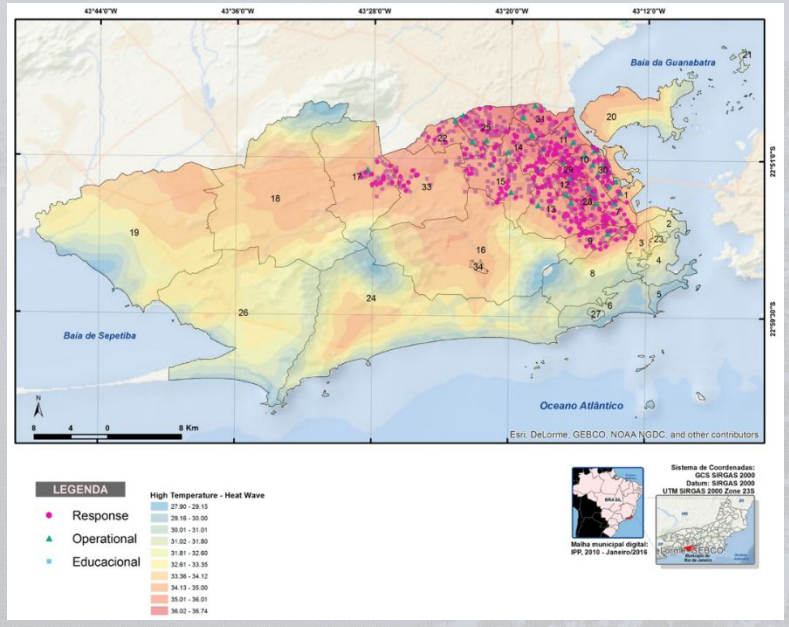


ADAPTATION STRATEGIES



INFRAESTRUCTURE – Potential exposure





CLIMATE HASARDS

- **Potential Exposure of infrastructure**, according to the sensitivity to floodings (average, high and very high) and high temperatures – heat waves (>= 35.0 ºC)

Centro Clima
CENTRO DE ESTUDOS INTEGRADOS SOBRE MEIO AMBIENTE E MUDANÇAS CLIMÁTICAS

Climate change action at the subnational level: activities of Brazilian states and cities

- Elaboration and regular updating of GHG Emissions Inventories.
- Projection of GHG Emissions Scenarios and identification of mitigation actions.
- Elaboration and regular updating of GHG Emissions Mitigation Plans.
- Implementation of mitigation actions and monitoring of mitigation milestones.
- Similar steps in Adaptation to Climate Change: Impact Scenarios; Assessment of Vulnerability; Adaptation Plans.
- Privileged opportunities at state level: Waste, Transportation, Energy efficiency, Environmental licensing, among others.
- Privileged opportunities at city level: Waste, Urban Transport, eficiente electricity use, among others.

Investment Opportunities in Brazilian Cities Waste Management (1)

✔**Landfill gas collection and destruction systems in flares (or system upgrades and improvements to existing landfills).**

Total mitigation potential (2020 – 2050):

Reference Scenario: 274.4 MtonCO_2e = 9.8 Mt CH_4

Mitigation Scenario: 428.4 MtonCO_2e = 15.3 Mt CH_4

Landfill costs (revenues not included):

- 200t/day – Capex USD 3.9 million – Opex USD 19.2 million (20 year lifespan)
- 2000 t/day – Capex USD 18.1 million – Opex USD 130.2 million (20 year lifespan)

Investment Opportunities in Brazilian Cities
Waste Management (2)

✔**Biogas upgrade: replacement of natural gas by biomethane.**

Total mitigation potential (2020 – 2050):

Reference Scenario: 240.8 MtonCO_2e = 8.6 Mt CH_4

Mitigation Scenario: 708.4 MtonCO_2e = 25.3 Mt CH_4

Plus avoided emissions by the use of biomethane in industry

Biogas refinery costs (revenues of biomethane sales not included):

- 200t/day – Capex USD 2.5 million – Opex USD 8.3 million (20 year lifespan)
- 2000 t/day – Capex USD 15.7 million – Opex USD 53.2 million (20 year lifespan)

Investment Opportunities in Brazilian Cities
Waste Management (3)

✔**LFG power plant**

Total mitigation potential (2020 – 2050):

Reference Scenario: 8.6 Mt CH_4

Mitigation Scenario: 25.3 Mt CH_4 (not including avoided emissions in power generation that mostly comes from renewable energy sources)

Power plant costs (revenues not included):

- 200t/day – Capex USD 0.9 million – Opex USD 1.8 million (20 year lifespan) – 1.0 MW
- 2000 t/day – Capex USD 7.2 million – Opex USD 18.2 million (20 year lifespan) – 8.0 MW

Centro Clima
CENTRO DE ESTUDOS INTEGRADOS SOBRE MEIO AMBIENTE E MUDANÇAS CLIMÁTICAS

INVESTMENT OPPORTUNITIES IN TRANSPORT

(i) vehicle fleet electrification, mainly buses and urban trucks

(ii) energy efficiency gains

(iii) urban public transport improvements

(iv) electrification of transport networks

(v) redesign of transport networks

(vi) increased use of biofuels

INVESTMENT OPPORTUNITIES IN TRANSPORT

(i) vehicle fleet electrification, mainly buses and urban trucks

(ii) energy efficiency gains