



6



ENVIRONMENT AND METEOROLOGY

- *A natural stage for the world's athletes*
- *Integrated environmental Governance*
- *Carbon neutral Games Operations*
- *Optimal use of clean energy sources*
- *Ideal weather conditions for an enjoyable Games experience*

ENVIRONMENT AND METEOROLOGY

INTRODUCTION

Endowed with stunning natural assets, Brazil's territory comprises diverse ecosystems such as the Amazon Rainforest - the largest in the world – and the Atlantic Forest, which together sustain the world's greatest biodiversity. Brazil plays a leading role in the world's clean energy balance with more than 45% of its total energy supplied from renewable resources. All three levels of Government are committed to sustainable development principles to conserve and protect the natural environment.

In Rio, nature is not just part of the city; it is the city itself. With Games venues strategically located to embrace nature, the beauty of Rio's physical environment will be clearly evident to all members of the Games Family. Rio's cultural environment is equally impressive; it is a historical city with many protected cultural heritage monuments, enlivened by Rio's multi-ethnic culture which passionately embraces music, dance, cuisine, cultural festivities and, of course, sport.

In the past, Rio's physical environment has suffered from deforestation, poor air quality, issues with the water supply and waste management. Recent programs by all three levels of Government including the Plan for Growth Acceleration and the Environmental and Economic Zoning have improved urban planning, water, sanitation, air quality and regeneration of natural resources. Consequently, both air quality and water supply meet World Health Organization standards.

The Federal Sports and Environmental Ministries have agreed that the Environment Special Committee established in the bid phase will transition to create the Olympic Sustainability Division (OSD). The OSD will be a special purpose Games agency, under the Olympic Development Authority (ODA), which will provide practical operational delivery capability to underpin planned and additional investments included in the environment program.

The Rio 2016 Olympic and Paralympic Games environment and sustainability plan, supported by all levels of Government, will focus on four areas: Water Conservation, Renewable Energy, Carbon Neutral Games, and Waste Management and Social Responsibility. A comprehensive set of management tools will be used to monitor, achieve and report on targets and compliance.

Rio's climate during the Olympic and Paralympic Games will be ideal, with tropical winter conditions, minimal wind impact and limited rainfall.

6.1 RIO AND ITS UNIQUE LANDSCAPE

HISTORY AND NATURE EMBRACE THE GAMES

General geographic features of Rio and its surrounds

Rio is located in a coastal mountain system of great contrasts, with steep mountains and rocky outcrops rising abruptly over extensive plains. The city contains forest cover totaling 29,000 hectares or 20% of its total area and enjoys 106km of coastline, divided among ocean, bays and a series of oceanic lakes.

The largest hydrographic system incorporates basins that flow into Guanabara Bay and features wetlands and flood plains. Guanabara Bay, with a perimeter of 131 linear km, is one of the main natural physical features in Rio.

A group of rivers is formed of watercourses that flow into coastal lakes. Various rivers flow down the slopes of the mountains and into the lakes, which in turn are connected to the sea via different channels.

Cultural Heritage Monuments

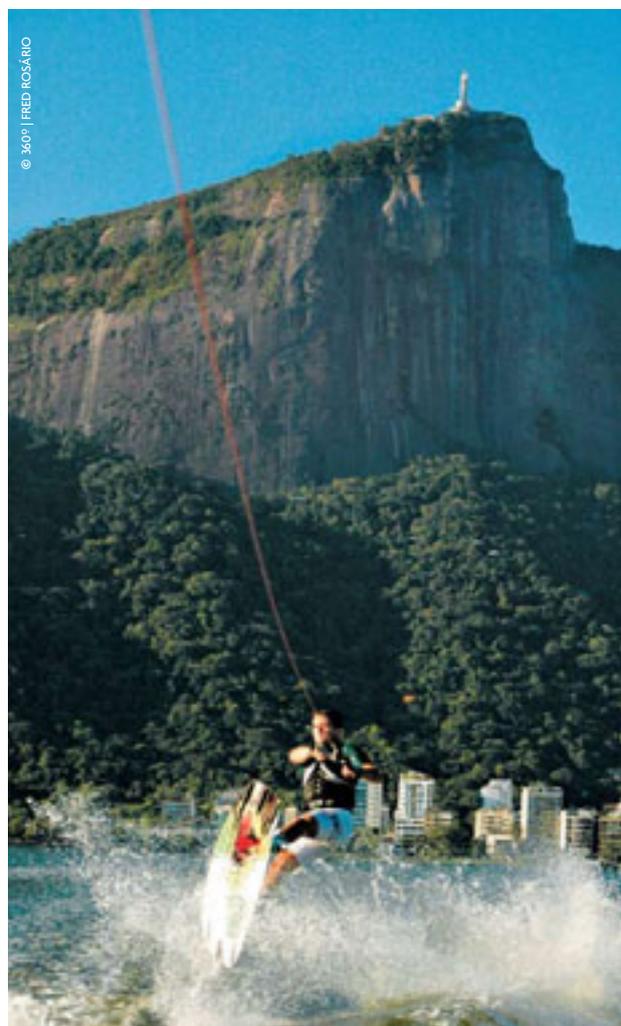
Founded in the 16th century and Brazil's capital for 200 years, the city center is the heart of Rio's heritage; hundreds of buildings of historical and cultural value are preserved and protected by Federal, State and City regulations. Prominent among these are the São Bento Monastery (1617-1785), the Fortress of Nossa Senhora da Conceição (1713) and the old Imperial Palace in Praça XV (1743). Many special projects organized by the City of Rio enhance and preserve the cultural heritage.

Potential Natural Risks

Rio's mountainous and coastal areas have historically been characterized by the informal occupation of land. Urban expansion has in certain cases invaded the ecosystems of the plains as well as the mountain slopes, increasing the risk of landslides, silting of drainage systems in adjacent plains and flooding caused by rainfall during summer (December to March). The area most susceptible to flooding is the Guanabara Bay basin.

Due to its geographical location, its geomorphological and geological formations and climatic conditions, Rio does not experience earthquakes, hurricanes or typhoons.

There are no potential natural risks in Games areas.



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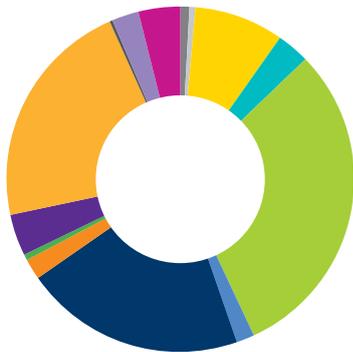
Protected Areas

The City of Rio possesses approximately 100 protected areas, covering 235.8km² or around 20% of the total area. Areas protected by Federal, State and City environmental legislation in Rio are shown below:

PROTECTED AREAS IN CITY OF RIO DE JANEIRO

PROTECTED AREAS IN THE CITY OF RIO DE JANEIRO	Total per category	Government level		
		City	State	Federal
Environmental conservation unit	57	49	5	3
- Environmental protection area	26	25	1	0
- Environmental protection and recovery area	3	3	0	0
- Reserve	2	1	1	0
- Park	21	16	3	2
- Area of significant ecological interest	4	3	0	1
- Natural monument	1	1	0	0
Legally protected area of significant environmental value	53	26	17	10
- Protected natural areas	32	5	17	10
- Park (urban)	15	15	0	0
- Buffer zone protection areas	2	2	0	0
- Environmental preservation area	1	1	0	0
- Area of ecological and landscape preservation	1	1	0	0
- Zoological garden	1	1	0	0
- Botanical garden	1	1	0	0

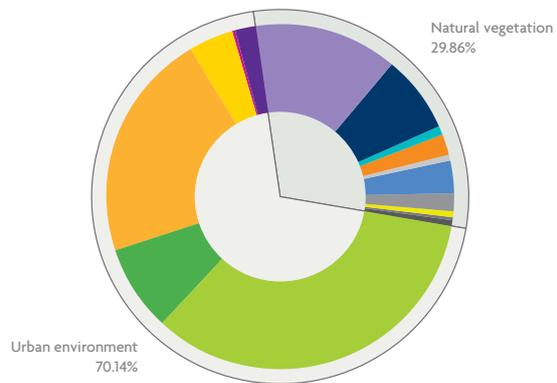
SOIL OCCUPATION BY SECTOR / ACTIVITY



SECTOR/ACTIVITY	SURFACE AREA (%)
Sports and Leisure (multisport complex)	0.93 *
Industrial	0.60 *
Residential	8.23 *
Comercial services	3.02 *
Urbanized areas	30.30
Other construction areas	0.07 *
Water bodies	1.77
Forest areas	20.55
Mangroves	1.98
Beaches	0.38
Crops and pasture	4.06
Human altered grass/fields	21.55
Squares, gardens, parks and other gardening and free spaces	0.17
Rocky outcrops	2.55
Other green areas	3.83

* Data from 2000

NATURAL VEGETATION AND URBAN ENVIRONMENT



SECTOR/ACTIVITY	SURFACE AREA (%)
Forest	13.23
Altered Forest	7.32
Salt flats	0.87
Mangrove	1.98
Sandy coastal plain vegetation	0.62
Wetland vegetation	2.93
Inland water	1.77
Rocky outcrops	0.48
Estuary environments	0.28
Beaches and sand dunes	0.38
Urban area	34.32
Unoccupied urban area	7.97
Human altered grass/fields	21.55
Crops and pasture	4.06
Vegetation in public parks	0.17
Exposed soil and mining area	2.07

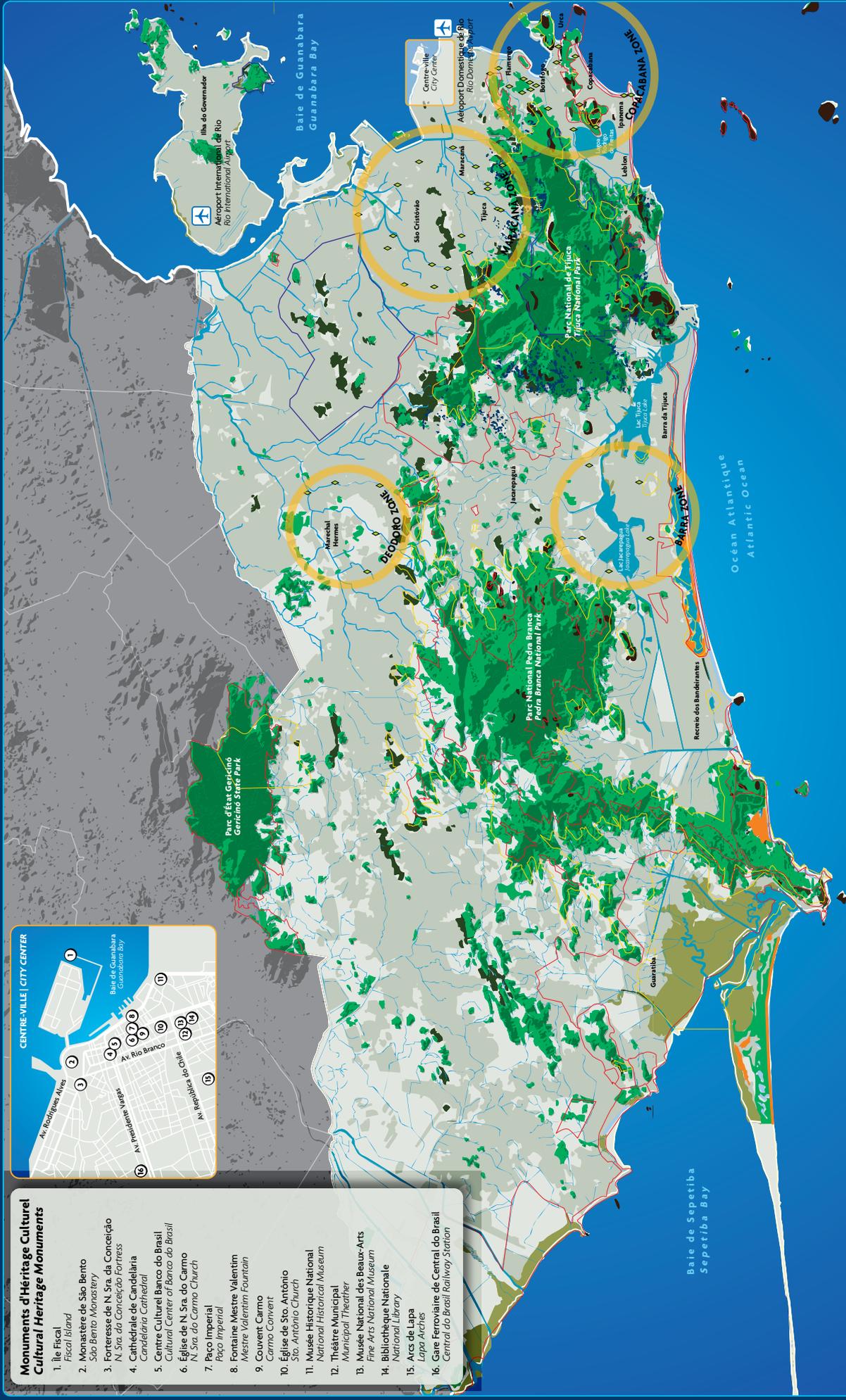
Natural vegetation
29.86%

Urban environment
70.14%

All of these features are shown on the following map.

Monuments d'Héritage Culturel
Cultural Heritage Monuments

1. Ilé Fiscal
Fiscal Island
2. Monastère de São Bento
São Bento Monastery
3. Forteresse de N. Sra. da Conceição
N. Sra. da Conceição Fortress
4. Cathédrale de Candelária
Candelaria Cathedral
5. Centre Culturel Banco do Brasil
Cultural Center of Banco do Brasil
6. Eglise de N. Sra. do Carmo
N. Sra. do Carmo Church
7. Paço Imperial
Paço Imperial
8. Fontaine Mestre Valentim
Mestre Valentim Fountain
9. Couvent Carmo
Carmo Convent
10. Eglise de Sto. Antônio
Sto. Antônio Church
11. Musée Historique National
National Historical Museum
12. Théâtre Municipal
Municipal Theater
13. Musée National des Beaux-Arts
Fine Arts National Museum
14. Bibliothèque Nationale
National Library
15. Arcs de Lapa
Lapa Arches
16. Gare Ferroviaire de Central do Brasil
Central do Brasil Railway Station



Utilisation de la terre Land Use

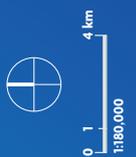
- Forêt Forest
- Palouse/Champs modifiés par l'homme Human altered grass/field
- Mangrove Mangrove
- Reboisement Reforestation
- Zone urbaine Urban area
- Vegetation de la plaine côtière sablonneuse Sandy coastal plain vegetation
- Eau à l'intérieur des terres Inland water
- Relief rocheux Rocky outcrop

Risques naturels potentiels Natural potential risks

- Glissement de terrain Landslide
- Zone d'inondation Flooded area
- Zone urbaine Urban area
- Eau à l'intérieur des terres Inland water

Zones protégées Protected areas

- Protection intégrale/Utilisation restreinte Protected area/Restricted use
- Utilisation viable à long terme Sustainable use
- Zone de protection environnementale et de récupération urbaine Area of environmental protection and urban regeneration



PROJECTO UTM
SMAE/18-2018
UTM PROJECTION
SMAE/18-2018

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6.2 AIR QUALITY

CLEAN AIR WITH AN UPWARD TREND OF IMPROVEMENT

The relief, vegetation and climate characteristics of the city create four aerial basins in which air pollutants are subject to four distinctive circulation and dispersion characteristics. Games events are located in the Aerial Basin II, corresponding to the districts of Jacarepaguá and Barra de Tijuca, and Aerial Basin III, covering the northern part of the city and the districts of Copacabana, Flamengo and Lagoa in the south. The table below shows the air quality data for Rio and São Paulo. The other cities hosting Football do not differ significantly from Rio.

While Rio has faced air quality issues in the past, as a result of vigorous air quality improvement programs, general conditions are continually improving such that today, Rio's air quality standards are within the limits recommended by the World Health Organization (WHO). Carbon monoxide and sulfur dioxide emissions have reduced in Rio and in the cities hosting Football since the 1980s, after a specific government program (PROCONVE) was established nationwide. In Rio, the only parameter higher than legislated standards is O₃.

Currently, air quality is measured at 27 sites in Rio's metropolitan area, including manual and automatic units. Historic data shows that 77% of polluting emissions are caused by vehicular traffic. The monitoring stations use standard analysis techniques for carbon monoxide CO with non-dispersive infrared methodology, for sulfur dioxide concentration SO₂ measured by the ultraviolet fluorescence method, for nitrogen dioxide concentration NO₂ measured by a chemi-luminescence analysis, for suspended particulate matter concentration (PM10) measured by the beta ray absorption method and for ozone concentration O₃ using measurement based on ultraviolet absorption photometry. In the table below, the compilation of five year measurement data is presented.

6.3 WATER SUPPLY

PREDICTABLE, SAFE AND EXPANDING

The drinking water in Rio is collected, treated and distributed by the State Company of Water and Sewage (CEDAE) with more than 43,000 l/s collected from the Guandu River. The water supply system is very predictable in terms of volume and quality given the size of the Guandu system and the fact there is a single source.

CEDAE vigorously meets the drinking water standards established by the Ministry of Health (2004) and WHO.

Existing water storage consists of 55 reservoirs in the Guandu, Ribeirão das Lajes, Acari and other isolated systems.

The Guandu water treatment station produces around 43,000 l/s. This equates to more than 3.7 billion l/day of clean water supplying Rio. The treatment works feature a quality control laboratory which conducts physical, chemical and bacteriological analysis at all stages of the process, thereby ensuring that the stipulated drinking water standards are met.

Water quality information is provided in the following table based on analyses performed over the last five years, sourced from the respective State and Federal District water and sanitation companies.

CEDAE rigorously applies hydro-biological, microbiological, chemical and physical-chemical testing methods to assess drinking water quality using turbidity, color, pH, fecal coliforms and fluoride as the analysis parameters.

CONCENTRATION OF POLLUTANTS BY ZONES

PARAMETER	Rio de Janeiro				São Paulo
	Barra Zone	Copacabana Zone	Maracanã Zone	Deodoro Zone	Morumbi Stadium
Carbon monoxide (CO)	1,174	521	479	N/A	943
PM10	88	44	45	60	40
Sulfur dioxide (SO ₂)	7	44	8	N/A	6
Nitrogen dioxide (NO ₂)	46	N/A	N/A	N/A	37
Ozone (O ₃)	9	N/A	N/A	N/A	33

Concentration of air pollutants in venues/zones (µg/m³)
City of Rio – Period: 2001/2007 and the City of São Paulo

DRINKING WATER QUALITY ANALYSIS RESULTS

PARAMETER	Government legislation limits	Sample Percentage Within Standards (%)				
		Rio de Janeiro	São Paulo	Brasília	Salvador	Belo Horizonte
Turbidity	5.00	98.80	95.77	99.70	98.81	99.70
Color	15.00	98.62	94.08	99.69	100.00	99.48
pH	6.00 to 9.50	98.60	96.62	99.03	98.57	99.85
Fecal Coliforms	Absence	99.98	95.88	98.74	98.03	96.18
Fluoro	1.50	98.12	94.44	77.40	100.00	92.94

Period of 5 years - Source of data: CEDAE - Water and Sanitation Company of the State of Rio, SABESP - Water and Sanitation Company of the State of São Paulo, CAESB - Water and Sanitation Company of Brasília, EMBASA - Water and Sanitation Company of the State of Bahia, COPASA - Water and Sanitation Company of the State of Minas Gerais

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6.4 STAKEHOLDER ENGAGEMENT PLAN

INTEGRATED ENVIRONMENTAL MANAGEMENT

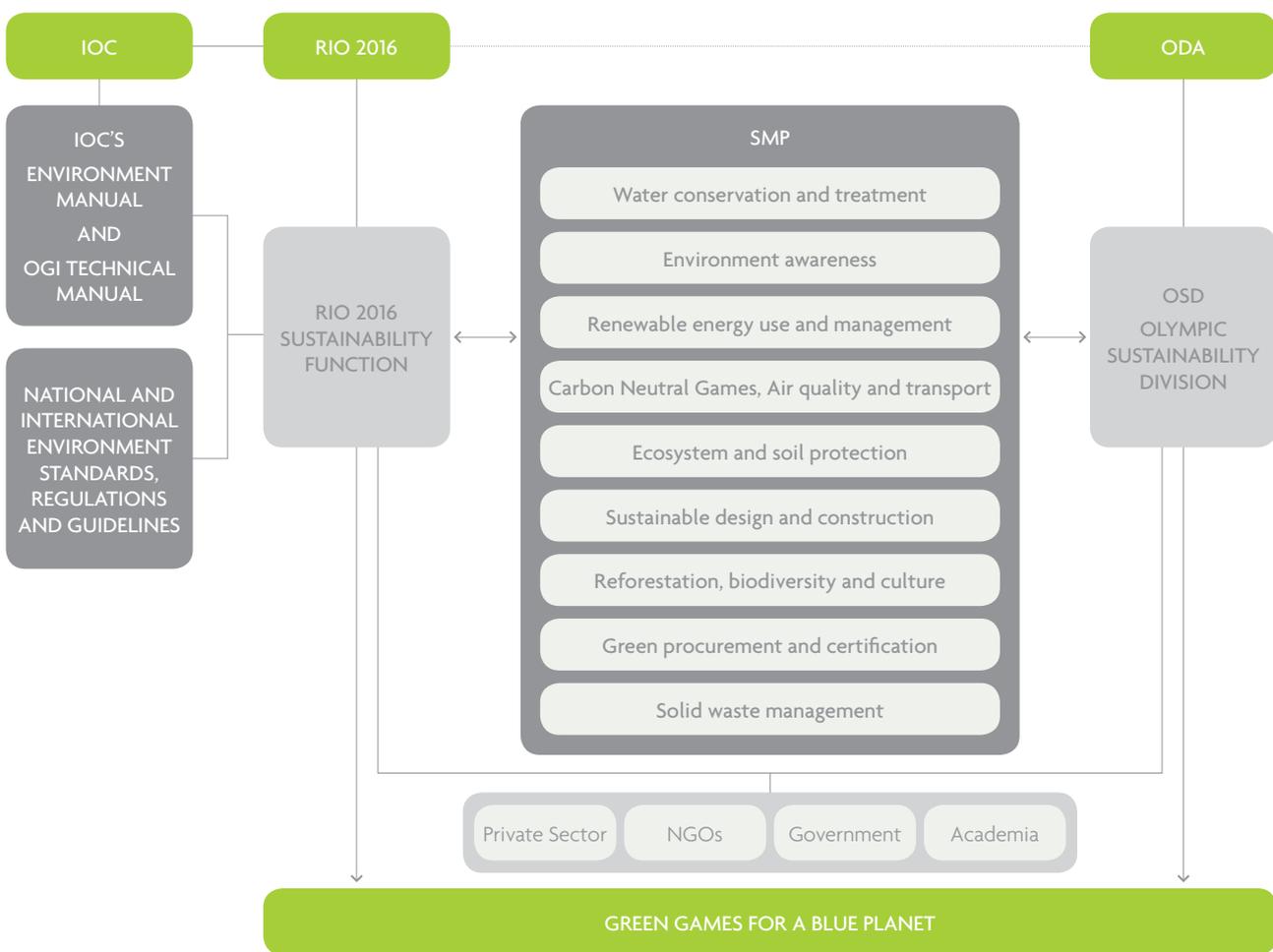
Brazilian environmental policy is noted for its excellent legal and regulatory instruments. The 1988 Federal Constitution is considered one of the most thorough in the world in its treatment of the environment. The three levels of Government together coordinate the legal measures and programs related to environmental assets and liabilities.

At the Federal level, the main legislative platform is the National Environment Policy implemented by the Ministry of the Environment. Under this institutional umbrella, the National

System for the Environment and the responsibilities of the National Councils of the Environment and Water Resources are defined. Regional policies are established by the State Environment Secretariat and, in the case of Rio, are executed by the same Secretariat which coordinates the agencies responsible for managing water, air pollution and forest policies. The city system is organized in a similar way, overseen by a Municipal Environment Commission.

The sustainability framework for the Games is presented in the diagram below.

RIO 2016 SUSTAINABILITY FRAMEWORK



New Olympic Sustainability Division

All three levels of Government have considerable environment and sustainability projects impacting Rio. Rio is the original home of the Global Agenda 21 (AG21) and the City continues with its own AG21 implementation.

During the bid, a special environment committee was established to ensure efficiency and coherency of Games-related plans across all three levels of Government. Given the complexity of

environment and sustainability projects with direct correlation to the Games venues, the Governments have agreed to create the Olympic Sustainability Division (OSD), a special purpose agency which will provide practical operational delivery capability to underpin the high level Government policy, financial and legislative support. The OSD will be an ancillary agency of the Olympic Development Authority (ODA) which is discussed fully in Theme 3.

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Simultaneously, Rio 2016's Sustainability function will lead Games environment plan delivery to meet client requirements within Games venues, not only to deliver outstanding Games but also to set new standards for sustainability in the region.

The OSD and Rio 2016, for their respective responsibilities of city and Games projects, will integrate all public authorities, NGOs, private sector and any other stakeholders involved in project delivery.

Responsibilities of the OSD and Rio 2016, within their respective projects, will include policy development, coordination, planning, delivery capability assessment, research, project accountability, stakeholder engagement coordination, definition and monitoring of project indicators and reporting. Monitoring of government programs will follow the National Institute for Geography and Statistics (IBGE) indicators which comply with nationwide public initiatives and with UN standards.

In addition to the development and coordination of the Sustainability Management Plan (SMP), the Rio 2016 Sustainability function will be the point of contact to ensure that the IOC's Technical Manual for Environment and Sustainability and Olympic Games Impact requirements are followed in the SMP and within the OSD's framework.

Stakeholder Engagement (NGOs, Business Sector and Academia)

An integrated Stakeholder Engagement Plan has been drafted to ensure the identification, participation, capacity-building and dialogue with public authorities, NGOs and private companies in Games-related projects.

Given the importance of active involvement of society, businesses and commercial associations and academia in achieving the objectives of the SMP and in ensuring that legacy objectives are properly delivered, partnerships are already underway with well-established NGOs, companies and universities on local, national and international levels.

6.5 ENVIRONMENTAL PROTECTION OBJECTIVES

SUSTAINABILITY MANAGEMENT PLAN:
PLANET, PEOPLE, PROSPERITY

In alignment with the sustainable development principles proposed by the UN's "Our Common Future Report" and ratified by Rio's World Environment Summit of 1992, the Rio 2016 Games in Rio will catalyze the environmental policies and programs of the three levels of Government via the Rio 2016's Sustainability Management Plan (SMP). The three pillars of Rio 2016's Sustainability Management Plan (SMP) - planet, people, prosperity - will integrate economic, environmental and social elements into the "Green Games for a Blue Planet" vision for the Rio Games:

- *Planet* signifies the overall environmental commitment of the Games to act locally with a global vision of sustainability
- *People* indicates the need for ample social benefits, consistent and inclusive for the entire Rio public
- *Prosperity* symbolizes well administered and transparently managed Games, and economic growth for the city.

The SMP will contribute to the implementation of the current public policies improving new green social and environmental technologies in the *Games Green Zone*, formed by the perimeter of the four venue zones, which represents more than the 50% of the built environment of the city.

Objectives

The SMP core objective is to support the delivery of the Games and to create, with Government engagement and integration, the means for a definitive transformation in the city. This coordinated plan will set a new standard for urban transformation and sustainability in South America, and will create a foundation for the integration of sustainable events and environment regeneration.

With the strong focus on improving the environment (Planet), quality of life (People) and the economy (Prosperity), the SMP reflects specific objectives associated with the City's priorities:



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- **Water Conservation Games**
The Games program defines short and long-term objectives to regenerate Rio's magnificent waterways, particularly the lakes system in the Barra Zone and Guanabara Bay. This initiative, which involves river treatment units construction, sewage network expansion and education programs, will set a new standard of water quality preservation for the next generations which is the main pillar for the "Green Games for a Blue Planet" vision
- **Renewable Energy Games**
The Games will extensively use renewable sources and contribute with new models and technologies for energy use, monitoring and consumption reduction among others, by implementing Brazilian state of the art hydrogen energy cells and generators in all venues
- **Carbon Neutral Games**
Emissions generated by Games preparations and operations will be neutralized through the reforestation of over 3 million trees in strategic rain forest areas out of the 24 million trees to be planted in the state before 2016. This initiative will lead

to legacy Clean Development Mechanism implementation in surrounding communities. It includes the Atlantic Forest protection campaign, Zero Illegal Deforestation, to reinforce the official green recovery targets in the Pedra Branca and Tijuca buffer zones surroundings the venues and in the mangroves at the Barra lakes

- **Waste Management and Social Responsibility**
Following successful cooperative recycling programs in Brazil, 100% of solid waste generated during the Games preparations and operations, including construction, will be processed and recycled through a sustainable chain with direct social benefits to surrounding communities. Procurement and acquisitions processes before, during and after the Games will follow the same principles.

Rio 2016 Actions

To maximize the effectiveness and impact of the SMP, all actions have been aligned with the overall strategic environment plan for the city. Actions presented below refer to the above environment priorities:

SUSTAINABILITY ACTION PLAN

THEME	Rio 2016 proposed actions	Government engagement
WATER CONSERVATION GAMES		
Water management and treatment	Construction guidelines for Games venues following international water saving standards, such as dual water saving flushes, to decrease demand for drinking water and generate financial savings on collection and solid waste treatment by public agencies	Ensured by the Federal Government's National Sewage Program (2008) which defines clear targets of treatment at national, state and municipal levels, investment of USD4 billion is already committed for restoration programs (Guanabara Bay Sanitation Program and Barra-Jacarepaguá Sanitation Program) which will result in more than 80% of overall sewage collected and treated by 2016.
	Extensive deployment of grey water recycling and secondary use of rainwater for irrigation as part of the Rio 2016 Green Building Program	
	Olympic Training Center (OTC) facilities, Olympic and Paralympic Village and X Park with self contained sewage treatment units	
	Restoration of Marangá River course in Deodoro Zone by a community program	
Environmental education and awareness	Olympic Eco-Citizenship Program promoting sustainability for all Rio civil groups New permanent Ecomuseum, a center for environmental education and culture within Rio Olympic Park, boosting awareness of heritage and Games measures for environmental sustainability. With the support of local NGOs, local Agenda 21 projects will be undertaken	Extensive school environmental programs will increase awareness of climate change impacts and the ways individuals and communities can fight against this global phenomenon; other programs will focus on lagoon protection.
RENEWABLE ENERGY GAMES		
Energy supply and conservation, renewable energy use and management	Overlay construction with self-supplying renewable energy generators powered by ethanol for broadcasting and mission-critical operations	The "National Program for Production and Use of Biofuel" launched in 2004 is ensuring a progressive and sustainable diffusion of biofuel in the local market leading to significant reduction of diesel importation and improvement in the national renewable energy matrix.
	Swimming pools with solar panels for water heating in OTC and Modern Pentathlon venues	
	Extensive photovoltaic cells in the OTC Halls to minimize energy demand for lighting	
	Brazilian state of the art hydrogen cell technology, powered by ethanol, in all overlay for lighting operational areas	
	Energy management systems in new buildings to complement the energy conservation and savings	
Within the existing State Government's Vegetable Oil Gathering Program, oil disposed from the Olympic and Paralampic Village, MPC/IBC and venues recycled into biodiesel		

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SUSTAINABILITY ACTION PLAN

CONTINUED

THEME	Rio 2016 proposed actions	Government engagement
RENEWABLE ENERGY GAMES		
Air quality and transport	100% public transport for spectators and workforce	Although Rio's air quality is within WHO standards, in 2009 a Nationwide Air Quality Program, promoted by the Federal Government, will be undertaken. This will lead to an increased number of monitoring stations, increased control over particulates NO ₂ , SO ₂ and O ₃ , engagement in the incentive State Plan of Action for the Reduction of Greenhouse Gas Emissions, enhancement of the Automotive Vehicle Air Pollution Control Program and reduction of sulfur levels in diesel.
	Expansion of the city's cycle lane network to connect Games zones and, within each zone, Games venues	
	100% of T1-T3 fleet running on ethanol	
	100% of public bus fleet with high percentage use of clean fuel (biodiesel, ethanol)	
Ecosystem and soil protection	Soil contamination analysis in each new construction site	<ul style="list-style-type: none"> Through a series of integrated programs and laws like the National Climate Change Plan, "Mata Atlântica" Law approval, "Zero Illegal Deforestation" Program, Environment Licensing Decentralization and Environment Compensation Fund, a solid plan is being undertaken to strengthen the protection and conservation of all city forests and parks and the preservation of local biodiversity. Creation of the Carbon Park with more than 24 million trees to be planted.
	Increased green spaces in the city by the creation of new Games venues, for cultural events and outdoor recreation	
	In OTC, X Park, Marina and Lagoa Rodrigo de Freitas a preventive study undertaken to ensure the preservation of natural areas of fauna and flora	
CARBON NEUTRAL GAMES		
Sustainable venue design / construction and noise pollution	Implementation of strict LEEDs guidelines and certification of 100% of new buildings with reduced consumption of natural raw materials and use of renewable natural resources	Government institutions, Green Building Council (GBC) of Brazil and the Brazilian Sustainable Building Council (CBCS), are developing extensive work on improving the quality of construction. For the legacy constructions, Government will implement sustainability criteria throughout concept, planning, construction, operation and maintenance phases.
	Minimum distance criteria for material transport and reuse of demolition waste including relevant overlay materials	
	Extensive implementation of green areas and water ponds in venue designs	
	Full compliance with national environmental legislation and regulations for environment assessment and noiseless constructions	
Reforestation, biodiversity and protection of environment and cultural heritage	Transport corridors will be constructed with acoustic barriers through urban tree planting and landscape design	The Agenda 21 Education for Sustainability works at the venues, coordinated through the Ecomuseum, will focus not only on integrated sports and environment activities; it will also promote the cultural traditions of Rio's multi-ethnic society, integration of art shows (Samba and Capoeira), modern technologies, contemporary creative street art formed by reusing waste materials opening new possibilities for creativity without jeopardizing authentic traditions.
	The Games Carbon Neutral offsetting program in a 1,360 hectare "Carbon Park" in Pedra Branca Park where 3 million trees will be planted in association with the State Forest Institute out of the overall 24 million trees that will be planted in the region by 2016	
	The X Park fully converted into a protected public park with an extensive reforestation plan, reintroducing rain forest species. This plan will designate local residents to maintain the park's sustainability in the long term	
	Rio Olympic Park landscape and reforestation over 40 hectares through an effort with surrounding communities, local residents and underprivileged groups	
Green procurement and certification	Catering for Olympic and Paralympic Village - 100% supplied with organic food enhancing biodiversity	A strong Sustainable Procurement Program from the State Government of Rio is being implemented with support of ICLEI (International Council for Local Government for Sustainability), providing a significant change in the local market procedures.
	Internal procedures by Rio 2016 procurement to ensure green compliance for all tenders	
Waste Management	All Green Office principles adopted in Rio 2016 and all venues adhering to the concepts of nature-friendly equipment, furniture, supplies and waste management. ISO 14000 certification process completed in accordance with international standards	City and State Governments will introduce integrated waste management systems ensuring maximization of recycling and will launch a new perspective for reuse of materials in all phases of the event: by installation of methane gas pumps from landfill for energy production and carbon credit generation, deployment of construction and demolition plants, the eradication of all illegal landfill in the city by 2010 and enhancement of the Recycling Cooperative National Movement.
	100% of new buildings sending demolition waste to new recycling plants, introducing a new era for material reuse in Rio	
	Self-contained recycling plants for separate streams (recyclable and organic) in large venues to minimize waste forwarded to landfill and to lead to a zero waste approach.	
	Catering contractors will comply with packaging waste minimization including biodegradable packaging materials	
	Rio 2016 and NGOs together will create a program to recycle disposable Games assets such as Look which will generate additional income to the involved communities	

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6.6 ENVIRONMENTAL IMPACT ASSESSMENTS

MINIMAL GAMES IMPACT

Maximum use of existing facilities and thorough planning of new venues according to sustainable building specifications will ensure the minimum environmental impact of Games infrastructure. An Environmental Impact Assessment (EIA) is required by the national legislative framework before the execution of any development project. For existing facilities no EIA is required however retrofitting assessments introducing sustainable building parameters will be undertaken.

The initial environment impact assessments compiled by zones, non-competition venues and interconnecting infrastructure are presented on the next page and scaled from 0 (no impact)

to 5 (very high impact). These assessments were carried out in alignment with the city's priorities and SMP's specific objectives to improve water, energy, waste and carbon conditions.

The dark and light blue areas, respectively, represent the combined impact for each dimension with and without the planned remediation actions. Hence, the reductions of the plotted areas reflect the expected improvements with SMP implementation.

The result of these assessments, presented in the following table and diagrams, shows that all sites are suitable to accommodate the Games and that the impact is reduced by the protection measures that will be undertaken by Rio 2016 and Government.

INITIAL IMPACT ASSESSMENT QUALITATIVE DESCRIPTION

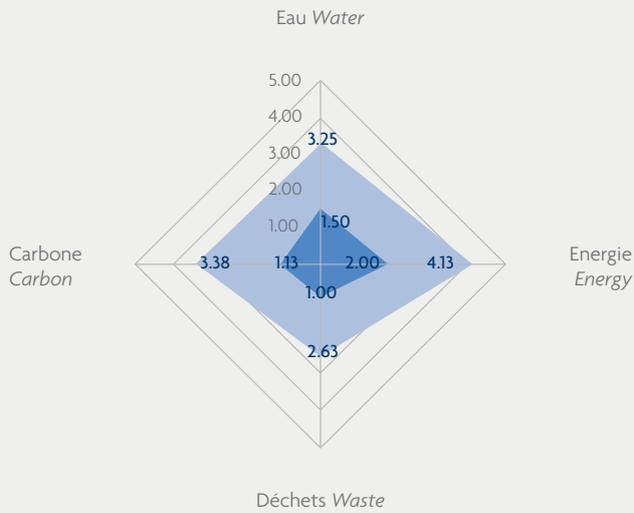
NEW PERMANENT VENUES	Status	Remarks
Olympic Training Center (OTC)	EIA completed and approved for existing venues (Maria Lenk Aquatics Stadium, Rio Olympic Arena and Rio Olympic Velodrome). Initial study assessed no major impacts in Rio Olympic Park. Detailed study to be carried out before construction tender including integration of existing venues in to Olympic Training Center.	Significant benefits are identified to the region as the Rio Olympic Park is developed. Transfer of irregular housing from the shores of the Jacarepaguá Lake to the surroundings and integration of a park will help to regenerate a protected area and open it to the public. In the Olympic Training Center, extensive self-sustainable energy facilities equipped with green landscaping elements is proposed. The waste production process will be controlled and the space will be assigned to recycling and composting.
IBC/MPC	Initial EIA carried out and assessed requirement for detailed soil analysis for IBC/MPC but no major impacts. Benefits are foreseen with the transfer of a small community to proper housing and the construction of green hotel and retail green building on the space.	In all new venues and in the Olympic and Paralympic Village, the construction process will follow Green Building criteria, with the implementation of low emission constructions, environmentally friendly materials with an emphasis on environmental comfort which is required for athletes.
Olympic and Paralympic Village	EIA completed in 2005 and approved. New EIA in progress incorporating all changes of new development.	In the Aquatics Centers and Villages water saving and consumption will be observed as well as heating through a renewable source of energy (solar panels).
X Park Olympic Whitewater Stadium	An initial environmental impact evaluation for each site is completed. Remediation plan will be established for soil, water and waste management in the area.	A special environmental recovery project will be implemented in the Deodoro region's Marangá River, including restoration and a treatment station. Implementation of energy efficiency mechanisms and material quality control methods according to ecological criteria. Structural work management control and environmental impact will allow reduction of impact in the construction.
X Park Olympic BMX Center		
X Park Olympic Mountain Bike Center		
Deodoro Arena		
Lagoa Rodrigo de Freitas	At present, the Lagoa is only being considered for sporting and landscape use. A combined public-private partnership, already initiated, will promote the recovery of spill channeling, by correcting the tributary sources and the environmental and sanitary treatment of the Jockey Club's discharge.	
Marina da Glória	The Marina Project will be planned around the reorganization of the Marina and the process of surveying the tributary sources that pollute the water.	

ESTIMATIONS D'IMPACT ENVIRONNEMENTAL ENVIRONMENT IMPACT ASSESSMENTS

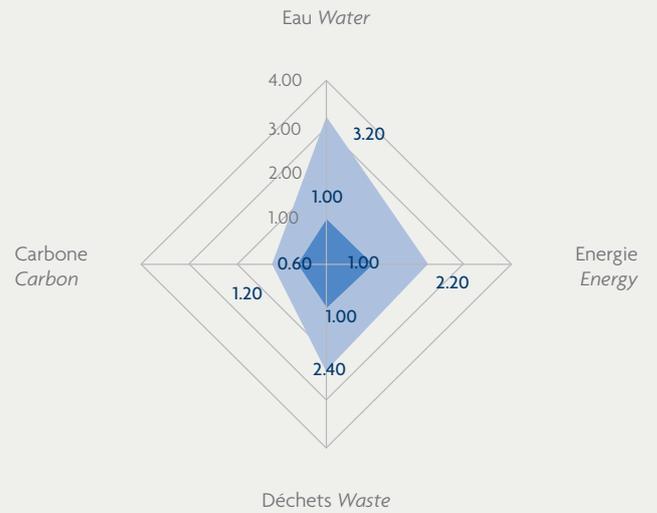
■ Impact sans Mesures de Protection *Impact without protection measures*

■ Impact avec Mesures de Protection *Impact with protection measures*

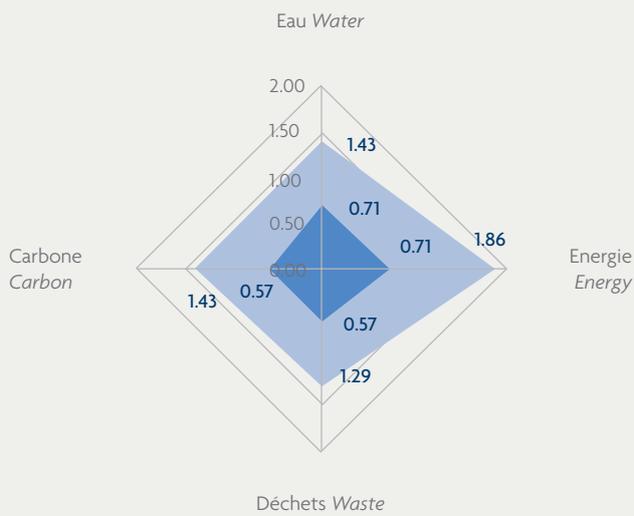
ZONE DE BARRA | BARRA ZONE



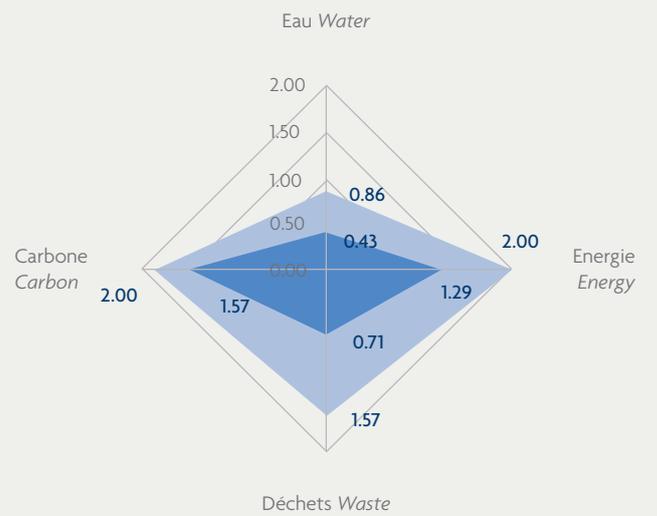
ZONE DE COPACABANA | COPACABANA ZONE



SITES DE ANNEXES | NON-COMPETITION VENUES



INFRASTRUCTURE D'INTERCONNECTION | INTERCONNECTING INFRASTRUCTURE



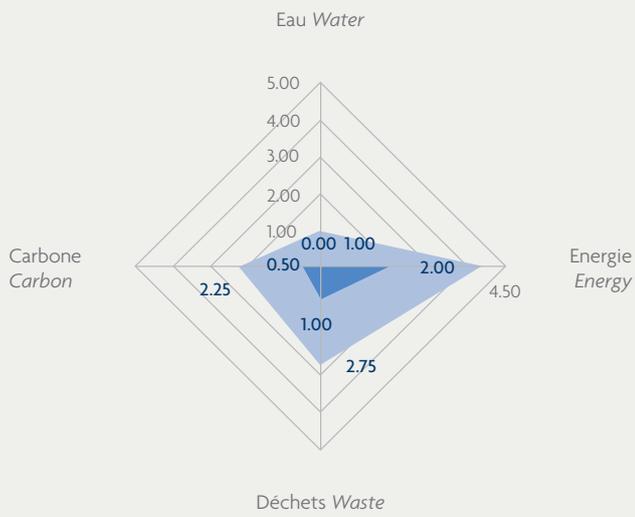
ENVIRONMENT AND METEOROLOGY

ESTIMATIONS D'IMPACT ENVIRONNEMENTAL ENVIRONMENT IMPACT ASSESSMENTS

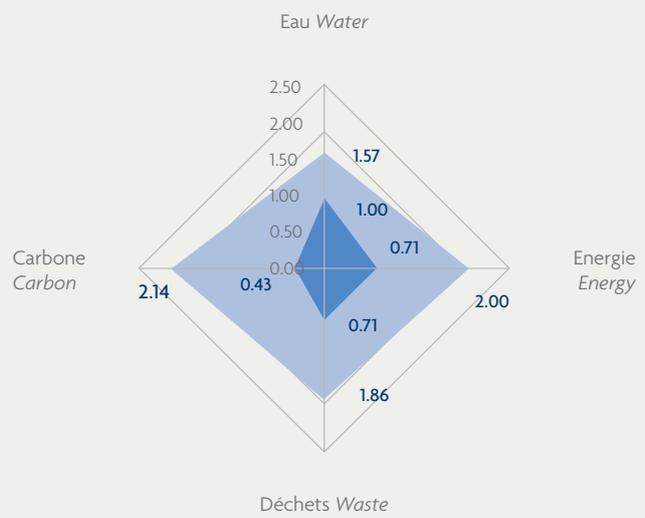
■ Impact sans Mesures de Protection *Impact without protection measures*

■ Impact avec Mesures de Protection *Impact with protection measures*

ZONE DE MARACANÃ | MARACANÃ ZONE



ZONE DE DEODORO | DEODORO ZONE



ENVIRONMENT AND METEOROLOGY

6.7 LEGISLATION AND INTERNATIONAL PROTOCOLS

COMPLIANT CONSTRUCTION WORKS

In line with Brazilian Environment Law, guarantees have been provided by all three levels of Government and the relevant competent authorities and developers that all construction work necessary for the organization of the Games will comply with local, regional and national regulations and acts, and with international agreements and protocols regarding planning, construction and protection of the environment.

All construction will be in agreement with the Brazilian Institute of the Environment, the resolutions of the National Council of the Environment as well as with the Environmental Engineering State Foundation, responsible for the permitting of structural works in the city at a regional level.

The City Civil Structure Work Code, the Urban Zoning Law, the rules of the Brazilian Association of Technical Norms and the National Institute of Metrology will all be enforced and construction will be aligned with LEED certification criteria. The Kyoto Protocol, the Montréal Protocol, the Basel Convention, the Stockholm Convention and the Biodiversity Protection Treaty will also be respected.

Refer to Section 6 of the Guarantees File.

6.8 ENVIRONMENTAL MANAGEMENT TOOLS AND COMPLIANCE STANDARDS

COMPREHENSIVE SET OF INDICATORS

Rio 2016's SMP will comply with the National Institute for Geography and Statistics (IBGE) indicators and international standards ISO 14000 and ISO 26000. The SMP will define and monitor indicators for Games delivery, in addition to using the indicators below:

- The Global Reporting Initiative to enhance identification and monitoring of sustainability
- World Wildlife Fund's *One Planet Living* program to measure the Games' ecological grip
- United Nations indicators to assess Games sustainability: the Human Development Index establishes quality of life values (education and life expectancy) and the Sustainable Development Index evaluates and quantifies more than 60 other sustainability norms. These will be cross referenced with the other economic, environmental and social indicators issued by NGOs which monitor the population's life sustainability and socio-economic factors
- Olympic Games Impact indicators will also be monitored.

6.9 PILOT PROJECT

Rio 2016 and the Government have identified three Games-related pilot projects to advance the agenda for sustainable development within Brazil:

- Construction pilot project: the indoor training halls of the Olympic Training Center (OTC) will be designed using cutting edge environmental technologies and implementing established Environmentally Sustainable Design (ESD) principles. With a total footprint of 65,000m², this venue will be an iconic structure located in the heart of Rio Olympic Park with the following environmental features: a solar skin, clean

energy, water conservation, natural ventilation, sustainable materials. This pilot project will include a series of applied research projects to advance Brazilian and global technologies around sustainable sport venues. The provision of enhanced sustainability models which can be applied to similar indoor sports facilities across the world will support the promotion of increased sport activity in an environment sensitive world

- Test of a next generation hybrid autobus operated by fuel cells and/or electrical sources
- Using carbon credit market revenues in social communities: Engage in the possibility to enhance social housing and solid waste recycling from an environmental perspective with the support of micro credit institutions and by using the global carbon credit market.

A series of other pilot projects has been identified to facilitate and enhance the environmental sustainability field related to the Games and to the long term legacy of the city.

6.10 IMPACT OF ENERGY CONSUMPTION AND GREENHOUSE GAS EMISSIONS

CLEAN ENERGY SOURCES AND REDUCTION OF EMISSIONS

Recognizing the utmost importance of preserving the Amazon and the Atlantic Forest, Brazil has paid particular attention to global environmental issues, particularly climate change through the extensive use of high efficiency green energy plants and low energy consumption design strategies in all competition and non-competition venues.



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Brazil plays a leading global role in clean energy: over 89% of its electrical energy is from renewable sources, 75% of the national light vehicle fleet (around 6 million cars) runs on ethanol with 90% less CO₂ emissions compared to regular fossil fuels, and almost 100% of the city's taxi fleet is powered by natural gas. Building on this base, Rio 2016 will apply Brazilian cutting-edge technology initiatives for the use of renewable energy sources during the Games.

The creation of the already-funded Carbon Park will have the capacity to offset the direct emissions of the Games, a project that will be validated by the technical mechanisms of the Kyoto Protocol as a Clean Development Mechanism project. This project will be complemented by extensive school environmental programs to increase awareness of climate change impacts. The Carbon Park project will create new jobs and fund social development projects in local communities close to the Games venues.

Other initiatives include:

- For new construction, sustainable building principles will be incorporated with passive bioclimatic architectural features as well as the expansion of renewable energy use
- The Games transport system will use 100% low emission fuels and other travel demand management measures will introduce an overall plan for reduction in energy demand
- Rio 2016 will endorse the State's incentive program of voluntary contribution of used domestic and commercial vegetable oil. The resultant biodiesel will be used by the Games transport fleet
- Power generators and back up power equipment for the Games will use fuel cells with hydrogen supplied from ethanol
- State of the art emissions measurement tools will constantly monitor Games greenhouse gas inventory. This initiative will be further extended for water management.

Rio 2016 has already calculated the carbon footprint of hosting the Games and will progress this estimation to encompass the whole Games life cycle and will progressively develop more detailed program implementation to minimize Games impact.

6.11 ENVIRONMENTAL APPROACH WITH SUPPLIERS AND SPONSORS

GREEN PURCHASING

Rio 2016 will incorporate a sustainability code into the pre-selection phase of all providers of services or goods. All providers will have to comply with this code. The criteria will be developed according to the published *Guide for Sustainable Purchasing* developed by the State Fund for the Environment, the NGO International Council for Local Governments for Sustainability and the Center for Studies of Sustainability. Specific measures will be included such as minimized packaging materials, compostable packaging, organic and ethical food, eco-efficient electronic equipment, biological cleaning products and furniture, fixtures and equipment with a secondary use post-Games.

6.12 SPECIAL FEATURES

FURTHER INITIATIVES

Rio 2016 will undertake the following further initiatives:

- Green action forum: a communication program to establish immediate engagement of the Rio population through a call



for action of civil groups, involving athletes and artists who share Rio 2016's green philosophy

- Sustainability - Climate Change Pavilion: a specific warehouse in Rio Olympic Park with the aim of assembling a technological, scientific experiential space to increase public consciousness about climate change with a link to Games operations and infrastructure
- Green eye project reinforcement: regular flights by helicopter to monitor the water bodies, conservation units and soil threatened areas
- Rio 2016 will create special lines of products as part of the Licensing Program with a portion of the revenues donated to Rain Forest Preservation Funds.

6.13 TEMPERATURE AND HUMIDITY

IDEAL CONDITIONS FOR SPORT COMPETITION

Athletes will enjoy spectacular climatic conditions in Rio, a city whose meteorological characteristics are strongly influenced by the landscape and ocean. The mild southern hemisphere winter climate provides the optimal environment for athlete performance. Pleasantly warm days, cool nights and the absence of heavy rainfall combine to produce a favorable atmosphere for spectators to watch the competition, engage in cultural activities and enjoy the delights of Rio.

The temperature and humidity assessment for the competition venues was obtained using statistical data for the proposed Games dates for the last ten years and through the measurements of 12 meteorological stations within the City of Rio.

With respect to the cities hosting Football, average data for each city was obtained for the last ten years and values do not vary significantly from Rio's.

Table 6.13 on the next page shows the tropical winter climate that athletes and Games Family will enjoy during the Games.

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TABLE 6.13 - TEMPERATURE AND HUMIDITY

	Temperature in °C			Humidity in %		
	Maximum	Average	Minimum	Maximum	Average	Minimum
CITY OF RIO						
9:00	29.0	23.1	17.6	97	70	36
12:00	34.9	25.5	17.9	96	61	23
15:00	34.6	25.1	18.4	96	62	22
18:00	30.7	22.2	17.0	96	74	34
21:00	28.1	21.2	16.1	97	79	42
COMPETITION VENUES WHERE CONDITIONS ARE SIGNIFICANTLY DIFFERENT FROM THE REST OF RIO						
BARRA ZONE						
9:00	27.0	22.6	18.0	99	73	40
12:00	37.0	25.6	18.0	98	64	25
15:00	36.0	25.7	21.0	98	65	25
18:00	30.0	21.6	17.0	98	78	40
21:00	29.7	20.6	16.3	98	76	37
COPACABANA ZONE						
9:00	28.8	22.3	18.4	94	73	32
12:00	32.4	23.3	18.9	94	71	26
15:00	28.7	21.7	19.2	95	77	25
18:00	28.7	20.9	18.0	95	80	36
21:00	29.1	20.7	17.8	95	79	33
MARACANÁ ZONE						
9:00	31.7	24.0	16.8	96	64	32
12:00	36.5	26.7	16.8	96	53	21
15:00	37.7	26.5	16.8	95	53	18
18:00	33.3	24.0	15.5	95	65	29
21:00	30.6	22.9	15.8	96	79	38
DEODORO ZONE						
9:00	28.4	23.3	17.3	98	68	39
12:00	33.8	26.3	17.7	95	54	18
15:00	36.1	26.3	16.5	96	54	18
18:00	30.8	22.2	17.3	95	72	29
21:00	24.5	20.1	14.7	98	83	60
COMPETITION VENUES SITUATED MORE THAN 50KM FROM RIO						
BELO HORIZONTE						
9:00	20.8	18.7	12.9	95	66	38
12:00	24.7	19.0	13.4	94	65	32
15:00	22.7	18.8	15.1	97	81	69
18:00	21.4	18.8	16.1	96	81	69
21:00	20.8	17.9	13.4	97	61	43
BRASÍLIA						
9:00	24.7	20.6	16.4	58	50	12
12:00	29.2	21.2	16.5	58	49	10
15:00	24.3	21.7	19.5	61	59	10
18:00	24.9	21.6	17.1	62	58	9
21:00	24.2	21.2	16.5	67	45	12
SALVADOR						
9:00	33.1	22.9	20.2	98	82	45
12:00	35.4	23.7	19.6	97	80	39
15:00	30.8	21.3	19.6	97	97	60
18:00	30.8	21.5	19.6	98	97	70
21:00	30.2	23.7	21.2	98	79	43
SÃO PAULO						
9:00	21.0	14.7	12.5	81	75	26
12:00	21.1	16.0	14.2	83	79	35
15:00	23.9	17.2	13.9	83	73	36
18:00	23.9	17.8	14.9	83	70	25
21:00	23.5	18.0	15.0	83	71	27

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6.14 PRECIPITATION

LIMITED RAINFALL

Table 6.14 below provides precipitation data for each Rio venue zone and cities hosting Football.

TABLE 6.14 – PRECIPITATION

LOCATION	Number of precipitation days		Average volume of precipitation (in L/m ²)	
	Per year	For proposed Games dates	Per year	For proposed Games dates
City of Rio	126	3.7	1,229.8	25.6
Competition venues where conditions are significantly different to the rest of the Candidate City				
Barra Zone	125	4.0	1,303.6	32.2
Copacabana Zone	121	3.5	1,156.7	24.1
Flamengo Park Cluster	121	4.0	1,258.6	26.9
Maracanã Zone	126	3.5	1,313.8	24.5
Deodoro Zone	137	3.5	1,116.5	20.3
Competition venues situated more than 50km from Rio ¹				
Brasília	133	2.0	1,552.1	6.4
Belo Horizonte	107	1.5	1,491.3	6.8
Salvador	201	8.5	2,098.7	67.9
São Paulo	129	4.0	1,454.8	19.4

¹ National Institute of Meteorology - INMET - Average volume of precipitation (in L/m²) (1961 - 1990) and Number of precipitation days (2008/2000)



6.15 WIND DIRECTION AND STRENGTH

MINIMAL WIND INTERFERENCE

Wind conditions are ideal for Sailing, Rowing and Canoe/ Kayak (Flatwater) which will be held in venues regularly and successfully used for international competitions and signed off by their respective IFs with respect to wind conditions. Wind impact is minimal for all other sports. Table 6.15 provides data for the proposed Olympic Games dates for the last ten years.

TABLE 6.15 – WIND DIRECTION AND STRENGTH

	Wind Data	
	Average wind direction	Average wind strength (km/h)
RIO OLYMPIC PARK - TENNIS		
9:00	N	7.9
12:00	SSE	11.3
15:00	S	12.1
18:00	SSW	7.4
21:00	SSW	8.2
COPACABANA STADIUM - VOLLEYBALL (BEACH)		
9:00	WSW	13.1
12:00	WSW	15.5
15:00	E	17.6
18:00	WSW	13.6
21:00	ENE	12.3
MARINA DA GLÓRIA - SAILING		
9:00	SSE	11.7
12:00	S	17.1
15:00	S	15.9
18:00	S	10.1
21:00	E	9.6
LAGOA RODRIGO DE FREITAS - CANOE/KAYAK (FLATWATER), ROWING		
9:00	WSW	13.1
12:00	WSW	15.5
15:00	E	17.6
18:00	WSW	13.6
21:00	ENE	12.3
MARACANÃ ZONE - ATHLETICS, ARCHERY		
9:00	NNE	8.9
12:00	SE	13.9
15:00	SSE	15.3
18:00	SE	10.6
21:00	ESE	9.8
VENUE DEODORO - CYCLING (BMX), CANOE/KAYAK (SLALOM), SHOOTING		
9:00	WNW	3.9
12:00	ENE	8.1
15:00	SSE	12.8
18:00	S	10.4
21:00	E	7.8

6.16 ALTITUDE

NO DETRIMENTAL ALTITUDE IMPACT

All competition venues in Rio and Salvador are located at altitudes of between sea level and 40 meters. Brasília and Belo Horizonte are located at around 1,200 meters while São Paulo is located at 760 meters above sea level.