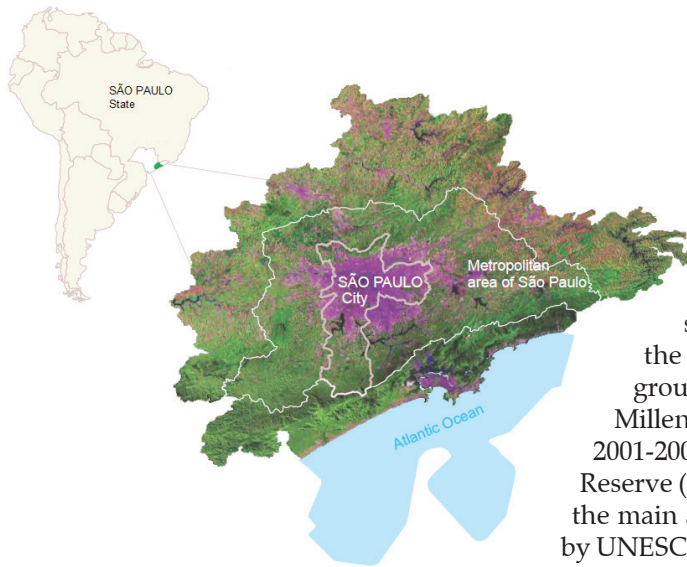


ECOSYSTEM SERVICES AND HUMAN WELL-BEING IN THE SÃO PAULO CITY GREEN BELT BIOSPHERE RESERVE

EXECUTIVE SUMMARY



ECOSYSTEM SERVICES AND HUMAN WELL-BEING IN THE SÃO PAULO CITY GREEN BELT BIOSPHERE RESERVE



São Paulo City Green Belt Biosphere Reserve, with its marine and terrestrial area

Cities are one of the most important social phenomena of mankind. Half the planet's population (54%)¹, and over 84.3%² of the Brazilian population, live in urban areas. They are both agents and victims of the world's environmental degradation and pose serious threats to the services their ecosystems provide. We depend on these ecosystems to provide the materials that are necessary for life, regulate the biotic and the abiotic processes, and also allow for the cultural services; these services need to be distributed throughout the city and in its surrounding area. With the aim of providing grounds for the main decisions about the environment, the Millennium Ecosystem Assessment (MEA) was carried out within 2001-2005. Its application in the São Paulo City Green Belt Biosphere Reserve (GBBR), the so-called Subglobal Assessment (SGA), is one of the main actions implemented by the GBBR. Having been declared by UNESCO in 1994, the Green Belt is the largest biosphere reserve in an urban context, with an area that covers 78 different cities and towns.

The Green Belt's ecosystem assessment aims at bringing to public knowledge the ecosystem services that need to be protected and those that should be recovered. The importance of such a diagnosis in the regional scale is to enable us best understand the environmental wealth that ensures vital resources for 25 million people³ and promotes an economy which is worth 20.7% of Brazil's GDP⁴. Just as important is its originality as grounds for Government policy, especially as a product for the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) and also for the compliance with the São Paulo State Action Plan and State Policy on Climate Change. The relationship between the area under analysis and the theme of the investigation makes it possible to have an innovative process, materialized by the interaction and integration among 70 researchers and 35 institutions. The result of this work is a reference document for the São Paulo City Green Belt, particularly at this critical moment when the collapse in the supply of services that are essential to life cast a shadow of doubt upon the options regarding the use and the conservation of the ecosystems which sustain our metropolises. The EXECUTIVE SUMMARY is a document for publicising and divulging the book by the title of "Ecosystem Services and Human Well-Being in the São Paulo City Green Belt Biosphere Reserve", to be published in the short term.

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Notes: ¹ 2015 data, HABITAT, U. N. (2016) Urbanization and development emerging futures. ² FARIAS, A. R. et al. (2017) Identificação, mapeamento e quantificação das áreas urbanas do Brasil. Embrapa Gestão Territorial. ³ FUNDAÇÃO SEADE. (2018) Municipal Profile. População e Produto Interno Bruto. Retrieved July 18, 2018. ⁴ IBGE. (2017). Sistema de Contas Nacionais Brasil 2015. Contas Nacionais número 56. Rio de Janeiro: IBGE.

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The UN launched in 2015 the 2030 Agenda for Sustainable Development, which includes the 17 Sustainable Development Goals (SDGs) to face complex global

challenges like to eradicate poverty and hunger; to ensure good health, well-being, water and sanitation for all; to build resilient and sustainable cities; to ensure sustainable production and consumption patterns; to respond to climate change; to promote inclusive growth; to sustainably manage natural resources. The publication of this Executive Summary, which shall be followed by the full book itself, will contribute to the efforts from this Environment Secretariat to achieve the SDGs. As a matter of fact, the ecosystems services benefiting São Paulo and Santos Metropolises are provided by ecosystems that extend beyond their limits, sheltered by the São Paulo City Green Belt Biosphere Reserve – GBBR. This Biosphere Reserve is source of a major water volume supplying São Paulo State, harbors a huge Atlantic Forest biodiversity, cools down local temperature, produces local food, provides eco-tourism opportunities, reduces urban air pollution, among others. This publication brings many evidences on how forests and all forms of natural vegetation contribute to people. Comprehensive and interdisciplinary, it shows the connections between ecosystems and the services they provide for the well-being of over 25 million people, a reference for the territorial integrated and sustainable management of Brazil’s largest and most complex metropolitan region.

EDUARDO TRANI
São Paulo State Environment Secretary



The establishment of the São Paulo City Green Belt Biosphere Reserve – GBBR - stemmed from a huge civil movement in the late eighties that, while opposing to the Via Perimetral

Metropolitana (a former version of the current Rodoanel ring road), advocated granting the green belt this important international recognition. The São Paulo State Forest Institute elaborated the technical report for the Biosphere Reserve nomination in the early nineties and has been its executive coordinator from the beginning. The designation came in 1994, as an integral part of the Mata Atlântica Biosphere Reserve. In 2017, UNESCO recognized the GBBR as an individual Biosphere Reserve within the World Network, an important milestone for this protected area. The area encompassed by the GBBR and its inner urban area corresponds to just 0,27% of the national territory but is host to nearly 12% of Brazilian population and produces 20% of the national GDP. The ecosystem approach used by this Biosphere Reserve in its urban and peri-urban context is a powerful decision-making tool allowing for sustainable management of ecosystems with local, regional and national significance. The studies outlined in this Executive Summary convey to the understanding that we need to adopt the GBBR as a territorial management platform for the system’s sustainability to ultimately ensure metropolitan environmental and water security for improved human well-being over the next decades.

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DIAGNOSIS OF THE ECOSYSTEM SERVICES FOR PROVISION THE PRODUCER AND THE ECOSYSTEM SERVICES FOR PROVISION OF FOOD

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For the GBBR territory, the provisioning ecosystem service food is essential. The chapter explores both the role of the consumer and that of the producer of food, in systems such as “Sao Paulo Plateau” (Planalto Paulista), “Sao Paulo Coast” and “Preservation Units”. Due to the stress currently experienced by the ecosystem service for water provision in the region, food production is associated not only to land use and cover, but also to the hydrographic basins and water reservoirs. Extractivism, agriculture and livestock production are typical provisioning ecosystem services, but when agroecology is the technological choice regulating (especially water-related ones), cultural and supporting ecosystem services are added. The high urbanization level in the GBBR is convergent with urban agriculture specificities. In order to provide a consumers’ perspective, an ecological footprint study on the vegetables commercialized by the Central Wholesale supplying São Paulo Metro Area was conducted. Also, an analysis of food consumption, nutritional state and



An Organic Agriculture. Photograph: Hamilton Trajano, 2006

food insecurity for the Southeast of Brazil, the State of São Paulo, and the São Paulo Metropolitan Area, was conducted. In a nutshell, we present some of the main drivers that impact the ecosystem service food, and its socio-environmental consequences, through the availability of water and tillable soil. We also provide an analysis of the extent to which the systems renewal capacity has been jeopardised and attempt to how the impact this has had on human well-being through the use of some indicators. Our evidences show that agroecological agriculture may contribute to reduce ecosystems’ degradation, protect the rural characteristics of the Green Belt, keep the provision of regulating services of water bodies, as well as support and cultural services, reversing the trend for a greater distance between production and consumer areas. Agroecological urban agriculture can be used for educational purposes, both to strengthen demand for healthy products, as well as to improve nutritional and food standards.

DIAGNOSIS OF THE ECOSYSTEM SERVICES FOR PROVISION TIMBER AND NON-TIMBER FOREST RESOURCES



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Planted eucalyptus forests of high productivity and high added value. *Photograph: Edgar Fernando de Luca, 2006*

The human species has made use of wood since very early days. Food production, naval and civil construction, energy uses and, more recently, urbanization have all been causes of the significant reduction in the native vegetation on the planet. Seeking the supply of alternative sources of forest products, afforestation with alien species came about in Brazil at the start of the 20th Century, especially with the *Eucalyptus* and *Pinus* genera. Brazil stands out with cutting-edge technology in the global silviculture scene with these genera, and this has made a significant contribution in the supply of the national and the international markets, in the sectors of pulp and paper, solid wood and fiberboard, and also in the energy sector. At the São Paulo City Green Belt Biosphere Reserve (GBBR), recent studies have shown the presence of some 120 thousand hectares of the genera as here mentioned, an area equivalent to 6.6% of its territory. Apart from the provision of timber and non-timber products, these forest stands provide other ecosystem services, acting directly upon the preservation of water, erosion and landslide control, climate regulation and also reduction of the carbon concentration in the atmosphere. The total carbon stock at the GBBR in these

types of forests reaches 23 million tons in CO₂ equivalents (C-CO₂). The estimated annual rate of atmospheric carbon removal due to the growth of these cultures comes to almost six million tons of C-CO₂. Considering the trend of an increased urban sprawl towards environmentally vulnerable areas, these plantations have a relevant role in the control of urbanization and, hence, the maintenance of ecosystem services in the GBBR. However, recently, large extensions of reforested areas have been the object of real estate speculation for conversion into condominium projects, urban sprawl and infrastructure work. In a hypothetical scenario, if all the reforested areas in the GBBR were developed, urbanization would increase by more than 50%, leading to significant loss of ecosystem services with an impact on human well-being.

DIAGNOSIS OF THE ECOSYSTEM SERVICES FOR PROVISION BIOCHEMICAL PRODUCTS, NATURAL MEDICINES AND PHARMACEUTICAL PRODUCTS

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According to the World Health Organisation (WHO), the use of medicinal plants in therapy is as old as civilisation itself, and is closely linked to the evolution of humanity. Medicinal plants, phytopharmaceutical preparations, and also natural products taken in isolation, are now a market which involves billions of dollars, both in developed countries as in those developing nations. Phytotherapeutical products have always been an important part of the drug market. In 2008, in the whole world, this segment has handled USD 25 billions. In Brazil, it is estimated that this market should revolve around the mark of USD 160 millions per annum. Within the scope of ecosystem services of GBBR (Greenbelt Biosphere Reserve) and its relationship with human well-being, the main aim of the current work is that of surveying and mapping the vegetation, with studies published from the chemical, pharmacological, phytochemical, medicinal and toxic standpoints. According to the preliminary study carried out on 277 plants out of the 2,256 species that have been catalogued by BIOTA¹-FAPESP², that occur in the 78 municipalities of GBBR, all the species mentioned in this diagnosis have shown some study, showing the sheer potential that this vegetation presents as services for provision of natural products. Out of the 277 plants that have been entered in the catalogue, 20 are included in the list of 74 medicinal plants taken up by the Brazilian Government's Unified Health System



Lantana camara L. , cambará - medicinal e toxic.
Photograph: Massako Nakaoka Sakita, 2013

(SUS), in 2006, including the monographs, and also pre-clinical, clinical and toxicological pharmacological studies that are necessary for its distribution and use by the population. The analysis of the pharmacological potential of the species found at the GBBR brings promising results for the 78 municipalities that make up the Green Belt, with regard to the usage of these plants from the medicinal and pharmacological standpoint, thereby contributing towards the development of actions related to the preservation of the vegetation for the present and future generations.

¹BIOTA-FAPESP: FAPESP Research Program on Biodiversity Characterization, Conservation, Restoration and Sustainable Use

²FAPESP - São Paulo Research Foundation: is an independent public foundation with the mission to foster research and the scientific and technological development of the State of São Paulo



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Support services (biodiversity maintenance and ecological processes) of regulation (through the marshland) and provision (upstream from the supply reservoir of Ponte Nova). This is a marshland area close to the source of the Tietê River. *Photograph: Donato S. Abe, International Ecology Institute collection, 2004*

Human settlement processes on the GBBR territory generated important impacts upon the provision, regulation and support services with regard to water. In this respect, one can highlight at the GBBR ecosystem services for provision of surface and underground water both in their qualitative and quantitative aspects, with special emphasis to the water basin of the Upper Tietê and the Santos lowlands, which fully lie within the GBBR area, and also the basin of the Piracicaba, Capivari and Jundiá rivers, that is only in part within that territory, but with serious implications on the water supply. The Upper Tietê basin includes a population of over 19 million inhabitants (10.232 inhabitants/km²) and has the most critical demand for water in the whole state, consumption being more than double of its availability (including underground water reserves). Forty percent of the GBBR surface is covered by native vegetation, that provides surface and underground water regulation services, with special attention to the relationship between water and forest, water and riparian forest, and for the services of purification of water from

eutrophicated water and streams provided by marshlands and other flooded areas. Through the Government water resources policies analysis, in heavily populated urban areas are the analysis of the standards for protection and recovery of water catchment areas for the water public supply to the Metropolitan Area of São Paulo (RMSP) (Guarapiranga and Billings reservoirs). Starting from the contextualisation concerning the main direct and indirect causes of modification of the water ecosystem services and risks presented to human well-being, it was confirmed that ignoring the necessary conditions for water renewal will seriously jeopardise the ecosystem services and directly affect the population life quality as a result of the water increasing availability reduction (quality and quantity), exposure to factors leading to health risks, both those of a microbiological nature as well as the ones of physical and chemical sort, and human and material losses caused by floods and landslides, making absolutely crucial to control the deterioration situation of the ecosystem water services in the Green Belt.

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The runoff regulation service, responsible for geo-hydrologic processes, may be considered in three geomorphological compartments of the São Paulo City Green Belt Biosphere Reserve (GBBR): Atlantic Plateau, coastal plain and escarpments of Serra do Mar. The human occupation in Atlantic Plateau began in the sandstone/claystone (sedimentary rocks) low hills, and expanded to higher hills of granites, gneisses, schists and phyllites (crystalline rocks). Those new landforms, of high declivity, determine high erosion susceptibility and inadequate conditions for urban occupation, developing risk areas, and revealing be more dependent of the ecosystem services of biosphere. However, the way to live in plain areas and the techniques for human occupation, disrespecting physical environment limitations, continue to cause undesirable geo-hydrological processes, especially floods and flooding in metropolitan São Paulo. In escarpment of Serra do Mar, contrasts the disorderly occupation (neighborhoods-quota) and several transport routes (roads, railways, pipelines, power line, hydroelectric and industries), crossing high slopes that favor erosion processes as landslides and debris flow, promoting risk of the occupations, both in the Serra do Mar as in neighboring areas in coastal plan. This coastal lowland - Baixada Santista and Port of Santos - stand out from the hills of Santos, São Vicente and Guarujá, where landslides occur, submitting occupations to serious risk. The estuarine system of Santos and São Vicente cities, gets the sediment produced by these processes, requiring constant dredging to maintain the port system. The Inadequate occupation human induces the geo-



Ecosystem-services loss, and geo-hidrologic processes arising, by erosion and sediment deposition in watercourse. Implementation of the North Ring-Road, Guarulhos region (São Paulo/ Brazil), with deforestation, and processes of cut and landfill. *Photograph: Antonio Manoel dos Santos Oliveira, 2014*

hydrological processes that reducing ecosystem services São Paulo City Green Belt Biosphere Reserve (GBBR) and involve: stagnation of economic activities; increase in infrastructure maintenance costs, especially of urban drainage systems and water supply reservoirs and port system; damage to public and private patrimony; impairment of health, physical and mental, of the population; deaths and victims of serious accidents, particularly from landslides and floods; increase in public management costs (corrective works, civil defense actions, health systems, others). As a consequence, is strategic, the land use conservation of plant coverage areas appropriate, for the regulation of the geo-hydrological processes in the GBBR, and ecosystem services production. This preventive action have significant and immediate gains to human well-being, including economic advantages in the medium and long term.



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Air pollution has become one of the most serious environmental and public health problems in large cities; it causes serious damage to the ecosystems and also affects people's health. The inhabitants of the major urban centres, such as the Greater São Paulo Metropolitan Area, are those most affected by the adverse action of air pollutants. Trees are an important instrument for public management of cities, as they can reduce air pollution. They can control pollutants in four different ways: absorption by the stomata of the leaves; deposition of gases and particulates on leaves and barks; reduction of the wind speed due to the natural barrier formed by vegetation, leading to the decantation of particulate material; and the reduction of ozone and other pollutants with reduction of temperature and increase in the air moisture, as these provide. Studies in different parts of the world show that trees in urban areas can bring down air pollution in the region by between 1% and 70%. While a reduction of 20% in the vegetated area of a city can increase the concentration of ozone (O₃) by 14%, an increase in tree cover from 20% to 40% can mean a reduction of 1 ppb of O₃ per hour. As mortality caused by cardiorespiratory diseases and lung cancer are linked to prolonged exposure to particulate materials, especially the finest fraction (MP 2.5), the densification of vegetation in the cities has a direct influence on people's quality of



Aspects of urban pollution in São Paulo with direct effects on human health and the quality of the environment.

Photograph: Francisco de Assis Honda, 2010

life. In a survey carried out in five parks in the city of São Paulo, where samples of tree barks were taken as biomonitors of atmospheric pollution, it was proven that the central areas of the parks have a lower concentration of pollutants when compared to the fringes of the said parks, thereby proving their efficiency in the reduction of gases and particulate materials. To conclude, we can assess that: i) the Green Belt of São Paulo is a potential reducer of atmospheric pollution generated by the urban areas; ii) inside the urban areas, small and medium-sized green areas play an important role in the reduction of pollutants; iii) the increase or reduction of urban green areas may bring considerable positive or negative impact on public health

DIAGNOSIS OF ECOSYSTEM REGULATION SERVICES

CARBON SEQUESTRATION AND REDUCTION OF GREENHOUSE GASES

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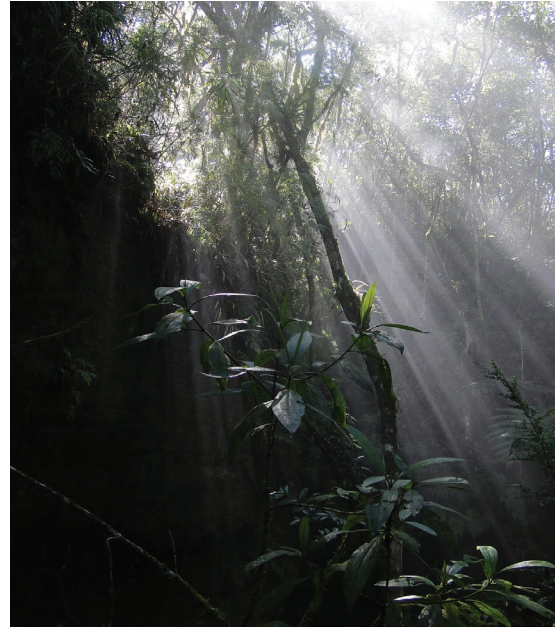
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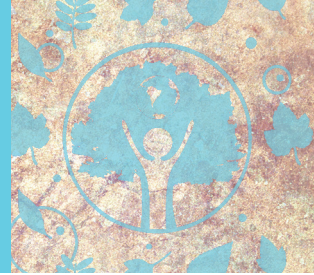
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The greenhouse gases that have greatest influence on global climate change (GCC) are carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O), mainly emitted by the human activities of production and consumption of usable goods. Among the strategies to reduce the atmospheric concentration of greenhouse gases are the reduction of emissions from fossil fuels and deforestation and the rationalization of land use changes. The State of São Paulo has established a State Policy on Climate Change (PEMC) and has also set a target to reduce emissions of CO₂ by 20% by 2020 as compared with 2005 levels. In this scenario, vegetation and the forest stands in the São Paulo City Green Belt Biosphere Reserve (GBBR) have an important role considering GCCs and PEMC; apart from the regulation of greenhouse gases, they also provide ecosystem services such as water production, erosion and landslide control, and also climate regulation, which helps the well-being of 24 million inhabitants of the São Paulo Metropolitan Region and its surrounding areas. The current storage of carbon by forest ecosystems of the GBBR comes to 450 million tons in CO₂ equivalent (C-CO₂), which represents almost ten years of



Vegetation inside the Atlantic Rainforest: ecosystem services of carbon sequestration and reduction of greenhouse gases. *Photograph: Rodrigo Antonio Braga Moraes Victor, 2010*

total emissions from of fossil fuel in the State of São Paulo. The rate of atmospheric removal by forests undergoing regeneration exceeds 28 million tons of C-CO₂ per year (36% of annual state emissions). Thus, the ecosystem services provided by the GBBR ecosystems are relevant on a local, regional and global scale, for the accomplishment of state, national and international climate change targets and its effects on the environment. On a local scale, the forest brings benefits to the population of the metropolis. However, the maintenance of this ecosystem contribution depends on the preservation of the vegetation, as a possible expansion of deforestation in GBBR shall contribute to the increase in emissions and also a reduction of the potential for carbon sequestration, bringing harm to the quality of urban and periurban life and also the achievement of the above-mentioned goals.



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The town of São Paulo de Piratininga, currently São Paulo City, as well as other major cities in the world, grew along its rivers, essential to human activities. With the urbanization process, the central area of GBBR, the drainage system was covered by streets and avenues and altered the water cycle and air circulation. Features of weather and climate of the region are reviewed, highlighting the consequences of human action in the Metropolitan Area of São Paulo (RMSP) and Serra do Mar (SM). The main local weather systems are discussed in the light of their morphological characteristics and their impacts such as floods and landslides. The weather and climate evolution is the object of analysis from Weather Station data series of the Institute of Astronomy, Geophysics and Atmospheric Sciences (IAG) of the University of São Paulo (USP), which enabled the assessment of the climate role in establishing the ecosystems and the regulation of these climatic conditions on GBBR. With the degradation, decline and disappearance of unique ecosystems, the environment loses its ability to provide ecosystem benefits. Synergistically, due to changes in the microclimate of GBBR, the population is more exposed to environmental risks arising from urban development. Floods, floods, landslides, lightning, wind gusts, hail and other weather events in the spring and summer period, have caused loss of life and material increasingly larger and more



Thermal inversion and pollution over São Paulo City. View from Jaraguá. Photograph: Augusto José Pereira Filho, 2006

frequent. Similarly, temperature inversions, high temperatures, low relative humidity and high pollutant concentrations in the fall and winter to help reduce the quality of life and human well-being of the population of the metropolis. This framework requires appropriate actions to prevent and mitigate extreme events and to integrate government, civil defense, public and private institutions, media and society, in order to anticipate risk situations and act strongly in the recovery of degraded environments.

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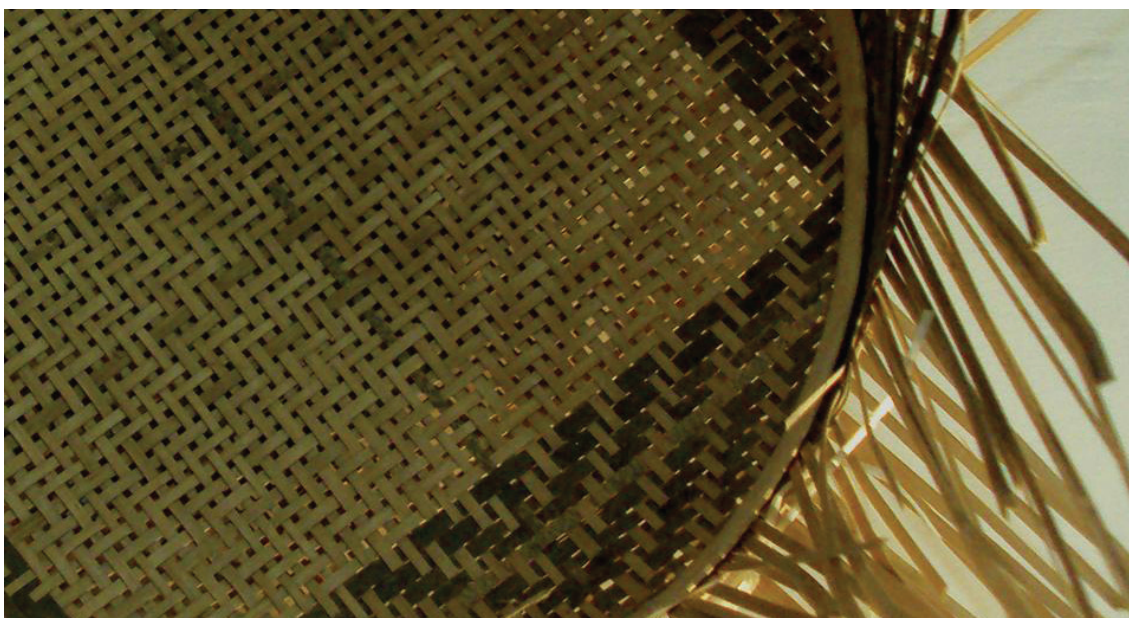
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Caipira basket art: a product of the ecosystematic cultural service. Piece in finishing, woven with a kind of Brazilian Bamboo (taquara). *Photograph: Cristina de Marco Santiago, 2009*

The ecosystem services are appraised from the cultural standpoint, adopting as principle the intrinsic relationship between biodiversity and cultural diversity. The expressions of folklore are addressed starting on the understanding that folklore expresses the relationship nature-society in a particular culture, in this case the traditional caipira, a relic that is representative of the social rural organisation of Colonial Brazil. The elements that make up this culture are treated with the adding of three case studies within the area covered by the São Paulo City Green Belt Biosphere Reserve (GBBR). The assessment of the cultural services occurs through

secondary data which treated inside a historic context have allowed the analysis of the acting forces and their trends. We see that the caipira nuclei have been drastically reduced due to the processes of urban and industrial development, and the culture is vulnerable due the deficiency of government policies and studies to based them properly. Thus, is elected a set of indicators that measures the cultural services provided by the ecosystems and the relationship of these services with the general well-being of the communities, being useful for the checking and the monitoring thereof.



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The natural areas of the GBBR provide ecosystem services of leisure and tourism. The social and economic importance of these practices allows its understanding from different approaches, often contradictory. On the social side, leisure and tourism are part of an understanding about the social relations of production, while, at the same time, allowing movements, supported by informal education, towards critical and creative thought by their practitioners. Thus, in an approach based on ecosystem services, it is possible to reflect about the role of leisure and tourism within protected areas, where people are looking for reconnect to nature. This understanding provides a great opportunity for people, in their free time, to rest while having fun and developing culturally. In the economic dimension, considering the movement of people, this brings about a wide variety of activities related to accommodation, meals, transport and organisation of trips, among others. Protected areas thus appear as important spaces for ecosystem services along these thematic lines. In the region of the GBBR, there are natural attractions, with this term being taken as meaning ecosystemic services, in the 78 constituent towns, largely due to the protected areas and rural properties distributed within it. Here we highlight the government



The Village of Paranapiacaba, in Santo André, State of São Paulo. *Photograph: Francisco de Assis Honda, no date*

programmes to encourage sustainable tourism, such as the hiking and trekking trails of São Paulo (Trilhas de São Paulo) programme, of the State Secretariat for the Environment; of the 40 trails which are listed on this programme, 9 lie within the borders of the GBBR, such as the trail known as Historic Monuments of the Sea Route (Monumentos Históricos Caminho do Mar). In the Routes of São Paulo (Rotas de São Paulo) programme, of the Secretariat of State for Tourism, there are 7 itineraries about natural, historical and gastronomic aspects of the GBBR, such as the Taypa de Pilão (adobe build) circuit. There is also a need to know what is already unfolding within the Green Belt, as also show the potential to be appropriately handled, considering leisure as a constitutional right and also a contributing factor for the critical grooming of the citizens, who have in the GBBR an important space for their leisure and tourism pursuits.

DIAGNOSIS OF ECOSYSTEM SERVICES IN SUPPORT BIODIVERSITY AS AN ECOSYSTEM SERVICE IN SUPPORT

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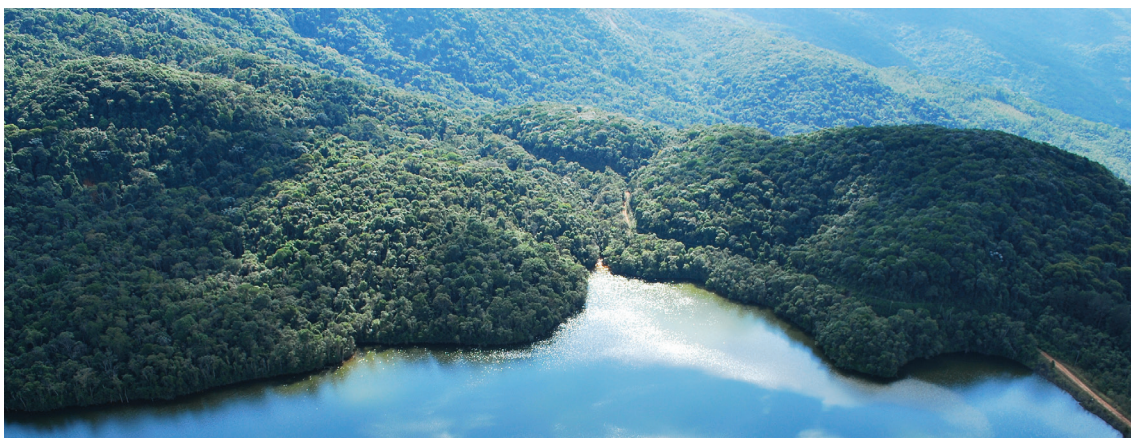
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Montane Ombrophilous Dense Forest at the Itaberaba State Park , one of the protected areas that are part of the São Paulo City Green Belt Biosphere Reserve. *Photograph: Francisco de Assis Honda, 2009*

The concept of biological diversity has been considered as the variability of living organisms in land and water ecosystems in three different levels: genetic diversity, taxonomic diversity and variety of ecosystems. Part of this biodiversity has been analysed within the scope of the GBBR, and here we highlight the vegetation types that are present, and also for associated plant and animal life. In relation to the ecosystem services in support provided by biodiversity, special prominence has been given to interaction between plants animals and the environment, including the flowers pollination and propagules dispersion, the nutrient cycling , and also the soil and water conservation. However, changes in habitats, overexploitation, invasion by alien species,

pollution and climate change caused by the humans are all direct causes of changes in ecosystems which, when degraded, lead to loss of biological diversity and also a rise in the number of threatened species. If action plans are not implemented, then may increase the risk of extinction, as a result of the synergy between these types of adverse pressure. Strategies for preservation of biodiversity and the associated genetic resources include complementary actions for in situ preservation, which keeps the species in their natural habitat, and ex situ preservation, in which the species are widely outside their habitat. Finally, there is a presentation of how biodiversity has been contributed for the other ecosystem services and for the well-being of the human species.



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The water basin of the Cantareira Water Supply System. *Photograph: Oscar Sarcinelli, 2012*

The valuation of ecosystem services should be compatible with the principles of Ecological Economics approach. Briefly, an ecological economics valuation differs from the environmental economics valuation practices currently in use as it seeks to take into account the complex nature of the ecosystems in their multiple dimensions, ecological, social and economic. The metric of the first one is not monetary, but a sustainability metric, i.e. the importance of the focused ecosystem for the long-term sustainability of a larger set of ecosystems and the risks of irreversible and potentially catastrophic losses of ecosystem functions. The sustainability metric can only be gauged through a careful ecosystem assessment and ecological modelling. The social dimension metric is not monetary either; it can be measured through participative methods capable of assessing the relative importance of the focused ecosystem in terms of the cultural identity of a community

or ethnic group. Finally, the metric of the economic dimension is monetary. However, in the ecological economics approach the assumptions about human capacity in the assessment of natural resources monetary values are more realistic. The chapter presents also a discussion connecting the practice of valuation to the schemes of Payment for Environmental Services (PES), as an ecological economics valuation can be useful to design and to implement PES mechanisms. Last but not least, the use of valuation is exemplified in analysis of the case studies which have been presented throughout the book.

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