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The Environmental balance sheet of nations: reflections on global climate change scenarios

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ABSTRACT: The objective of this work is to prepare environmental balance sheets of countries based on the scenarios for climate change and global warming indicated by the Intergovernmental Panel on Climate Change (IPCC) of the United Nations (UN). We consider the stock of forest resources and the residual balance between emission and capture of carbon or greenhouse gases (GHGs) estimated for each country in 2020 and 2050, according to the two editions (A1B1 and A2B2) of the *Special Report on Emission Scenarios* (SRES). The study is multidisciplinary in nature, involving concepts from the areas of climate change biology, energy, geoscience, economics and accounting. The last discipline was used to delineate the research subject and served as a method, by means of the Inquired Balance Sheet technique, to measure and classify environmental assets, liabilities and net equity. We selected a sample of seven countries, the four leading developing countries (Brazil, Russia, India and China – the

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BRICs) and one developed country each from the Americas, Europe and Asia (USA, Germany and Japan). The balance sheets of each country were calculated in equivalent gross domestic product (GDP) units, adjusted by per capita energy consumption in metric tons of oil equivalent (TOE) and megatons of carbon (MtonC), priced at the cost (in US$) of carbon credits suggested by the UN. The results show that the developed countries are consuming resources not only from other nations, but from future generations as well, and although Brazil and Russia have environmental surpluses, the consolidated balance sheet for the planet in the scenario for 2050 indicates a deficit or bankruptcy situation, with an "uncovered liability" or negative net equity of US$ 2,300 annually for each of the current 6.6 billion people (2008) and an environmental liability equivalent to a quarter of global GDP. This unconventional accounting report is a rendering or global accounts based on future scenarios and suggests the need for coordinated actions involving social, environmental, cultural and economic aspects.

Key words: Balance sheet of nations; global climate change; environmental net equity.

1.INTRODUCTION

It took thousands of years for the human population to reach the one billion mark, in around 1802. In the little more than two centuries since then, the population has veritably exploded, due to greater food production and improved health care and basic sanitation. According to most estimates, the world's population will reach 9 billion in the next few decades, with an increase of a billion people every 15 years, as shown in Figure 1, prepared with data from the United Nations (www.un.org).

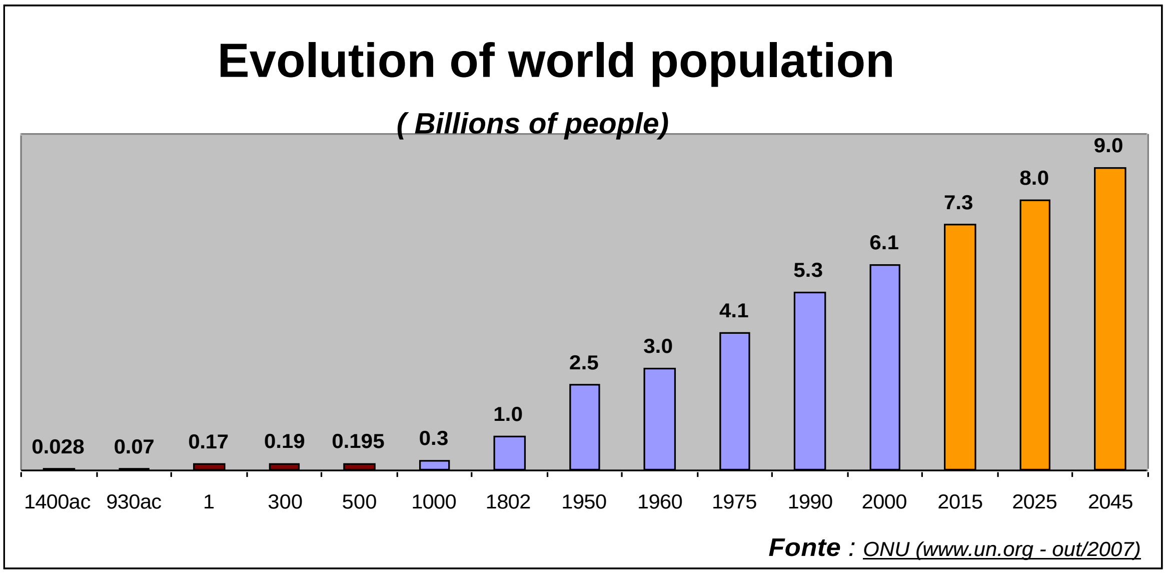

Figure 1 – Global population growth and perspectives (UN).

These people will have to meet their basic needs and, to maintain the current consumption of scarce and partly nonrenewable resources, they will continue emitting greenhouse gases (GHGs), which by definition cause global warming (UCS, 2008). The International Energy Agency estimates that in 2050 global energy demand will be 110% higher than the level of 2004, while 30% more petroleum will be used (Sachs, 2007).

Greenhouse gases (GHGs) are gaseous substances that absorb part of the infrared radiation that otherwise would be reflected back into space. This leads to a buildup of heat in the atmosphere, making the world hotter than it otherwise would be. The greenhouse effect is a natural phenomenon that has been at work since the Earth's formation. It is necessary to maintain life on the planet, because without it, the average temperature would be 33 ºC lower than at present, making life as we know it today impossible (Ortega, 2008).

Marcovitch (2006, p. 13), in his study on how to change the future prospects in light of global climate change, lists some of the questions that researchers and scholars are posing:

> Does global warming affect human health and food supplies? To what extent does the use of fossil fuels aggravate the concentration of greenhouse gases? What are the alternatives to stabilize this concentration level? What is the probability that sea levels will rise and which are the most vulnerable areas? How do local, regional or national decisions result in global climate changes? How can the impacts of unsustainable consumption habits on nature be reduced? How can climate change decrease potable water supplies?

Based on the above, the overall question that arises is: "Will the children and grandchildren of today's generation have to pay this bill? Or is it possible to take collective measures to minimize this environmental liability?"

The hope is that the nations of the world will take the necessary measures to assure sustainable development, as expressed in the Kyoto Protocol, and that future generations will be able to pay this bill, even if in the red.

The Kyoto Protocol is an international treaty that requires signatory developed countries to reduce emissions of the six GHGs (carbon dioxide-CO_2, methane-CH_4, nitrous oxide-N_20, perfluorocarbons-PFCs, hydrofluorocarbons-HFCs and sulfur hexafluoride-SF_6) in relation to the 1990 levels by at least 5.2%. Negotiated in Kyoto, Japan in 1997, it was opened for signing on March 16, 1998, ratified on March 16, 1999, and came into effect on March 16, 2005. Countries were supposed to comply as from 2008 through actual reductions or alternative means, such as investments in Clean Development Mechanism (CDM) initiatives and carbon credits (Marcovitch, 2006).

The Clean Development Mechanism (CDM) is one of the flexibility mechanisms created by the Kyoto Protocol to help developed countries (Annex I countries) in the process of GHG emission reduction or carbon capture (carbon sequestration) and to enable developing countries (non-Annex I countries) to achieve sustainable development (Marcovitch, 2006).

This is an exploratory study that aims to identify the environmental liability that each person in the world will have to bear. To do this, it is necessary to convert information of a qualitative nature into information with a monetary or accounting nature.

We are not aware of other similar studies, namely to prepare environmental balance sheets for the main countries of the world and in consolidated form. This entails gathering multidisciplinary data and classifying environmental assets, liabilities and net equity, according to each country's natural resources and carbon sequestration capacities. To respond to the research question, the balances are presented in per capita units, for each of the countries analyzed and in consolidated form for the planet.

The countries chosen for the database are the BRICs (Brazil, Russia, India, China) and developed countries from the Americas, Europe and Asia (USA, Germany and Japan). The sample represents 32% of emerged area on the planet, 50% of the world population and 68% of global gross domestic product (GDP). It involves the main economic blocs, such as the European Union (EU), the Southern Cone Market (Mercosur), the Asia-Pacific Economic Cooperation group (APEC), the North American Free Trade Agreement (NAFTA) and the proposed Free Trade Area of the Americas (FTAA). It also contains the five so-called "monster countries" (Kennan, 1994), which are the countries with continental landmasses, huge populations and thus important missions for the future of humanity.

Figure 2, adapted from Google Maps (2010), shows the location of these countries.

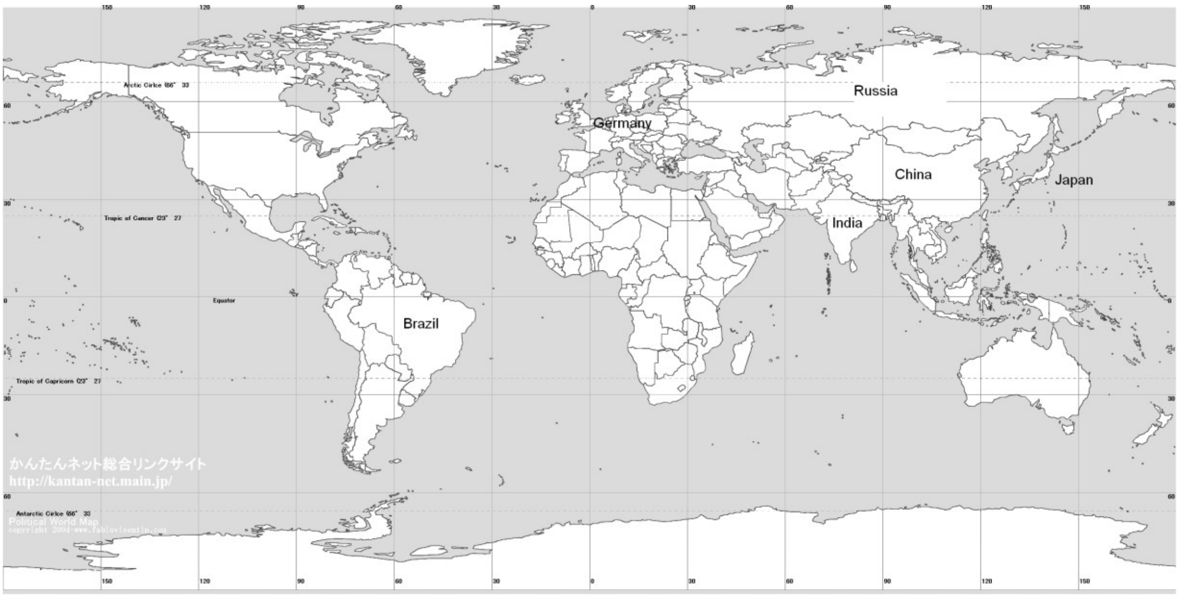

Figure 2 – Countries chosen in the sample (Brazil, Russia, India, China, USA, Japan and Germany).

The future scenarios chosen here are those established by the Intergovernmental Panel on Climate Change (IPCC) of the United Nations (UN), more specifically the forecasts in the Special Reports on Emission Scenarios (SRES) A1B1 and A2B2, with the refinement proposed in this study, related to the simulation of other variables in carbon sequestration, such as type of forests, deforestation and technology use.

We use the Inquired Balance Sheet method (Kassai, 2004) to measure in monetary terms the quantitative and qualitative variables involved in this study. The advantage of this method is that it reflects the law of balance between credits and debits, sources and uses, and is based on the fundamental equation of accounting (assets minus liabilities equals equity), and permits the preparation of accounting statements in situations of a shortage or difficulty of obtaining data.

This study is descriptive and exploratory in nature. It relies on information obtained from official databases, review of the literature and definitions of constructs to enable reaching the desired objective.

The work is timely because of the relevance of the questions involved. We hope the environmental balance sheets will allow analyses and interpretations of the future of nations and the planet as a whole, to contribute to the decision process of each citizen and of policymakers. As framed by Marcovitch (2006, 26), the goal is “to change the future and permit the survival of the human species, giving new force to the concept that man also lives in the world, not only in his house, city or country.”

2.GLOBAL WARMING AND THE MAIN RELEVANT EVENTS

Although atmospheric studies at the start of last century (Arrhenius & Callendar) already revealed a significant increase in global temperature, the fact that this warming is provoked by human activity has only recently become a consensus. The conservative line previously argued that the climate variations in the last two centuries were extreme repetitions of natural oscillations in glacial processes. But this argument was destroyed by the examination of ice cores more than 3,000 meters long taken from polar regions. The air bubbles preserved during the formation of ice layers during thousands of years were analyzed for their concentration of greenhouse gases, revealing the atmospheric composition of each age (Ramathan & Carmichael, 2008).

These ice-core studies show small changes in GHG concentrations until 1750, after which there was an abrupt increase (Alley, 2000; Osborn & Britta, 2006). Carbon dioxide (CO_2) concentrations increased from 280 ppm (parts per million) in 1750 to 430 ppm in 2005, while methane (CH_4) and nitrous gases (N0x) jumped from 715 ppb (parts per billion) and 270 ppb to 1774 ppb and 320 ppb in the same period (Howweling et al., 2008; Osterberg et al., 2008). The recognition that these gases really worsen the greenhouse effect and that the sudden increase in their concentrations can only be explained by industrial activities put an end to virtually all disagreement.

Further support came from the Union of Concerned Scientists – Citizens and Scientists for Environmental Solutions (UCS, 2008), represented by 20 Nobel laureates and 19 winners of the National Medal of Science. After analyzing the reports on climate change discussed at the end of the century, the scientists not only confirmed the worrying picture, but also accused the Bush administration of politically manipulating regulatory bodies to protect polluters. The influence of the UCS did not sensitize the US federal government, which maintained its veto against the Kyoto Protocol, but it promoted the mobilization of 17 states and more than 400 American cities, including New York, Los Angeles and Chicago, prompting them to set their own emission reduction goals, many of which are much more radical than the Kyoto levels. The UCS report stresses the following figures (UCS, 2008):

- The mean temperature on the planet has risen by 0.6 degrees Celsius in the 20th century.
- Warming in the 20th century is greater than in any other ages during the past 400-600 years.
- Seven of the ten warmest years in the 20th century occurred in the 1990s.
- Glaciers are disappearing around the world, as well as the permafrost.
- Floating ice in the Arctic has lost 40% of its thickness in the past four decades.
- Sea level has been increasing three times faster in the last 100 years.
- A growing number of studies show changing varieties and behaviors in plants and animals.
- Marine currents are changing directions.
- Sea level can rise by 4.9 meters.

The fourth edition of the IPCC report (2007) differed from the other versions by the methods it adopted in climate analyses. The findings presented in this edition were produced through the use of computers with much greater processing capacity, which permitted simulating a larger number of variables more precisely. The largest Brazilian computers used by the scientific community until 2010 were below processing capacity of one terabyte, as opposed to the Americans and Japanese, which were close to 50 terabytes (a thousand gigabytes), with capacity measured in petabytes being discussed (IPCC, 2007).

The Stern Review Report, covering the economic impacts of global warming, was sent to the British Treasury in 2006 and rapidly became the guidebook of the European political agenda for public and private investments and, at the same time, turned into the most judicious manual of the emerging field of “climate change economics”. The Stern Report evaluates environmental challenges and new business opportunities, such as profiting from environmental reputation, in the expected new global order, based on three needs: (1) carbon pricing, (2) energy efficiency technology and (3) change in consumption behavior (Stern, 2006).

Nevertheless, the financial market anticipated the recommendations of the Stern Review Report. The Chicago Climate Exchange (CCX), founded in 2003, before its closure in 2010 enabled two types of trading: carbon quotas, through the CDM under the Kyoto Protocol, and carbon sequestration credits through reforesting and forest maintenance projects, independent of the Protocol. In the first case, companies that reduced their emissions below maximum levels sold their “right to pollute” to companies that chose or were not technologically able to comply with their targets. In the second case, public or private projects sold credits from carbon sequestered through biomass, by the maintenance of forest reserves or reforestation. Companies purchasing these credits could “compensate” for their pollution as if they were protecting or planting trees, which consume carbon from the atmosphere (CCX, 2008).

The figure below depicts the chronology, or knowledge curve, of the main relevant events regarding the realization of global warming, starting with the discovery of carbon dioxide in 1753 by Joseph Black until the proclamation of the International Year of Planet Earth (IYPE), using the slogan: “Earth Sciences for Humanity”:

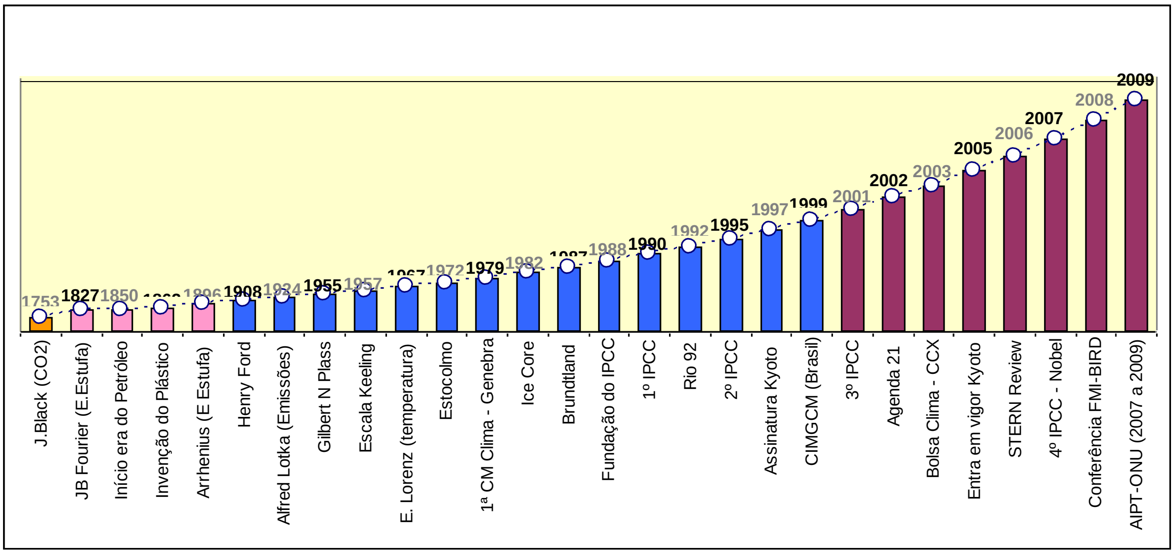

Figure 3 – Global warming knowledge curve.

1753: **Joseph Black** (1728-1799), a physician, physicist and chemist, discovered carbon dioxide, first calling it “fixed air”. (http://faculty.cua.edu/may/black.pdf , 2010)

1827: **Jean Batiste Joseph Fourier** (1768-1830), a French historian, physicist and mathematician, developed the concept of the greenhouse effect as a condition *sine qua non* of the planet’s climate stability, enabling life to exist. (http://en.wikipedia.org/wiki/Joseph_Fourier, 2010)

1850: The modern **era of petroleum** started in the mid-eighteenth century when America’s Edwin Drake found crude oil about 20 meters below the surface in western Pennsylvania. It was initially used to make kerosene. In 1859, he drilled a well using the drive pipe method. Gasoline was invented in 1886. (MGB, 2007)

1862: **Invention of Plastic** by Alexandre Parkers, based on cellulose. Twenty years later, plastic became popular with the invention of Bakelite by Belgian chemist Leo Baekeland. It takes more than 400 years to naturally decompose. (http://www.planetaplastico.com.br/main.htm, 2010)

1896: **Svante August Arrhenius** (1859-1927), a Swedish chemist and winner of the Nobel Prize in 1903, proposed the hypothesis that human activities such as burning coal were increasing the greenhouse effect and causing a harmful rise in the planet’s temperature. (http://pt.wikipedia.org/wiki/Svante_Arrhenius, 2010)

1908: **Henry Ford** started mass production of cars. Karl Benz had obtained a patent on the internal combustion engine in 1885. (http://en.wikipedia.org/wiki/Henry_Ford, 2010)

1924: **Alfred James Lotka** (1880-2949), a chemist, demographer, ecologist and mathematician, born in Lemberg, in what is now Ukraine, stated that industrial activities would double carbon dioxide emissions in 500 years. (http://pt.wikipedia.org/wiki/Alfred_J._Lotka , 2010)

1955: **Gilbert Norman Plass** (1921-2004), a Canadian physicist living in the USA, conducted pioneering studies in which he concluded that CO_2 in the atmosphere intercepts infrared radiation reflected from the earth's surface into space, causing a temperature increase (greenhouse effect). (http://en.wikipedia.org/wiki/Gilbert_Plass, 2010)

1957: **Keeling Curve**: 1957 was considered the "International Geophysical Year" and the American chemist and oceanographer Charles David Keeling (1928-2005) was invited to start the first global measurement of CO_2 levels on Mount Mauna Loa, Hawaii. He discovered carbon levels at around 315 ppm and was surprised by the increased measures in subsequent years: 1958 (315.7ppm), 1959 (316.65ppm), 1960 (317.58ppm) and so on until 2004 (378.41ppm). According to the IPCC, levels in 2005 had reached 430ppm. (http://sio.ucsd.edu/keeling/, 2010).

1967: **Edward Norton Lorenz** (1917-2008), an American meteorologist and mathematician, graduated from the Massachusetts Institute of Technology (MIT), developed a nonlinear, three-dimensional and deterministic system called the "Lorenz Attractor" and applied the "butterfly effect" to "chaos theory". He performed the first computer simulation of the global temperature increase, calculating a rise of 0.50 degrees Celsius when the atmosphere reached a carbon dioxide concentration twice as high as in the pre-industrial age. (http://web.mit.edu/newsoffice/2008/obit-lorenz-0416.html, 2010)

1972: **United Nations Conference on the Human Environment**, known as "Stockholm 72", where representatives from developed countries advocated a decrease in global growth to mitigate the harmful effects of pollution, while underdeveloped countries advocated economic growth and their right to pollute. (http://pt.wikipedia.org/wiki/Confer%C3%AAncia_de_Estocolmo , 2010)

1979: **First World Climate Conference**, held in Geneva, Switzerland, acknowledged the problems caused by global warming. (http://homologa.ambiente.sp.gov.br/proclima/negocia_inter/pre_convencao.asp, 2010)

1982: First scientific shallow **ice core** studies in the high-impact journals *Science* and *Nature*. (http://www.geosc.psu.edu/people/faculty/personalpages/ralley/index.html , 2010)

1987: **Report of the World Commission on Environment and Development**, known as the Brundtland Report or "Our Common Future", which officially coined the term "sustainable development" to consider decent work opportunities and environmental responsibility. (http://en.wikipedia.org/wiki/Brundtland_Commission , 2010)

1988: Founding of the **Intergovernmental Panel on Climate Change** (IPCC) by the World Meteorological Organization and the United Nations Environment Program. It consists of three groups that address: (I) the scientific aspects of climate change, (II) socioeconomic and natural systems, and (III) the limitations of greenhouse gases and other actions needed. (http://www.ipcc.ch/ , 2010)

1990: **First IPCC Report**, known as Assessment Report I (AR-I), evidences the responsibility of human activities in global warming. (http://www.ipcc.ch/, 2010)

1992: **Rio Declaration on Environment and Development** at the Rio de Janeiro Summit, known as "RIO 92" or "Earth Summit", when the "Agenda 21" and the United Nations Framework Convention on Climate Change (UNFCCC) were signed. Regarding the number of participants, governments and products, this event held in Brazil was much more important than "Stockholm 72". (http://www.un.org/geninfo/bp/enviro.html , 2010)

1995: **Second IPCC Report** (AR-II), demonstrating the impacts of global warming on countries. Start of annual COP (Conference of the Parties – 1) in the context of the UNFCCC, held in Berlin. (http://www.ipcc.ch/, 2010)

1997: Signing of the **Kyoto Protocol**, on the occasion of COP-3, whereby developed nations committed to reduce their emissions levels between 2008 and 2012 to be equal to the levels observed in 1990, and which established the regulations for the

Clean Development Mechanisms (CDM) and carbon credits. (http://www.onu-brasil.org.br/doc_quioto.php , 2010)

1999: In view of Brazil's adherence to the Kyoto Protocol, the **Interministerial Commission on Global Climate Change** (CIMGC) was created through a decree first issued on July 7, 1999 and altered by another decree on January 10, 2006. This Commission was created to articulate government actions deriving from the United Nations Framework Convention on Climate Change and its subsidiary instruments of which Brazil is a party. (http://www.mct.gov.br/index.php/content/view/4016.html , 2010)

2001: **Third IPCC Report** (AR-III), which proposed economic measures to mitigate the effects of climate change. (http://www.ipcc.ch/, 2010)

2002: **Johannesburg Summit** *2002 or* Rio+10, to assess the implementation of the "Agenda 21", (http://www.un.org/jsummit/html/basic_info/basicinfo.html, 2010)

2003: Creation of the **Chicago Climate Exchange** (CCE), to trade instruments related to carbon credits via Kyoto and carbon sequestration via compensation mechanisms. (http://www.chicagoclimatex.com/, 2010)

2005: The **Kyoto Protocol** came into effect, on the occasion of COP-6, on May 16, 2005. Brazil signed the agreement on April 29, 1998 and ratified it on August 23, 2002. The American Congress still has not ratified this international agreement, despite isolated measures taken by one-third of its states and more than 400 cities. (http://www.onu-brasil.org.br/doc_quioto.php, 2010)

2006: **Stern Review Report**, ordered by the British government and prepared by Nicolas Stern and a large team. For the first time, important economists joined with eminent scientists to denounce the risks of an ecological hecatomb. It was evidenced that the cost of climate change is equivalent to an annual 5% loss of GDP, while the annual costs of reductions calculated by the IPCC amount to 1% of GDP. The term "econometrics of sustainable development" emerged and a window of alternatives was opened for projects in the development of each country. (http://mudancasclimaticas.cptec.inpe.br/~rmclima/pdfs/destaques/sternreview_report_complete.pdf, 2010) e (http://www.equalities.gov.uk/stern_review.aspx, 2010)

2007: **Fourth IPCC Report** (AR-IV) and granting of the Nobel Peace Prize to the IPCC, shared with former American vice president, Al Gore, for his campaign and documentary "An Inconvenient Truth" about the physical, economic and social impacts provoked by global climate change. (http://www.ipcc.ch/, 2010)

2008: **IMF and IRDB Conference** jointly launched a new agricultural funding model, with a view to fighting hunger, decreasing deforestation and mitigating global warming, contributing billions of dollars to emerging nations. (http://ictsd.org/i/news/pontesquinzenal/11166/ , 2010)

2009: **International Year of Planet Earth** (IYPE), proclaimed by the United Nations (UN), to run from 2007 to 2009, with 2008 as the main year. Goal number 1 was to "ensure greater and more effective use by society of the knowledge accumulated by the world's 400,000 Earth scientists". The slogan was "Earth Science for Society". (http://www.un.org , 2010)

3. METHODOLOGY AND RESEARCH PROCESS

The preparation of the environmental balance sheets of countries proposed in this article, according to the global climate change scenarios, involved consideration of multidisciplinary concepts, applied in the following steps:

(1) Verification of each country's residual carbon balance in MtonC and in U.S. dollars in the scenarios considered.

(2) Conversion of the gross domestic product (GDP) measured according to purchasing power parity (PPP) of each country into per capita units, equivalent to the number of inhabitants and average energy consumption in tons of oil equivalent (TOE). The concept of purchasing power parity is recommended by the United Nations and the World Bank as the most suitable way to make international comparisons, since the prices are adjusted for a determined reference country (Kilsztajn, 2000). Since the same prices are used for all countries, the PPP GDP represents the actual variation in the countries' economic activity, regardless of the exchange rate. For this reason, here we adopted the USA as the reference country.

(3) Finalization of each country's balance sheet using the inquired balance sheet technique.

Residual carbon balances are determined in function of each country's stock of carbon from forests and soil, of the avoided part minus estimated emissions for the 2020 and 2050 scenarios, measured in MtonC and converted into dollars in function of the value suggested by the IPCC. Each country's GDP (in purchasing power parity) is converted by an equivalent unit related to each nation's average energy consumption, measured in tons of oil equivalent (TOE), so as to equalize regional differences in terms of each country's geographical characteristics and comfort level, of which a possible change is supposed in a scenario of climate change. To close the balance sheets, we used an accounting technique that simplifies the bookkeeping process, given the degree of imprecision and difficulty to process the information. The technique is based on the basic principle of accounting and balance between cause and effect: assets minus liabilities equals equity.

Here assets are valued by the "equivalent" per capita GDP in American dollars, while liabilities correspond to each citizen's environmental obligation in carbon reduction targets and equity is correlated with each citizen's or country's surplus (or deficit) residual balance vis-à-vis all other nations, as illustrated below.

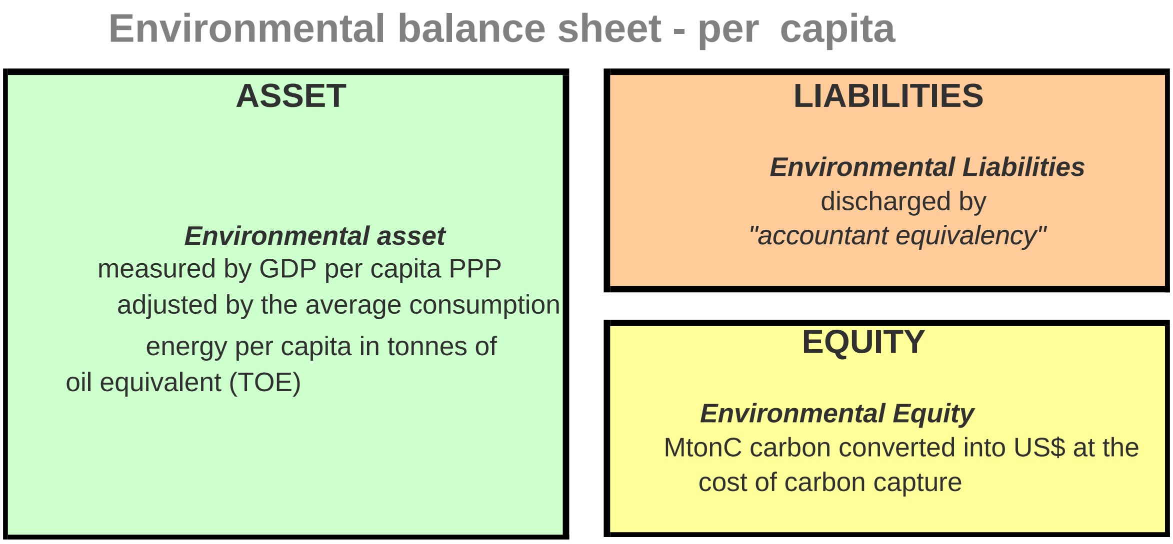

Figure 4 – Constructs of the "Environmental Balance Sheet" of Nations model.

3.1 Determination of Residual Carbon Balance of each Country in MtonC and Conversion into Dollars

To determine the residual balances and balance between carbon emission and capture, we consulted the specialized literature, cross-referencing information with a view to composing specific data that are not readily available. The data obtained were distributed in four similar tables, two of which consider the absence of deforestation and two with fixed deforestation rates in the countries, all formulated in megatons of carbon (MtonC). These four tables were then replicated, converting the units into dollars (US$), considering that the IPCC suggests a mean cost of carbon capture, with current technologies of US$ 45/tonC. Tables 1 to 8 in the appendix show the results.

Each of the four basic tables (1 to 4) and their replicas in monetary values (5 to 8) contain nine columns with the following rubrics: country, inventory of potential forest carbon, accumulated emission of carbon in the IPCC's scenario A1B1, accumulated emission of carbon in scenario A2B2, carbon capture by forest and soil biomass, industrial carbon capture through high technology, industrial carbon capture through low technology, accumulated carbon balance (best relative scenario), and accumulated carbon balance (worst relative scenario).

The details of obtaining the specific data of each column are presented below:

Tables 1 to 4:

1. COUNTRY column: countries analyzed in this article

2. FOREST AND SOIL CARBON INVENTORY column: considers the total stock of carbon contained in biomass and organic compounds in the soil. In this respect, forests are deposits of "avoided carbon" from the atmosphere. It is common in the literature to employ inventory data, as suggested by the *Human Development Report* 2007-2008 (UN, 2007), whose method consists of using a single mean inventory index for all biomes, in function of the plant coverage area of each country. In this study, however, we chose a method we feel is more precise, using specific inventory indices for each of the different biomes (savannas, tropical forests, temperate forests and boreal forests), suggested by the IPCC (2000). We then multiplied these by the residual areas of the respective biomes present in each country, obtained from the FAO (2007). In the situation "with deforestation" – Tables 3, 4, 7 and 8 – the deforestation rates for each country were in line with FAO (2007) projections, assuming fixed rates year by year. In these cases, accumulated carbon inventories decrease proportionally in 2020 and 2050 in comparison with the rates in the "without deforestation" situation - Tables 1, 2, 5 and 6.

3. ACCUMULATED CARBON EMISSION SITUATION column, taken from the *Special Report on Emission Scenarios* (IPCC SRES A1B1). Accumulated emission refers to all carbon released into the atmosphere, in a specific period, originating from industrial activities, vehicles, thermal energy generation and forest burn-off (in case of deforestation). This column presents figures, estimated for this article, of accumulated carbon emissions between 2006 and 2020 and between 2006 and 2050, using each

country's emissions in 2006 (NEAA, 2007) and UNSD (2007) as a reference, and figures presented by the IPCC (2000) for 2020 and 2050 in scenario A1B1, which forecasts continued growth of fossil fuel use, low substitution by renewable energy sources and global population growth. We considered fixed average annual rates for each country.

4. ACCUMULATED CARBON EMISSION SITUATION column (IPCC SRES A2B2): This column shows figures, estimated for this article, for accumulated carbon emissions between 2006 and 2020 and between 2006 and 2050, using each country's emissions in 2006 (NEAA, 2007) and UNSD (2007) as a reference, and figures presented by the IPCC (2000) for 2020 and 2050 in scenario A2B2, which forecasts decreasing annual rates of fossil fuel use, high substitution by renewable energy sources and global population growth. To estimate accumulated levels for the period, we considered fixed average annual rates for each country.

5. CARBON CAPTURE BY FOREST AND SOIL BIOMASS column: Capture is considered to be the amount of carbon the forest and soil withdraw from the atmosphere through photosynthesis and other biogeochemical processes. The accumulated amount captured between 2006 and 2020 and between 2006 and 2050 was estimated using annual capture rates specific for the biomes (IPCC, 2000) in function of the area each of them occupies in the analyzed countries (FAO, 2007). For the two tables showing scenarios without deforestation, annual capture rates were fixed and constant. For the two tables with deforestation, annual capture rates were considered fixed, identical to each country's deforestation rates taken from FAO (2007).

6. AVOIDED INDUSTRIAL CARBON, USING LOW TECHNOLOGY column (IPCC SRES A1B1). Avoided industrial carbon is the amount of carbon industries do not discharge into the atmosphere (BP, 2007). The amount depends on the number of industries, but mainly on the technological level for the efficient use of energy systems, changing to non-fossil sources, which reduces emissions. In this column, the accumulated amount of avoided carbon was considered between 2006 and 2020 and between 2006 and 2050 in the industrial capacity scenario of low-efficiency, A1B1, suggested by the IPCC (2000), with fixed annual rates.

7. AVOIDED INDUSTRIAL CARBON, USING HIGH TECHNOLOGY column (IPCC SRES A1B1) Similar to column 6, applied to the industrial capacity scenario with high energy efficiency technology A2B2, suggested by the IPCC (2000), with fixed annual rates.

8. ACCUMULATED CARBON BALANCE column (worst relative scenario). Carbon balances per country are presented in each table, given by inventory + capture – emission, considering scenario A1B1 for emission and industrial capture.

9. ACCUMULATED CARBON BALANCE column (best relative scenario/worst relative scenario). Carbon balances per country are presented, given by inventory + capture – emission, considering scenario A1B1 for emission and industrial capture.

Tables 5 to 8 present the conversion of the quantities in tons of carbon (tonC) to dollars (US$), following the method suggested by Metz et al. (2005) contained in the *Special Report on Carbon Dioxide Capture and Storage* from the IPCC. That report estimates carbon capture costs ranging from US$ 39-51/ton of carbon. These values are understood as the cost necessary for each ton of carbon emitted by industrial activities to be captured and stored underground instead of released into the atmosphere. The costs fluctuate according to a series of variables, particularly the sector of industrial activity, the volume of output, the energy source used and the type of carbon capture (deposit of untreated CO_2 in fissured underground formations, deposit with processing of carbon into derivatives, deposit in geological formations under the seabed, dissolution in seawater). All of these are technologies currently available. We used a value of US$ 45.00/tonC, the simple arithmetic mean of the extreme estimates in the referred report, because of the absence of more precise instruments for weighting of the cost.

The table below summarizes the information in the eight tables (1 to 8) contained in the appendix, to allow a better understanding of the calculations carried out in the main scenarios.

Table 9**: Summary of the main scenarios for carbon emission and capture 2020 and 2050**

PAÍS	Em MTONC				In Billions US$			
	(1) CD-BT	(2) SD-AT	(3) CD-BT	(4) SD-AT	(1) CD-BT	(2) SD-AT	(3) CD-BT	(4) SD-AT
	Pior 2020	Melhor 2020	Pior 2050	Melhor 2050	Pior 2020 CD	Melhor 2020	Pior 2050	Melhor 2050
Alemanha	(4.566,33)	(3.077,77)	(14.289,26)	(2.094,99)	(205,49)	(138,50)	(643,02)	(94,28)
Brasil	3.997,42	6.624,43	2.171,49	22.013,98	179,88	298,10	97,72	990,62
China	(31.504,78)	(20.747,24)	(119.340,33)	(25.654,17)	(1.417,72)	(933,63)	(5.370,32)	(1.154,44)
EUA	(29.877,93)	(19.587,00)	(103.269,48)	(17.810,23)	(1.344,51)	(881,41)	(4.647,13)	(801,46)
Índia	(5.953,65)	(3.761,62)	(20.359,29)	(2.292,48)	(267,91)	(169,27)	(916,17)	(103,16)
Japão	(6.691,99)	(4.513,16)	(21.448,74)	(4.516,80)	(301,14)	(203,09)	(965,20)	(203,28)
Rússia	(392,88)	4.683,66	(20.937,82)	27.876,83	(17,68)	210,76	(942,20)	1.254,46
Total	**(74.990,14)**	**(40.378,70)**	**(297.473,43)**	**(2.477,86)**	**(3.374,57)**	**(1.817,04)**	**(13.386,32)**	**(111,51)**
Mundo	**(119.893,93)**	**(51.896,96)**	**(660.401,52)**	**(21.982,88)**	**(5.395,21)**	**(2.321,87)**	**(29.718,08)**	**(989,23)**

Legenda : CD-BT = com desmatamento e baixa tecnologia SD-AT = sem desmatamento e alta tecnologia

The table above summarizes the four main accumulated balance simulations for carbon emission and capture for the period until 2020 and until 2050, taking into account the worst and best case scenarios, that is, with deforestation and low technology (WD-LT) and without deforestation and high technology (WOD-HT), for each of the countries under study individually, as a group and for the entire planet.

The graphs below illustrate the situation in these countries and the world. It can be seen that only two countries show positive accumulated balances and an overall planetary deficit is indicated in both scenarios. When comparing 2020 with 2050, the optimistic and pessimistic projections, it is evident that "time" is the relevant variable in these simulations, permitting inferring that regardless of the degree of precision of the study variables, a critical scenario for the future is a reality.

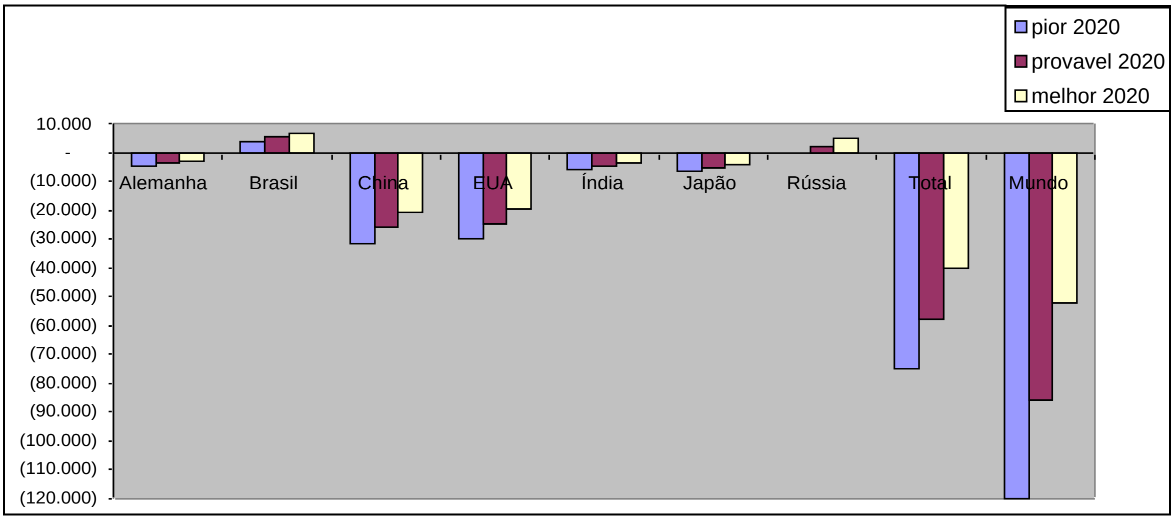

Figure 5 – Scenario for 2020 in MtonC – balance of carbon emission and capture.

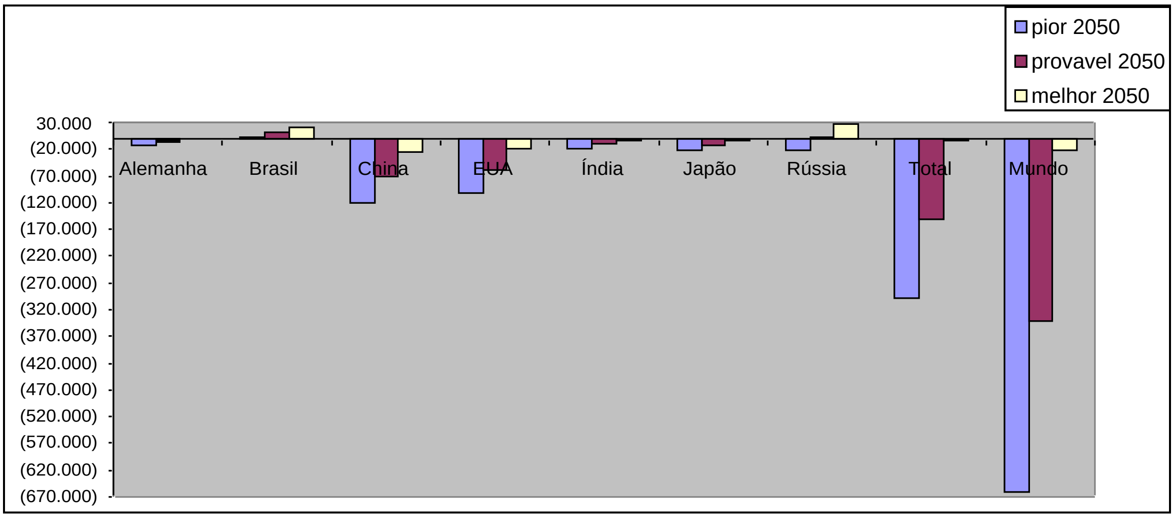

Figure 6 –Scenario for 2050 in MtonC – balance of carbon emission and capture.

It should be observed that if the population growth and energy consumption continue to grow at the same rates as today, the biosphere's resiliency may reach a threshold, above which the adjustment will be much more difficult, as indicated in Figure 7 below.

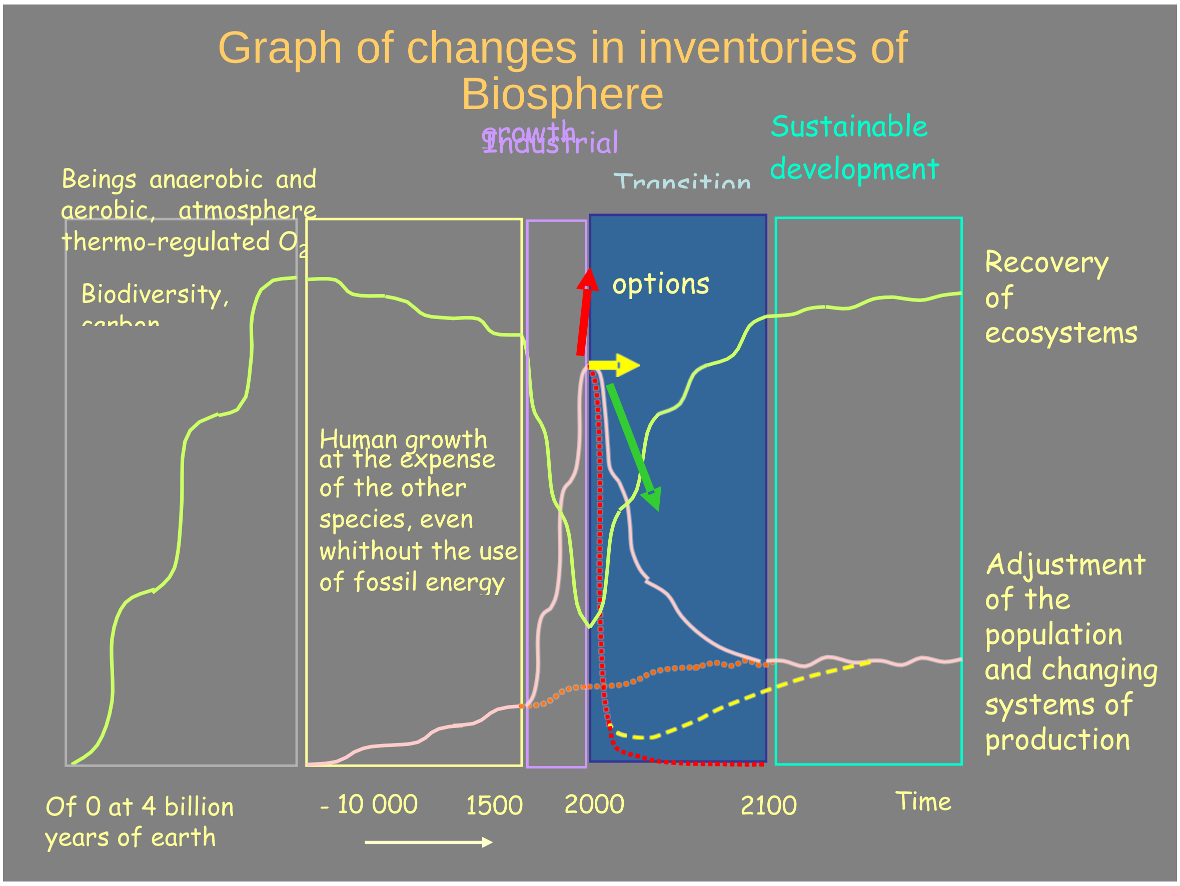

Figure 7 – "The world as a system" (source: Enrique Ortega Rodrigues– FEA/Unicamp)

According to the scenarios of Ortega (2008), there are two alternatives: recuperation of ecosystems or adjusting the population and changing the production and consumption systems. The time line in Figure 7 indicates this population adjustment should be very drastic, on the order of a billion people.

3.2 Conversion of each country's gross domestic product (GDP) into equivalent per capita units and average energy consumption in tons of oil equivalent (TOE)

Gross domestic product (GDP) represents the monetary sum of all goods and services produced in a given country. Therefore, we defined it as the parameter to evaluate assets. For easier comparisons among the countries under study, GDP assessed by the purchasing power parity (PPP) method was chosen, as adopted by the United Nations and the World Bank. It measures how much a given currency can buy internationally, converted into American dollars (UN, 2007).

The figure below shows these countries' GDP according to the International Monetary Fund, World Economic Outlook Database, April 2008 (www.imf.org) and demonstrates that these countries are responsible for a relevant part (54%) of global GDP.

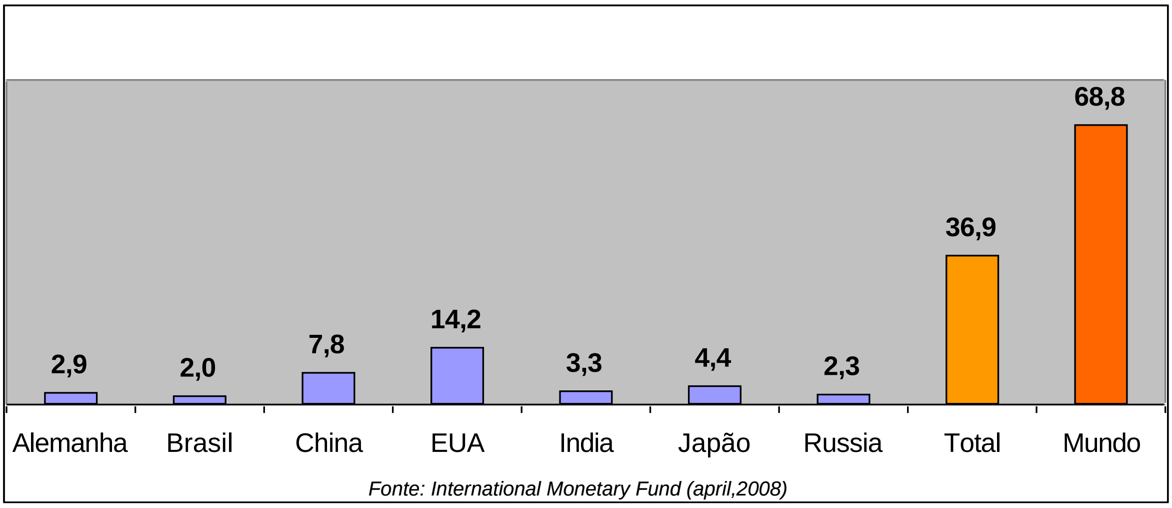

Figure 8 – Gross Domestic Product - purchasing power parity (trillion US$).

The figure below shows the populations of the countries included in this study.

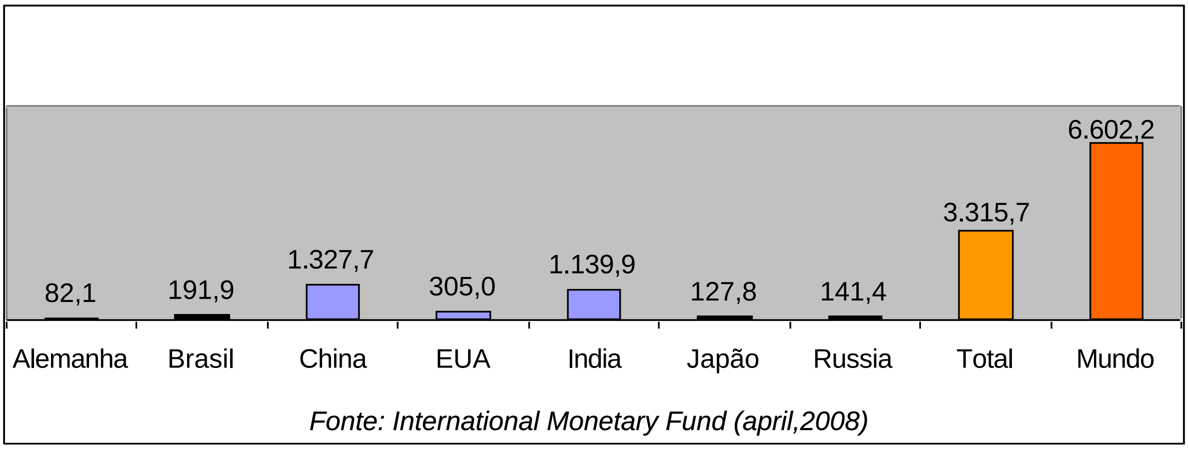

Figure 9 – Population (million inhabitants).

In this study, per capita GDP is adjusted by each country's mean energy consumption, with a view to equalizing each country's geographical characteristics and comfort level. For example, in countries with a tropical climate, energy needs are lower than in countries with freezing winters.

This paper does not address consumption level reductions in developed countries or increases in poor countries, which could be considered in a new study.

Humanity has gone through the phases of wood, charcoal and coal and today is at the crest of the oil age. Many experts, such as Sachs (2007), assert that when the oil price per barrel surpasses one hundred dollars, other energy sources become viable (oil prices reached a record US$ 122 per barrel on May 6, 2008) (Estadão, 2008).

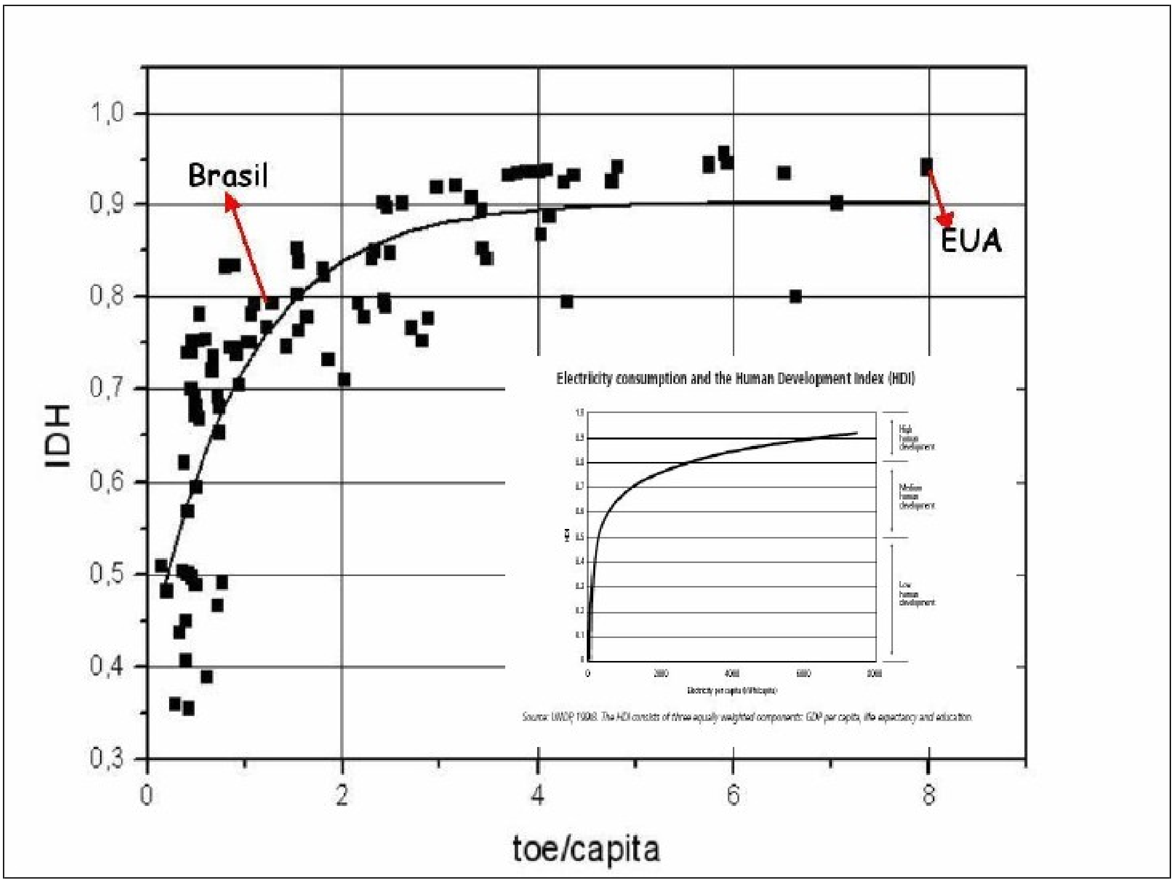

Figure 10 – Relation of the HDI and energy consumption of the countries in TOE (Source: UNDP, 1998).

Figure 10 shows the relation between the Human Development Index IHDI) of various countries and the respective energy consumption in tons of oil equivalent (TOE). There is a direct relation between improved social indices (quality of life, income distribution and energy consumption) and energy consumption, including electricity consumption.

The HDI is a comparative measure of longevity, education and income. Its formulation contemplates life expectancy, literacy rate, school attendance rate and the base-10 logarithm of per capita GDP (UN Human Development Index Report, 2007*).* It was developed in 1990 by the Pakistani economist Mahbub ul Haq, with the collaboration of the Indian economist Amartya Sem (winner of the Nobel Prize in Economics in 1998), and is used by the United Nations Development Program in its reports. Its precise formula is the following:

$$PIB\ per\ capita equivalente\ de\ energia = \frac{PIB\ ppp\ per\ capita\ anual}{Consumo\ Médio de\ Energia\ Anual\ (em Tep)}$$

Figure 11 shows the HID map of the countries of the world according to the formulation described here. We should note that a new formulation took effect in 2010.

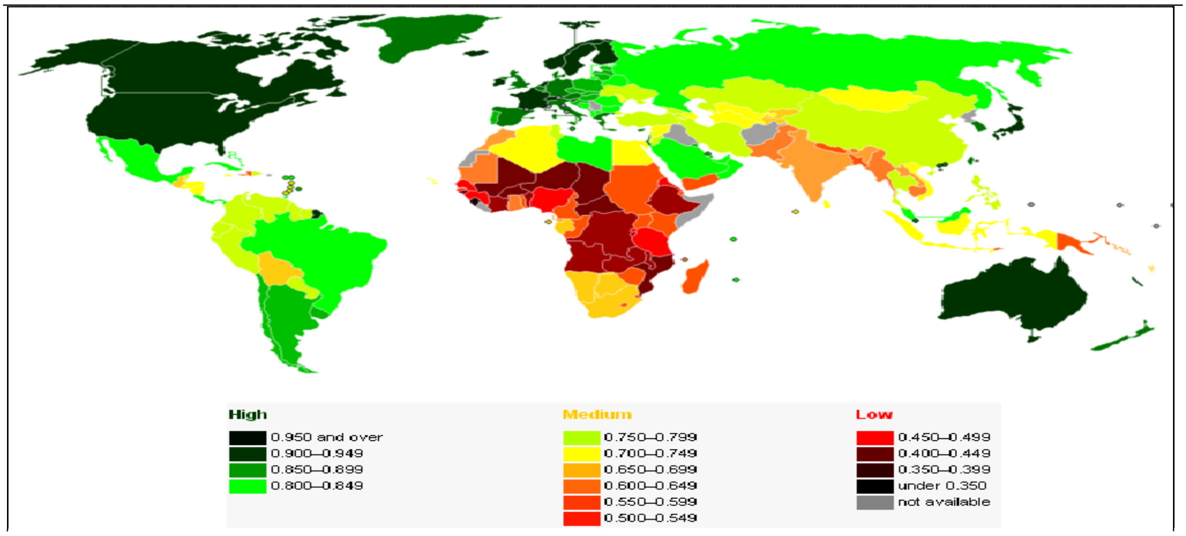

Figure 11 – Map indicating the Human Development Index (HDI) for 2007.

According to the National Energy Balance prepared by the Energy Research Company (EPE), which is part of the Brazilian Ministry of Mines and Energy, annual energy consumption in 2030 can reach 18,185 million tons of oil equivalent (TOE), raising per capita consumption mean from the current 1.69 to 2.22 TOE.

In countries where average energy consumption is less than 1 TOE a year, the rates of illiteracy and life expectancy and the overall HDI are low. Therefore, despite the need to reduce energy consumption, or to shift to less polluting sources, it is vital to increase the average energy consumption of poor countries (Goldemberg, 2007).

Based on the sum of all energy consumed in the world at present from all sources (renewable and non-renewable) and current population, the average annual per capita energy consumption is 1.69 TOE (Goldemberg, 2007). And since TOE is an energy equivalence measure, it can be converted into other units based on transformation coefficients (LEIA, 2010). Considering that a TOE corresponds to 10,000,000 Kcal (BE, 2008), daily energy consumption is equivalent to 46,301 Kcal for each of the world's inhabitants, according to the formula below.

Assuming a basic meal of about 2,000 Kcal and the energy spent during all daily activities, such as bathing, lighting, cooking, TV, internet, heating, refrigeration, transport etc., daily average consumption can be obtained. While this daily average in Brazil is 29,800 Kcal, in the USA it exceeds 230,000 Kcal, and for Bangladesh it is only 4,000 Kcal. The graph below shows the results for various countries based on the preceding formula.

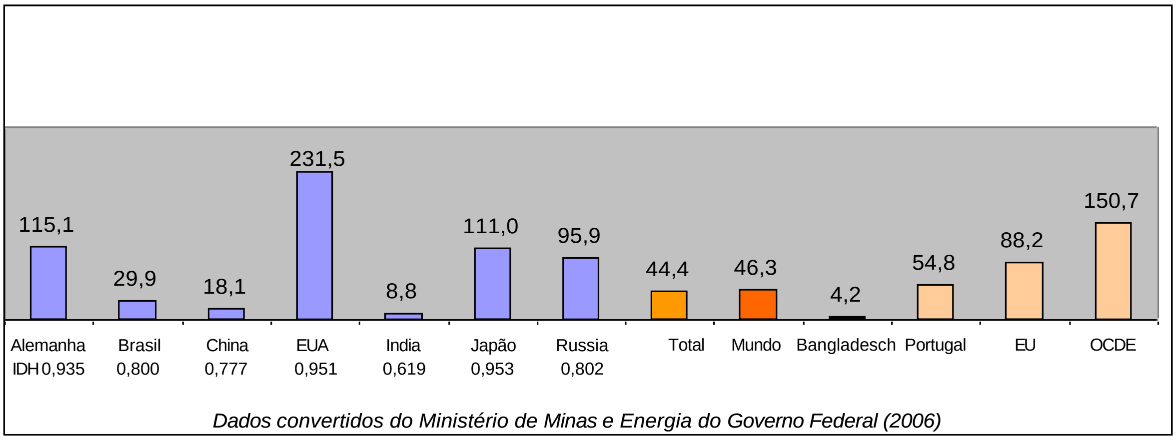

Figure 12 – Average daily per capita energy consumption of various countries (in thousand Kcal) – calculated by the authors.

The strong correlation of per capita GDP of the countries considered with the HDI (0.91) and with energy consumption in TOE (0.94) strengthens the arguments for the adjustment proposed. Also, considering that energy consumption is positively related to economic development, quality of life and GHG emission levels (Ortega, 2008), we believe the Environmental Assets measure of each country is a valid way to calculate the "environmental depreciation", in a broad concept of externalities.

Hence, we calculated the environmental assets of the countries based on the formula proposed above and the data on energy consumption in TOE, obtained from the Energy and Development Dossier (cited in Goldemberg. 2007), as shown in Figure 13 below.

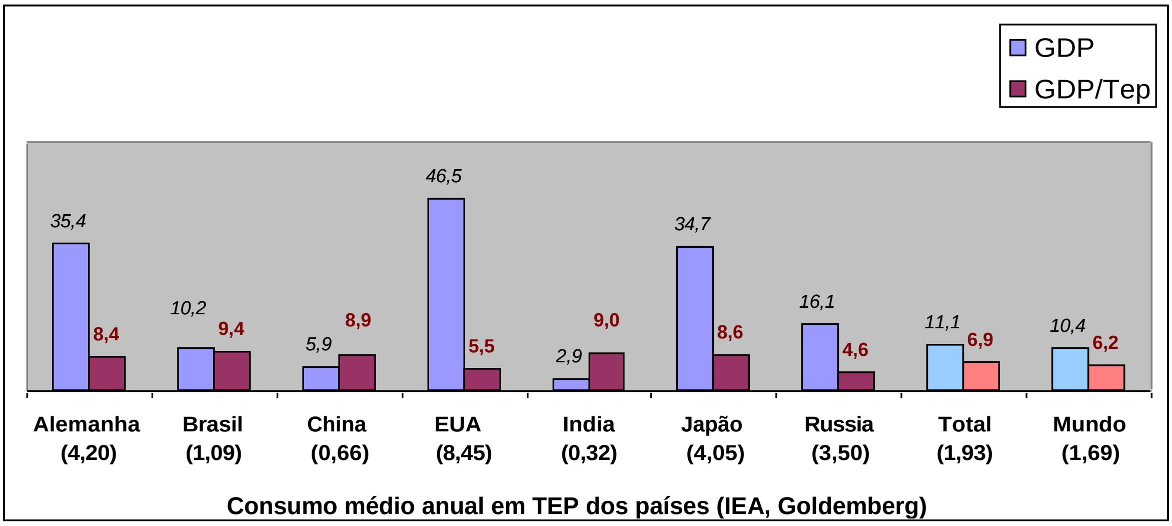

Figure 13 – Per capita GDP (PPP) adjusted into equivalent energy consumption (TOE).

For example, the calculation for Brazil is as follows: divide the per capita GDP (US$ 10.2 thousand) by the respective energy consumption (1.09 TOE), resulting in an equivalent and adjusted GDP (9.4 thousand). With these adjustments, per capita GDP (GDP/TOE) expresses not only the purchasing power parity (PPP), but also the parity of energy consumption, which enables better comparison of the environmental assets of each country, net of environmental depreciation, in a broad context of negative externalities caused to the environment in function of economic development and in the global climate change scenarios.

3.3 Closing the countries’ enviromental balance sheets through the Inquired Balance Sheet technique

The development of accounting has been much slower than the advances in other areas of knowledge, such as geosciences. Still, the movement towards harmonization and internationalization of accounting standards signals good perspectives and is a first step to establish global environmental accounting standards. In 2005, Europe adopted the International Financial Reporting Standards (IFRS) for consolidated balance sheets, and Brazil did this for individual balance sheets starting in 2010 (Iudícibus et al., 2010). The Group for Studies of Accounting and the Environment of the Accounting and Actuarial Department of the School of Economics, Administration and Accounting of the University of São Paulo has promoted various events on “IFRS & Sustainability” (NECMA, 2010). Environmental liabilities, as a mere instrument for complaints from other parties, is still the main focus, but the alignment with social accounting for intangible assets is moving towards the acknowledgement of global warming issues (Crowter, 2000).

National accounting systems (NAS) are still incomplete for the assessment of natural resources and they use measures, such as GDP, that do not recognize either the quality or the degradation of natural resources (resiliency and depreciation). To correct this deficiency, the UN has established a new accounting tool that can help monitor the exhaustion of natural resources and environmental degradation, called the "System of Integrated Environmental and Economic Accounting" (SEEA). It is a hybrid system with accounts that register physical measures (materials, energy, emissions), environmental management events, environmental goods, and the economy's impacts on the environment (exhaustion, defense, degradation), and proposes the monetary valuation of these physical measures (Lange, 2007). This initiative is important, as it encourages the development of environmental or "socio-environmental" accounting, the latter term considered in a broader and multidisciplinary way.

In comparison with other branches of natural sciences, accountancy is more similar to an administrative technique, but from a deeper perspective it implies some important basic principles, such as the law of balance and accountability. Balance is reflected in the fundamental accounting equation: assets minus liabilities equals equity (Luca Pacioli, 1445-1517) and is based on debits and credits, changes in financial position, supply and demand and the risk and return principle, or on cause and effect laws. The other basic principle is accountability (Carvalho, 1991; Nakagawa, 1991; Nakagawa, 2003), an ethical concept that refers to the obligation to account for one's spending and social responsibility (Schedler, 1999).

In this study our aim is to contribute to the emerging issue of climate change, by expanding the meanings of environmental liabilities and suggesting environmental net equity, relating it with the preservation of the whole natural patrimony of mankind. It is a form of accountability to humanity and, therefore, accountancy should not be limited by normative and auditing aspects and audit courts, but rather by each citizen's conscience. These values are implicit in the concepts of balance and accountability.

The United Nations proclaimed the period from 2007 to 2009 as the International Year of Planet Earth (IYPE) and goal number 1 was to "ensure greater and more effective use by society of the knowledge accumulated by the world's 400,000 Earth scientists." This article is inserted in this context.

Due to the imprecision of the data collected in this study and the difficulty of processing multidisciplinary information, we chose an accounting method to simplify the bookkeeping of economic events, called the Inquired Balance Sheet technique (Kassai, 2004). This method does not require analytic and simultaneous records and attempts to assemble the "pieces of a balance sheet", respecting the basic principle of equilibrium.

Just as in a traditional balance sheet, the data ascertained so far are used in the following form:

- **Assets:** corresponds to per capita GDP, assessed by the purchasing power parity (PPP) method, converted into equivalent energy units in tons of oil equivalent (TOE). Through this "equivalency" measure, the assets figure represents the natural resources each citizen of a given country has to generate in future benefits to sustain him or her and preserve the environment.
- **Liabilities:** corresponds to the balance of obligations each citizen of a given country has to sustain him or her and preserve the environment. It is found through accounting equivalency or as a simple arithmetic operation, using the basic accounting equation.
- **Equity:** corresponds to the residual balance of potential stocks of forests, carbon emissions and captures, measured in megatons of carbon and converted into American dollars according to this study.

According to the model proposed, the accounting treatment of events allows three possible results:

- **"Positive" Environmental Equity:** the economic situation of each citizen of a given country shows a surplus, which means he or she generates income that is more than sufficient to honor his/her commitments to environmental preservation, with surplus carbon credits.
- **"Zero" Environmental Equity:** the economic situation of each citizen of a given country is zero, which means he/she generates sufficient income to his/her commitments to environmental preservation.
- **"Negative" Environmental Equity:** the economic situation of each citizen of a given country shows a deficit, which means he/she generates insufficient income to honor

his/her commitments to environmental preservation, therefore requiring reduced emissions or carbon credit trading with other countries.

The interpretation of these possible results can be focused on the (1) individual balance sheet of a given country, or the (2) consolidated balance sheet of the world as a whole. Despite being an unfair equation, in that the countries that are more affected are not necessarily those that contribute most to carbon emissions, all countries must also consider the consolidated situation of the planet, because the consequences of global climate change will affect all people of all nations.

In an individual situation of negative equity (deficit), citizens are consuming resources from other citizens in certain countries. To maintain a positive equity situation (surplus), however, citizens have to be aware, enabling them to maintain their level of contribution to society and the environment.

In the global consolidated balance sheet, a positive net equity situation demonstrates that the situation is under control, merely requiring the coordination of political and economic actions among surplus and deficit nations. On the other hand, a deficit situation (negative net equity) indicates a critical bankruptcy situation and the need for strong changes in countries' strategic decisions.

To prepare the closing of accounts, the information in Table 1 (Carbon Emission and Capture Balance) is converted into per capita units in function of the number of inhabitants in each country and for each of the scenarios chosen. The result is shown in the table below.

Table 10: **Simulation scenaries 2020 and 2050 in US$Mil per capita**

PAÍS	População (mil)	Em US$-Mil per capita					
		(1) CD-BT	(2) SD-AT	(3) CD-BT	(4) SD-AT	2020	2050
		Pior 2020	Melhor 2020	Pior 2050	Melhor 2050	provável	provável
Alemanha	82.599	(2,5)	(1,7)	(7,8)	(1,1)	(2,1)	(4,5)
Brasil	191.791	0,9	1,6	0,5	5,2	1,2	2,8
China	1.328.630	(1,1)	(0,7)	(4,0)	(0,9)	(0,9)	(2,5)
EUA	305.826	(4,4)	(2,9)	(15,2)	(2,6)	(3,6)	(8,9)
Índia	1.169.016	(0,2)	(0,1)	(0,8)	(0,1)	(0,2)	(0,4)
Japão	127.967	(2,4)	(1,6)	(7,5)	(1,6)	(2,0)	(4,6)
Rússia	142.499	(0,1)	1,5	(6,6)	8,8	0,7	1,1
Total	**3.348.328**	(1,0)	(0,5)	(4,0)	(0,0)	(0,8)	(2,0)
Mundo	**6.602.224**	(0,8)	(0,4)	(4,5)	(0,1)	(0,6)	(2,3)

Legenda: CD-BT = com desmatamento e baixa tecnologia SD-AT = sem desmatamento e alta tecnologia

Finally, to close the balance sheets, the information from Figure 10 (per capita GDP PPP by TOE) and Figure 11 (Simulations of emissions in the 2020 and 2050 scenarios in thousand US$ per capita) are used, respectively, for the monetary valuation of assets and equity. The liabilities are obtained through accounting equivalency, according to the Inquired Balance Sheet method.

To exemplify the accounting process, below the closing balance sheet is demonstrated for Brazil and the world in the 2050 scenario (probable).

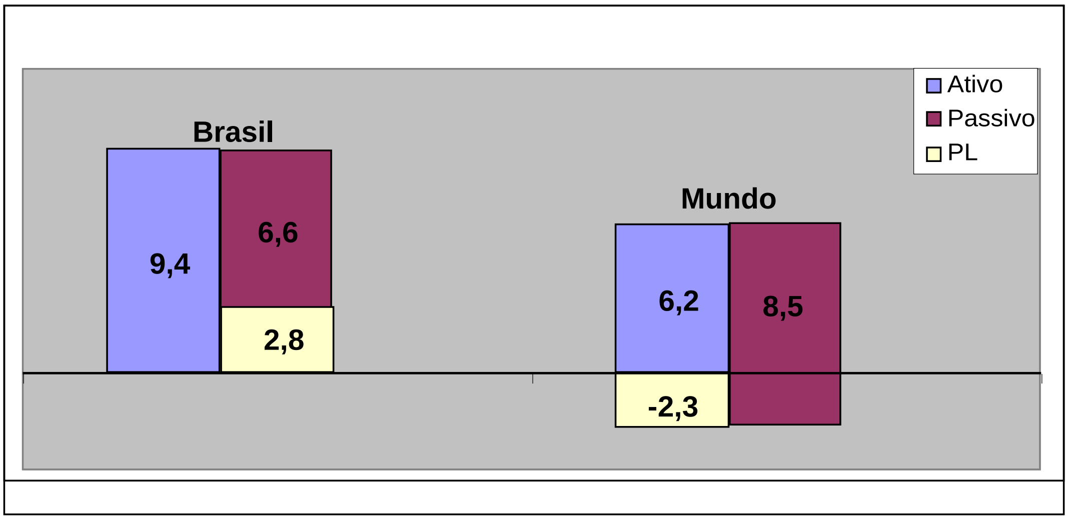

Figure 14 – Environmental Balance Sheets – Brazil and World – Probable 2050 scenario.

Brazil presents surplus equity (US$ 2,800): total assets (US$ 9,400) exceed liabilities (US$ 6,600) for each Brazilian individual. This demonstrates that in the probable scenario for 2050, the country owns sufficient equity to cover its individual commitments and moreover to contribute positively to the environment on Earth with surplus carbon quotas. These quotas, if converted by the price suggested by the IPCC, correspond to 62.2 tonC per capita, or about 11.9 billion tonC for the entire country, and could be used to compensate other countries' needs through carbon credits. And, if one considers that a single tree contains around 7 tons of carbon sequestered, each Brazilian corresponds to a positive balance of 9 trees or a total of 1.7 billion trees for the country.

On the other hand, the global balance sheet presents a deficit situation (US$ 6,200 – US$ 8,500 = US$ 2,300 per capita) – liabilities in excess of assets – which results in a negative "book value". Although some countries have positive balances, like Brazil, the global situation prevails over each country's individual situation, indicating a bankruptcy situation.

4.RESULTS AND DISCUSSION

The two tables below presents the balance sheets of the nations, obtained from the data in Tables 1 to 8 in the appendix, demonstrating three simulations (worst, best and probable) for each of the 2020 and 2050 scenarios in this study. We considered six of these ten possible simulations to be the most representative. It is important to highlight that in the "worst case scenarios", deforestation and carbon capture technology follow their current trend, considering fixed annual deforestation rates as observed in 2005. The "best case scenarios", on the other hand, consider no deforestation and capture technology rising annual efficiency levels, as estimated by the IPCC report (Metz et al., 2005).

Table 11: **Balance sheets of the nations - scenaries 2020**

PAÍS	Pior			Melhor			Provável		
	Ativo	Passivo	PL	Ativo	Passivo	PL	Ativo	Passivo	PL
Alemanha	8,4	10,9	(2,5)	8,4	10,1	(1,7)	8,4	10,5	(2,1)
Brasil	9,4	8,5	0,9	9,4	7,8	1,6	9,4	8,2	1,2
China	8,9	10,0	(1,1)	8,9	9,6	(0,7)	8,9	9,8	(0,9)
EUA	5,5	9,9	(4,4)	5,5	8,4	(2,9)	5,5	9,1	(3,6)
Índia	9,0	9,2	(0,2)	9,0	9,1	(0,1)	9,0	9,2	(0,2)
Japão	8,6	11,0	(2,4)	8,6	10,2	(1,6)	8,6	10,6	(2,0)
Rússia	4,6	4,7	(0,1)	4,6	3,1	1,5	4,6	3,9	0,7
Total	6,9	7,9	(1,0)	6,9	7,4	(0,5)	6,9	7,7	(0,8)
Mundo	6,2	7,0	(0,8)	6,2	6,6	(0,4)	6,2	6,8	(0,6)

Tabela 12: **Balance sheets of the nations (US$ per capita) - scenaries 2050**

PAÍS	Pior			Melhor			Provável		
	Ativo	Passivo	PL	Ativo	Passivo	PL	Ativo	Passivo	PL
Alemanha	8,4	16,2	(7,8)	8,4	9,5	(1,1)	8,4	12,9	(4,5)
Brasil	9,4	8,9	0,5	9,4	4,2	5,2	9,4	6,6	2,8
China	8,9	12,9	(4,0)	8,9	9,8	(0,9)	8,9	11,4	(2,5)
EUA	5,5	20,7	(15,2)	5,5	8,1	(2,6)	5,5	14,4	(8,9)
Índia	9,0	9,8	(0,8)	9,0	9,1	(0,1)	9,0	9,4	(0,4)
Japão	8,6	16,1	(7,5)	8,6	10,2	(1,6)	8,6	13,2	(4,6)
Rússia	4,6	11,2	(6,6)	4,6	(4,2)	8,8	4,6	3,5	1,1
Total	6,9	10,9	(4,0)	6,9	6,9	(0,0)	6,9	8,9	(2,0)
Mundo	6,2	10,7	(4,5)	6,2	6,3	(0,1)	6,2	8,5	(2,3)

Based on the simulations in the above tables, the two graphs below illustrate the "probable" scenarios for 2020 and 2050, considered here as the arithmetic means of the worst and best case scenarios.

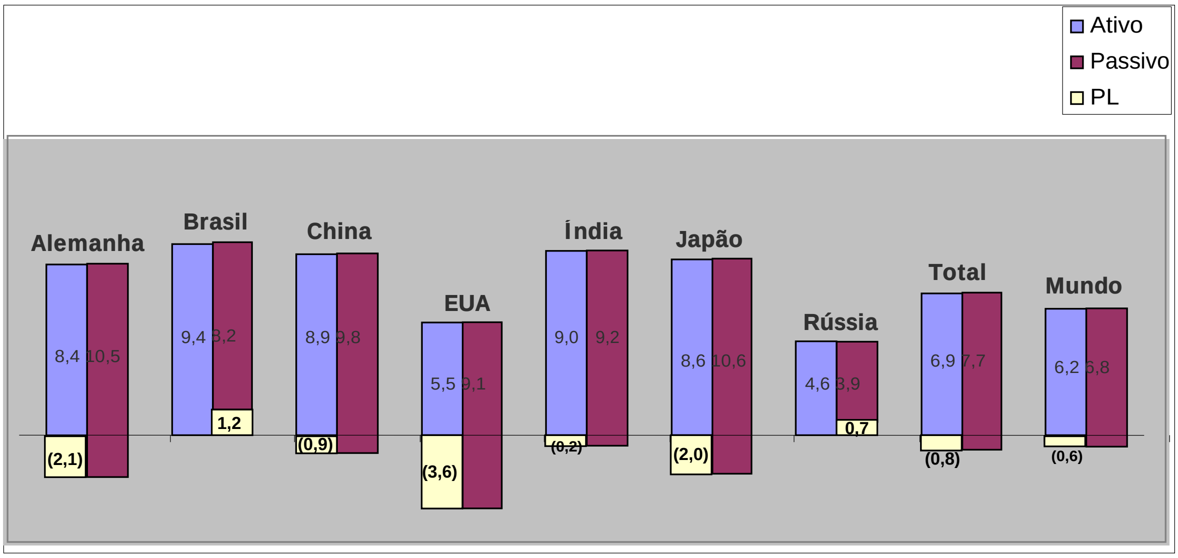

Figure 15 – Environmental Balance Sheets – "Probable" Scenario for 2020 (per capita).

In the average 2020 scenario, only Brazil and Russia present positive net equity, while the other countries' carbon emission accounts are in deficit. The global situation is negative, which means that the situation is critical in this scenario and the per capita balance (US$ 600) represents a deficit of about 4 trillion dollars.

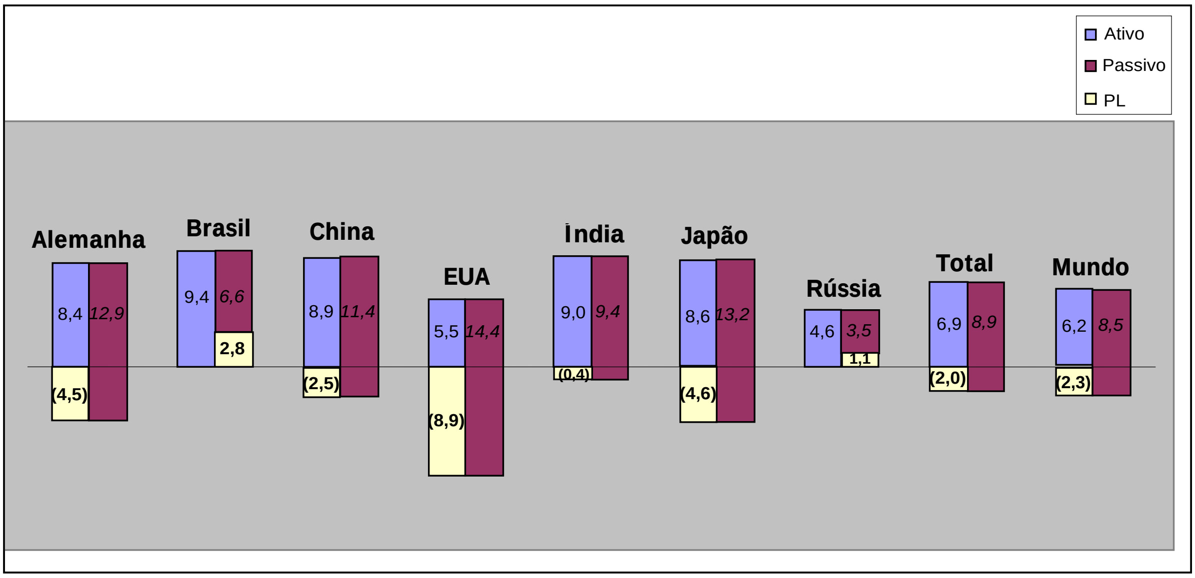

Figure 16 – Environmental Balance Sheets – "Probable" Scenario for 2050 (per capita).

In the "probable" scenario for 2050, Brazil and Russia continue the favorable situation of surplus carbon balances, evidencing the importance of their forests in the global scenario. Here the global deficit rises to 15.3 trillion dollars.

The figure below compares the evolution between the two scenarios (2020 and 2050). It can be seen that over these three decades, the global situation worsens (298%). On the one hand, Brazil and Russia sustain the favorable situation, but on the other China and the USA appear as the greatest producers of carbon and negative environmental net equity (ENE).

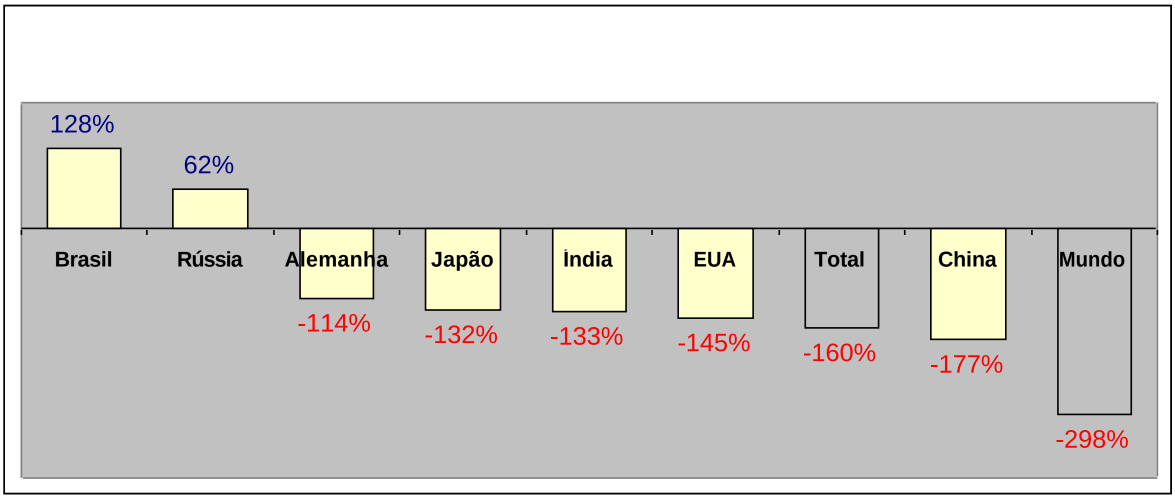

Figure 17 – Evolution of Environmental Equity in the 2020 and 2050 Scenarios (%).

The graph below demonstrates the "probable" 2050 scenario, but converted into total figures for each country, and each country's or the planet's consolidated account is shown.

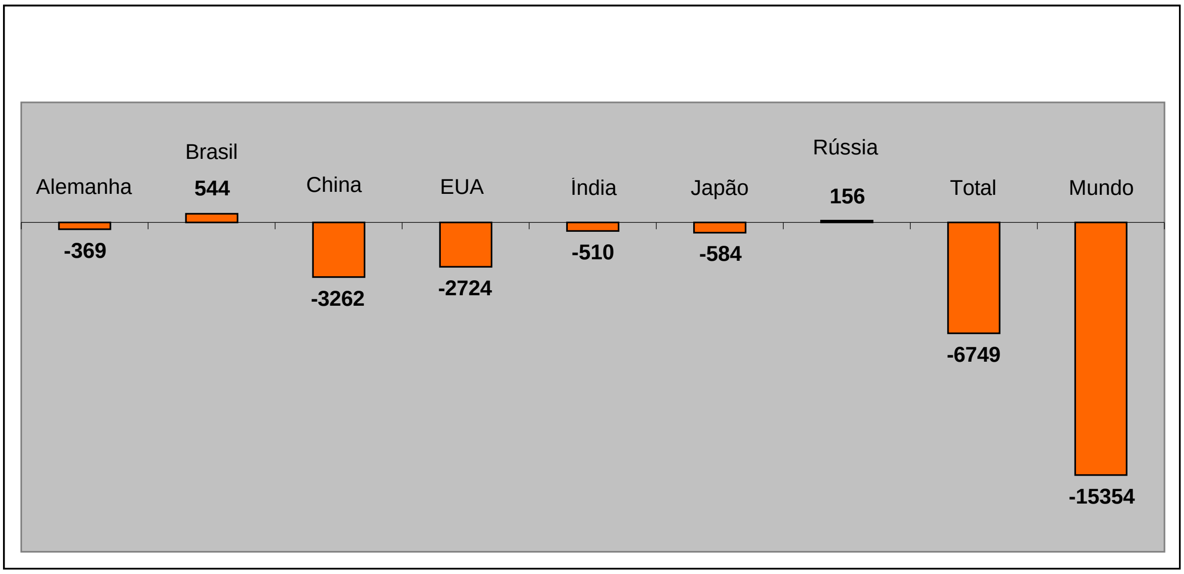

Figure 18 – Environmental Balance Sheets – "Probable" Scenario for 2050 (total values).

Thus, the above chart presents countries' total "account" due to the climate change scenarios. Only Brazil (US$ 544 billion) and Russia (US$ 156 billion) have positive environmental net equity (ENE). These two "monster" countries are equivalent to 2.22 trillion full-grown trees. Unfortunately, the total balance, i.e., the consolidated balance of the world, shows a deficit (US$ 15.3 trillion), equivalent to 48.7 trillion trees.

The size of these figures indicates that solutions for the world's emerging situation demand action from all countries. Brazil's and Russia's privileged situations are insufficient, as they represent less than 5% of the global deficit. Therefore, more developed nations need to act. Even if the American Congress had ratified the Kyoto Protocol (signed by then Vice President Al Gore), the results of this action would be insufficient, which highlights the responsibility of this country on the global environmental stage.

However, this accounting report indicates it is possible to find alternatives to settle this environmental deficit, or negative equity. The total debt represents less than one-fourth of global GDP, as shown in Figure 19 in percentage terms.

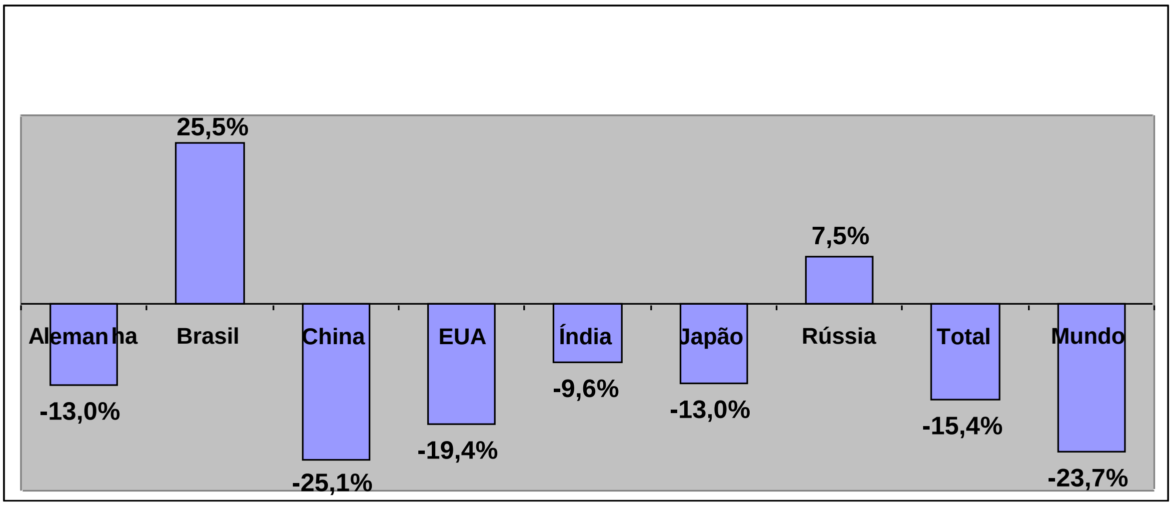

Figure 19 – Environmental Balance Sheets – ENE of each country in relation to its GDP.

The planetary deficit represents 23.7% of global GDP. The USA can contribute with 19.4% of its GDP. China's 25.1% account is frightening because of its population (they cannot acquire the habit of eating beef). Japan and Germany are equivalent to 13% of their respective GDPs. These two countries do not have continental dimensions, but play important roles in the international scenario, as they can make scientific and technological contributions. India also has a high account to settle, corresponding to 9.6% of its GDP, but this is an adverse situation since, as opposed to developed countries, India needs to raise its income and exceed the mean energy consumption of one TOE. All of these actions obviously need to be coordinated harmonically. And that is the huge challenge.

These debit/credit and simulations and the financial deficit produced by them depict a situation that compromises the future of humanity. Hence, the actors on the world stage will have to make up the difference somehow. They will have to use the scientific and technological knowledge accumulated in the physical, social, economic and political sciences, from a premise of social responsibility or accountability, based on ethical and moral values. It is a plan that involves all humanity and requires cooperation. It is not a zero-sum game: either everybody wins or everybody loses.

The first point to consider is that both the accumulated quantity of emissions and captures vary over time. This demonstrates that each country's options and global efforts will have more favorable results depending on how early measures are taken to mitigate emissions. Our results clearly show the fundamental importance of the carbon inventory contained in forests, as well as their capacity to capture carbon. Deforestation is a crucial factor in the environmental balance sheet of nations, a result in line with the assertions of the Stern Report. According to that document, among all rearrangement alternatives nations have at their disposal to mitigate global warming, suppressing deforestation in the most "highly cost-effective". The Stern Report (Stern, 2006) highlights that 18% of all carbon released into the atmosphere comes from deforestation burn-off, which is the only source of non-structural carbon – such as energy production (24%), industrial activities (14%), transportation (14%) and agriculture (14%) – and that, therefore, the reduction neither depends on large technological investments nor will provoke an economic impact on production and demand for goods and services, all the more so because the traditional use of deforested land tends to be extensive and unproductive. The opportunity cost of maintaining forests, calculated for the eight countries jointly responsible for more than 70% of burning, led by Brazil, is US$ 10 billion per year, i.e., one-third of the US$ 30 billion carbon credits traded on the Chicago Climate Exchange (CCX) before its closure.

This study also contributes in terms of the possibilities it offers to complement environmentally sensitive measures like "green GDP". Green GDP has tried to offer the best of conventional GDP: a bottom line that makes it possible to assess the extent to which consumer markets affect public goods, permitting comparisons between periods for the same nation and among nations at any time. In this sense, green GDP accounts for all public goods and services, in non-monetary values, such as the amount of drinking water or the size of green areas in a city. In a historic series, these serve to assess increased or decreased well-being due to scarcity over the years, and in relation to other countries (Boyd, 2007). That author clearly shows the difficulties of converting these figures into monetary figures, but offers a solution by defining environmental services as "...the aspects of nature that society uses, consumes, or enjoys to experience those benefits... that are valued by people" (Boyd, 2007;719).

It is not easy to make people value these goods, precisely because they are free, there is no price attached and their consumption is not excluding (the "tragedy of the commons"). However, as defined by Boyd, in this study the balance sheet can be considered in terms of "avoided monetary cost of abatement", as the reflection of countries' efforts to offer basic environmental services by maintaining air quality, in terms of avoided MtonC, trying to administer the average levels of 430 ppm of CO_2, the level measured in 2005 (Howweling et al., 2008). These benefits clearly echo beyond the well-being of breathing unpolluted air, such as thermal comfort and less exposure to climate catastrophes. But in the final analysis, they are all mitigated by the same concrete action of "avoided spending on abatement". That is the opportunity cost implicit in this study.

Thus, the environmental balance sheet of nations proposed here can also add to National Emission Inventories (NEI), offering monetary figures, in an attempt to solve the non-comparability of non-monetary figures, as evidenced by Peters, 2008, at the same time as it departs from the inefficient "satellite accounts" proposed by Morilla, Díaz-Salzar & Cardenete (2007). The environmental net equity (ENE) put forward here is a proposal to put a value on green GDP.

Based on this set of data, citizens can join in a global "extraordinary general meeting", composed of citizens representing all nations, to practice corporate governance. This time, the strategy would be management of the planet, with each citizen or country acting as a business unit, with strong correlations among their results, and the future of coming generations would depend on the decisions made starting today.

5.CONCLUSIONS

Accountancy can play an important role in the context of earth sciences. Monetary valuation broadens horizons and possibilities to discuss alternatives for climate change issues. The measurement method suggested here permits monetary valuation as countries' opportunity cost of saving atmospheric carbon and can complement the information of the NEI, in the UNFCC, of “satellite accounts”, of GDP and their accounting treatment.

Countries like Brazil and Russia will play an important role. First, as seen, preserving forests and savannas constitutes the best cost-benefit relation in the recycling of global atmospheric carbon (Stern, 2006), besides preserving biodiversity. Second, if they know how to make the best of this advantage, they can receive large amounts of foreign investments through Clean Development Mechanism (CDM) projects and compensation. In our opinion, it is not coherent for countries like China and the United States to benefit from these investments, due to their overall deficit situation.

Independently of technological projections on carbon captures and avoided carbon, deforestation is the main problem countries will have to face to achieve a better balance of their environmental equity, for two reasons: deforestation emits carbon in the short term, when the deforestation occurs, and reduces the carbon stock to the same extent in the medium and long term. Therefore, in monetary terms increased expenses on non-avoided carbon can be affirmed in the short term, and decreased environmental equity in the medium and long term. On the other hand, we agree with the Stern Review Report (2006), according to which the opportunity cost of containing deforestation is the lowest of structural alternatives, which reaffirms forest maintenance as a trump card to sustain ENE.

The objective of this study was attained by proposing the accounting model to prepare national environmental balance sheets, with assets assessed by the “equivalent” per capita GDP, net equity by the residual carbon balance and liabilities as a global environmental obligation. The environmental liability concept received a broader approach and the term “environmental net equity” was suggested, which covers the effects not only of the social aspects of environmental liabilities, but also the future benefits of natural and forest equity. As initially suspected, the baseline hypothesis was confirmed, i.e., negative global net equity or “uncovered liability”. Like in a corporate report, this economic situation represents a deficit and possible bankruptcy in the future, but something that can be avoided if corrective measures are taken promptly to reduce emissions.

The USA leads the ranking of negative environmental net equity, with a deficit corresponding to US$ 8,900 per capita or a total amount for the country of around US$ 2.72 trillion, approximately 19% of the planet’s deficit, revealing its importance in the context of joint global actions. As to the global per capita balance (also in deficit), if socialized, each of the current 6.6 billion inhabitants would have annual environmental liabilities of about US$ 2,300, to be deducted from their income or traded through carbon credit compensations, and also subject to global coordination between developed and developing countries, mainly countries whose per capita GDP is lower than this debt. This debt has already been accounted for, its due date is either 2020 or 2050, and there is a risk of some extra-judicial charges at any time, by nature herself. Despite the pessimistic scenario, the balance sheet of nations has shown that the planet's global deficit represents 23.7% of global GDP, which means that there is room for corrective actions. That is the meaning of this financial report with global dimensions: it means accountability to humanity, subject to the conscience of each citizen on the planet and his/her ethical or moral values. It is not a "zero-sum" game: either everybody wins or everybody loses. It requires economically feasible, socially fair and environmentally correct actions and respect for local cultures and beliefs. All people must try to make their contributions, led by scientists, political leaders and businesspeople, focusing on the search for truth and the use of power to assure a favorable outcome in line with beliefs and values.

The difficulty of working in interdisciplinary form was the greatest limitation in carrying out this study, and in many cases the choice of the path to take was based on the simplicity of the concepts of biology, energy, economics and actuarial practice, besides accounting itself. The accounting entries were based on statistical data and estimates, but what prevailed was a search for coherence among the principles of each area, and accountancy is fundamental to this process, because it is based on the universal principle of balance between the causes and effects or double-entry ledgers.

6.REFERENCES

ALLEY, R.B. Ice-core evidence of abrupt climate change. **Proceedings of the National Academy of Sciences,** 97, 1331-1334, 2000.

BOYD, N. Nonmarket benefits of nature: what should be counted in green GDP. ***Ecological Economics***, 61, 716-729, 2007.

BRUNDTLAND, Gro Harlem. **Nosso futuro comum**. Editora da FGV, 1987. "*Our Common Future"*, Oxford: Oxford University Press, 1987.

CARVALHO, L.N. Contabilidade e ecologia: uma exigência que se impõe. **Revista Brasileira de Contabilidade**, ano XX, n. 75, p.20-25, jun. 1991.

CLEVELAND, J. C., ***Tools and methods for integrated analysis and assessment of sustainable development.*** In: Encyclopedia of Earth. Eds. (Washington, D.C.: Environmental Information Coalition, National Council for Science and the Environment), February, 2007.

CROUNTER, D. ***Social and environmental accounting.*** London: Financial Times Management, 2000.

CSD-COMMISSION OF SUSTAINABLE DEVELOPMENT, **I*ndicators of sustainable development: framework and methodologies*.** **ONU**, *1996.*

GOLDEMBERG, José. **Energia e meio ambiente no Brasil**. São Paulo: IEA/USP, 59:7-20, 2007.

HOWWELING, S.; VAN DER WERF, G.R.; GOLDEWIJK, K.K.; ROCKMANN, T.; ABEN, I. Early anthropogenic CH_4 emissions and the variation of CH_4 and $^{13}CH_4$ over the last millennium. ***Global Biogeochemical Cycles***, 22:1-9, 2008.

INSTITUTO DE PESQUISAS DA CIVILIZAÇÃO YOKO (IPCY). Como viver o século XXI. Congresso Brasileiro da Civilização Yoko. **Anais....** USP – São Paulo: 2006.

INSTITUTO DE PESQUISAS DA CIVILIZAÇÃO YOKO (IPCY). Vida e meio ambiente. Congresso Latino Americano da Civilização Yoko. **Anais...** Hakka – São Paulo: 2007.

IUDÍCIBUS, S.et al. **Manual de contabilidade societária aplicável a todas as sociedades de acordo com as normas internacionais e do CPC**. São Paulo: Atlas, 2010.

KAHN, Herman; HIENER, A.J. **O ano 2000**. São Paulo: 1968.

KASSAI, J. R. Inquired balance sheet ou balanço perguntado: uma técnica para elaborar relatórios contábeis de pequenas empresas. CONGRESSO BRASILEIRO DE CUSTOS, XXI, **Anais…** Porto Seguro/Ba, 25 A 30 De Julho De 2004.

KENNAN, George Frost. **A*round the cragged hill*:** *a personal and political philosophy*. New York: Norton, 1993.

KILSZTAJN, S. Paridade do poder de compra, renda per capita e outros indicadores econômicos. São Paulo: **Pesquisa & Debate**, volume 11, número 2 (18) p. 93-106, 2000.

LANGE, G-M. Environmental accounting: introducing the seea-2003. **E*cological Economics***, 61(4):589-591, 2007. Special Issue Environmental Accounting

MARKOVITCH, Jacques. **Para mudar o futuro**: mudanças climáticas, políticas públicas e estratégias empresariais. São Paulo: Edusp, 2006.

MEADOWS, D. H.; RANDERS, J.; BEHRENS W. **T*he limits to growth*, a report to the club of rome.** 1972.

MINISTÉRIO DE MINAS E ENERGIA DO GOVERNO FEDERAL - Empresa de Pesquisa Energética (EPE) - **Balanço Energético Nacional**. 2006.

MORILLA, C.R.; DIAZ-SALAZAR, G.L. ; CARDENETE, M.A. Economic and environmental efficiency using a social accounting matrix. ***Ecological Economics,*** 60:774-786, 2007.
NAKAGAWA, Masayuki. **Gestão estratégica de custos**. São Paulo: Atlas, 1991.

______. **No Iraque a busca da essência em contabilidade** (região da Mesopotânia). FEA/USP, 2003.

ORTEGA, Enrique. **O Mundo como sistema**. Unicamp, 2008.

OSBORN, T.J. ; BRIFFA, K.R. The spatial extend of 20th-century warmth in the context of the past 1200 years. ***Science***, 311, 841-844, 2006.

OSTERBERG, E., MAYEWSKI, P., KREVTZ, K., FISHER, D., HANDLEY, M., Sneed, S., ZDANOWICS, C. ZHENG, J., DEMUTH, M., WASKIEWICS, M. ; BURGEOIS, S. Ice core record of rising lead pollution in the north Pacific atmosphere. ***Geophysical Research Letters,*** 35(5):1-11, 2008.

PETERS, G.P. From production-based to consumption-based national emission inventories. ***Ecological Economics***, 65:13-23, 2008.

RAMANATHAN, U. ; CARMICHAEL, G. Reducing uncertainty about carbon dioxide as a climate driver. ***Nature,*** 419:188-190, 2008.

SACHS, Ignacy. **A revolução energética do século XXI**. São Paulo: IEA/USP 21 (59), 2007.

SCHEDLER, Andreas. **Conceptualizing accountability: the self-restraining state: power and accountability in new democracies**. London: Lynne Rienner Publishers, pp. 13-28, 1999

CONSULTED SITES

BE Balanço Energético - Secretaria de Saneamento e Energia do Estado de São Paulo (2008) - http://www.saneamento.sp.gov.br/noticias/2009/Fevereiro/05_02_a.html

BP (2007) Statistical Review of World Energy 2007
http://www.bp.com/marketingsection.do?categoryId=2&contentId=7013628

Chicago Climate Exchange – CCX – (2008) -
http://www.chicagoclimatex.com/content.jsf?id=821
COSEAS - Coordenadoria de Assistência Social da Universidade de São Paulo – Cardápio das refeições diárias em Kcal (2010) - http://www.usp.br/coseas/cardapio.html

CPTEC/INPE – Centro de Previsão do Tempo e Estudos Climáticos do Instituto Nacional de Pesquisas Espaciais – Grupo de Pesquisas em Mudanças do Clima (GPMC) -

http://mudancasclimaticas.cptec.inpe.br/~rmclima/pdfs/destaques/sternreview_report_complete.pdf

FAO (2007) State of the world's forests 2007. Rome: Electronic Publishing Policy and Support Branch Communication Division http://www.fao.org/docrep/009/a0773e/a0773e00.htm

FEA/USP (2008) http://www.fea.usp.br/mudarfuturo

Google Map – acesso em 2010, http://maps.google.com.br/

IAP – Instituto Avançado do Plástico (2010) - http://www.planetaplastico.com.br/main.htm

IBGE-Instituto Brasileiro de Geografia e Estatística, www.ibge.gov.br

ICTSD – International Centre for Trad and Sustainable Development (2010) - http://ictsd.org/i/news/pontesquinzenal/11166/

IMF (2008) International Monetary Found. http//www.imf.org/external/pubs/tf/survey/so/2008/NEW041008A.htm

INPE – Instituto Nacional de Pesquisas Espaciais do Ministério da Ciência e Tecnoloiga – acesso em 2011. http://www.inpe.br

Instituto de Pesquisas da Civilização Yoko - http://www.sukyomahikarieurope.org

International Monetary Fund, World Economic Outlook Database, April 2008 - GDP PPP dos países - http://www.imf.org/external/index.htm

IPCC – Intergovernmental Panel on Climate Change (2007) - http://www.ipcc.ch/pdf/special-reports/srccs/srccs_wholereport.pdf

Jornal o Estado de São Paulo – 06/05/2008 - http://www.estadao.com.br/noticias/economia,petroleo-sobe-156-e-fecha-acima-de-us-121-pela-1-vez,168254,0.htm

LEIA – Laboratório de Engenharia Ecológica e Informática Aplicada do Prof. Enrique Ortega da Unicamp (2010) - http://www.unicamp.br/fea/ortega/

Massachusetts Institute of Techonology – MIT (2010) http://web.mit.edu/newsoffice/2008/obit-lorenz-0416.html

Metz, B., Davison, O., Coninck, H., Loss, M. & Meyer, L. (eds.). (2005) Special report on carbon dioxide capture and storage. IPCC International Panel on Climate Change/Cambridge: Cambridge University Press, http://www.ipcc.ch

MGB Museu Geológico da Bahia – Memórias da indústria do petróleo – de MGB, 2007

Ministério da Ciência e Tecnologia – Programa Nacional de Mudanças Climáticas (2010) - http://www.mct.gov.br/index.php/content/view/4016.html

Nações Unidades no Brasil (2010) - http://www.onu-brasil.org.br/doc_quioto.php
NEAA (2007) Netherlands Environmental Assessment Agency "Global CO2 Emission" http://www.mnp.nl/en/dossiers/Climatechange/moreinfo/Chinanowno1inCO2emissionsUSAinsecondposition.html

NECMA/USP – Núcleo de Estudos em Contabilidade e Meio Ambiente do Departamento de Contabilidade e Atuárias da Faculdade de Economia, Administração e Contabilidade da Universidade de São Paulo (FEA/USP), 2010 - http://stoa.usp.br/necma/profile/ - http://www.erudito.fea.usp.br/portalfea/Repositorio/3581/Documentos/JCRS%2026mai10.pdf

Programa Estadual de Mudanças do Clima do Governo do Estado de São Paulo – Secretaria do Meio Ambiente (2010) - http://homologa.ambiente.sp.gov.br/proclima/negocia_inter/pre_convencao.asp

Stern, N. (2006) The economics of climate change: the Stern Review. Cambridge: Cambridge University Press - http://www.equalities.gov.uk/stern_review.aspx e http://www.hmtreasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_report.cfm

The Catholic University of Amercia (2010) - http://faculty.cua.edu/may/black.pdf

UCS - Union of concerned Scientist (2008) http://www.acsusa.org

UN - United Nations (2007)Human Development Report 2007/2008: Fighting climate change: human solidarity in a divided world http://hdr.undp.org/en/media/hdr_20072008_en_chapter1.pdf - http://www.un.org/geninfo/bp/enviro.html e http://www.un.org/geninfo/bp/enviro.html

UNDP – United Nations Development Programme. Relação IDH e consumo de energia em TEP, 1998 - http://www.undp.org/

University Southerm Califórnia – USC – Tyler Prize for Environmental Achievement (2010) - http://www.usc.edu/admin/provost/tylerprize/

UNSD (2007) United Nations Statistical Division, United Nations http://www.unstats.un.org/unsd/default.htm

Watson, R.T., Noble, I.R., Bolin, B., Ravidranath, N.H., Verardo, D.J. & Dokken, D.J. (eds.) (2000) Land-use, land-use change and forestry. Cambridge: IPCC International Panel on Climate Change/Cambridge University Press http://www.ipcc.ch/ipccreports/sres/land_use/index.htm

Wikipédia – A Enciclopédia Livre (2010) - http://pt.wikipedia.org/wiki/

Wikipedia – The Free Encyclopedia (2010) - http://en.wikipedia.org/wiki/

7.APPENDIX

Table 1: **Scenaries 2006-20 (MTONC)**
with and without compliance whith the guideliness of the Kyoto protocol, whithout deforestation

PAÍS	ESTOQUE DE CARBONO FLORESTAL Potencial 2020	EMISSÃO C acumulada entre 2006 e 2020 Cenário IPCC SRES A1B1	EMISSÃO C acumulada entre 2006 e 2020 Cenário IPCC SRES A2B2	SEQUESTRO DE C PELA BIOMASSA FLORESTAL E SOLO acumulada entre 2006 e 2020	CARBONO INDUSTRIAL EVITADO acumulada entre 2006 e 2020 Cenário IPCC SRES A1B1	CARBONO INDUSTRIAL EVITADO acumulada entre 2006 e 2020 - Cenário IPCC SRES A2B2	SALDO ACUMULADO (emissão - captura) PIOR CENÁRIO EM 2020 SEM KYOTO E BAIXA TECNOLOGIA	SALDO ACUMULADO EMISSÃO (Emissão - captura) MELHOR CENÁRIO EM 2020 SEM KYOTO E ALTA TECNOLOGIA
Alemanha	1.683,55	(5.208,21)	(3.974,86)	127,93	526,26	769,16	(4.554,02)	(3.077,77)
Brasil	116.080,61	(2.552,86)	(1.968,07)	8.219,40	255,22	373,10	5.921,76	6.624,43
China	29.988,08	(37.010,80)	(28.309,06)	2.071,58	3.755,78	5.490,24	(31.183,44)	(20.747,24)
EUA	46.069,56	(36.676,48)	(28.284,65)	3.337,05	3.675,56	5.360,60	(29.663,87)	(19.587,00)
Índia	16.451,34	(7.781,71)	(6.032,70)	1.137,36	779,24	1.133,72	(5.865,11)	(3.761,62)
Japão	3.779,93	(7.722,66)	(5.919,76)	277,78	771,12	1.128,82	(6.673,76)	(4.513,16)
Rússia	174.136,08	(11.680,28)	(8.953,32)	12.020,26	1.089,34	1.616,72	1.429,32	4.683,66
Total	**388.189,15**	**(108.633,00)**	**(83.442,42)**	**27.191,36**	**10.852,52**	**15.872,36**	**(70.589,12)**	**(40.378,70)**
Mundo	**961.332,00**	**(197.400,01)**	**(156.952,49)**	**82.377,23**	**15.734,80**	**22.678,30**	**(99.287,98)**	**(51.896,96)**

Table 2: **Scenaries 2006-50 (MTONC)**
with and without compliance the guideliness of the Kyoto protocol, no deforestation

PAÍS	ESTOQUE DE CARBONO FLORESTAL POTENCIAL EM 2020	EMISSÃO C acumulada entre 2006 e 2050 Cenário IPCC SRES A1B1	EMISSÃO C acumulada entre 2006 e 2050 Cenário IPCC SRES A2B2	SEQUESTRO DE C PELA BIOMASSA FLORESTAL E SOLO acumulada entre 2006 e 2050	CARBONO INDUSTRIAL EVITADO acumulada entre 2006 e 2050 Cenário IPCC SRES A1B1	CARBONO INDUSTRIAL EVITADO acumulada entre 2006 e 2050 Cenário IPCC SRES A2B2	SALDO ACUMULADO (emissão - captura) PIOR CENÁRIO EM 2050	SALDO ACUMULADO EMISSÃO (Emissão - captura) MELHOR CENÁRIO EM 2050
Alemanha	1.683,55	(16.459,99)	(10.337,31)	365,64	1.814,12	7.876,68	(14.280,23)	(2.094,99)
Brasil	116.080,61	(8.215,60)	(6.113,26)	25.222,56	901,12	2.904,68	17.908,08	22.013,98
China	29.988,08	(134.250,10)	(91.309,41)	6.510,68	12.884,96	59.144,56	(114.854,46)	(25.654,17)
EUA	46.069,56	(118.723,40)	(87.683,43)	10.001,20	6.527,84	59.872,00	(102.194,36)	(17.810,23)
Índia	16.451,34	(25.101,92)	(18.637,84)	3.574,56	2.760,56	12.770,80	(18.766,80)	(2.292,48)
Japão	3.779,93	(25.027,20)	(18.275,40)	820,60	2.775,72	12.938,00	(21.430,88)	(4.516,80)
Rússia	174.136,08	(48.702,54)	(33.841,85)	37.777,96	5.936,04	23.940,72	(4.988,54)	27.876,83
Total	**388.189,15**	**(376.480,75)**	**(266.198,50)**	**84.273,20**	**33.600,36**	**179.447,44**	**(258.607,19)**	**(2.477,86)**
Mundo	**961.332,00**	**(815.029,99)**	**(603.360,00)**	**258.899,96**	**50.056,17**	**322.477,16**	**(506.073,86)**	**(21.982,88)**

Table 3: **Scenaries 2006-20 (MTONC)**
with and without compliance the guideliness of the Kyoto protocol, no deforestation and burned

PAÍS	ESTOQUE DE CARBONO FLORESTAL POTENCIAL - EM 2020	EMISSÃO C acumulada entre 2006 e 2020 Ccenário IPCC SRES A1B1	EMISSÃO C acumulada entre 2006 e 2020 Cenário IPCC SRES A2B2	SEQUESTRO DE C PELA BIOMASSA FLORESTAL E SOLO acumulada entre 2006 e 2020	CARBONO INDUSTRIAL EVITADO ACUMULADA ENTRE 2006 E 2020 CENÁRIO IPCC SRES A1B1	CARBONO INDUSTRIAL EVITADO acumulada entre 2006 e 2020 - CENÁRIO IPCC SRES A2B2	SALDO ACUMULADO (emissão - captura) PIOR CENÁRIO EM 2020	SALDO ACUMULADO EMISSÃO (Emissão - captura) MELHOR CENÁRIO EM 2020
Alemanha	1.659,89	(5.208,93)	(3.975,58)	116,34	526,26	769,16	(4.566,33)	(3.090,08)
Brasil	105.842,27	(4.283,16)	(2.698,37)	8.025,36	255,22	373,10	3.997,42	5.700,09
China	23.060,88	(37.223,80)	(28.522,06)	1.963,24	3.755,78	5.490,24	(31.504,78)	(21.068,58)
EUA	44.134,62	(36.735,69)	(28.343,65)	3.182,20	3.675,56	5.360,60	(29.877,93)	(19.800,85)
Índia	13.917,90	(7.857,66)	(6.108,65)	1.124,77	779,24	1.133,72	(5.953,65)	(3.850,16)
Japão	3.727,01	(7.724,21)	(5.921,31)	261,10	771,12	1.128,82	(6.691,99)	(4.531,39)
Rússia	156.826,90	(12.720,99)	(9.994,03)	11.238,77	1.089,34	1.616,72	(392,88)	2.861,46
Total	**349.169,47**	**(111.754,44)**	**(85.563,65)**	**25.911,78**	**10.852,52**	**15.872,36**	**(74.990,14)**	**(43.779,51)**
Mundo	**826.745,52**	**(211.775,18)**	**(171.327,66)**	**76.146,45**	**15.734,80**	**22.678,30**	**(119.893,93)**	**(72.502,91)**

Table 4: **Scenarios 2006-50 (MTONC)**
with and without compliance the guideliness of the Kyoto protocol, with deflorestation

PAÍS	ESTOQUE DE CARBONO FLORESTAL POTENCIAL	EMISSÃO C acumulada entre 2006 e 2050 Cenário IPCC SRES A1B1	EMISSÃO C acumulada entre 2006 e 2050 Cenário IPCC SRES A2B2	SEQUESTRO DE C PELA BIOMASSA FLORESTAL E SOLO acumulada entre 2006 e 2050	CARBONO INDUSTRIAL EVITADO ACUMULADA ENTRE 2006 E 2050 CENÁRIO IPCC SRES A1B1	CARBONO INDUSTRIAL EVITADO acumulada entre 2006 e 2050 - Cenário IPCC SRES A2B2	SALDO ACUMULADO (emissão - captura) **PIOR CENÁRIO** EM 2050	SALDO ACUMULADO EMISSÃO (Emissão - captura) **MELHOR CENÁRIO** EM 2050
Alemanha	1.599,05	(16.467,54)	(10.344,86)	364,16	1.814,12	7.876,68	(14.289,26)	(2.104,02)
Brasil	79.515,11	(20.950,13)	(18.847,79)	22.220,50	901,12	2.904,68	2.171,49	6.277,39
China	5.248,08	(136.467,34)	(93.526,65)	4.242,05	12.884,96	59.144,56	(119.340,33)	(30.140,04)
EUA	39.159,06	(119.342,72)	(88.302,32)	9.545,40	6.527,84	59.872,00	(103.269,48)	(18.884,92)
Índia	7.403,34	(25.890,96)	(19.426,88)	2.771,11	2.760,56	12.770,80	(20.359,29)	(3.884,97)
Japão	3.590,93	(25.044,14)	(18.292,34)	819,68	2.775,72	12.938,00	(21.448,74)	(4.534,66)
Rússia	112.317,58	(59.475,36)	(44.614,67)	32.601,50	5.936,04	23.940,72	(20.937,82)	11.927,55
Total	**248.833,15**	**(403.638,19)**	**(293.355,51)**	**72.564,40**	**33.600,36**	**179.447,44**	**(297.473,43)**	**(41.343,67)**
Mundo	**480.666,00**	**(861.015,54)**	**(549.345,55)**	**150.557,85**	**50.056,17**	**322.477,16**	**(660.401,52)**	**(76.310,54)**

Table 5: **Scenarios 2006-20 (Bilhões US$)**
with and without compliance the guideliness of the Kyoto protocol, no deforestation

PAÍS	ESTOQUE DE CARBONO FLORESTAL POTENCIAL em 2020	EMISSÃO C acumulada entre 2006 e 2020 Cenário IPCC SRES A1B1	EMISSÃO C acumulada entre 2006 e 2020 Cenário IPCC SRES A2B2	SEQUESTRO DE C PELA BIOMASSA FLORESTAL E SOLO acumulada entre 2006 e 2020	CARBONO INDUSTRIAL EVITADO acumulada entre 2006 e 2020 Cenário IPCC SRES A1B1	CARBONO INDUSTRIAL EVITADO acumulada entre 2006 e 2020 - CENÁRIO IPCC SRES A2B2	SALDO ACUMULADO (emissão - captura) **PIOR CENÁRIO** EM 2020 SEM KYOTO E BAIXA TECNOLOGIA	SALDO ACUMULADO EMISSÃO (Emissão - captura) **MELHOR CENÁRIO** EM 2020 SEM KYOTO E ALTA TECNOLOGIA
Alemanha	75,78	(234,37)	(178,87)	5,76	23,68	34,61	(204,93)	(138,50)
Brasil	5.223,63	(114,88)	(88,56)	369,87	11,49	16,79	266,48	298,10
China	1.349,46	(1.665,48)	(1.273,91)	93,22	169,01	247,06	(1.403,25)	(933,63)
EUA	2.073,13	(1.650,44)	(1.272,81)	150,17	165,40	241,23	(1.334,87)	(881,41)
Índia	740,31	(350,18)	(271,47)	51,18	35,07	51,02	(263,93)	(169,27)
Japão	170,10	(347,52)	(266,39)	12,50	34,70	50,80	(300,32)	(203,09)
Rússia	7.836,12	(525,61)	(402,90)	540,91	49,02	72,75	64,32	210,76
Total	**17.468,51**	**(4.888,48)**	**(3.754,91)**	**1.223,61**	**488,36**	**714,26**	**(3.176,51)**	**(1.817,04)**
Mundo	**43.259,94**	**(8.883,01)**	**(7.049,36)**	**3.706,97**	**708,07**	**1.020,52**	**(4.467,97)**	**(2.321,87)**

Table 6: **Scenarios 2006-50 (Bilhões US$)**
with and without compliance the guideliness of the Kyoto protocol, no deforestation

PAÍS	ESTOQUE DE CARBONO FLORESTAL POTENCIAL EM 2050	EMISSÃO C acumulada entre 2006 e 2050 Cenário IPCC SRES A1B1	EMISSÃO C acumulada entre 2006 e 2050 Cenário IPCC SRES A2B2	SEQUESTRO DE C PELA BIOMASSA FLORESTAL E SOLO acumulada entre 2006 e 2050	CARBONO INDUSTRIAL EVITADO acumulada entre 2006 e 2050 Cenário IPCC SRES A1B1	CARBONO INDUSTRIAL EVITADO acumulada entre 2006 e 2050 Cenário IPCC SRES A2B2	SALDO ACUMULADO (emissão - captura) **PIOR CENÁRIO** EM 2050	SALDO ACUMULADO EMISSÃO (Emissão - captura) **MELHOR CENÁRIO** EM 2050
Alemanha	75,78	(740,70)	(465,18)	16,45	81,63	354,45	(642,62)	(94,28)
Brasil	5.223,63	(369,70)	(275,10)	1.135,01	40,55	130,71	805,86	990,62
China	1.349,46	(6.041,25)	(4.108,92)	292,98	579,82	2.661,50	(5.168,45)	(1.154,44)
EUA	2.073,13	(5.342,55)	(3.945,75)	450,05	293,75	2.694,24	(4.598,75)	(801,46)
Índia	740,31	(1.129,59)	(838,70)	160,85	124,22	574,69	(844,52)	(103,16)
Japão	170,10	(1.126,22)	(822,39)	36,90	124,90	582,21	(964,42)	(203,28)
Rússia	7.836,12	(2.191,61)	(1.522,88)	1.700,01	267,12	1.077,33	(224,48)	1.254,46
Total	**17.468,51**	**(16.941,63)**	**(11.978,93)**	**3.792,29**	**1.512,06**	**8.075,13**	**(11.637,28)**	**(111,51)**
Mundo	**43.259,94**	**(36.676,35)**	**(27.151,20)**	**11.650,50**	**2.252,53**	**14.511,47**	**(22.773,32)**	**(989,23)**

Table 7: **Scenaries 2006-20 (Bilhões US$)**
with and without compliance the guideliness of the Kyoto protocol, with deforestation and burned

PAÍS	ESTOQUE DE CARBONO FLORESTAL POTENCIAL EM 2020	EMISSÃO C acumulada entre 2006 e 2020 Ccenário IPCC SRES A1B1	EMISSÃO C acumulada entre 2006 e 2020 Cenário IPCC SRES A2B2	SEQUESTRO DE C PELA BIOMASSA FLORESTAL E SOLO acumulada entre 2006 e 2020	CARBONO INDUSTRIAL EVITADO ACUMULADA ENTRE 2006E 2020 - CENÁRIO IPCC SRES	CARBONO INDUSTRIAL EVITADO acumulada entre 2006 e 2020 - CENÁRIO IPCC SRES A2B2	SALDO ACUMULADO (emissão - captura) **PIOR CENÁRIO** EM 2020	SALDO ACUMULADO EMISSÃO (Emissão - captura) **MELHOR CENÁRIO** EM 2020
Alemanha	74,69	(234,40)	(178,90)	5,23	23,68	34,61	(205,49)	(139,06)
Brasil	4.762,90	(192,74)	(121,43)	361,14	11,48	16,79	179,88	256,50
China	1.037,74	(1.675,07)	(1.283,49)	88,34	169,01	247,06	(1.417,72)	(948,09)
EUA	1.986,06	(1.653,11)	(1.275,46)	143,20	165,40	241,23	(1.344,51)	(891,03)
Índia	626,31	(353,59)	(274,89)	50,61	35,07	51,01	(267,91)	(173,27)
Japão	167,71	(347,59)	(266,46)	11,75	34,70	50,80	(301,14)	(203,91)
Rússia	7.057,20	(572,44)	(449,73)	505,74	49,02	72,75	(17,68)	128,76
Total	**15.712,61**	**(5.028,94)**	**(3.850,36)**	**1.166,01**	**488,36**	**714,25**	**(3.374,57)**	**(1.970,10)**
Mundo	**37.203,55**	**(9.529,88)**	**(7.709,74)**	**3.426,60**	**708,07**	**1.020,52**	**(5.395,21)**	**(3.262,62)**

Table 8: **Scenaries 2006-50 (Bilhões US$)**
with and without compliance the guideliness of the Kyoto protocol, with deforestation

PAÍS	ESTOQUE DE CARBONO FLORESTAL POTENCIAL em 2050	EMISSÃO C acumulada entre 2006 e 2050 Cenário IPCC SRES A1B1	EMISSÃO C acumulada entre 2006 e 2050 Cenário IPCC SRES A2B2	SEQUESTRO DE C PELA BIOMASSA FLORESTAL E SOLO acumulada entre 2006 e 2050	CARBONO INDUSTRIAL EVITADO acumulada entre 2006 e 2050 - CENÁRIO IPCC SRESS A1B1	CARBONO INDUSTRIAL EVITADO acumulada entre 2006 e 2050 - CENÁRIO IPCC SRES A2B2	SALDO ACUMULADO (emissão - captura) **PIOR CENÁRIO** EM 2050	SALDO ACUMULADO EMISSÃO (Emissão - captura) **MELHOR CENÁRIO** EM 2050
Alemanha	71,96	(741,04)	(465,52)	16,39	81,63	354,45	(643,02)	(94,68)
Brasil	3.578,18	(942,75)	(848,15)	999,92	40,55	130,71	97,72	282,48
China	236,16	(6.141,03)	(4.208,70)	190,89	579,82	2.661,50	(5.370,32)	(1.356,31)
EUA	1.762,16	(5.370,42)	(3.973,60)	429,54	293,75	2.694,24	(4.647,13)	(849,82)
Índia	333,15	(1.165,09)	(874,21)	124,70	124,22	574,69	(916,17)	(174,82)
Japão	161,59	(1.126,99)	(823,15)	36,88	124,91	582,21	(965,20)	(204,06)
Rússia	5.054,29	(2.676,39)	(2.007,65)	1.467,07	267,12	1.077,33	(942,20)	536,75
Total	**11.197,49**	**(18.163,71)**	**(13.200,98)**	**3.265,39**	**1.512,00**	**8.075,13**	**(13.386,32)**	**(1.860,46)**
Mundo	**21.629,97**	**(38.745,70)**	**(24.720,55)**	**6.775,10**	**2.252,52**	**14.511,47**	**(29.718,08)**	**(3.433,98)**