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Contribution from brazilian postgraduate studies to sustainable development

Capes at Rio+20

RIO+20
United Nations Conference
on Sustainable Development

The book Contribution from brazilian postgraduate studies to sustainable development: Capes at Rio+20, is published by the Foundation for the Coordination and Improvement of Higher Level or Education Personnel (Capes) and represents the Brazilian PostGraduation contribution to the United Nations Conference on Sustainable Development - Rio+20, at a time when Brazil commemorates the 60th anniversary of the creation of Capes. The publication is a synthesized version of the efforts made by Brazilian Institutions, within the National PostGraduation System (SNPG), and Capes in particular, to identify resources, potentials and challenges that need to be jointly addressed in order to create a coherent development standard in harmony with sustainable development ideals.

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PRESENTATION

Brazil, in its current stage of socioeconomic development, must face the challenge of educating its population and train highly qualified human resources to consolidate a policy of science, education and technology, committed to the continued building of scientific, technological and innovation basis required to social, environmental, economic, spatial, political and cultural sustainability.

Capes plays a key role in the formation of highly qualified professionals, through the continued promotion and periodic assessment of *stricto sensu* graduation (academic master's degree, doctoral and professional master's degree). To this end, it identifies, stimulates and promotes initiatives of new graduate courses and academic, scientific, technological, technological, cultural and innovation cooperation, at the national and international levels. It provides scholarships for students, teachers and researchers, support to postgraduation activities and access to scientific, academic, technological and cultural, Brazilian and international literature.

In 2007, it also started acting on the training of basic education teachers, extending the reach of its actions in the capacity building of qualified personnel, inducing and fostering teachers ' initial and continued formation for basic education, in face-to-face and distance learning formats.

In commemoration of the 60 years of its creation, Capes, taking advantage of the United Nations Conference on Sustainable Development (Rio +20) – to be held in June 2012, in Rio de Janeiro – an event recording the 20th anniversary of the United Nations Conference on Environment and Development (Rio 92), launches this document *Contribution of Brazilian Graduation to the Sustainable Development: Capes in Rio+20.*

The participation of Capes in Rio+20 was established by Ordinance No. 11 of February 13, 2012, which created a Commission, under the Presidency of Prof. Dr. Livio Amaral, Director of Evaluation of Capes, with the participation of various coordinators of Assessment Areas at Capes and renowned experts, who later designated the Working Group under the coordination of the Environmental Science Area of Capes to produce this document. The publication is based on information from the National Graduate Plan (PNPG) 2011-2020 (Volume I) and Sectoral Documents of this Plan (Volume II), in addition to include texts prepared by international recognized experts. Other studies were added to the studies of PNPG, derived from contributions from consultants and coordinators of Assessment Areas of Capes.

This document presents a synthesized version of the achievements of Brazilian institutions, in particular the Coordination for the Improvement of Higher Level Personnel (Capes), linked to the Ministry of Education (MEC), within the National Graduation System (SNPG), to identify resources, potentialities and strategies to be jointly elaborated aiming at a pattern of development consistent with the principles of sustainability.

The text records the evolution of Brazilian graduation focused on sustainable development and its historical landmarks, in addition to the current postgraduation frame and challenges related to the themes of Rio+20, with the presentation of aspects related to important instruments for the formation of human resources.

The proposals made to strengthen the Brazilian postgraduation, reflect policies, experiences and lines of action aligned with the promotion of science, technology and innovation. We hope that they can serve as a reference to various sectors of society in order to provide subsidies and guidance to the leaders of higher education institutions, Governments and public managers, and political leaderships of the country, of States and municipalities, as well as governmental and non-governmental institutions of other countries participating in the Rio+20, enabling and stimulating national and international partnerships and cooperation in the light of sustainable development.

Capes is aware of its role in the formation and development of highly qualified human resources to face the great challenges for the development of the country and the world on a sustainable basis. To this end, the study produced from 2011-2020 PNPG and the documents from Capes Areas submitted purports to contribute.

We express our thanks to the work of the members of Rio+20 Capes Commission, the authors the PNPG documents who have authorized the use of their respective data and texts, and the contributions of Area Coordinators and other authors. In particular, we thank the dedicated work of the Coordination of the Environmental Sciences Area, as well as the participation and support of several officials of Capes, without whom this document would not be achieved.

Jorge de Almeida Guimarães
Brasília, June 5, 2012
President/Capes

1. INTRODUCTION

Increases in global population rates and the disorganized use of natural resources have stressed the need to address a number of demands such as energy, metropolitan growth, environmental protection and preservation, increased and improved food production, monitoring and prevision of extreme meteorological phenomena. Population growth has also exposed some vulnerable areas such as the use and protection of water resources, the exploitation and preservation of biodiversity and the development of new products and services.

In Brazil, increased pollution and the degradation of natural resources have become a challenge that needs to be addressed due to increased demands by the population. We have witnessed sharp changes to the demographic curve: a decrease in nativity from 6.2% in 1960 to 2% in 2010, a change that has halted the vertiginous population increases of the past 130 years. In 1872 the population of Brazil was slightly more than 10 million inhabitants and 185 million by the end of 2010. Furthermore, we have registered an increase in social mobility and the creation of a new breed of ambitious youngsters with a craving for culture and higher education.

Brazilian science has earned a presence on the international scene on a quantitative level, as well as on a qualitative scale proved by the presence of Brazilian scientists within international scientific institutions often holding important positions, and through noteworthy scientific cooperation projects sponsored by federal and state agencies. It is also worth mentioning that several Brazilian institutions and enterprises have earned international recognition through their scientific and technological expertise.

The partnership between universities, the State and private and public enterprises which have been implemented and broadened through SNPG policies, will now give way to the so called "triple propeller" model. The Directives for a National Agenda for Postgraduation and Sustainable Development Research are at the center, and at the basis of the model which will count with the participation of federal and state agencies connected to SNPG and implement public policies that will lead to targeted actions and broaden the partnership between universities and the public and private sectors.

The United Nations Conference on Sustainable Development - Rio+20, in June 2012, offers a unique opportunity to divulge the improvement of Postgraduation

practices in Brazil during the last 20 years and to debate future strategies and negotiate new partnerships between Brazilian and international institutions.

The methodology used for the creation of this publication is the synthesis of the National Postgraduation Plan (PNGP) 2011-2020, both from Volume I but also from texts provided by several acknowledged specialists compiled in Volume II of the same Plan - Sectorial Documents, that are directly connected to Rio+20 conference topics. Apart from this valuable data base we have used completing material provided by official institutions available on the GeoCapes website, and added information provided by Capes assessment coordinators directly related to Rio+20 topics.

In this document, the term postgraduate studies means: academical master; doctorate or professional master degree. Therefore, it is equivalent to graduate studies, used in most american speaking countries.

The publication is composed by seven chapters of which the first consists of a brief introduction. The second chapter deals with the evolution of Brazilian Postgraduation practices in a sustainable development and historical context. The third chapter deals with the current situation and Postgraduation challenges in relation to topics raised during Rio+20: water, oceans, employment (a green economy and social inclusion), energy, sustainable cities, food (food safety and sustainable agriculture) climate change and natural disasters. Apart from these topics directly related to Rio+20 we have also added other topics considered relevant to Brazilian specifics: The Amazon and biodiversity.

Chapter four presents the existing tools for the creation of human resources on a post-graduate level. Chapter five presents proposals for the improvement of Postgraduation practices in Brazil in a sustainable development context, providing details on current topics and used tools. The sixth Chapter describes the subjects of the postgraduate scientific production relating them to the themes of the Rio+20 Conference The seventh chapter includes the final considerations emphasizing the importance of interdisciplinary studies and debate for the establishment of policies, experiences and aspects of sustainable development in conjunction with science, technology and innovation.

It is our hope that this publication will become a valuable contribution for debate in specialist circles and inspire decision makers to take the necessary steps towards a dynamic and sustainable development of the country.

2 THE EVOLUTION OF BRAZILIAN POSTGRADUATION AND SUSTAINABLE DEVELOPMENT

This chapter presents the Brazilian context with focus on sustainable development, detailing the historic benchmarks of post graduation national plans, as well as the evolution and current situation of postgraduation studies in Brazil.

2.1 SUSTAINABLE DEVELOPMENT IN A BRAZILIAN CONTEXT

The concept of sustainable development was launched during 1980 and was acknowledged in 1987 by the World Commission on the Environment, the Bruntland Commission, when it released a report that was considered as the basis for the definition of the concept. The principles of sustainable development form the basis for Agenda 21 Global, a document that was approved by more than 170 countries during the United Nations Conference on the Environment and Development held in Rio de Janeiro in1992, Rio92. The Conference's concepts and ideas have been accepted by United Nations organizations and by several international organizations and have, since then, been progressively incorporated into the agendas of numerous countries.

Rio92 created the right environment for an international consensus on the operationalization of the concept of sustainable development. The concept gained in popularity after the conference and was the target of numerous studies and attempts to establish management policies based on its central principles. The concept demands an integrated and interdisciplinary approach and emphasizes the need to increase the political, social and ecological measures and to deal with threats and changes and uphold or broaden the options that can address constantly changing social and environmental issues.

The essence of the term sustainable development is a broad grouping of key principles that can be observed in various theoretical and applied models and has been discussed and implemented in a wide variety of contexts due to strong pressure by the global environmental movement. Amongst the most common models we find the long term perspective, the capacity to preserve and support ecosystems, generational responsibilities, precautionary principles, community well-being and participation, cooperation, conservation and justice as well as the fact that the concept of sustainability is multi-dimensional and safeguards the interrelation ecology, economy and society.

The Bruntland Report has become a consolidated political reference, even if we today still do not have a universally accepted sustainable development concept. The global institutionalization of the concept culminated when it was widely accepted as the basis for the creation of Agenda 21 Global and its ramifications. It contains principles that the majority of the authors considered necessary for its effectuation and has, according to Veiga (2005), become a central concept in different political-theoretical approaches related to human development and environmental protection.

In a Brazilian context, with a territory of continental proportions that extends throughout 8.5 million square kilometers and with diversities that are compatible with its extensiveness, the safeguarding of sustainability requires the sum of all efforts undertaken by the public and private sectors. Brazil's 27 states, comprised of 5.565 municipalities, have during the past 10 years experienced a high rate of urbanization. In the year 2000, 81% of Brazilians lived in urban areas. The current rate is 84% (IBGE, 2012).

The Brazilian territory is currently inhabited by a population of 190 million individuals irregularly distributed throughout its five political-administrative regions, North, Northeast, Center-west, Southeast and South.

The North region represents 45.2% of the total area of Brazil but even if it is the most extensive region it contains only 8.1% of the country's population and a density of 4.0 inhabitants per square kilometer. The North region occupies an area of 3.850.000 sq/km and is home to the States of Acre, Amapá, Amazon, Pará, Rondônia, Roraima and Tocantins. The largest area is occupied by the Amazon and a few Cerrados. The Amazon plateau is home to the largest hot-humid forest in the world.

The Northeast region occupies 1/3 of the national territory, covers a landmass of 1.556.001 sq/km and is home to the States of Alagoas, Bahia, Ceará, Maranhão, Paraíba, Pernambuco, Piauí, Rio Grande do Norte and Sergipe. This region is dominated by Backlands (sertão), Wastelands, Forests, Cerrado and Littoral ecosystems.

The Southeast region is considered to be the most developed and has more than 42% of the population and the highest population density, currently 87.4 inhabitants per sq/km. The region has a total area of 924.000 sq/km, 10% of the national territory, and is home to the States of Espírito Santo, Minas Gerais, Rio de Janeiro and São Paulo. The landscape is heterogeneous, between the coast and the mountain, the Restinga and the Atlantic Forest. Other regional ecosystems are Fields and Cerrados.

The Center-West region is home to the States of Mato Grosso, Mato Grosso do Sul, Goiás and the Federal District of Brasilia and is, except for the northern part of Mato Grosso State, completely dominated by the Cerrado, the Pantanal being an area

in transition. The Cerrado is an enormously varied ecosystem with the largest fauna circulation in the country; it borders the five large geopolitical regions in the country and is also considered as an important natural route between these five big geopolitical regions. The Region's territory corresponds to 23% of Brazil and amounts to approx. 2.000.000 sq/km.

The South region is also a diverse region that is home to the States of Paraná. Rio Grande do Sul and Santa Catarina. Its environment is composed of various types of forests such as the mixed Atlantic Forest where we find the Brazilian pine and tropical forests. Fields, cerrados and the ranch lands (campanha Gaucha) are also part of the landscape as well as the pioneering várzea (seasonally flooded woodlands), mangroves and restingas.

The colonization of this territory took place during different moments of the capitalist economy and forms a large and diversified curve from the agro-exporting colonial economy up to the current industrial goods and export based economy. From an historic perspective this socioeconomic process was consolidated through the use of different and distinct landscapes, each with its specific topography, climate and vegetation characteristics.

The complexity of these natural Brazilian landscapes upon which people live their lives were classified by the geographer Aziz Ab'Saber as morpho-climatic zones: Amazon Zone, Caatinga Zone, Cerrado Zone, Mares de Morros (Coastal Mountain) Zone, Araucárias Zone, Ranch Land (Pradaria) Zone and Transition Land (Pantanal). Each of these zones is a respective predominant factor in each of the geopolitical regions and can also be found in connection with mixed or transitional areas. It is also important to highlight, apart from the above zones, the diversity that characterizes the Brazilian coast that stretches for circa 8,500 km.

The colonization process of the above zones was very disorganized and the use of the local natural resources is a challenge that demands the search for scientific, technological and political alternatives that can safeguard its continuity. The ascendancy of Brazil to one of the largest economies on the planet demands the implementation of processes that can transform the current socioeconomic profile and address the different demands from the private and public sectors. An example of the changes is the agrarian sector. Driven by new technologies, the availability of well empowered human resources from Brazil and abroad, competitive enterprise management and business practices, the Brazilian agriculture has reached extraordinary production rates and the grain cultivated area has, during the last two decades, only increased by 25% while production was raised by 154%, making Brazil a "breadbasket" of the world in direct competition with the USA and Europe.

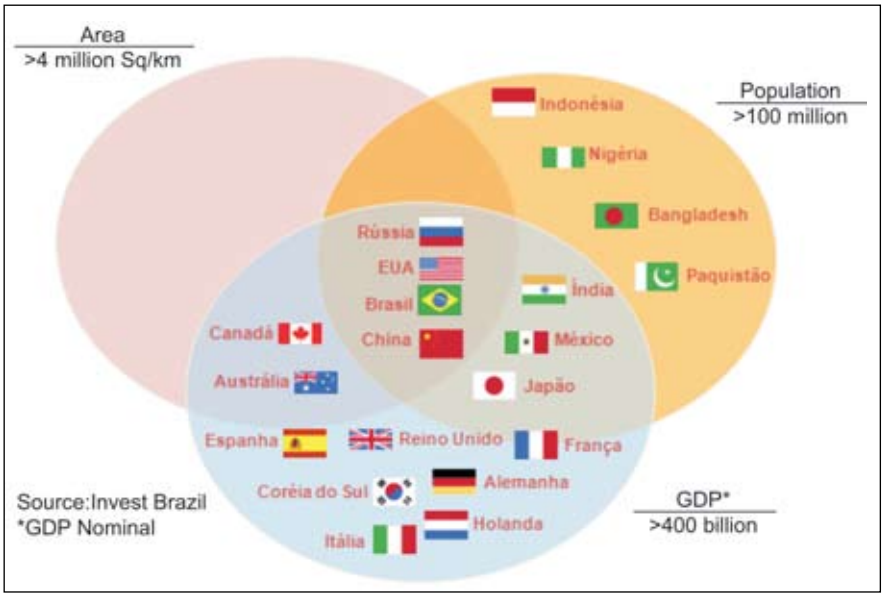
The discovery of the "pre-sal" oil fields represents another process of transformation and demands a different level of analysis not only in relation to the new technological and socioeconomic configurations that implies the use of more resources, increased demand for professionals in particular in the areas of engineering and infrastructure, but also and most importantly the demand for alternatives for the protection of ecosystems and related human development.

On a global scale Brazil is, jointly with China, Russia and the USA, one of the countries that holds an important position if we combine territorial extension, BNP and population. However, if we add the Nuclear Program to the above mentioned indicators and see it as part of the natural resources of these countries through its energy generation, China would not be included if we include all four indicators. Likewise, if we include a Space Program as one of the four indicators, Brazil would not be one of the above countries. This fact is illustrated on Graphic 2.1.

The above facts, which are unique in many aspects, lead us to conclude that Brazil should aspire to demographic standards similar to Europe and North America and should occupy a place of relevance on the international scene, not only as a world "breadbasket" and a big exporter of industrial goods and use its greatness, and this rare opportunity, to overcome our historic social heritage, pay the social debt and create a welfare society.

It is in this context that the SNPG, in harmony with the principles that it has exercised for more than half a century, has an important role to play in relation to Postgraduations and research centers. The existence of announcements, support to scientific events, support for national and international exchange and the implementation of broadened Postgraduation qualitative and specific course processes – through assessment processes – are some of the tools that allow us to share the common responsibility and to use all possible opportunities to develop Brazil based on sustainability.

Graphic 2.1 - Territorial extension, BNP and population



Source: R. Dauscha (ANPEI) 3rd CNCTI (http://www.cgee.org.br/cncti3)

2.2 HISTORIC BENCHMARKS OF THE NATIONAL POSTGRADUATION PLANS

The PNPG 1 (1975-1979) was based on facts that showed that the process of Postgraduation expansion was apparently spontaneous, disorganized and depended on existing economic realities. From that moment of the introduction of the Plan the expansion should become the object of state planning and Postgraduation practices were seen as a subsystem of the university system and were therefore a part of the national educational system. Postgraduation practices were incorporated into socio-economic development policies and to the II National Development Plan (PND), through the Sector Plan for Education and Culture (PSEC) and II PBDCT (Basic Plan for Scientific and Technological Development for the period 1975-1980.

The creation of this Plan took place parallel to discussions initiated by the United Nations Conference for the Environment held in Stockholm in 1972. The conference became a benchmark for the debate on environmental issues on an international level and focused mainly on hazards and environmental perspectives in light of population explosion, accelerated urbanization processes and industrial technology. The conference had a strong effect in Brazil, a country that subscribed to an economic model that propagated for growth at any cost.

The 70's and 80's were marked by the demand for environmental diagnostics that could provide a base for legislation, zoning and directives for the establishment of effective environmental policies and the development of environmentally friendly technologies that could minimize the risks of contemporary development models.

Therefore, the Stockholm Conference in 1972 apart from becoming a benchmark for the advancement of environmental debate it also had a direct effect on the urgent need for the production and exchange of information and knowledge.

The above repercussions initiated a series of changes in Brazil with the creation, in the late 70's, of legal and institutional tools. This change can be illustrated by some of the then approved national policies such as the urban soil allotment law, Federal Law 6766/1979.

The government started to established laws and institutions which reflected, through political discourse, its concerns in relation to human development and the environment. Several entities were created and strengthened during that period and we point in particular to those related to the environment and those that led to the aggregation of environmental state organs and institutions, the majority of them under the umbrella of the new Secretariats for the Environment in each State of the Federation. The period was also marked by the creation of specific policies for sectors that dealt with the education of personnel and with the institutional framework needed in order to meet social demands in the areas of education, science and technology.

It was in this historical context that the II PNPG (1982-1985) was created. The Plan was an attempt to harmonize its targets with the II National Development Plan (PND) and the III Plan for Scientific and Technological Development in Brazil (PBDCT) that was launched for the period 1980-1985. The main objective of the II PNGP continued to be the empowerment of human resources, mainly doctorates, in research and technology in order to meet the demands from the public and private sectors.

During this period new Postgraduation courses were launched that focused on research lines for the empowerment and qualification of students in subjects related to environmental questions, this as a result of increased demand and in order to fulfill the contents of the National Environment Policy from 1981 and Federal Law 6938/1981.

The III PNPG (1986-1989) was created parallel to the launching of the I National Development Plan (PND) of the New Republic and clearly shows a trend that prevailed at the time: the achievement of national autonomy. From this perspective, the main focus of the plan was the development of research by universities and the integration of Postgraduation practices with the science and technology that provided a basis for the

Brazilian productive sector. The care for the environment and the reduction of regional development policies are also important components of the III PNGP.

The timing of this Plan coincides with the promulgation in 1988 of the new and actualized Federal Constitution of Brazil. A period characterized by the creation of new institutional models and the elaboration and strengthening of national systems, new directives and principles which directly linked education and science, technology and the environment. From a Postgraduation perspective The Plan was closely associated with the economic development of the country and in particular with both the National Science and Technology System and the National Education System.

The onset of democracy and the Constitutional right granted to all Brazilians of basic rights and the right to basic survival conditions strengthened the role of education in these processes, a role that was consolidated through the principles contained in the document Our Common Future, released during 1987 as part of the World Commission for the Environment and Development. Some measures had already been undertaken for these purposes such as those included in the National Policy for Diffuse Rights, launched during 1987 and focusing on indigenous matters and traditional communities.

Brazil has also signed important international agreements at the United Nations Conference on Development and the Environment - Rio92, in particular: (i) the Rio de Janeiro Declaration, (ii) the Agenda 21 Global, (iii) the Climate Convention and (iv) the Convention on Biodiversity, agreements that were embraced on both national and local levels, by the legal system and specific institutional framework.

The sum of these and other related documents and their inherent commitments show that the question of education and research were considered as the fundamental pillars of a strategy that would lead changes in production and consumption standards directly related to the ideology of sustainable development. It was therefore of paramount importance to strengthen the areas of research and education for Postgraduations purposes as well as to combat inequality in the Brazilian society, while respecting its specifics.

Have the next IV PNPG, that was not promulgated, but its guidelines were adopted by Capes, characterized by emphasis on system expansion, diversification of the model of postgraduation, to introduce changes in the evaluation process and international integration of SNPG.

The V PNGP 2005-2010 introduced the concept of strategic induction in Postgraduation practices through partnerships with state foundations and funds for the sector which aimed at the improvement of the qualitative Postgraduation assessment process (the concept of centers, the revision of the Qualis/CAPES system

and the introduction of PROEX), addressed the subject of solidarity and the effect of Postgraduation programs on society in general: expansion of international cooperation; fight discrepancies; empower human resources for technological innovation in a globalized and competitive world; emphasize the empowerment of doctors for all levels of education, such as technicians, through the introduction of professional masters degrees for both the private and public sectors. The following measures were of paramount importance for the creation of CAPES programs as demanded by PNGP 2005-2010:

- a decrease in regional discrepancies: New Boundaries Program (PROCAD); New Boundaries Program (DINTER); Bolsa Familia for All Program;
- induction practices for the knowledge sector: Bionanogtechnology, Pro-Botany, Pro-Science of the Sea;
- induction practices for strategic areas: Pro-engineering, Digital TV, Pro-Defense;
- national partnerships: CAPES - Ministries, Capes - CNPq, CAPES - Fap's.

The V PNGP provided the impulse for the measures to subsidize the creation and implementation of public policies for the education, science and technology sectors. The adopted policies were an attempt to address the demands and emerging trends in society and to safeguard the consolidation of the SNPG.

The creation of the Ministry of the Environment (MMA), the Ministry of Cities (MC) and the Ministry of Science and Technology (MCT) and the strengthening of several institutions such as the Brazilian Institute for the Environment (IBAMA) demanded the contribution of the SNPG and the empowerment of specialized technicians and harmonization with national and state strategies for science, technology, education and the environment. Funds were created for applied and interdisciplinary research and edictal and induction policies were introduced in harmony with the specifics of current strategies.

The above retrospective leads us to acknowledge that Brazil has made significant efforts to strengthen postgraduation practices and the empowerment of doctors for universities, assess the performance of the postgraduation system and, on a final note, develop scientific and technological research in order to address national priorities.

Directives and challenges of VI PNGP 2011-2020

The VI PNGP 2011-2020 subscribes to the framework of "windows of opportunity" created by national economic growth and a new social and economic order. It represents

an important tool to concatenate the level of current development enjoyed by Brazil and to overcome our historical-social heritage, pay the social debt and create a welfare society propelled by sustainable development. It has an organization in place and is currently developing induction policies according to the following principles:

- SNPG expansion, focus on quality, combat endogeny and the reduction of discrepancies;
- creation of a new national agenda for research and incorporate it with Postgraduation practices;
- improvement and broadening of assessment practices to other segments of the C,T&I system;
- Postgraduation practices centered on multi and interdisciplinary subjects seen as important research subjects;
- provide support to basic education and to other educational levels and models, in particular medium-level education.

In this context, the National Postgraduation Plan (PNPG), in all of its editions, has provided the essential elements for the creation, conceptual development and framework for effective Postgraduation practices in the country. Seen as a subsystem of the aggregate that forms the educational system, Postgraduation has been included in different National Plans as a macro-political benchmark providing diagnostics and establishing targets and measures, supported through a broad governmental financing system for the sciences, technology and the environment.

SNPG's efforts to lend support to the Brazilian development process through Postgraduation empowerment can be observed within the five main stages of its evolution: (i) empowerment of doctorates in universities, graduating the first contingent of researchers and specialists on a national level; (ii) attention to performance and quality; (iii) focus on national development and integrate research undertaken by universities with the productive sector; (iv) flexibility in Postgraduation models, the improvement of assessment models and emphasis on internationalization; (v) introduction of strategic induction, the combat against discrepancies and the impact of Postgraduation activities on society, which resulted in the incorporation of innovation by the SNPG and in the inclusion of social parameters in assessment processes.

The above mentioned stages represent the respective leading principles upon which the first national plans developed for the SNPG in Brazil are bases and led to the creation of the current V SNPG Plan 2011-2020. In this context we take the opportunity to contextualize from an environmental perspective the historical benchmarks during

the evolution of the SNPG and thereby attempt to shed light on the basic factors which led to the current expansion in national scientific and technological development. To revisit these benchmarks strengthens our commitment to go forward, meet the challenges and participate in SNPG's research agenda in harmony with the principle of development based on sustainability.

2.3 EVOLUTION AND CURRENT SITUATION OF POSTGRADUATION IN BRAZIL

Brazil has, during the current century, become an emerging power and one of the seven largest economies of the world. This is an extraordinary fact and shows that the country has experienced a large expansion of important sectors of the economy stimulated by public policies that further development in the whole country. It has also made efforts to correct regional discrepancies which have led to changes in the different sectors of society and a presence in global geopolitics.

This important economic advancement has stressed the responsibilities that the country has to implement know-how policies and innovation that will together lead to the strengthening of the social base and establish productive processes that include the socio-environmental responsibility needed for sustainable development. The country already possesses the necessary critical mass that can face up to the challenge as far as the educational system is concerned, and high-level education in particular due to the excellence of the National Postgraduation System (SNPG), as noted earlier.

SNPG activities currently include 3,397 Programs and 5,080 postgraduation courses spread over nine large subjects: Agrarian Science, Biological Science, Health Science, Exact Science and World Science, Human Science, Applied Social Science, Engineering, Linguistics, Literature and Arts and Multidisciplinary practices (CAPES, 2012).

The System of Brazilian Post-Graduate (SNPG) consists of: (i) academic master's degree with average duration of 24 months starting after the undergraduate course, (ii) professional master's degree, also with an average duration of 24 months, focused on the training of human resources entered into the labor market and (iii) doctorate with an average duration of 48 months usually initiated after conclusion of the masters degree. A Postgraduate program may contain one or two postgraduate courses, in other words: (i) academic master and/or doctorate, (ii) only professional master.

According to the 2011 data included on Table 2-1, the number of courses at all levels of Postgraduation *stricto sensu* has increased from 699 in 1976 to 5,080

and an impressive increase of 150% in Multidisciplinary courses which now include interdisciplinary Postgraduation programs in the new subject of Environmental Science.

Table 2-1: Number of Postgraduation Courses in Brazil

Year	*Level*			
	Doctorate	**Professional Masters**	**Masters**	**Total**
1976	181	0	518	699
1980	260	0	680	940
1985	332	0	784	1,116
1990	469	0	993	1,462
1992	537	0	1,083	1,620
1995	682	0	1,289	1,971
2000	903	98	1,620	2,621
2005	1,099	202	1,923	3,224
2010	1,602	334	2,706	4,642
2011	1,738	417	2,925	5,080

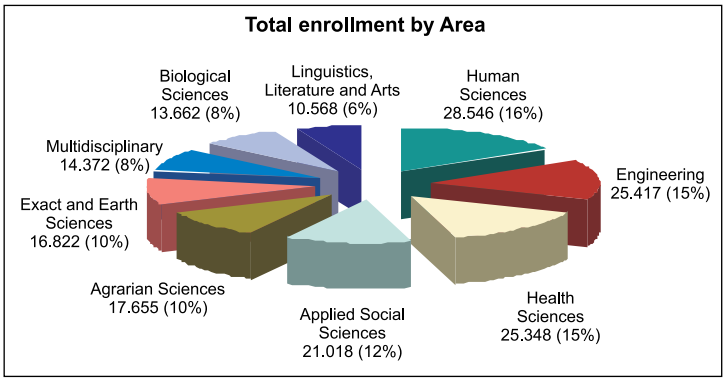
Source: CAPES, data actualized on 08/05/2012.

As part of the PNPG, the Federal Higher Education Institutions are responsible for the offer of the majority of the courses and have a large share of the academic education in Brazil in partnership with state institutions, which amounts to about 30% of the total academic education apart from municipal, community and private institutions.

Human Sciences is the knowledge area with the largest share of students with 16% share, Engineering[1] with 15%, Health Science with 15% and Applied Social Sciences with 12%, as shown in the distribution of total of enrollments in Postgraduation courses by area, Graphic 2-2.

[1] The proportionally low number of students enrolled in engineering Postgraduation courses is directly related to the lack of engineers in the country. There is today a great demand for engineers and technicians in Brazil: the deficit in construction is 38.5 thousand professionals, the Pre-Sal oil and gas sectors will demand a further 250 thousand engineers with different specialties while other technology based activities will generate the need for a further 100 thousand during 2011 and a further 200 thousand until 2005 plus an expressive number of engineering jobs for the other 5 years that are covered by the Plan.

Graphic 2-2: Shares of postgraduation enrollments by area, 2009

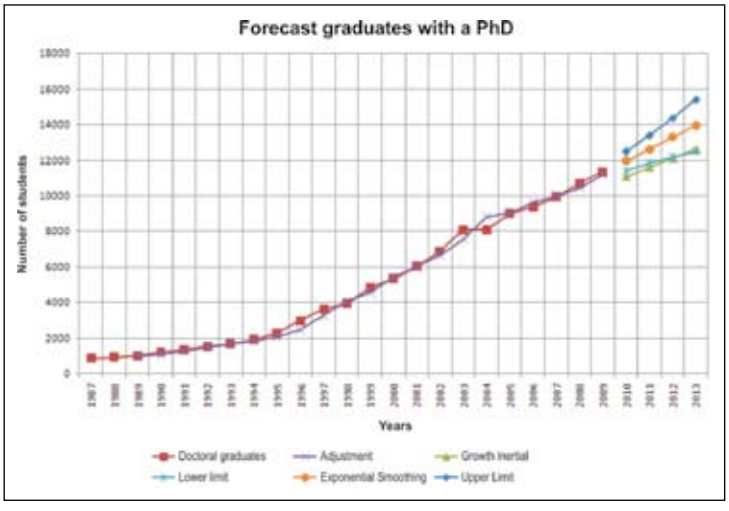


Source: CAPES/MEC Statistics, 2010

When divided according to postgraduation levels, the majority of students, 98,607, is found in master's enrollments followed by 64,588 doctorates. Students attending professional master's degrees represent a low share of the total, due to the fact that they have only been recently introduced, and total about 10.000 individuals.

In order to attend to the growth demands for the coming decade the SNPG continues to educate a contingent of masters and doctors as shown in Graphic 2-3 and projects a continued increase in the Postgraduation rate based on studies undertaken by CAPES for the period 2010-2013 which envisions the education of 13.962 doctorates. However, we must point to the fact that the SNPG projected for 2010 a total of 11.974 doctorates, due to its aggressive induction policies, but the actual figure for 2010 was 11.368 doctorates.

Graphic 2-3: Growth Projection for Brazilian Postgraduations

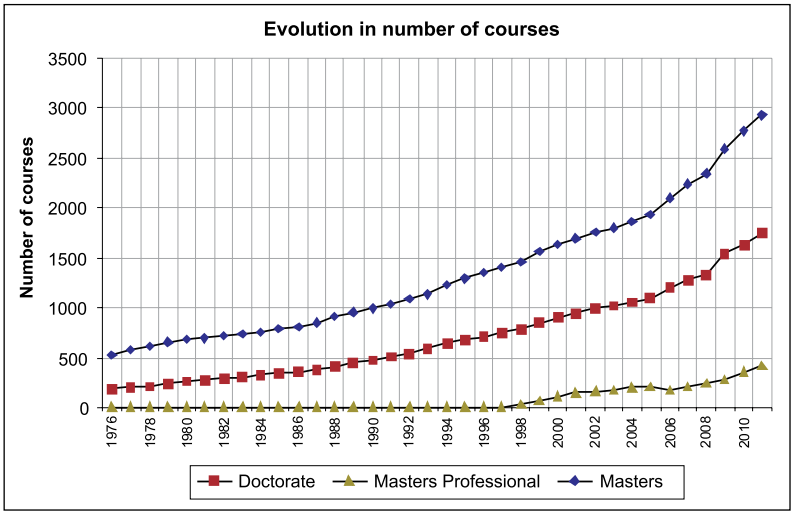


Source: Capes, 2-3PNPG 2010

We would like to point to the fact that apart from the quantitative growth, Brazilian Postgraduations have played an important role in the broadening and renewal of specific areas of knowledge and has allowed for a significant expansion of the scientific community and an increase in intellectual production, providing thereby an important contribution to national development.

SNPG activity has led to an ascending curve in the number of Capes recommended and implemented courses, as shown by Graphic 2-4.

Graphic 2-4: Evolution of the National Postgraduation System: recommended and implemented courses 1976-2011



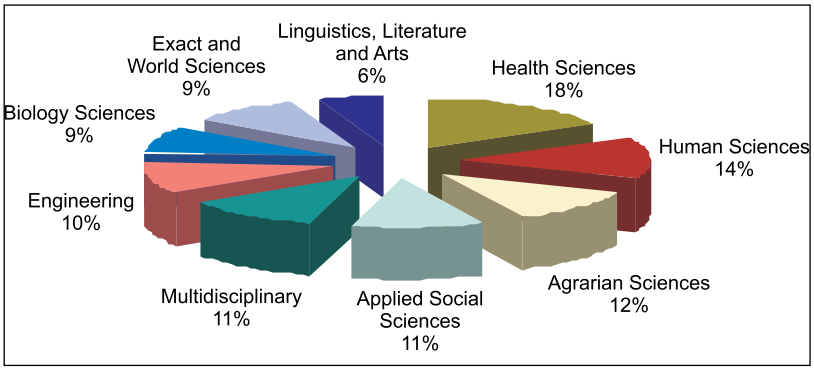
Source: Capes, data actualized on 08/05/2012

The above Graphic shows a growth of 460% in the number of master's degree courses and 860% in doctorates for the period between 1976 and 2011. There were no courses for professional masters in 1976. Between 2004 and 2011 we note an increase of about 57% in the number of courses for academic master degrees, 65% for doctorates and approximately 120% in courses for professional master degrees.

Graphic 2-4 shows that Agrarian Science's professional master's degrees experienced the strongest increase between 2004 and 2011. There is also a strong discrepancy in the offering of courses by knowledge area. In 2011 Multidisciplinary courses show the highest rate of offered courses, namely 32%, while Human Sciences represents only 2% of the same total.

There are strong variations in the distribution of Postgraduation courses by knowledge area, as illustrated by Graphic 2-5, Linguistics, Literature and Art represent 6% of the total of offered courses while Health Sciences present 18%.

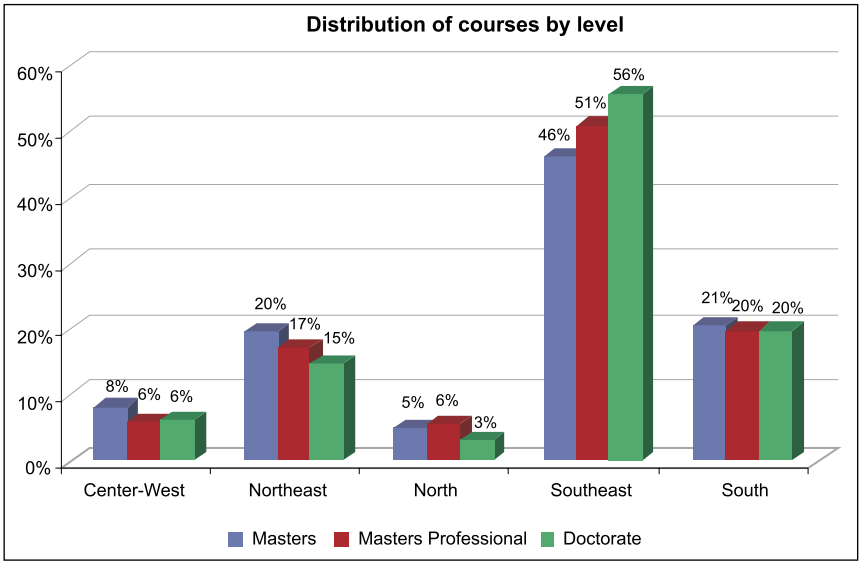
Graphic 2-5: Distribution of postgraduation courses by knowledge area, 2011



Source: CAPES/MEC Statistics (2011)

The regional distribution of Postgraduation courses by level shows that more than 50% are concentrated in the Southeast region and that the percentage of doctorate courses, 56%, is superior to that of professional master's degrees, 51%, and masters, 46%. Other Brazilian regions show a decrease in the percentage of course concentration as follows: in the South, Northeast, Center-West and North regions the percentages are 3% for doctorates, 6% for professional masters and 5% for academic master degrees, which illustrates the discrepancies in relation to the region with the highest concentration, the Southeast, according to Graphic 2-6 and Graphic 2-7.

Graphic 2-6: Distribution of postgraduation courses by level, 2011



Source: CAPES/MEC Statistics, 2011.

The regional discrepancies acknowledged by the SNPG, caused by existing socio-economic and cultural inequalities that are a part of the national fabric, have been the focus of incentive and induction policies. The sectorial funds are an example. These funds reserve 30% of their resources for scientific and Postgraduation policies for the North, Northeast and Center-West regions. Induction measures have also been practiced in order to attempt to reduce the discrepancies between areas of knowledge and to simultaneously to provide incentives for the creation, strengthening or expansion of Postgraduation systems in areas of strategic interest for national development.

Graphic 2-7: Distribution of Postgraduation Programs by Federal States in Brazil, 2010.

Source: Capes, 2010.

There are a large number of universities that offer consolidated Postgraduation courses in the majority of the Brazilian States. From an historic perspective they show a positive trend in the creation of centers of excellence in certain regions of Brazil.

A positive aspect of this historic process is the current existence of a critical mass of qualified doctors which leads to increased system efficiency. This question cannot be ignored when plans are made for the expansion of the Postgraduation system and the subsequent need to broaden the empowerment of doctors for the development of the country.

Table 2-8, shows the positive evolution of Brazilian sciences and its impact, provied by the Institute for Scientific Information (ISI).

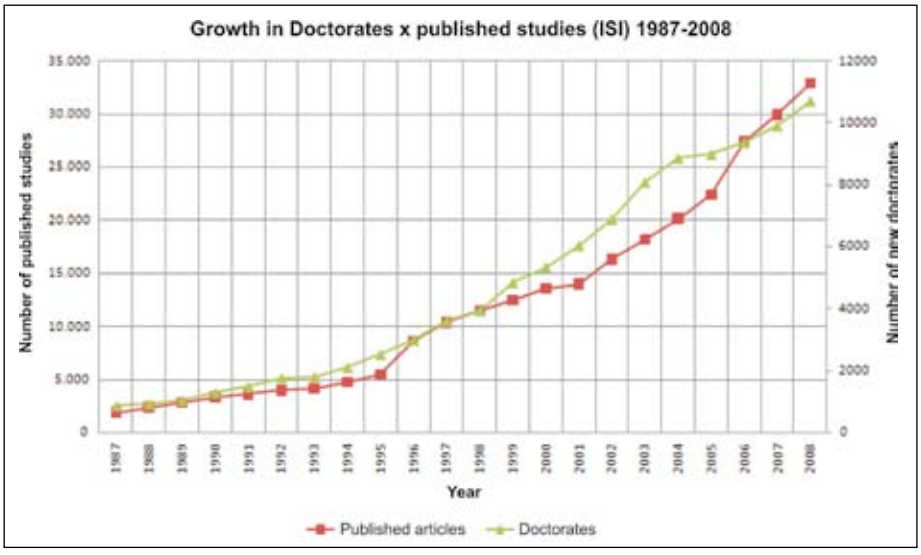
Table 2-2: Science in Brazil 1996-2000 / 2001-2005 / 2006-2010

	Period of years		
	1996-2000	**2001-2005**	**2006-2010**
% Brazilian publications related to international production	1,15	1,66	2,42

The evaluation of the contents of CAPES reports has allowed us to note a positive trend in relation to general incentives as well as specific incentives for the quantitative and qualitative creation of jobs for technicians and academic professionals. The trend is also positive in relation to researchers that provided a strong contribution through the spreading of knowledge and cooperation in order to achieve scientific advances and, last but not least, the improvement of life conditions for society in general.

Brazil currently occupies the 13th position in the ISI and SCOPUS reports in relation to the number of published studies. The SNPG is today a well-established institution and is strongly supported by the entire scientific community. We have also noted that the number of published studies follows the increase in the number of new doctorates (Graphic 2-8) illustrating a strong correlation between scientific production and doctorate thesis.

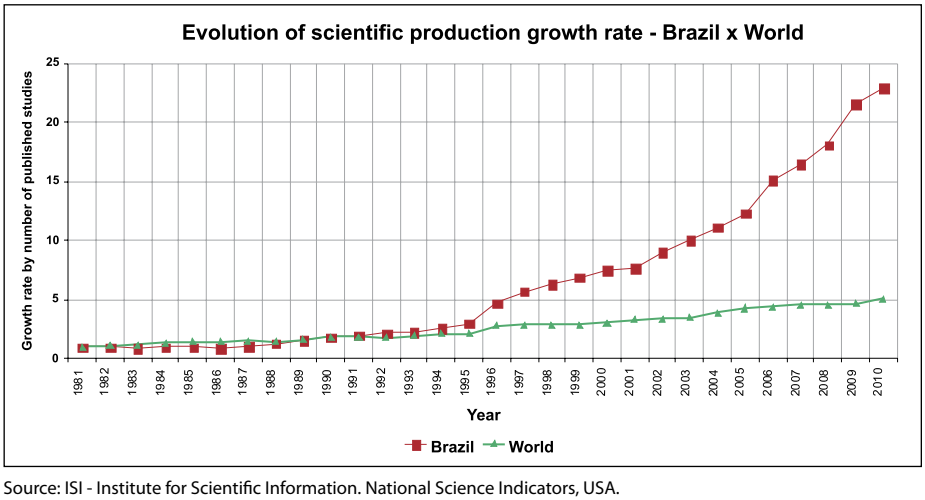
Graphic 2-8: Growth Rate: Doctorates and Published Studies (Scopus) 1987-2008



SCOPUS, 2009.

According to Scopus (2010) the Brazilian production of scientific studies between 1981 and 2010 has exceeded the global medium rate (Graphic 2-9).

Graphic 2-9: Growth Comparison Brazil x World (1981 a 2010 – Scopus Basis)



Source: ISI - Institute for Scientific Information. National Science Indicators, USA.

Brazil has achieved a higher growth rate in the number of published studies than Belgium, Holland, Poland, Russia, Sweden and Switzerland. In 1988 Brazil published

a lower number of scientific studies in comparison with each of the above mentioned countries and today Brazil is at the top of the list. In spite of this Brazil still publishes fewer scientific studies than China, Germany, Japan, England, France and the United States. When compared with other Latin American countries Brazil is the incontestable leader a position that has been strengthened during the last decade.

On the other hand, in spite of the fact that Brazil is credited with 2% of the global scientific production it is still an under-performer if we take into account the number of patents registered in the USA.

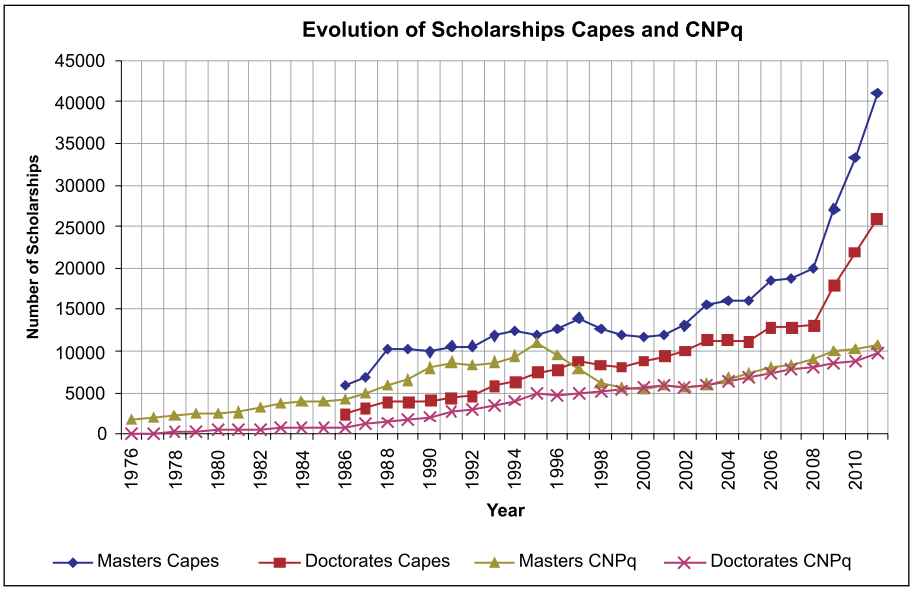
The development of research and total dedication to studies is an important part of Postgraduation practices and is the duty of academic institutions and research institutes, public or private. The application of research results provides the knowledge and technology sectors with strong tools to stimulate economic, social and environmental development and is directly related to the partnership between Universities, State and enterprises.

This partnership demands dynamic synergies between different segment of society: regional, national and international and must aim to integrate Postgraduation practices with the entrepreneurial sector and other social sectors.

We have also noted an increase in the granting of Postgraduation scholarships by Federal Agencies (Graphic 2-10). Available data shows that during 2011 Capes granted a total of 70,742 scholarships, 41,104 for academic master's degrees (Capes does not offer scholarships for professional master's degrees), 26,108 doctorates and 3,580 post-doctorates.

Apart from financing the system's regulatory framework we must continuously improve and incorporate new procedures through a dynamic synergy between several federal ministries and organs. There are two available options: (i) to introduce more flexible and simplified procedures, such as the import of resources and tools, which demands less than one week in developed nations and at least six months in Brazil; (ii) to achieve an improved equation in the regulation of the relationship between the public and private sectors, allowing the establishment of partnerships and reducing the time for actions, such as the payment of national and international consultancy fees without any negative affect on activity monitoring by control organs.

Graphic 2-10: Evolution of scholarships Capes and CNPq from 1976 to 2011



Source: Geocapes e CNPq/AEI. (2.2.2-GrupoMod_PaisExt_6309_nº)

Therefore we conclude that it is possible to envision the adoption of a daring national agenda for research projects in conjunction with the mobilization of the scientific community which will lead to the medium term improvement of Brazilian scientific practices and elevate it to a level of excellence.

The presence of Brazilian science on the international scene can be referred to as qualitative, if not quantitative, a statement that is supported by the involvement of Brazilian researchers in many of the most respected international scientific institutions, often on a high level, and is the result of actions undertaken by federal and state agencies. It is also noteworthy to highlight the prestige enjoyed by several Brazilian institutions, globally acknowledged for their scientific and technological expertise.

The planned expansion in PNPG 2011-2020, to meet the demands of development of the determines the achievement of goals consistent with the country developed nations. As an example, the USA has 8.4 doctors to 1000 inhabitants aged 25-64 years, Germany has 15.4, Australia, 5.9 while Brazil this proportion is only 1.4. Thus, the targets for the expansion of SNPG 2020 include:

– Increase the number of doctors/1000 inhabitants, aged 25-64 years from the current 1.4 to 2.8.
– Annual degree of 19,000 doctors, 57,000 masters and 6,000 professional masters.

This partnership demands dynamic synergies between different segment of society: regional, national and international and must aim to integrate Postgraduation practices with the entrepreneurial sector and other social sectors.

3 RIO+20 THEME'S: CURRENT SITUATION AND POSTGRADUATION CHALLENGES

This chapter contains an analysis of the current situation and challenges of post graduation programs related to the themes established for the Rio+20 Conference, plus priority themes to the Brazilian specifications. The themes of the Rio +20 are: water, sustainable energy, oceans, food security and sustainable agriculture, sustainable cities, employment, climate change and natural disasters. The priority themes for Brazil included in this document are: Amazon and biodiversity. These themes are presented below.

3.1 WATER

Text based on the compilation of the chapter "The empowerment of human resources for water resource management in Brazil: strategies and progress perspectives" and was written by Professor Doctor José Galizia Tundisi (PNPG 2011-2020).

Brazil holds only 2.8% of the world's population and 12% of the earth's fresh water resources plus very large reserves of subterranean water and is therefore considered one of the richest countries in water resources. The strategic assessment of these resources plays a fundamental role in territorial management and in the adequate supply to the Brazilian population. However, water supplies are irregularly distributed throughout the country. The North region is home to only 7% of the Brazilian population but holds 69% of the surface water resources. The Northeast has 29% of Brazil's population but holds only 3% of the total water resources. The South, where 43% of Brazilians live and where most of the industry is concentrated, holds only 6% of total water resources. These numbers still represent comfortable reserves when compared with other countries of the world.

Irregular droughts in the Northeast demand catchment processes that are socially accessible such as the storage and conservation of rain water, the sustainable exploitation of subterranean waters, desalinization of contaminated and saline water and the development of efficient irrigation techniques. The unorganized occupation of springs, the dumping of untreated sewage water into the ocean and rivers and the

consequent pollution of water present a growing problem in the supply of water to the densely populated areas of the South and Southeast regions and has created problems for the local economy.

The most demanding challenges in this sector are: water sustainability of the semi-arid regions, integrated water and urban management, the management of the impact of climatic variations on large water systems and the affected population, the use and preservation of the soil and hydric systems, the prevention and control of extreme events, the integrated exploitation of hydric systems and environmental conservation, the quality of water and of hydric systems, the sustainable use of coastal resources and the development of products and processes.

The unorganized growth of metropolitan areas and the lack of basic sanitation infrastructure in inland cities present a risk to the quality of watercourses and to the environment. There is a strong need for basic sanitation such as: (i) potable water supply, (ii) management of rain water, (iii) collection and treatment of sewages, (iv) urban cleaning, (v) solid waste management and (vi) plague control and control of any pathogenic agents. The lack of infrastructure or precarious sanitation conditions and socioeconomic and cultural factors are elements that can easily lead to the upsurge of parasite infections that are common in Brazilian children.

Basic sanitation measures can safeguard the health of the population, minimize the contamination and proliferation of diseases and protect the environment. In order to address this challenge and preserve hydric resources we need to empower human resources in all areas and in particular in the operational areas management and exploitation of hydric resources and environmental sanitation.

This set of problems poses evident consequences for management practices and is fundamentally conditioned to the gathering of scientific knowledge by research groups in universities and in postgraduation programs, as they share the common responsibility to promote the empowerment of human resources needed to face up to the challenge of changing the management processes and the quantity/quality of hydric resources.

As far as management is concerned, the National Hydric Resource Management System bases its management program on the work of the Hydrographic Basin Committee and the Basin Agency. We must emphasize that the technological base for the management of hydric resources must solve three fundamental problems that affect management and need a strong academic support:

– improved understanding of the interaction between terrestrial systems (soil usage and occupation) and aquatic systems;

– the constant and growing unbalance between supply and demand;
– increased contamination which renders substantial volumes of water useless, in particular in the regions South/Southeast, and is hazardous to the population.

Environmental management and in particular hydric resource management is a process that must undergo radical changes in its paradigms: from local, sectorial and crisis management in the direction of a management on the hydrographic basin level and the integration of predictive and multiple measures. This new management process requires scientific investments and changes in the approach to basic studies, as well as profound changes in the development of human resources. It requires the necessary systemic and interdisciplinary vision in relation to water sciences and water in general and will lead to improvements in interface areas such as water engineering, basic sanitation and aquatic biology.

Surface hydric systems such as lakes, rivers, artificial dams or flooded areas are complex systems with strong interaction between physical, chemical, biological and hydrological phenomena. The understanding of this complexity was reached during the last decades of the 20th century (TSUNDISI & MATSUMURA-TUNDISI, 2008) and is the basis for the need of interdisciplinary approaches for the study of these ecosystems and for the development of human resources. It is also necessary to point that the envisioning of hydrographic basins and the dependency of processes for continental aquatic ecosystems and hydrographic basins– lakes, rivers, dams, has led us to approach the process, firstly through study and the development of scientific knowledge and posteriorly, management. The set of processes and impacts related to subterranean waters is equally complex as their chemical composition is, as an example, the result of hydrogeochemical interactions, which involve geology and hydrogeology.

Furthermore, we must take into consideration the impact of, on top of these natural phenomena and of the processes that occur in these ecosystems, human activities and the ensuing consequences on the chemical composition of water, aquatic biodiversity and sedimentation and on the interrelation between hydrographic basins and continental ecosystems. We must therefore consider the following basic principles in relation to the development of human resources in hydric resource management:

– interdisciplinary vision with the capacity to understand and study processes on the level of hydrographic basins and its interactions and impact on the aquatic continental ecosystems;
– the capacity to create future scenarios through the analysis of the behavior of aquatic ecosystems when faced with anthropic impact of soil exploitation

and occupation of bordering hydrographic basins and the impact caused by global changes. It is therefore necessary to lend support and assistance to programs that prioritize mathematic and ecological models for the quantification of processes and the creation of scenarios for surface and subterranean waters;

- the capacity to undertake studies and interpret processes on the ecosystem level and the interaction between natural and anthropic processes;
- the capacity to broaden the inventory, description and understanding of natural systems and the climatological, hydrological, limnological, ecological interactions; biodiversity distribution and the effect of human activity on natural processes;
- emergent processes caused by contamination through persistent organic pollutants is a subject that needs scientific study and investments in detection systems, monitoring and the creation of sophisticated treatment processes. The development of human resources in this area is of paramount importance;
- finally, "competence networks" should become a part of postgraduation programs set up at the different hydrographic basins throughout the country in order to be able to counteract the urgent management demands according to Science, Technology and Innovation. "Innovation Banks" must be the object of stimulus. These "networks of competence" can be realized through the promotion and implementation of Centers for Advanced Research, Development and Innovation of Hydric Resources. Advanced Centers can maximize the potential of interdisciplinarity in postgraduation programs and the application of new research and management concepts through the implementation of ecohydrology and ecotechnology (JORGENSEN et al 2005, ZALEWSKI 2006, ZALEWSKI, 2007). The intensive usage of subterranean water has increased during the last decades and it is now urgent to start the processes of monitoring, study and territorial planning in relation to the management of subterranean waters as a fundamental and strategic component of the hydrologic cycle (LLAMAS & MARTINEZ SANTOS, 2006).

It is also relevant for this interdisciplinary subject to approach it through integrated and predictive vision and integrate the biophysical, economic and social components of the hydrological cycle and include them in postgraduation studies, proposals and programs.

Problems, difficulties and limitations

The application of scientific and innovative knowledge in the management of hydric resources is a strategic process that implies long term consequences and impacts for environmental sustainability and the Brazilian economy.

Postgraduation in hydric resources has experienced a significant expansion since the 70's through the implementation of numerous courses and programs in the areas of: basic sanitation; continental water ecology; basic and applied limnology, and aquatic biology. These programs are supported by innumerous research, monitoring and biological mapping and biochemical projects that have produced an enormous and varied bank of scientific knowledge in the country and led to the education of masters and doctors on a large scale who currently assist in postgraduation programs and research projects throughout the national territory (TUNDISI & MATSUMURA TUNDISI, 2008). However, a critical analysis of these programs reveals the following facts:

- Excessive intedisciplinarity. The fragmentation of knowledge in the area of hydric resources is a well-known and well documented fact. The programs either emphasize the areas of chemistry and biology or give little attention to the physical processes (hydrodynamics, for instance, is an area that with a low level of development in postgraduation practices), or emphasize the area of engineering (mainly sanitary) and forget its interaction with biology and the economy.
- Students lack the opportunities for fieldwork. There are only a few field stations and field labs that offer opportunity for effective work in a real local or regional environment. The offer of practical and demonstrative courses is low; exceptions are the INPA and the Goeldi Museum, both situated in the Amazon.
- Conceptual fragmentation leads also to the relative fragmentation of ecosystems: we have specialists on rivers, dams, or on lakes but we have few specialists with a joint vision of all continental aquatic ecosystems and subterranean waters.
- Economic and social processes are strategic components that are almost nonexistent during courses and these interrelations are not studied in detail and are not included in the postgraduation *curriculum*. The literature upon which the courses are bases is also fragmented and disciplinary.
- The capacity for interaction between managers and researchers is still incipient. The education of hydric-resource post-graduates in Brazil has

prioritized masters and doctorates and invested too little in specialists, professional masters or short courses for the education of managers. A new form of fragmentation was thereby created which distanced postgraduation from the management of hydric resources, which today has a predictive character on the scale of a hydrographic basin. In the past, decisions on the management of hydric resources were unilateral and did not take into account the multiples and synergies between the various components of aquatic systems, including socio-environmental processes.

Hydric resources of the different Brazilian hydrographic regions

Brazil is a country that shows great diversity in respect to the availability/demand of hydric resources. Furthermore, there are fundamental differences in relation to the multiple exploitation of water, impacts, hydric resources and the use and occupation of soil. It is therefore necessary to create a strategy for the development of human resources in hydric resources adapted and adjusted to regional realities, apart from the principles of interdisciplinarity, as well as the creation of scenarios and predictive capacity.

Some basins in the South and Southeast show symptoms of hydric stress, such as the Tietê rives in Sao Paulo State. Some basins have a strong impact like the basins of the Tietê river, the Iguaçu river and the Sinos river. Studies on the use and occupation of the soil, impacts, toxicology and bio-indicators are fundamental. It is also necessary to invest in the scientific creation of multiple exploitation scenarios. The South and Southeast basins require ecosystem recuperation processes, advanced technologies for integrated management as well as the implementation of programs and courses on mathematical models and ecology, as described by Fragoso et al (2009). Management models, the use of existing databanks and the assessment of future scenarios are also important topics that must be considered (BARBOSA, 2008).

The Amazon, Tocantins and Paraguai regional basins need actions that emphasize the natural relations of hydrological and hydro-social cycles, through the promotion of efforts to understand the main mechanisms of the ecosystems, the usage of water *vis à vis* future impacts that may occur as a result of deforestation and the expansion of agrarian and cattle production. The institutions dedicated to the preservation of the hydrographic regions need: (i) long term studies; (ii) the creation and use of regional data and (iii) the assessment of specific functional processes that take into account the space/temporal variables. Strategic studies on future hydroelectric exploitation

of the Amazon and the Mato-Grosso pantanal must be broadened and included in postgraduation programs.

The priorities for the semi-arid regions are the scarcity of water and processes for the upholding of biodiversity, water supplies and human health as well as assessments and scenarios related to global changes and their impact on resources and, last but not least, the adoption of technologies through scientific development that will lead to actions in areas of extreme scarcity such as Brazil's semi-arid region of the Northeast.

There is also a need for new technologies and a new approach processes to the study of ecosystems and the interactions between terrestrial and aquatic systems that are common to all regions. Monitoring technologies in real hydrometeorological time on the quality of water, new assessment processes of multiple uses are also common to all programs.

The Centers for Advanced Hydric Resource Studies can play a fundamental role in the implementation of innovations and new proposals for regional programs. Its function is to promote the interaction of postgraduation programs with privately funded innovative projects and the consolidation of programs and their respective proposals. They should also play a role as critical assessment centers of scientific production and program performance. They are, therefore, of great importance for the introduction of new models such as hydric resource courses for managers and executives in the private and public sectors. These Centers will be essential for the interrelation between regional postgraduation programs and the regional economies, promoting long-term partnerships and actions.

The relation human-health/hydric-resources is fundamental for all Brazilian hydrographic basins and must be included in programs and projects for the development of human resources in hydric resource management.

Reflections on postgraduation and specialized education

The management of hydric resources is of strategic importance for Brazil as water is the fundamental resource for the development and sustainability of the economy. Therefore, the management of Brazilian continental and subterranean hydric resources demands broad and sophisticated processes for the gathering of knowledge about these complex systems in various hydrographic regions. Existing programs must develop these concepts and include hydrographic basins, prediction capacity, toxilogical studies, mathematic models and the creation of scenarios. New programs

must incorporate interdisciplinary vision and systemic projects, as well as the interaction and communication of biophysical, economic and social approaches.

Post -graduation practices must become the basis for this integrated vision and stimulate new approaches to the management process that will affect the economy, the recycling of water and the technological development of management practices.

This new approach to postgraduation will bring many benefits from an economical viewpoint due to increased demand and the relation demand/availability, increased knowledge on biodiversity and possible impacts on biodiversity and a broadening of hydrographic basin management technology (TUNDISI, 2007). Monitoring, water recycling, data banks and desalinization are subjects that can be developed through postgraduation practices and lead to the development of new scientific and technologic management processes. The support of the Centers for Advanced Studies in Hydric Resources for innovation should lead to positive effects for the economy and for the development of managers and specialists.

3.2 SUSTAINABLE ENERGY

Text based on a compilation of the Chapter "Energy" written by Professor Doctor Luiz Pinguelli Rosa (COPPE/UFRJ) who is a contributor to the National Postgraduation Plan (PNPG 2011-2020).

During the coming decades the world will meet a series of challenges and in particular in regard to the distribution of energy, a necessity for development and for the competitiveness of the national industry. Bellow, we highlight some of the prioritized areas:

Oil and natural gas

During 2007 Brazil declared its self-sufficiency in oil production and consumption. Estimated oil reserves amount to 14 billion of barrels of oil and the natural gas reserve at the Campos and Santos Basin is estimated to fulfill the goal of self-sufficiency during the next decade.

The following year, 2008, Brazil announced the discovery of new and gigantic fields at the Pre-Sal region coinciding with the energy crisis that faces the developed countries. The newly discovered fields are located underneath a layer of salt at a depth

of about 6.000 kilometers. These reserves, which amount to 100 to 338 billion of barrels, are located between the states of Espírito Santo and Santa Catarina, an area of about 800 km which includes the sedimentary basins of Espírito Santo, Campos and the Santos basin.

The investment projections by the Brazilian oil and natural gas sectors during the coming years present a unique opportunity for the use of these resources in order to achieve economic and social development. It is therefore very important to develop robust actions that will safeguard the necessary level of development and increase the capacity and competiveness of the national industrial sector and allow it to produce as many as possible of the goods and services needed for oil and natural gas exploitation.

The empowerment of human resources on all levels and in particular in technology, is one of the actions needed to meet the demands for industrial infrastructure. However, we must not only address industrial requirements, specific and quantitative, but also the Academic requirements needed to address technological research activities and the expertise to fulfill industrial demand.

Brazil is currently undertaking some important initiatives in this area. The National Oil, Natural Gas and Biofuels Agency (ANP) started the development of a Human Resources Program during 1999, a professional empowerment initiative at the service of the Oil and Gas production chain. The program's objectives include specific subjects that address the requirements of the oil, natural gas and biofuel industries in the curriculums of several courses offered by universities and federal educational institutions throughout the country. Examples are courses such as Exploitation and Production Engineering, Duct Engineering, Cellular and Molecular Biology, courses that directly meet the demands of oil companies. The program grants scholarships for studies in technology, graduation and masters and doctors degrees and has already empowered 2.500 professionals in 13 states.

Another initiative launched to address the demand for qualified personnel for the goods and services industry within the oil and natural gas sector is the National Plan for Professional Empowerment (PNPQ) part of the Program for the Mobilization of the National Oil and Natural Gas Industry (PROMINP) which was launched during 2006 and had, up to 2011, the goal to empower 78.000 professionals. The levels of courses are basic, medium, technical and superior and include 175 categories of professionals linked to the oil and natural gas sector. Projections show a continued increase in demand for qualifies personnel and the Petrobrás Business Plan alone will require the empowerment of more than 207 thousand individuals.

Action is also required for the furthering of technological development and in particular for actions targeted at increasing the competitiveness of the goods and services industry, and not only in the area of professional empowerment. The technological demands of enterprises are being addressed through their own initiatives, and in particular in relation to Petrobrás which today recruits professionals from the world market as the numbers of human resources empowered in Brazil do not fulfill its requirements.

Hydroelectric

Brazil is home to one of the largest hydroelectric dams in the world, the Itaipu located in the State of Pará (PA) as well as large dams at Ilha Solteira in Sao Paulo State (SP), Tucuruí, Pará State (PA) and Balbina in the Amazon (AM). A new addition to the list is the recent start of the construction of the Hydroelectric Plant of Jirau on the Madeira River and near the city of Porto Velho in the State of Rondônia which will have the capacity to produce 3.45 MegaWatts and will make energy cheaper for both Brazil and its neighboring countries. This Plant and the Santo Antônio plant, which is also under construction, are considered as fundamental for the supply of electric energy in Brazil from mid-2013 and onwards.

Environmental movements and the new regulations for the management of the environment have become a threat to this kind of enterprises and have created a window of opportunity for the construction of small plants, the so called Small Hydroelectric Plants.

Thermoelectric

Thermoelectric plants are industrial complexes used for the generation of energy from the energy liberated by heat, most often through the combustion of renewable or non-renewable combustibles. There are several types of thermoelectric plants but the processes for the production of energy are very similar even if they use different combustibles. Some examples are: oil plants, natural gas plans, coal plants and nuclear plants.

The Brazilian government has, since 2009, created obstacles for the construction of new thermoelectric plants using diesel and coal as combustibles and has facilitated the granting of licenses for the production of solar or wind energy. Environmental licenses for new thermoelectric plants will only be granted if they compensate for all carbon gas emissions (CO2), the main villain in global warming.

Fossil fuels

The most common types of thermoelectric plants are driven by some kind of fossil fuel such as oil, natural gas or coal burned in the combustion chamber. One of the advantages of these types of plants is their possible proximity to consumers shortening the extension of the transmission lines and minimizing losses of energy than can reach 16%.

Gas plants are the least pollutant of all thermoelectric plants and offer a higher yield, about 55%, as they use natural gas in order to feed a gas turbine. Gases also produce very high temperatures that are also used to produce water vapor that can in turn be used to propel another turbine, a vapor turbine.

Nuclear Energy

Some countries have been forced to develop and build atom-electric power plants due to increased energy demand from various sectors of society and limited hydric resources. Reactors using nuclear energy are very large and are used for the production of energy, to power and drive ships, submarines, and atom-electric plants.

The Brazilian soil holds enough uranium for the production of nuclear combustibles and is in particular rich in thorium. The country has a de facto monopoly on thorium, which can substitute uranium as a nuclear combustible. The technology for the production of a combustible from thorium still needs a lot of development but the country's thorium and uranium resources give Brazil a comfortable edge in relation to the production of nuclear combustibles on a large scale and their possible use in nuclear power plants.

The Almirante Álvaro Alberto Nuclear Plant (CNAAA) located at Praia de Itaorna, Angra dos Reis, Rio de Janeiro, was started through the Angra I project and became the first atomic-electric plant in the country. This also marked the launching of the Brazilian Nuclear Program with the ambitious aim to build and power nuclear submarines. The program has expanded and today includes Angra II (operational) and Angra III (under construction) and two new plants which will be built in the Northeast region. All three plants use pressurized water reactors.

The construction of Angra I started in 1972 and was granted an operational license by the National Nuclear Energy Commission (CNEN) in December 1984. The Plant was supplied by Westinghouse, is operated by Eletrobrás Eletronuclear, has a potency of 657 MW and produced 3.515.486 MWh during 2008.

Angra II is the product of a Brazilian-German nuclear agreement, which included technology transfer, and its construction and operation led to the development of national technologies and Brazilian control of all stages of nuclear combustible production. It has a potency of 1.350 MW and was projected by Siemens. Together, Angra I and II account for about 3% of all electric energy production in the country.

Brazilian nuclear energy enterprises also demand the empowerment of human resources for the sector.

Solar energy

The use of solar energy is connected to systems that require high temperature levels and use solar concentrators in order to catch solar rays/power that fall on a relatively large area and concentrate it in a much smaller area achieving thereby a substantial increase in temperature. The reflecting surface (mirror) of the concentrators has a parabolic or spherical form in order to allow for the reflection of solar rays onto a much smaller surface, called focus, where the material that should be warmed is placed. Parabolic high-concentration systems reach very high temperatures and efficiency levels vary between 14% and 22% of the incident solar energy and can be used for the generation of vapor and consequently, electric energy. However, the need to focus solar light on a small area demands orientation devices which is an additional cost to the system, costs that can be minimized by the construction of large scale systems.

Photovoltaic energy

The photovoltaic effect is a product of the excitation of the electrons of some materials through solar light (or other appropriate forms of energy). Silicon is one of the most effective materials, usually called solar or photovoltaic cells, for the conversion of solar radiation into electric energy. The efficiency of the conversion of solar cells is measured by the proportion of solar radiation incidence on the surface of the cell and the conversion into electric energy. The best currently available cells present an efficiency index of 25%.

Wind (Eolic) energy

The aerogenerator is a device that uses wind energy and converts it into electric energy. During 2009 the world wind energy capacity was estimated at approximately

158 gigawatts (GW), enough to supply the basic needs of two countries as large as Brazil. Wing generated energy produced 59GW in 2007 and 120GW in 2008, numbers that illustrate the magnitude of the expansion of this type of energy in the world. The majority of electrical generation production models demand extremely high investments and low maintenance costs. This is particularly true in relation to wind energy that imposes very high costs for the construction of each aerogenerator, which can reach millions of Brazilian Real, while the costs for maintenance are low and the cost of combustibles is zero.

At the end of 2009 the total capacity of Brazilian wind energy amounted to 602 MW, enough energy to supply a city with 300 thousand residences. In 2009, the 36 Brazilian eolic parks and farms were located in the Northeast region (5 states), South (3 states) and Southeast (1 state). Brazilian wind energy production represents half of the total production in South America but is only 0.38% of the world total.

The highest potential for wind energy production in Brazil is between June and December, a period with low rain incidence. Wind power is therefore a potential supplementary for energy generated by hydroelectric plants. Ten new projects were under construction during 2009 with the potential to produce 256 MW and 45 projects started construction in several states during 2010 with a total capacity to generate 2.139 MW.

Contracts were signed with 71 wind power plants in December 2009 for the delivery of approx. 1.800 megawatts (MW) from June 2012 onwards. The national focus on wind power generation gives Brazil a place in the international movement to make eolic energy a primary energy source. In fact, wind power energy has shown the highest expansion rate in relation to other available renewable energy sources and has grown by a medium of 27% per year since 1990 (GWEC,2009).

Biomass

Biomass is a source of clean energy that is used in Brazil and is credited for its contribution to the reduction of environmental pollution as it uses organic garbage, agricultural byproducts, sawdust or vegetable oil for the production of energy. Sugarcane residuals contain a high energy value and are today used in Brazil for energy production. More than 1 million individuals in Brazil work with biomass production and this energy source could come to represent 27% of Brazil's energy matrix.

The recent interest in the conversion of biomass into electricity is not only due to its potential but also to its low cost, the capacity to supply energy to indigenous

communities and its potential to benefit the environment and foment development. Biomass can represent an option for the reduction of carbon rates as it will allow us to stop using fossil combustibles. This is further supported by the fact the biomass cultivation has a small carbon footprint.

On a local level biomass cultivation may lead to reduction in soil erosion, offer the possibility to restore degraded areas and neutralize the local impacts of local carbon emissions from fossil energy production. Apart from direct and environmental benefits biomass energy systems can be beneficial in many different ways for developing countries, such as Brazil. Some of these benefits include employment for underutilized workmanship and the production of products and byproducts such as firewood.

Residuals are the main resource used in the production of biomass generated energy. The production of electric energy from wood is an emerging technology that can become very successful. However, the commercial use of plantations for the generation of energy is limited to some isolated experiments. Timber from plantations is not the way to obtain cheap energy and if world prices for coal, oil and gas remain relatively low we should not expect the creation of plantations dedicated to the supply of resources for electric energy generation or other forms of energy and it will only happen when existing subsidies and incentives for other forms of energy are no longer available.

Postgraduation and Energy Planning

The idea of postgraduation-courses in energy planning gained strength in some of the world's universities during the oil crisis of the 70's, in 1973 and 1979. Brazil reacted by launching some measures related to energy policies: (i) investments in the exploration of possible sea resources, a well succeeded policy in light of the Pre-Sal discovery; (ii) the ethanol/alcohol program, another success story in relation to the growing numbers of flexi-fueled cars and the increased consumption and production of ethanol/alcohol; (iii) the nuclear program, a questionable project due to high costs and possible environmental contamination illustrated by the fact that the second of eight reactors that were planned in 1975 , and launched in 1990, is still under construction.

Among the different efforts of the Brazilian postgraduate courses in the energy planning area, some reference centers for energy research should be highlighted, COPPE's Energy Planning Program, which includes master's and doctor's degrees, was launched in 1990 and several of its teachers also teach graduation classes at the Polytechnic School of the UFRJ. The Area of Energy was part of the Nuclear Energy

Program. After a period of consideration a proposal was accepted to split the Area of Energy and create the Energy Planning Program.

Postgraduations in Production Engineering, Transportation Engineering and, along the same lines, Energy Planning were directly associated with the area of social sciences. Since the creation of the Area of Energy teaching and research lines are structured as (i) Energy Physic Principles and Technology; (ii) Energy Economy; (iii) Energy Models and (iv) Environmental Impact. This division did not change much apart from the recruitment of new doctors and the introduction of Environmental Planning as part of the Program. Postgraduation courses in Energy Planning have provided a large number of public servants for the government such as the director of the National Water Agency; the vice-minister of Mines and Energy; the president of the Energy Research Enterprise (EPE) and of Eletrobrás; the director of FAPERJ as well as many positions in the private sector.

The University of Sao Paulo (USP) developed studies on energy at its Physics Institute since the Creation of COPPE's Interdisciplinary Energy Area and before the Nuclear Agreement with Germany. The USP did not at the time offer postgraduation courses in energy planning. The Physics Institute of the USP was later transferred to the newly expanded Electro-technical and Energy Institute (IEE). Postgraduation courses were implemented through the Inter-Unit Program for Postgraduation in Energy and the collaboration of the IEE, Polytechnic School, College of Economy and the Physics Institute of the USP. The research lines are: integrated planning of energy resources, institutional and economic analysis, renewable energy sources, energy-society and the environment.

The USP group created the Biomass Reference Center (CENBIO) in 1996 and has since then provided important contributions on bio-combustibles and ethanol in particular. The headquarters of Unicamp's energy planning group is located at the Mechanic Engineering College. Masters degrees exist since 1987 and doctorates since 1993. The lines of research are: energy supply and demand research, energy and energy policies, society and the environment.

In 1999 a postgraduation course in Energy Engineering was created by the Federal University of Itajubá (EFEI) which unified areas such as hydroelectric energy production and the rational use of energy, and thermoelectric energy production and its environmental impact. They were thereby restructured as: rational use of energy, energy planning, energy production and energy, society and the environment.

The Salvador University (UNIFACS) offers Master degrees in Energy Industry Regulation. The UNB has implemented studies in energy planning several years ago.

3.3 OCEANS

Text created from a compilation of the chapter "Sea" written by the Captain-of-Sea-and War (RM1) Paulo Renato Pimentel Nogueira (PNGP 2011-2012)

During this century Brazil must deal with a task that it cannot postpone: to incorporate the Brazilian sea with its territory and to promote the sustainable use of marine natural resources. The Brazilian sea extends far beyond the Atlantic littoral and its islands and is very rich in mineral and biological resources spread throughout an area of more than 4 million sq/km and is hereby referred to as the "Blue Amazon", a national patrimony unfamiliar to most Brazilians. Blue, in comparison to Green, not only through its dimensions and biodiversity but also due to the efforts it demands from researchers working in varied fields of science and technology in order to reach an understanding of its complexity.

This new "Amazon" challenge is the object of plans, programs and projects that have led Brazilian academic circles to focus on the ocean for the benefit of the whole society. One of the current challenges is the exploitation of the maritime area according to the provisions of the United Nations Convention on the Law of the Sea and the Brazilian Continental Shelf.

The Convention states, in relation to the preservation of the environment, that costal States have the obligation to protect and preserve the marine environment but have also the right to exploit its natural resources according to their own environmental policies and their respective duties to protect and preserve the marine environment.

It is important to note that the final deliberation of the UN's Commission on the Limits of the Continental Shelf (CLCS) allows Brazil to trace the maritime borders of the country as "Blue Amazon" which allows the country to establish a legacy of utmost importance for future generations of Brazilians, the discovery of new oil fields, the exploitation of marine biodiversity and the exploitation of mineral resources at great depths, not economically viable at present.

Oceans occupy most of the world's surface and are responsible for the weakening of seasonal extremes: evaporates water and delivers fresh water to terrestrial and marine life and is thereby a key element in the global food chain. Oceans hold 96% of the world's water supplies 86% of total water evaporation and receive 78% of all water precipitation, apart from exerting a strong influence on the climate.

We can therefore assert that oceans are a system in perpetual evolution due to their interaction with the atmosphere and a system that requires knowledge

in oceanography, a science that is essentially interdisciplinary involving: physics, mathematics, meteorology, cartography (currents, tides and climatic phenomena), biology (biodiversity and marine ecosystems), geology (composition of the sea bottom and geophysical phenomena) and chemistry (water composition and the recuperation of degraded aquatic environments or exposed to a degradation processes).

The exploitation of the oceans will continue to be of great importance for the wellbeing of humankind and will further development in several areas, including social development. The Blue Amazon can, in relation to the improvement of the population's quality of life, lead to positive effects in the social conditions of all Brazilians and in particular for the population that inhabit the extensive coastal areas of the country. The sectors that have most to gain from these positive impacts are science and the environment, sectors that must take into account the value of the exploitation of oceans for the Brazilian population.

Brazil depends enormously on sea resources and not only in relation to the fishing and tourism industries. Energy safety depends largely on the safety of offshore installations. Economic success and the capacity to succeed in the world market as a provider of commodities is conditioned to the safety, efficiency and readiness of harbors and maritime terminals. Brazilian prosperity is, in all dimensions from the purely economic to the reduction in social inequality that threatens internal peace, directly related to the capacity to protect, exploit and expand the opportunities offered by the "Blue Amazon". The following are some of the activities developed in Brazil through ocean exploitation: fishing, tourism, entertainment and marine sports, oil and natural gas, marine mineral resources, energy, maritime transportation and harbors as well as military activities.

The creation in 1974 of the Interministerial Commission for Marine Resources (CIRM) is largely responsible for the development of oceanography and implement the coordination of subjects related to the National Marine Resources Policy (PNRM) from 1984, the Admiral Paulo Nogueira Sea Research Institute (IEAPM) aimed at safeguarding and rationalizing the necessary studies, within the Brazilian Navy, for the exploitation of the oceans and national interior waters.

The National Marine Resources Policy (PNRM) is the basic tool for the research and knowledge on the exploitation of the ocean and interior waters. It establishes the principles and objectives for the creation of plans, programs and governmental actions related to human resources required for the development of research, science and marine technology as well as the exploitation and sustainable use of marine resources for socioeconomic development in Brazil.

The Inter-ministerial Commission for Marine Resources (CIRM) develops programs and marine actions that depend on the availability of human resources empowered in the above mentioned areas and in particular:

- Program for the Assessment of the Mineral Potential of the Continental Shelf (REMPLAC) aimed at realizing a geological-geophysical survey and analysis, and an assessment of the mineral deposits, of the Blue Amazon Continental Shelf;
- Program for the Assessment of the Sustainable Potential and Monitoring of Marine Life Resources (REVIMAR) for the systematical assessment and monitoring of the sustainable potential of life stocks in waters under Brazilian jurisdiction;
- The São Paulo and São Pedro Archipelago Program (PROARQUIPÉLAGO) aimed at safeguarding the permanent human habitat on the archipelago and undertake research related to the exploitation, preservation and management of local natural resources;
- The Global Ocean Observation System (GOSS/Brazil) aimed at the implementation, broadening and consolidation of an operational information system on oceans, climate and meteorology and composed by network observations that serve as the basis for the production of knowledge and products that can allow for oceanographic and meteorological previsions within maritime areas of national interest, and assist in decision making processes on the effective exploitation of marine resources and collaborate in the prevision and mitigation of extreme natural phenomena that may affect the Brazilian coastal population and economy;
- Program for the Survey and Assessment of the Biotechnological Potential of Marine Biodiversity (BIOMAR) aimed at the development of knowledge, the incorporation of technologies and the promotion of innovative products, services and processes for the sustainable exploitation of the biotechnological potential of marine organisms of coastal and transitional areas as well as other marine areas of interest and under Brazilian jurisdiction, while safeguarding the protection of the biological diversity, the sustainable exploitation of ecosystems and the just and balanced division of the benefits collected from the exploitation of genetic resources;
- The Executive Committee for the Consolidation and Broadening of Marine Science Research and Postgraduation Activities (PPG-MAR), with the objective to support, consolidate and evaluate the empowerment of personnel in Marine

Sciences through the implementation of graduation and postgraduation courses and thereby create a basis for the development of Marine science in Brazil; and

– Antarctic Program (PROANTAR) whose objective is the promotion of research on the Antarctic environment.

We must also note the role of the Admiral Paulo Moreira Marine Research Institute and its assessment of the main aspects of the influence of the sea on the Brazilian territory, covering knowledge related to basic and applied research and an active participant in the fields of oceanography, meteorology, hydrography, geology and marine geophysics. The Institute is also an important contributor to the development of human resources in the above named areas.

The Blue Amazon Management System (SisGAAz), a structuring program/project that groups activities linked to oceans and focuses on vigilance, safety, natural resource management, pollution prevention and control and reaction in hazardous situations, integrated and coordinated by the Navy, as a Maritime Authority and in great need of a specific empowerment program and the development of technical and operational personnel for its subsystems (electronics, system analysis, telecommunications, aerospace engineering). These subsystems will monitor and control the waters of particular interest to Brazil and will uphold their safety, protection and defense during peacetime, and will are empowered to effectuate the continuous monitoring, detection, identification and assessment of the maritime environment through integration, fusion, analysis and dissemination of relevant information in the fastest possible way. It also possesses the flexibility to interact with Navy governmental organs.

Concerning the importance of marine scientific research for the broadening of our knowledge on the potentials offered by oceans:

– satellite supplied data can be used for large scales but is only an inadequate substitute for geological maps, mineral identification, habitat characterization and fishing management;
– the water column shows, in particular within its intermediary layer, the existence of new organisms detected through new technologies that have revolutionized our knowledge of the subject and scientist have already started to explore the secrets of the carbon cycle in the seas;
– the discovery of hot hydrothermal springs that are home to a fauna that lives in a poisonous environment has already allowed the marine scientific community to verify the existence of sulfuric oxidant bacteria that are the

basis of the ecosystem's food chain, a study that can lead to the discovery of revolutionary drugs; and

– the production of bioactive substances by marine organisms offers great potential for the production of antibiotics, anti-cancer substances and enzymes.

Knowledge on marine biodiversity, fishing stocks and the workings of ecosystems from where they originate are the basis for the sustainable exploitation of marine resources.

Challenges

The sustainable use of the oceans is conditioned to upholding their integrity and the health of marine ecosystems. In the same manner that public health is conditioned to food safety. Social and economic benefits, including cultural values, are conditioned to the rational use of the oceans. The majority of pollutants that affect the marine environment originate on land and are caused by human interference. It is widely known that oceans are used as if they were great deposits for the residuals produced by mankind.

It is estimated that 80% of the pollution affecting oceans is caused by land based non-sustainable human activities, such as industrial emissions and domestic sewages. The above mentioned emissions include the residuals of soil fertilization practices in agriculture which are led into the oceans by rivers and rainfall. Only 12% of the total marine pollution is caused by residual dumping from ships and oil platforms.

The Convention on the Law of the Seas constitutes a new multilateral tool for ocean management and marine pollution management. We underline that "States have the obligation to protect and preserve the marine environment", and "States should cooperate on a global basis and, when appropriate, on a regional basis, directly or through the intervention of competent international organizations, for the formulation and creation of rules, norms and practices and follow recommended procedures of an international character and compatible with the Convention, for the protection and preservation of the marine environment, taking into account the characteristics of each region".

Government guidelines on marine pollution have changed through the introduction of the concept of sustainability: the environment and its resources must be managed in order to allow for its continuity without loss for coming generations. The relationship between development and the environment is acknowledged

This should become the object of debate within academic circles, research centers of excellence, industrial and trade federations and by other sectors directly involved in socio-technological and socio-economic development as well as by the urban population located in coastal areas. In fact, by all that will benefit from and use the newly acquired knowledge achieved through oceanographic and marine research.

It is necessary to highlight that new available technology and models for oceanographic and marine research do not ignore the need to collect data "*in situ*" in order to achieve the calibration, result verification and a deepening of the knowledge on sea and ocean phenomena. Ships have to be used in order to obtain the necessary data on location and they can therefore be considered as the most important tool for oceanographic research.

Today Brazil possesses a fleet that is significantly bigger than 10 years ago. The partnership between the Brazilian Navy and the Ministry of Science and Technology (MCT) has allowed for the broadening of the Brazilian research fleet and increased it with one Polar Ship, the "Admiral Maximiano", an Oceanographic Research Ship, the "Cruzeiro do Sul" and the "Aspirant Moura", an Aviso Class ship for Oceanographic Research, all acquired by the Navy and the Ministry of Science and Technology through its Study and Research Financing Agency (FINEP). The above organs and institutions have, as many other, made large contributions for research undertaken by the Brazilian scientific community through agreements between universities and the Navy aimed at the development, exploitation and research of marine resources and phenomena.

The Brazilian research fleet is still under-dimensioned if we take into account the extension of the Brazilian coastline and this is an obstacle for compliance with the CNUDM and the development of the Brazilian Territorial Sea. Governmental and private parties involved in sea research must unite and share the financial burden and acquire, operate and maintain a fleet that corresponds to the size of the country.

It is necessary to undertake the strategic planning of the transportation matrix which can maximize the maritime potential and minimize costs. Actions are needed in order to improve the maritime transportation of cargo and passengers, sea tourism and leisure, the use of islands and rocks and to face and develop the competitive capacity to exploit fishing and food resources. Maritime transportation and exploitation must be prioritized in a country with a coast line totaling circa 8.500 km and a large river network of 55.000 km. The leisure sector is also of great importance for the development of Brazil. Cultural diversity is also an important and attractive factor for the development of marine tourism.

Brazil has currently 16 harbors with good operational capacity but they are all in need of modernizations in order to maximize their transportation potential. The number of jobs created in order to achieve growth is also a determining factor for the reduction of poverty. A large number of jobs can be created through the expansion of the naval industry, an increase in maritime transportation, increased inspection and control measures, the development of the spare parts industry and increased demand for harbor personnel.

All of the above mentioned benefits are conditioned to not only financial investment but also technological development. An example is the renewal of the Brazilian naval industry, stagnated since 1996, and the question of the technological gap; while Brazilian shipyards project construction plans for big ships that amount to 24 to 30 months, their competitors, largely Asian, deliver the same type of embarkations in 8 to 10 months. Investments in modernization, technology and personnel empowerment are market demands that must be addressed in order to increase the competitiveness of Brazilian shipyards.

3.4 FOOD SAFETY AND SUSTAINABLE AGRICULTURE

Text created from a compilation of the chapter "Agrarian Sciences" written by Ph.D. Evaldo Ferreira Vilela, Ph.D. Alberto Duque Portugal and Ph.D José Oswaldo Siqueira (PNPG 2011-2020)

The population of the planet is approaching 9 billion and more and more people enjoy improved income and consumption standards. The production of food must be increased by at least 50% and 70% of that growth must be achieved through increased production efficiency and the preservation of harvests which, due to the limited availability of farmlands, water, nutrients and energy do not offer the proper conditions for expansion. During the coming decades we must achieve radical changes to the ways we feed ourselves, consume, produce, transform and commercialize food products in order to address the challenges that face food production, the sustainability of the chains of production and food safety which affects more than 1 billion people.

Production systems that are inefficient or heavily dependent on manufactured input and require intensive limited natural resources must undergo radical and innovative changes. A blatant example is the availability of meat, the main source of proteins in human food, which can be complemented by agricultural protein-rich

products or substituted by insect proteins, such as grasshoppers, that can be produced more efficiently.

Another aspect worth mentioning is that even though we possess the technology to feed the world, the lack of land and other natural resources and the damages inflicted upon ecosystems and ecological services through high carbon emissions compromises the sustainability of current animal and vegetal production systems. Brazil has, in spite of previsions that the next 50 years represent the last phase of world agricultural expansion, a privileged position in this dark scenario due to the extension of its territory, the abundance of water resources and a climate that allows for diversified production. Brazil is therefore an important partner in the global agro-trade and is currently the third largest producer and exporter in the world, a position that not only represents great opportunities but also a series of challenges and responsibilities.

Brazilian research in the areas of agriculture and livestock has led to major technological improvements and innovations on production in tropical climates which, coupled with its competitive advantages, made the country a leader in tropical agriculture.

We need to continue to develop this science through the incorporation of vanguard know-how in Biology, Computation, Information Technology and Engineering and through the improvement and precision of animal and agro genetics, confinement techniques and in the quality of products that are made available to society. There is an increasing need for new research programs and the empowerment of synchronized human resources, such as:

- increase of harvest productivity;
- geographical expansion and the use of marginal areas;
- effective input and use of natural resources;
- exploitation of the most sustainable systems;
- product aggregation value; and
- supply regularization.

Technologies and agricultural practices need to be renewed and based on demand and requirement dynamics. We need to develop and uphold scientific research as the fundamental input for improved agricultural and livestock businesses. Postgraduation practices have the responsibility to address the future requirements of the Brazilian agro-industrial sector for intellectual and technological contributions the safeguarding of food safety, exports, technological independence and the transformation of current agrarian-extracting practices into an agrarian-exporting economy that is efficient and

capable of harmonizing the inherent conflict between the business of agriculture and environmental protection.

Food Safety[1]

Food and nutritional safety has been a central subject in Brazil during the last years and has been directly associated to technological innovation.

According to the Ministry of Social Development and Fight against Hunger (MDS) access to appropriate food is a fundamental human right acknowledged by the Federal Constitution. The Organic Food and Nutritional Safety LAW (Losan) specifies that it is the duty of the public powers to safeguard and foment the institutionalization of a food and nutrition policy. Actions undertaken by the MDS aim at providing citizens subjected to unsafe food and nutrition practices with access to qualitative and quantitative food and water through the implementation of structural emergency initiatives and programs and projects to assist in the production, distribution and consumption of adequate food. The National Council on Food and Nutritional Safety (Consea) is responsible for the future monitoring system that will lead to the progressive fulfillment of the Human Right to Appropriate Food in a national food and nutritional context, through the activities of its executive professional group and indicator monitoring through the application of food and nutritional safety indicators:

- Food production;
- food availability;
- Income/access and food costs;
- access to appropriate food;
- health and access to health services; and
- education.

The cause of unsafe food and nutritional consumption is the lack of income and not the lack of production, which is sufficient to feed the entire planet.

The current state of global food and nutritional safety is characterized by high food prices due to commodity speculation financial practices and climate change. The growing demand for food by developing countries not only contributes to increased food prices but is also proof of the success of inclusion policies in these countries and creates long term opportunities for food production and the safeguarding of benefits created by increased employment and income.

[1] Compiled from the MDS site and the Document on the Brazilian Contribution to the Rio+20 Conference.

The consolidation of the right to food is a priority for the Brazilian State. This objective demands the integration of inter-sectorial public policies and actions that spread from food production, including the valorization of the family agriculture sector, to food consumption. The integration of policies will allow us to face the challenges presented by environmental preservation, adaptation to climate change and to strive for the prevalence of social justice.

From an international viewpoint the Brazilian strategy for food and nutritional safety is two-dimensional: structural and humanitarian. Structurally, through the promotion of food and nutritional safety models that have been successfully adopted by socioeconomic programs in Brazil (agrarian reform, rural development, loans, infrastructure, technical assistance, insurance, storage, low-pricing policies, commercialization and, among other, agro-ecological matrixes) through the inclusion of social participation in their formulation, execution, monitoring and assessment. And humanitarian as Brazil has the ambition to contribute to the food and nutritional safety of the populations of other countries through food donations that are formally requested and acknowledged by the recipient State.

Sustainable Agriculture[2]

One of the current peculiarities of Brazilian agriculture is the increased demand for multifunctionality and pluriactivity placed on the new rural regions of Brazil. These demands have intensified the interface between the rural and urban worlds and have led to increased interdependency between the primary, secondary and tertiary sectors. It is important to note, in this context, the importance of family agriculture and governmental assistance programs.

Family agriculture uses production practices that are more balanced, such as the diversification of farming products, require less industrial input and promote the sustainability of genetic resources and agroecology. The environmental adaptation of family farming is a practical example of sustainable development that is economically viable, socially just and culturally suitable.

Family farming in the majority of developing countries is responsible for a large portion of agricultural production and employment in rural areas. In Brazil it consists of small and medium producers and represents a large majority of rural producers, in particular in the Northeast region where 50% of the 4.5 million existing family farms

[2] Compiled from the Document on the Brazilian Contribution to the Rio+20 Conference and the CAPES Document that Created Environmental Sciences

are located. The family farming sector occupies 20% of the land and answers for 30% of global production. The rate reaches 60% if we only take into account some of the basic products in the Brazilian diet such as beans, rice, corn, vegetables, cassava and small sized animals. Family farmers have often a low level of education and diversify production in order to diminish costs, increase income and make the most of available workmanship and environmental opportunities (EMBRAPA, 2004).

The Government currently supports a program linked to the Ministry of Agriculture – National Program for the Development of Family Farming (PONAF) which provides budget resources to municipalities earmarked for rural municipal development plans. The provision of resources is conditioned to the participation of family farmers, as a majority, in the rural development commission. PRONAF provides investments for the implantation, broadening, modernization, rationalization and relocation of infrastructure needed for the strengthening of Family Farming and for the improvement and broadening of support services including agro-livestock research, professional assistance and rural extension. The program has contributed to the creation of an institutional climate that favors rural development (ABRAMOVAY & VEIGA, 1999).

It is also important to highlight contributions made by the subject of agroecology as a field of knowledge under construction and of interdisciplinary and systemic character whose initiatives in the realm of education, research and extension sciences have become more and more relevant for universities which include agroecology in various technical level courses, graduation and postgraduation practices as well as in research and extension Institutions. The number of interdisciplinary courses has grown steadily.

It is also important to continue to invest in agro-livestock research and to provide assistance and incentives to producers that adopt technologies that increase productivity and sustainability and thereby safeguard food and nutritional safety, mitigate the effects of emissions, increase productivity in the agro-livestock sector, reduce production costs, improve the efficiency of the use of natural resources and in particular water, increase the resilience of productive systems, the sustainable development of rural communities and adapt the agro-livestock sector to climate change. It is also particularly important to continuously renew international cooperation and international investments in rural development and the spreading of technologies and meteorological data that is relevant for tropical agricultural practices.

Efforts in rural areas must focus on sustainable production, the strengthening of food safety, creation of jobs and income, respect biodiversity and mitigate the carbon emissions derived from other agricultural and livestock production. The production

of food and fibers can be achieved in various scales and can withstand sustainable production systems based on low carbon emission agriculture, the recuperation of degraded pastures, organic agriculture and the plantation of forests in order to increase the productivity and the preservation of natural forests. This must become part of the different productive processes and involve both large and the small rural producers.

The State must therefore use a group of policies that focus beyond agricultural production and create tools that safeguard the income of farmers and family production units.

3.5 SUSTAINABLE CITIES

Text divided in two parts: the first written by Prof. Dr. Benamy Turkienicz (UFRGS). The second part is the result of Capes International Seminar "Brazilian Metropolization and the Challenge of Urban Management: the role of postgraduation".

Part 1

The population of Brazil has, since the end of World War II, frequently changed its territorial distribution: a population that was predominantly rural is today highly urban. Data collected for IBGE's Demographic Census show that in 1950 Brazil had a population of 18.782.891 inhabitants and the urbanization rate was 36.1. %. In 1970 the urbanization rate increased to 55.9%. During a period of fifty years (1950 to 2000), the urban population increased by 633.4% and reached 137.755.550 million inhabitants, corresponding to an urbanization rate of 81.2%. In 2010 urban population represented 84.3% of the total and grew by 3.8% in a single decade, half of the increase registered during the previous decade (1990 to 2000). The vertiginous increase in urbanization rates and in particular during the 60's and 90's (about 10% per decade) has left in its tracks a passive attitude towards urban mobility, housing and basic sanitation .

Most Brazilian metropolitan regions experienced an intense period of industrial expansion, parallel to demographical changes, which in turn led to a significant increase in the demand for urbanized land. Brazil is today composed of 40 metropolitan regions and 20 of them, mostly located in the Southeast, are home to 88.6% of the country's urban population. Nine cities, including Sao Paulo, are responsible for 25% of the Brazilian GDP. The contribution of cities to the Brazilian GDP is not directly related to their number of inhabitants. In other words, cities situated in metropolitan regions produce more

with fewer inhabitants than cities located outside of the regions. Approximately 90% of Brazilian Universities are located in metropolitan regions, making them natural vortexes for the empowerment of human resources and technological innovation. Brazilian cities located in metropolitan regions often possess a stock of tangible assets (private and institutional hardware) that is proportionally higher than that of cities outside of these regions.

The competitive advantages of metropolitan cities have created several types of problems associated to the so called economy of scale: traffic congestions, pollution, social segregation and high criminality rates Until the implementation of the Program My House My life the salaries offered by employers in metropolitan regions were not enough to allow for the acquisition of housing plots and the construction of houses through the formal job market. This forced a large number of the population of these regions to occupy allotted plots clandestinely, illegally or invade public and private areas. This in turn led to doubled prejudicial consequences: on one hand, it substantially decreased the quality of life of urban populations and increased the costs for infrastructure in sanitation and mobility due to dysfunctions created by unplanned land occupation and; on the other hand, it increased the production effectiveness of these regions which in turn led to increased traffic congestions, pollution, criminality and social segregation as well as leading to a lack of land for industrial development, increasing the distances between farming areas and consuming markets and the costs for land used for different productive activities.

The advantages of scale, specialization and complementarity of economic activities within Brazilian metropolitan cities, have been compromised by the inefficiency of urban infrastructures that led to the reduction of competitiveness in the global market. The advantages of the so called "agglomeration economies" were partially neutralized by social and environmental disadvantages created during the stage characterized by the rapid demographic growth of Brazilian metropolitan areas.

The production of products within Brazilian metropolitan areas is more costly and more damaging to the environment than the production of similar products in metropolitan areas of developed countries. In Brazil, the competitive advantages created through agglomeration have a tendency to fall due to the lack of growth strategies that forward environmental quality and production cost rationalization. The last two decades have not shown any relevant improvement in the relation between urban land occupations and environmental quality: the sewage network has only grown by 13% between 1991 and 2009 and sewage treatment increased from 45.5% to 58.8%.

During the same period there has been no change to the amount of sewages that are dumped into rivers, streams or the sea which stabilized at 2%. Research provided by Marcos Cintra[3] (FGV/SP) has shown that the costs related to traffic congestions in the city of Sao Paulo (12% of Brazil's GDP) have reached 26.5 billion Brazil Real (cost of opportunity measured through the value of the loss of work time) while the accountable costs caused by the consumption of combustibles by cars and buses and the impact of pollutants and accidents on the health of the population, measured through the comparison between flowing and congested traffic reach almost 7 billion Brazil Real, raising the total costs to 33.5 billion/year with represents 10% of the municipal GDP. Recently collected data shows that Sao Paulo is not an isolated case. Most metropolitan areas are characterized by rising costs, both in opportunity and accounting costs. Research has therefore pointed to the fact that the characteristics of Brazilian metropolitan areas are in the contraflow of economic development.

In face of the deficiencies concentrated in Brazilian metropolitan areas it is a paradox that the majority of potential human resources is also concentrated within metropolitan areas, unless they are public employees or working in the development of technologies that lead to effective and sustainable urban environments. Such technologies, part of the so called "green economy, can lead to the reduction of transportation, sanitation and energy costs related to the construction and use of city buildings. South Korea has, during the last decade, provided a clear example of the use of this potential through significant resource investments in cities, depollution of rivers and improvements in transportation systems problem solving aimed at the reduction of energy costs in buildings and houses.

The Presidency of the Republic has, through the Terms of Reference (2010) for the tendering of consulting services for the study "Sustainable Cities", acknowledged that: The absence of an active national policy for territorial planning has led subnational states, striving to safeguard their depressed economies, to implement a series of policies and programs aimed at attracting productive enterprises and strengthen the dynamics of their economies and create the right conditions for the generation of jobs without any attention to territorial planning or environmental sustainability. This has led Brazil to become a concentrated country with unbalanced production and urbanization and in need of a long term vision that strives to build a low carbon nation that is polycentric – with integrated and standardized practices for economic, social, urban and cultural production.[4] The scope of the acknowledgement and the products demanded by the

[3] Cintra, M. The economic cost of traffic congestions in "Opinião" EFC (editorial), Sao Paulo, Aug. 15, 2008.
[4] Editorial PNUD 029/2010 Project BRA/=&/=#" PR-SAE, 2010

Terms of Reference for the study show us how much the State is aware of the fact that policies must be implemented in order to promote the sustainability of Brazilian cities. We cannot however say that Brazilian Postgraduation practices are in par with the State's initial stage of action.

Brazilian investments in scientific and technological education have increased substantially during the past ten years – 5.000 doctorates in the year 2000; over 10.000 in 2008 and more than 13.000 in 2011. 17.500 master's degrees in the year 2000 compared to about 45.000 masters degrees in 2011 (including professional masters).

Brazil has today a good supply of postgraduation research on urban subjects. Annals of the main events of Research and Postgraduation Associations such as Anpur[5], Anpocs[6], Anpet[7], Anparq[8] and Anpege[9] are important scientific references in respect to different urban subjects (infrastructure, violence, social segregation, mobility, housing, and among other sanitation and management) and are a reflection of knowledge developed through postgraduation practices in Brazil. Institutions and non-governmental organizations such as Metropolis Observation[10], IBAM[11] and Polis[12] represent permanent resources for the improvement of knowledge on the performance of Brazilian cities. Furthermore, there are several research groups and networks focused on the production of knowledge and assistance for municipal, state and federal urban planning organs. The Brazilian knowledge bank created through research is quite impressive. A search of the word "city" in CNPq's Research Group Directory[13] resulted in 660 research groups, the term "urban planning" in 343 research groups and the word "urbanism" in 242 research groups led by individuals linked to 36 areas of knowledge[14] in particular Architecture and Urbanism, Urban and Regional Planning, Sociology, Geography, Civil Engineering and Law.

Recently, the well renowned global enterprise Siemens [15] (smart grids) and IBM[16] (public safety, transportation, infrastructure and energy), opened research labs in Brazil focused on models and solutions for different urban problems through partnerships with Brazilian universities and startups. The quality of human resources produced by higher

[5] www.anpur.or.br
[6] www.anpocs.org.br
[7] www.anpet.org.br
[8] www.anparq.org.br
[9] www.anpege.org.br
[10] www.observatoriodasmetropoles.net/
[11] www.ibam.org.br
[12] www.polis.org.br
[13] http://dgp.cnpq.br/buscaoperacional/
[14] Administration, Agronomy, Anthropology, Archeology, Arts, Botany, Computer Science, Political Science, Demographics, Economy, Education, Physical Education, Material and Metallurgical Engineering, Mechanics Engineering, Production Engineering, Sanitary Engineering, Philosophy/Theology, Geoscience, History, Literature/Linguistics, Medicine, Mathematics, Museology, Oceanography, Urban and Regional Planning, Psychology, Chemistry, Forest Resources and Forest Engineering, Collective Health/Parasitology, Social Services and Tourism.
[15] www.siemens.com
[16] www-03.ibm.com/press/us/en/pressrelease/35944.wss

education in Brazil was undoubtedly an important fact during the decision process by these two mega enterprises that led to the opening of laboratories in Brazil.

Jorge Guimarães, President of Capes[17] stated during the opening of the seminar "The Metropolitan Challenge and Postgraduation": "(…) 10, 15 years ago, definitely more than 15 years ago we did not have a critical mass of empowered individuals that could address the challenges facing Brazil. (…) Even though we have reached the end of 2010 with more than 12.000 new doctorates we still have a deficit in the number of empowered individuals in certain areas and we need to develop different ways to deal with relevant matters, in particular in relation to public State policies, and to initiate the induction of projects and subjects and incorporate postgraduation into the inductive process (…)". Guimarães also stated that cities and metropolitan areas should be one of the primary objectives of induction practices as the problems facing Brazilian metropolitan areas must be addressed through specific strategies in human resource empowerment.

The Presidency of the Republic shares the views of the Capes President. In 2010 a document released by the SAE-PR[18] , Brazil 2022, stated that (…) it is of strategic importance to address the subject of Brazilian cities as an integral matter that includes housing, environmental sanitation and mobility in urban sectors . Two of the four actions included in Goal 1, "Broadening of tools for urban planning and management and tools for social control", of the document Brazil 2022 are directly related to educational initiatives and the empowerment of human resources that can be responsible for territorial planning and for the infrastructures needed to sustain cities:

- Create, through legislation, the Inter-Federal School of Municipal Management in order to empower managers to implement management tools.
- Increase the technical and institutional capacity in urban planning, urban and territorial management and in the rendering of services to all municipalities and states.

Both of the above strategic actions demand the crucial definition of human resources that will lead the empowerment actions. The options for municipal management can be met through graduation courses in administration. The options for urban planning and territorial management are not as easy to identify. Brazil needs to increase the offer of graduation courses in urban and territorial planning and in urbanization. There has been an increase of research activities in the area of Architecture and Urbanism but the number of Postgraduation programs continues to be under-

[17] Seminar " The Metropolitan Challenges and Postgraduation", Capes, Brasilia, June 9, 2010 (Transcription)
[18] Cities – Brazil 2022: Preparative Work/Secretariat for Strategic Subjects – Brasilia: Presidency of the Republic, Secretariat for Strategic Subjects – SAE, 2010. www.sae.gov.br

dimensioned in relation to the rates of expansion of postgraduation courses in general. In 2010 Brazil offered 215 graduation courses in Architecture and Urbanism enrolling 64.876 students and only 20 postgraduation courses and 1.381 enrolled students. Only one third of the current 30 Programs in the area of Urban Planning focus on urban subjects, the other focus on regional development.

Graduation courses in Architecture and Urbanism are the only courses that focus specifically on urban subjects and professional activities in the area. However, only 15% of the subject matter is dedicated to urban problems. The curricular organization of the graduation courses in Architecture and Urbanism, linked to Municipal Prefectures, does not offer sufficient empowerment capacities in order to address matters related to city management such as: measurement of environmental aptitudes and suitability for urban development. Graduates are not suitably empowered to use environment related analytical methods assisted by technologies such as geo-processing and performance models that allow for a quick and reliable assessment of the probable behavior of urban soil and respective edifications, the impact of rain, illumination, thermic comfort, energy consumption, traffic and noise pollution even if they have been requested to do it by the CREA-CONFEA system. Students must therefore learn, through practical practices, to deal with urbane diagnostics and with the concepts of methodologies for the use of diagnostics in urban programs and projects.

Postgraduation Programs in Architecture and Urbanism and Urban and Regional Planning are seen as important contributions for the empowerment in the areas of urban and territory planning and urbanism. However, they do not have a sufficient number of teachers and cannot address the demand for empowerment programs in 5.564 municipalities. Investments in two of the main areas responsible for the empowerment of human resources for the improvement of living spaces in cities and metropolitan areas – Architecture and Urbanism and Urban and Regional Planning – can become a strategic element for the country starting from environmental safety to the planning of factors for increased economic competitiveness. The recent natural disasters in Brazil between 2009 and 2011 illustrate the lack of human resource empowerment for professionals at the service of the public sector, resources that can prevent damages caused by inadequate soil usage. The picture becomes even darker if we take into account that the total demand for planners and managers by small, medium and large Brazilian municipalities implies that a minimum of 20.000 professionals need to be specifically empowered in the area of urban management and planning.

Challenges and perspectives

The solution for current human resource deficits in Brazilian municipalities cannot, in the short term, only depend on changes to the curricular content of existing graduation courses but must also address the empowerment of masters and doctors through Programs in Architecture and Urbanism and Urban and Regional Planning. We cannot envision a short term increase in knowledge related to the management, urban planning and urbanism through graduation courses alone. Brazil does not either possess institutional structures that can empower municipal technicians to use management tools and implement urban planning methodologies in urban projects. In order to reach Goal 1 of Brazil 2022 we need to create institutional strategies that have the capacity to organize postgraduation programs in Brazil which will in turn develop urban research and identify, through the respective research groups, which knowledge matrixes are needed for the solution of problems related to mobility and urban accessibility, sanitation, housing, violence and social inclusion, municipal management and governance.

Qualified interventions related to territorial problems in Brazilian cities must also include the use of social and technological variables and the subsequent empowerment of human resources in order to identify, analyze provide diagnostics and solve urban problems.

For Guimarães[19], "(…) Brazil has, during the past decades, demonstrated its competitive potential in the areas of renewable energy, aeronautics, banking automation and the exploitation of oil from deep waters. However, the commercial balance of the diverse industrial sectors has lost competitiveness year after year and this represents a challenge that must be addressed during the coming years." We must acknowledge the importance of Brazilian cities as the main economic motor; the quality of urban space as one of the main development indicators which will lead to changes in the approach of current urban policies for urban spaces. The current focus is on the reduction of poverty and social inequalities through salary increases and the improvement of the rates of access to healthcare, education and housing[20].

The current Brazilian model for urban development does not integrally use the human resources developed through Postgraduation practices. If well used, these human resources can produce Scientific knowledge and Technologies that can

[19] Guimarães, J A Ciência, Report on Thecnology and Innovation for a Competitive Brazil, Sao Paulo, SBPC 2011

[20] Investments by the Program for Accelerated Development (PAC) between 2007 and 2010 in the areas of housing and sanitation reached 96 billion Brazil Real , total of federal, state and municipal investments. PAC investments aimed at providing 7 million families with water supplies, 7.3 million families with sewage systems and 3.96 million families with improved housing conditions and build 1 million houses in cities with more than 100 thousand inhabitants located in metropolitan or capital areas.

improve the health and productiveness of urban populations. Their professional input can contribute to transform urban areas into assets for the development of national riches and safeguard environmental quality. Brazil can become, if it follows in the above direction, in both short and long terms, an exporter of advanced environmental technologies as it does with renewable energy, aeronautics, banking automation and the exploitation of oil from deep waters.

Unfortunately, Brazil's conception and administration of investments in Science and Technology is highly "a-spatial". In other words, it does not believe that there is a correlation between Science and Technological advances and the places inhabited by researchers. The recent National Post Graduation Plan, PNPG 2011-2022[21] does not include urban planning and architecture as development factors for Brazilian economic, scientific and technological development. A recent SBPC[22] document dedicated to the improvement of Brazilian global competitiveness does not mention the spatial qualities of Brazilian cities as a competitiveness factor. In respect to Science and Technology education and infrastructure the document includes a whole chapter on scientific and technological centers[23] but does not mention the relationship between these centers and the quality of the urban environment where they are usually located. The great majority of the centers are located in cities.

The link between Technological Centers (or Knowledge Centers) and universities and other scientific and technological centers is conditioned to both the use of information technology for fast communications and actual personal communication. An increasing number of scientists have chosen to establish their work locations in cities where they can enjoy their cultural riches and technological benefits offered through digital networks but also urban social interaction spaces such as bars, restaurants and public leisure public locations. Many cities are currently transforming themselves into spaces that offer infrastructures that further the so called knowledge economy. Barcelona and Lyon are clear examples of this trend. If Brazil does not care for the urban spaces within their cities, and metropolitan areas in particular, they will not be able to attract scientists which will result a decrease in the country's scientific and technological global competitiveness.

Part 2

[21] National Postgraduation Plan – PNPG 2011/2020/Coordination of High Level Personnel – Brasilia, Federal District: CAPES, 2010.
[22] Science, Technology and Innovation For a Competitive Brazil/Brazilian Society for the Advancement of Science – Sao Paulo: SBPC, 2011.
[23] By Miranda, P C G and Bevilacqua, AF. "Parques científicos e tecnológicos" in op. cit , chapter 6.

[19] Guimarães, J A Ciência , Apresentação in Tecnologia e Inovação para um Brasil Competitivo , São Paulo, SBPC 2011

Results from the International Seminar "Brazilian Metropolization and the Challenges facing Urban Development: the role of Postgraduation"

The International Seminar "*Brazilian Metropolization and the Challenges facing Urban Development: the role of Postgraduation*" was held from May 7 to 9 at CAPES. The main purpose was to stimulate debate on subjects related to urban management and the respective challenges facing Brazilian society as well as propose measures for the next decade. The panels were organized by the coordinators of the following CAPES assessment areas: Geography; Environmental Sciences; Architecture; Urbanism and Design; Engineering; Sociology; Regional and Urban Planning and Demography.

The event attracted the presence of 300 participants and included national and international lectures that were monitored by journalists specialized in the respective areas. The results of the seminar were synthesized according to principles, subjects and suggestions for lines of action,

Interdisciplinary work must be at the base of all lines of action and proposals that aim for academic structuralism through subject areas and according to the following principles:

- Communication between the geographic scales, considering the discrepancies between change and permanence that allow for the valorization of relations between the multiple dimensions of urbanization and urban life - social, economic, political, cultural and among other environmental, in order to observe processes (structures and agents).
- The acknowledgment of trends that show an internationalization of economic, cultural and social life without losing the focus to understand the particularities of socio-spatial interaction and the singularities of regions and localities.
- Academic research that is closely related to social phenomena and the definition of public policies that will use clear and applicable research in order to reach results, include decision-makers and service users and focus on environmental sustainability and social inclusion.
- Relevant research that allows for a better understanding of the adaptive capacity (resilience) of people and the development of risk-assessment techniques to prevent environmental catastrophes which must be seen by researchers and public managers as essential in order to prevent environmental disasters and their potential to annihilate social conquests through the loss of national patrimony and with negative effects for the living conditions of the population.

- Improvements in the environmental sustainability of urban areas which must also be a basic directive for research in human-environment interaction and uphold the principle that basic sanitation must be addressed as a public health issue.
- International urban development advances must be studied prior to the structuring and implementation of human resource empowerment programs focusing on the planning and management for increasingly sustainable urban areas.
- Acknowledge cities as a public patrimony, collectively constructed and a collective right, and safeguard the social redistribution of urban riches.
- Acknowledge that metropolitan governance is a political question and not a governance model. Institutional reform is required in order to transform the organization of the system of actors and establish or uphold a metropolitan force that favors good governance.

The subjects and action lines proposed during the above mentioned Seminar are detailed in Chapter 6, item 6.5.

3.6 EMPLOYMENT: A GREEN ECONOMY AND SOCIAL INCLUSSION

Text created through the compilation of the following chapters: "Regional Unbalances" written by Prof. Dr. Luis Antonio Barretto de Castro (MCT); "Social Development" written by Prof. Dr. Emmanuel Zagury Tourinho (UFPA); "Demography" written by Prof. Dr. José Alberto Magno de Carvalho and Prof. Dr. Laura L. Rodriguez Wong (UFMG); and "Technological Development and Innovation" written by Prof. Dr. Evando Mirra de Paula e Silva (UFMG/CGEE), all included at PNPG 2011-2020.

A green economy can be regarded as a form of economy that seeks to improve human wellbeing and social equality and simultaneously reduce environmental risks or, in other terms, it strives for low carbon emissions, increased efficiency of resource exploitation and social inclusion (UNEP, 2012). The idea of a green economy puts into question current production models and human living practices and is far from being an idea that is widely accepted by social actors.

If a green economy is understood as a concept that leads to the creation of a society that is socio-environmentally sustainable we must also promote the creation of

professional cadres that can use and associate technological know-how and humanism while taking into account the particularities of the country. The creation of this type of society, in a just, egalitarian and solidaritarian manner implies the conservation of natural capital stocks through the application of technological capital thereby reducing their current and long term depletion. (ZUIN, 2011).

The relationship between the critical mass of S&T and the regional GDP can has also been observed in different Brazilian locations. According to CNPq's 2012 database, in the year 2000 57% of Brazilian researchers were located in the Southeast region and the GDP of this region is in the order of 57.8% of the national GDP. If we add the same critical mass for the North, Northeast and Center-West regions we arrive at 23% of the national rate. The added GDP of the three regions was about 24% of the national GDP during the same period. All other researched and measured regions have shown a direct correlation between the critical mass of R&D and their respective regional GDP.

Brazil has adopted some policies in order to mitigate the above mentioned regional unbalances both through the empowerment of human resources and through direct investments in the North, Northeast and Center-West regions. The promotion and development of green technologies has also increased as a way to combat regional unbalances and to project Brazil onto the world stage. During the beginning of 2012, the National Industrial Property Institute (INPI), an organ linked to the Ministry of Development, Industry and Foreign Trade (MDIC) launched the program "Green Patents" in order to shorten the time for the registration of patents directly related to technologies that reduce the effects of global climate change. A patent is considered green if it is related to one of the following subject matters: (i) alternative energy; (ii) transportation; (iii) energy conservation; (iv) elimination; (v) residual reduction and management; and (vi) agriculture.

The concept of social technology is frequently used in the approach to processes and products that break social exclusion patterns and directly promote inclusion, processes that allow those that are marginalized by the economic system (or the informal economy) to seek employment alternatives and income through productive activities (DAGNINO, 2009). Another important aspect of social technology is that, apart from offering opportunities for formal jobs and the generation of income, it is expected to develop technologies through the interaction between researchers the benefiting communities (RODRIGUES & BARBIERI, 2008) and their appropriation by the same communities.

Agricultural research that was initiated during the end of the 19th century has allowed Brazil to develop technologies that have led to a competitive edge in several sectors. It was through research and development that we adopted the adequate technology to increase the production of grains, without increasing the planted area, such as soybean tropical production technology.

A broad study of the innovative capacity of Brazilian industries, publicized by the IPEA during 2005, has revealed that the introduction of innovations has led to increases in worker wages and the number of formal jobs. According to the same study, innovative enterprises paid medium salaries that were 2.9 times higher than those paid by non-innovative enterprises. Furthermore, the study reveals that innovative enterprises show increases in formal employment in the order of 29% between 2000 and 2004, a figure that is higher than the Brazilian medium for the same period. Increases in production and new job opportunities lowered the unemployment rate which contradicts the notion that technologies lead to the less available jobs. The fact is that the majority of innovative enterprises also contribute to the creation of formal jobs and current penetration of international markets demands more formality and transparence.

The greatest evident challenge is the creation of jobs that can keep-up with the growth rate of the active population. This growth represents, from a demographic perspective, a bonus that will eventually be beneficial to the whole society if the workforce is fully and properly employed[24]. It can also create migratory fluxes of citizens searching for better living conditions[25] and as these fluxes are usually composed of active age individuals it could also lead to the process of population aging (PEP).

The relative burden of a senior workforce (with 40 years of age or more) within the active population segment and a consequence of the aging of the population can be a positive factor for the acceleration of economic development due to its stronger tendency to save (LINDH & MALMBERG, 1999). This group is expected to grow constantly in Brazil during the next decades. Brazil can, as Singapore did according to the Navaneetham analysis (2001), use this demographic bonus during the next decades in order to increase savings by its population and use them for productive investments. However, the above mentioned demographic bonus is only an opportunity that can either be used by society or discarded. Behrman et al. (2001)[26] has found that population aging in Latin America has not led to increased savings as it did in Asian countries. A

[24] Literature on this subject, Urdal and Hoelscher, 2009; NRC, 2003; Muniz, 2001.
[25] This migratory movement is already a reality in Ecuador, Colombia and some Central American countries which in 2000 presented figures that showed that more than 10% of their citizens resided outside of the native country. Available at <http://www.eclac.cl/publicaciones/xml/8/27498/Observatoriodemografico.pdf>. Accessed on June 6, 2010.
[26] Reference not contained in the original document.

possible reason for this is the financial crisis of the 90's that coincided with the time when the region started to experience this demographic phenomenon.

Still within the active population segment, while the *senior* workforce will continue to grow both in absolute and relative terms (in relation to the total population) the *junior* segment (population between 15 and 24 years of age) will experience a negative growth period in absolute terms with consequent repercussions for the economically active population (PEA). This factor eases the pressure to create new jobs but can also become a worrisome situation. Chesnais (2004) has augmented that this is a *proxy* group for the consumption market that is composed of individuals that are starting new families and will demand housing, furniture, cars and other durable goods. So the negative growth of this segment of the population can equally be a negative factor if it is not properly assimilated by the system in order to achieve a heated economy and transform it into a highly productive segment.

In Brazil, a portion of the young population is still attending school while

another portion is already employed. In the beginning of the current century two thirds of youngsters between 15 and 19 attended school, whether they also worked or not; half of them, usually from poorer backgrounds, worked fulltime. Silva Leme and Wajnman (2000) have shown that many of those that both worked and attended school returned to school after becoming economically active which can be a sign of market pressures for additional professional empowerment. Policy formulators should therefore take advantage of the conjuncture offered by the aging process of the population and prioritize the empowerment of human resources, directed in particular to the younger generation.

3.7 CLIMATE CHANGE AND NATURAL DISASTERS

Text written by Prof. Dr. João Lima Sant'Anna Neto (UNESP) and by Dr. Sônia Maria Viggiani Coutinho (USP).

It is now 20 years since the United Nations Conference on the Environment and Development of 1992, the Rio92, it has been consolidated the idea of sustainable development in the terms proposed by the report Our Common Future from 1987 as well as consolidation several important documents like the United Nations Framework Convention on Climate Change and Agenda 21Global.

Brazil played an important role in Convention negotiations and later in the Kyoto Protocol and both documents were been ratified by the National Congress according to the provisions of the Brazilian Constitution and is thereby legally bound by the same.

Brazil concluded the work on its own Agenda 21 during 2002 according to the recommendation that every country should create its own Agenda. Among the set strategies for Natural Resource Management we find the promotion climate change related scientific and the establishment of cooperation networks between national, international and regional climate change research centers.

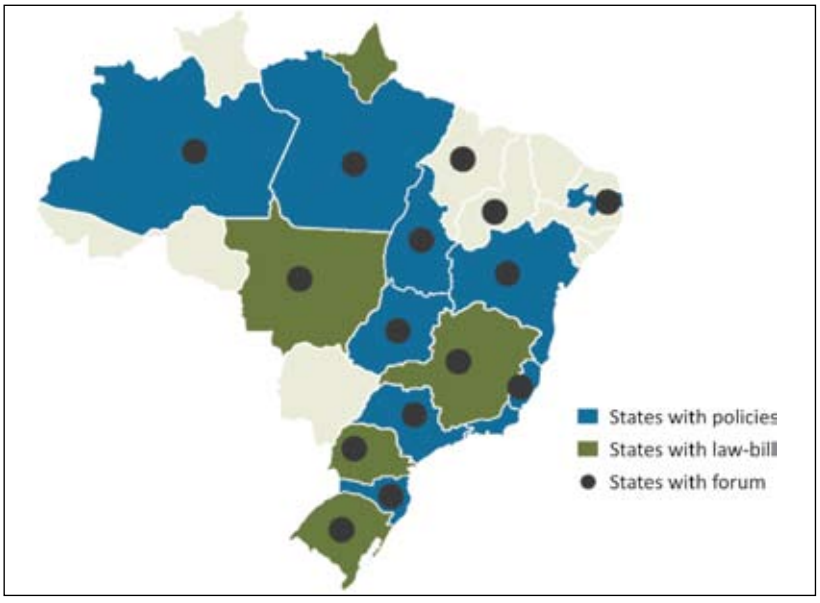
The formulation of public policies based on the recommendations of the United Nations Framework Convention on Climate Change were facilitated through the creation of national and state forums focused on climatic changes in Brazil. It is estimated that 16 Brazilian states have implemented their local forums since 2005 (Graphic 3-2). The creation of the Brazilian Panel on Climatic Change (PBMC) and the Climate Change National Science and Technology Institute (INCT) as cooperation networks for technic-scientific development has strengthened the formulation of public policies on the subject.

The Brazilian Panel on Climate Change, a scientific national organization instituted by the Ministry of Science and Technology (MCT) and by the Ministry of Environment (MMA) through administrative Inter-ministerial order MCT/MMA nr. 356 from September 25, 2009, aims at providing assistance in the creation of public policies and decision-making processes related to the challenges posed by climate change, and is also a reference source for society in general. The Panel also contributes to the implementation of the National Plan on Climate Change in the areas of Research and Development, Mitigation, Adaptation and Knowledge Distribution, where Capes has been represented.

The Climate Change National Science and Technology Institute (INCT) was created in 2008 with CAPES, CNPq and state research Foundations support and its headquarters functions by the Special Research National Institute (INPE). It consists of a network of interdisciplinary research on climate change assisted by 65 national research groups from all regions of Brazil and 17 international research groups, with a total of about 400 researchers, students and professionals. The Climate Change National Science and Technology Institute is strategically linked to the Brazilian Network on Climate Change (Climate Network) of the Ministry of Science and Technology and with the Fapesp Program for Climate Change Research. The objectives of the INTC involve both the understanding of risk variability and the effects of current climate change on society and the prevention of the long-term impact of climate changes in Brazil as well as provide decision makers and society with adaptation and mitigation measures (ARRAUT et al., 2010).

Of the 27 Brazilian states only ten have adopted climate change related public policies and nine have not reached any level of debate (policies, law-bills or forums) notably the Northeast region, according to Graphic 3-1.

Graphic 3-1: States with approved policies, law-bills and established forums of Climate Change



Source: MOTTA *et al*, 2011

The National Plan on Climate Change was also approved as well as the new and advanced National Climate Change Policy (Law 12.187 from December 29, 2009). This law sets objectives for cuts in the releases of hothouse gases until 2020 and has placed Brazil at the forefront of countries that are committed to actions that mitigate climate change. The above Law also established the National Climate Change Fund as a tool for the implementation of mitigation policies and for the financing of research and the collection of new knowledge (ARRAUT et al. 2010).

The strategies established for the mitigation of climate change during the two decades that separate Rio92 and Rio+20 have focused on two strands: (i) the promotion of scientific-technological development of knowledge on climate change: elucidate, reduce or eliminate current uncertainties in relation to causes, effects, magnitude and evolution of the climate change timeline and its economic and social consequences as well as the broadening of access to knowledge and available technology; (ii) the establishment of climate change cooperation networks between

international, national and regional research centers; interchange and spreading of climate change and air pollution related scientific-technological knowledge and environmentally friendly technologies for the reduction of atmospheric pollutants that can form a basis for decision making processes.

The frequency and intensity of natural disasters have increased considerably during the last years. Some are related to climate change, as highlighted by the report from 2007 presented by the Intergovernmental Panel on Climate Change (IPCC) which foresees precipitation increases in the South and Southeast regions and increased droughts in the Brazilian North and Northeast regions (MARCELINO, 2007).

Natural disasters have also increased throughout Brazil mainly due to extreme atmospheric phenomena such as severe storms, heat waves, and among other, electric discharges.

However, some natural disasters are more connected to hazardous forms of habitat, the disorganized occupation of land and the subsequent pressure on geo-systems, than to natural processes. Even if natural factors contribute to the magnitude of the extreme event.

In an article published in 2010 in the newspaper Estado de São Paulo on the current situation of Brazilian cities, Washington Novaes states: "it is difficult to ignore this subject due to the urgency and graveness of factual information on this area. And again, during the last weeks, vast areas of the Metropolitan regions of Recife, as well in municipalities from Paraiba and Bahia States, were subjected to intense rain, landslides and collapses, resulting in casualties and millions of individuals deprived of their homes and shelters, disasters that occurred simultaneously with the announcement by the National Water Agency that in 2010 no less than 563 municipalities were subjected to emergency situations due to rainfall".

There are many definitions for natural disasters depending on their characteristics, origins and repercussions. Both the Centre for Research on the Epidemiology of Disasters - CRED (UN-ISDR, 2009) and the glossary of the National Civil Defense understand disasters as perturbation events that can result in losses for communities and ecosystems – economic, social, material and environmental. The definition presented by the National Civil Defense differentiates disasters that are, or are not, caused by human intervention.

The Brazilian Agenda 21 from 2002 has implemented development plans that can lead to the minimization of disaster occurrences and disasters in cities, and in particular in relation to disasters caused river flooding through waterproofing control, preservation, protection and the recovery of areas in order to achieve natural retention and the outflow of water excesses from valleys.

Most of the extreme events in Brazil are, due to its geographic characteristics, caused by atmospheric dynamics. Intense spring and summer rain in the center-south of the country and winter rain in the Northeast region can, in exceptional circumstances, provoke inundations and flooding which are increasingly catastrophic due risky living conditions and the vulnerability of large portions of the Brazilian population. Disaster classification is also often defined by impact characteristics (Table 3-1).

Table 3-1: Natural Disaster Ranking and Impact Characteristics.

Order	Type of Disaster	Severity	Duration	Extension (area)	Human Losses	Economic Losses	Social Impact	Long Term Impact	Surprise Factor	Associated Disasters
1.	Drought	1	1	1	1	1	1	1	4	3
2.	Tropical Cyclone	1	2	2	2	2	2	1	5	1
3.	Regional Flooding	2	2	2	1	1	1	2	4	3
4.	Earthquakes	1	5	1	2	1	1	2	3	3
5.	Volcanic Eruptions	1	4	4	2	2	2	1	3	1
6.	Extra-tropical Temperatures	1	3	2	2	2	2	2	5	3
7.	Tsunami	2	4	1	2	2	2	3	4	5
8.	Forest Fires	3	3	3	3	3	3	3	2	5
9.	Soil Expansion	5	1	1	5	4	5	3	1	5
10.	Seal Level	5	1	1	5	4	5	1	5	4
11.	Icebergs	4	1	1	4	4	5	5	2	5
12.	Sand Storms	3	3	2	5	4	5	4	1	5
13.	Mountain Sliding	4	2	2	4	4	4	5	2	5
14.	Beach Erosion	5	2	2	5	4	4	4	2	5
15.	Debris/Avalanches	2	5	5	3	4	3	5	1	5
16.	Soil Solidification	5	1	2	5	4	5	4	2	5
17.	Tornadoes	2	5	3	4	4	4	5	2	5
18.	Snow Storms	4	3	3	5	4	4	5	2	4
19.	Coastal Ice	5	4	1	5	4	5	4	1	5
20.	Sudden Floods	3	5	4	4	4	4	5	1	5
21.	Thunder and Lightning	4	5	2	4	4	5	5	2	4
22.	Electric Discharges	4	5	2	4	4	5	5	1	5
23.	Blizzards	4	3	4	4	4	5	5	1	5
24.	Undertow	4	4	2	4	4	5	5	3	5
25.	Hail	4	5	4	5	3	5	5	1	5
26.	Frost	4	4	5	5	4	4	5	1	5
27.	Local Gales	5	4	3	5	5	5	5	1	5

Degree of Impact	1 – very high	2 – high	3 – medium	4 – low	5 – very low

Source: Bryant, 2001, Org. Sant'Anna Neto, 2010

A large part of the population is not affected by extreme events of a pluviometric nature but by the effects of its absence, droughts. The increasing demand for water in agriculture, industry and housing is exhausting water supplies which in turn can lead to problems even in atmospheric situations that do not cause accentuated droughts. Droughts are in fact the natural disaster that affects the largest number of people, even if they have a lower occurrence rate when compared to other types of extreme events, due to their spatial and temporal dimension, secondary effects and posterior consequences (Table 3-2).

Only 33 postgraduation thesis and dissertations were presented on the subject of natural disasters during the period between 1992 and 2010, according to the Capes databank. However, if the search word is floods, the number of research studies on the subject raises to 546 thesis and dissertations which is proof of the subject's importance and graveness.

Table 3-2: Number of people affected by type of event, Brazil, period 1975/2001

Type of event	Affected individuals (million)
Drought	47.812.000
Heat-waves	600
Floods and Inundations	20.291.770
Land movements	237.484
Storms	213.092
Fires	12.000
Total	**68.566.946**

Source: EM-DAT: The OFDA/CRED International Disaster Database. May 2012. Org. Coutinho and Sant'Anna Neto

Table 3-3: Number of events by type of event, Brazil, period 1975/2001

Type of event	Number of events
Drought	16
Heat-waves	7
Floods and Inundations	99
Land movements	19
Storms	14
Fires	3
Total	**158**

Source: EM-DAT: The OFDA/CRED International Disaster Database. May 2012. Org. Coutinho and Sant'Anna Neto

3.8 AMAZON

Text created through the compilation of the chapter "Amazon" written by Prof. Dr. Adalberto Luis Val (INPA) for PNPG 2011-2010.

The Amazon region stretches through eight countries in South America and 60% of its forest area is located in Brazil. The concept of the Brazilian Amazon, which comprises an area of 3.7 million sq/km, has been replaced by Legal Amazon, a geopolitical concept which has added 1.3 million sq/km to the Brazilian Amazon and includes a long strip of vegetation in transition (about 700 thousand sq/km) such as cerrados in the south and fields in the northern states of Roraima, Pará and Amapá. The Legal Amazon includes the Amazon, Amapá, Acre and Mato Gross, Pará, Rondônia, Roraima and Tocantins states and the western part of Maranhão state. It has an area of 5 million sq/km representing 60% of the national territory. The region is home to 25 million people (13.7% of the Brazilian population), about 22.000 isolated communities and only 4% of the doctorates in the Federation. The North Region holds about 14% of the Brazilian population, represents 8% of the national GDP but has only received 4% of the national resources allocated for Science and Technology.

The development rate of the Amazon region is much lower when compared to other Brazilian regions due to a low rate of human empowerment (IDH) and to its low productivity in S&T, a result of the scarcity of implemented Postgraduation courses on a doctorate level. This situation is further aggravated by the absence of efficient policies for the settlement of doctors and deficiencies on all levels of the education system.

The Legal Amazon is home to half of the know species of tropical plants, offers a variety of fish that surpasses the Atlantic Ocean and is the largest hydrographic basin in the entire world containing about 80.000 navigable rivers. In face of its intrinsic value and of the countless natural resource potential of the region we must implement actions that further its preservation and safeguard sustainable exploitation through the introduction of environmental, social and economic dimensions in direct development processes. In order to achieve this we need a better understanding of the natural resources of the Amazon, and the search for knowledge and scientific and technological regional production is as fundamental as the promotion of innovation.

The strategies needed to change this reality demand large investments in S&T (at least proportional to the revenue generated in the region), the settlement of human resources (creation of scholarships and differentiated salaries in order to attract researchers and avoid exodus) and a broadening of S&T infrastructures.

The continental like dimensions of the North Region of Brazil and its sparse population are factors that contribute to the area's isolation and can only be overcome through the implementation of modern communications technology.

The Amazon needs research projects that will add value to locally produced products and services and thereby revenue and stability. The region needs a broadening and consolidation of existing postgraduation programs and subject areas and inductive measures that further the creation of programs in non-existent subject areas, apart from social inclusion, the generation of revenue and the upholding of regional sovereignty. The region does not offer postgraduation practices in 23 of the 48 subject areas listed by Capes, including some areas that are of paramount importance for its sustainable development. In order to offset these discrepancies we need to implement actions for the empowerment of personnel compatible with the Amazon scale, to generate income and social inclusion, expand empowerment initiatives to other areas and achieve intraregional cooperation.

Evolution of regional postgraduation programs

The first postgraduation program in the Amazon region was started as late as 1971 and was a product of several recommendations regarding the need to empower human resources for comparative studies of the Amazon flora and fauna exemplified by the Murça Pires report (BEZERRA, 2007). The program was named the Tropical Botany Program, organized by the INPA in cooperation with the Kew Royal Botanic Gardens (LLERAS, 1981).

The program was broadened and empowered many of the professionals currently active in the Amazon region but reached a stagnation point 30 years later due to a lack of qualified permanent personnel areas of vital importance for the sustainable development of the region. In respect to the shortage of postgraduation practices in the Amazon region we highlight the fact that there are only two regional postgraduation courses in the subject of Botany and only one for doctorates. There is a wide scarcity of personnel resources for the areas of taxonomy and plant systematics which have become increasingly dependent on external personnel. A few years later, in 1973, a postgraduation course on Geophysical and Geological Sciences was implemented by the Federal University of Pará which in turn led to the creation of the Postgraduation Program in Geology and Geochemistry.

The widely accepted and imperative need to broaden the tools for the empowerment of personnel for the Amazon region led to the creation of three

Postgraduation programs through the intra-institutional cooperation of the IMPA and UFAM (Federal University of the Amazon): Ecology, Entomology, and Fresh-Water Biology and Inland Fishing. For a long time period doctor's degrees were only offered by the University of Pará in Belém and in Manaus by the INPA. The region had a few thousand doctors at the time. During the last ten years postgraduation courses have expanded to other Amazon states and surpassed the Belém-Manaus axis but even so, the States of Acre and Roraima still do not have any programs for the empowerment of doctors.

The absolute majority of the initiatives in S&T, with the Humid Tropics Program, the Northwest Pole and the Humbolt city as its standard bearers, were not able to collect the data they needed due to a lack of qualified personnel in the respective subject areas.

Currently the region has 232 postgraduation empowerment programs of which 51 are on the doctorate level, 173 masters and eight professional masters (Table 3-4). Programs on the level of doctorates represent only 3.4% of the existing programs in the country and only one of the programs has achieved grade level six.

Table 3-4: Distribution of postgraduation programs in Brazil by region[27]

Region	Total	M	D	F
Center-West	300	190	92	18
Northeast	729	475	212	42
North	175	124	44	7
Southeast	2279	1256	875	148
South	873	526	290	57
Brazil	4356	2571	1513	272
Amazon	232 (5,3%)	173 (6,7%)	51 (3,4%)	8 (2,9%)

Obs. Data for the Amazon region represent the sum of the programs in the North region with those of the states of Maranhão and Mato Grosso. M= Masters, D=Doctorates, F=Professional Masters.

An initiative with great local relevance is the creation of State Research Support Foundations and in particular the Foundation for the Support of Research in the Amazon State which was quickly incorporated into personnel empowerment processes on a postgraduation level, and direct or indirect financing for research as exemplified by the recently founded National Science and Technology Institutes (INTCs). This initiative has allowed us to trace a course for S,T&I initiatives based on state policies and has broadened the availability of scholarship's on all levels, from scientific initiation to post doctorate.

[27] CAPES (2010) Acknowledged Master's/Doctor's degrees.

Other initiative that had a deep impact on postgraduation practices was connected to the expansion of graduation and involved the internalization of Federal Universities trough the consolidation of several campuses in the Amazon Interior; the organization and consolidation of State Universities which used modern technology to reach all Amazon state municipalities; the quantitative and qualitative broadening of private universities some of which are taking the first steps towards postgraduation empowerment. The expansion in graduations resulted in an increase in the number of candidates for master's and doctor's degrees.

The results of the above initiatives are very important for the whole region. During the last seven years the number of postgraduation programs in the Amazon grew from 92 to 232, a growth of 150%. If we only count doctor's programs the growth is even more impressive, namely 200%, and the number of programs grew from 17 in 2003 to 51in 2010.

However, more than 70% of the masters programs are rated level 3 and only one of the doctor's programs reach degree level 6. The large majority (78%) of the doctorate programs are rated 4 which can be a factor that has led to the implementation of many of them (FOPROP, 2005). We would also like to point to the fact that three doctorate programs are rated 3, including the single doctorate program in Botany in the Amazon region.

Challenges

The World Science Conference held in Budapest in 1999 was followed by other meetings including the Mexico City meetings in March of 2009 (UN, 2009) and Buenos Aires in September of 2009. The Brazilian delegation brought to these meetings a document which addressed seven important subjects with wide and significant social repercussions[28]: hydric resources, food production, clean energy sources, climate change, new construction materials, disorganized expansion of urban centers and the constant creation of jobs. These subjects have a direct and striking relation to current and future challenges facing the area of Science and Technology in the Amazon region. Bellow, these subjects are treated in light of the main current and future challenges facing the Amazon region, subjects that require immediate C,T&I action and consequently, postgraduation education and empowerment.

[28] On the way to a global ST&I Agenda: the role of Latin America and the Caribbean. Preliminary text of the Brazilian delegation for the II Regional Science Forum held in Buenos Aires between September 23 and 25, 2009.

Biologic diversity

Biologic diversity is conditioned to forest wellbeing. The transformation of forest areas eliminates any future possibility of development and deforestation will continue until we find new and economically viable processes and products that can replace wood. Current regional deforestation, estimated according to preterit rates, demand immediate action on all fronts during the next 20 years. Deforestation cannot be seen to be a Brazilian problem alone. Brazil must cooperate with other Amazon countries in order to outline an agreement that addresses the above challenge and possibly ask developed countries to participate in this effort as most of them demand the preservation of the Amazon forest but produce the conditions that lead to its degradation.

Food

Food production in the Amazon region represents a broad and unexploited opportunity. The seemingly endless variety of aquatic organisms and in fish in particular can, through the use of modern management, production, post-harvest processing and marketing, create an important productive chain. The soil offers fruits, fibers, roots which are, among other, products that are already used by local people and can equally lead to attractive business opportunities. The land and water can also play a role that is yet to be specified through the collection of knowledge that is hidden in the genome of each species and we have only started to see "the tip of the iceberg"[29]. The collection of knowledge is not only important for food production but also for the production of medicinal and cosmetic substances and to combat plagues (CLAY, SAMPAIO, CLEMENT, 1999). The challenge lies in our capacity to reduce extraction processes, broaden the use of specific areas for the production of the respective organisms and increase the associated technical density, all conditioned to the collection of high-level scientific knowledge and the empowerment of people that can produce it.

Health

Health issues represent, in all aspects, an enormous challenge for the Amazon region; either due to the interaction of people with a diversity of agents present in the water, land and air that can lead to illnesses or due to the geographic distribution of the human population. The human-forest interaction exposes people not only to known

[29] INTC ADAPTA

etiologic agents but also to and infinity of agents that need to be studied and explained in order to be able to make diagnostics and find cures. The disturbances caused by human action in forest life are relatively well known as well as the indexes of illnesses such as malaria and dengue. However, we do not yet possess safe knowledge related to the behavior of the metapopulations of Amazon diseases when faced with climate change. Preliminary data forecast an increase in malaria and dengue rates in the region during warmer periods (TADEI, 2010).

Water

Water represents another challenge for the Amazon region. The extensive drainage network (EVA % HUBER, 2005), the enormous volume of water and the extension of its rivers are some of the parameters used to illustrate its magnitude and size. The significance of water from a social, economic and environmental viewpoint (VAL et al., 2010) and in particular if we consider a future global water scarcity scenario deserves and demands our doubled attention. The Amazon has a total of 25.000 km of navigable waters spread throughout 7 million sq/km of which 3.8 million are part of the Brazilian territory. The network of rivers is for the Amazon region what the road network is for Sao Paulo as it represents the main means of transportation for both humans and local production but unfortunately we are very far from maximizing its potential.

The Amazon Basin is also the last South-American frontier for the production of hydroelectric energy. The Brazilian official data of the electricity sector "2010 Plan" foresees the construction of 68 hydroelectric plants in the Amazon region. The Plan focuses on the need for energy production. However, the construction of hydroelectric plants is an intervention with significant environmental, social, economic and medical consequences (CABRAL & ALMEIDA, 2006). The above implications must be assessed and require broad studies.

Apart from transportation and energy water is also an important source for human food in a region that shows one of the highest rates of fish consumption in the country. Water is a source of food and creates jobs – the region's fishing activities generate more than 100 thousand direct jobs and about tenfold of that number in indirect job activities (CABRAL & ALMEIDA, 2006). However, as consumption is concentrated on a few species (a little more than a dozen of the 3.000 known species) we have already noted sign of overfishing in some parts of the region and in particular around large cities. We now focus on three of the elements of this fragmented production chain.

The first is on the activity of fishing itself, including artifacts, professionals, their organizations, the relevant economy and the sector's vulnerabilities. The second focuses on the production of fishing related products and fish farming through advanced technologies. The farming of fish has advanced rapidly in this region and should be the target of support measures that affect the environment, feeding sources, the production of fingerlings, etc. We stress the fact that this challenge includes the farming of ornamental fish. The interest for this area is very strong and some foreign countries are currently producing amazon fish through the use of modern technologies. However, the postgraduation program in Tropical Amazon Agriculture was first started in 2010. The third element is the aggregation of the value of fish for export oriented activities and the consequent requirement for empowerment in the area of Food Technology. It is evident that we can analyze this from different perspectives (SANTOS, FERREIRA & VALK, 2010).

Mining

The Amazon area is very rich in various mineral deposits and significant investments have been made in mining activities. The region not only offers conventional mineral deposits but also oil. Two aspects of the mining activities in the Amazon region deserve our particular attention: social inclusion and environmental impact. The first requires the implementation of empowerment actions for the inclusion of personnel in the areas of mining and the subsequent adoption of appropriate techniques for value aggregation. The poverty index in mining areas in the Amazon region is quite high which does not rime well with the exploitation of a national resource.

In respect to the environment, any type of subsoil exploitation leads to changes in the surface that can reach large areas and have a significant effect on local plant and animal life. Furthermore, the leaching of elements (metals, oil, formation water and other) from these areas into neighboring bodies of water has a negative influence on the habitat, metals in particular, due to the fact that aquatic Amazon organisms generally evolved in environments characterized by low ionic concentration (DUARTE et al., 2009); It is a definite fact that we need to enter a new phase and direction in Amazon mineral exploitation which involves at least two variables: the use of new and more appropriate technologies for bio-diverse environments and proactive social inclusion processes.

Generation of income and social inclusion

The future of the Amazon region is inexorably connected to the creation of alternatives for income generation and social inclusion and the inherent solution of the dichotomy between the sustainability of the forests and the conventional commodity market that includes, among other, soybeans and cattle. This is one of the main sources of conflict in the region. The forest satellite monitoring system is very precise and up-to-date and is carried out both by the Brazilian Government and foreign organizations such as JAXA, the Japanese government's aero-spatial agency. We currently have at our disposal a large amount of legislation for the reduction of deforestation in the Amazon area. However, this investment was not accompanied by measures that allow for the generation of alternative revenue sources. The result is a *continuum* of disputes that create all sorts of conflict. A paradigmatic change on this scale evidently requires the involvement of international markets (CLEMENT & VAL, 2009) and science in particular and qualified personnel that can achieve a decrease of the production timeline compatible with the demands from an increasingly globalized and demanding market.

This question holds two subjects that demand our attention. The first is the generation of knowledge that will allow for product exploitation and the development of processes based as the simple observation of the physionomic composition of the region provides us with clear indications regarding its ecologic zoning, a fact that should become a part of economic reasoning and lead to innovations in territorial exploitation (CGEE, 2009). Some of the current actions must be strengthened including the broadening and consolidation of initiatives in the areas of biotechnology, food technology, nanotechnology, and agriculture not only regarding the empowerment of personnel with master's and doctor's degrees but also in respect to productive processes.

The second subject represents another challenge of large proportions – the socialization of knowledge and information by society and the private sector. This process should both acknowledge demand and provide knowledge and information. This will lead to the creation and consolidation of productive networks halt their dependence on exogenous solutions. The generation of income and social inclusion are therefore conditioned to the implementation of direct and competitive actions and new products and processes that allow for environmental preservation and maximize the use of degraded areas.

Soil and degraded area exploitation

The upholding of forest areas is a challenge that demands radical changes in the way we approach soil exploitation. The particular characteristics of the Amazon soil can lead to loss of the productive capacity of local agrosystems in a very short time span and the consequent abandonment of non-productive areas and deforestation, a continuous process that leads to the destruction of pristine areas. In order to avoid this we need to face up to the challenge and develop appropriate techniques for the reuse of degraded areas, techniques that need to be specifically developed for these areas. Some pioneering studies have provided us with clear indications that it is viable to regain these areas for productive processes including through the reduction of hothouse gas emissions (INPA, 2009). In view of the dimensions of the degraded areas and the diversity in soil we need to continuously develop new and appropriate techniques for this purpose.

Climate change

Eleven of the last twelve years represent the hottest registered years since 1850. The planet is undergoing an unequivocal warming process that is more evident in higher latitudes (IPCC, 2007). It is also an acknowledged fact that global warming leads to the increased concentration of hothouse gases in the atmosphere and, carbon dioxide (CO_2) in particular, gases origination form a wide variety of anthropogenic processes. General increases in temperature will change other global climatic parameters and affect soil productivity, bodies of water and the chemistry of the atmosphere and, among other, ecological interaction. These changes can vary depending on intensity the biome, its geographic composition and, among other factors, the model and intensity of the use of natural resources. Future scenarios for the Amazon include a spectrum of mild changes and severe changes that will lead to the transformation of the biome into savannah (IPCC, 2007). The environmental complexity of the Amazon requires the production of effective knowledge on climate change and preparedness for the implementation of actions for the prevention, adaptation and mitigation of the effects caused by climate change (INPA & STRI, 2009).

Environmental services

The benefits of healthy ecosystems have attracted a lot of attention and represent a new and challenging economy model based on biological resources. Environmental

services can be divided into four categories: (i) production services (food, fuel, fibers tec.); (ii) regulation services (climate, illnesses etc.); (iii) support services (soil composition and nutrient cycles); (iv) cultural services (immaterial benefits, spiritual and esthetic) (ALCAMO et al., 2003). It is evident that the rendering and the performance of the above services is a task that requires study due the fact that it is more difficult to attribute a value to intangible services. Service areas analyzed by Constanza and collaborators (CANSTANZA et al., 1997) point to a value that corresponds to two times the global GDP. A specific analysis for the Amazon was made by Fearnside who conceptualized and grouped the services under three categories: (i) Biodiversity (services that uphold biologic biodiversity); (ii) water (water cycles and their importance for agriculture); and (iii) climate change prevention (carbon storage)[30]. A rigorous analysis undertaken by the Internal Commission of the INPA for the evaluation of the value of environmental services in the Amazon State concluded that among services such as biodiversity, environmental services in flooded zones, hydrologic cycles, carbon storage, nutrient cycles, pollination, soil conservation and recuperation of degraded areas, carbon is the only service that has an established even if volatile value (INPA, 2009). The establishment of standard values for complex environmental areas such as the Amazon is a challenge that must be addressed through continuous and in-depth studies.

Infrastructure, information and communications

The Amazon region, in light of the current future scenario, needs an appropriate ST&I infrastructure and other interventions in the areas of transportation, communications, health, energy, urban expansion, and among other, sports. The needed ST&I infrastructure must include the establishment of large labs equipped with the latest technology that will allow for the production of knowledge and information at the service of the region's sustainable development. It is ST&I that should provide the knowledge that is necessary for the implementation of local infrastructures according to environmental conservation norms, adaptation to tropical climate location and, among other the optimization of infrastructural lifespan. The challenge lies in the availability of knowledge for each action and respective timelines. A short term challenge is the integration of the western region of the Amazon with the national electronic communications system. The connection speed (internet) of the National Research Network must be increased in order to allow for the transference of data without the current itches (BRAZILIAN ACADEMY FOR THE SCIENCES, 2008).

[30] Fearnside, P. (2008) Amazon forest maintenance as a source of environmental services. Annals of the Brazilian Science Academy, 80: 101-114.

Technology and innovation

There are currently several products and processes that derive from the biological diversity of the Amazon and some of them have already been patented and offer well established production technologies. Some of these products have attracted the interest of the private sector and have led to technology transfers. Important investments were made in the structuring of the Centers for Technological Innovation. Many researchers share the interest to register their discoveries and have gained legal support for the posterior partition of possible benefits. However, the process lab-factory-consumer undergoes a series of stages that need to be equally studied and solved: scale, personnel training, packaging, stock time and among other, marketing. Conventional products can absorb these costs in the long run, new products cannot achieve that. This poses two important challenges for product and process innovation in the Amazon region: the broadening of innovation through information socialization and the empowerment of personnel capable to absorb the technology and the creation of strategies for production and commercialization.

Regional integration

The integration of continental Amazon is a challenge in itself and not only due to its characteristics as a biome with environmental and biological differences, similar cultural matrixes and common development aspirations, science and technology and education and health but also due to the lack of clear policies. The "greater" objective should therefore be "to create, implement and uphold an agenda based on common subjects" (MACHADO, 2009). Cooperation programs must be strengthened. The Amazon Cooperation Treaty from 1978 was signed in order to find solutions for regional integration. The later Amazon Cooperation Treaty Organization is another effort to formulate and execute science and technology policies for the Amazon countries and, among other, the increase in the national and regional capacities to develop a broad program for the assessment and sustainable exploitation of biodiversity in the Amazon region. Current fragile Science and Technology structures in all Amazon countries pose a grave threat to the accomplishment of this goal.

The search for convergences resulted in other regional arrangements such as the Association of Legal Amazon Universities (UNAMAZ) created in 1987 and the Amazon Initiative created in 2004. The first focuses on the empowerment of human resources on a postgraduation level and the second on the prevention of area degradation and the

recuperation of existing degraded areas (MACHADO, 2009). In this context, the Initiative for the Integration of the Regional Infrastructure of South-America (IIRSA) has some implications for the Amazon region as the integration of markets is associated to the physical integration of a very fragile region.

Brazil holds an important position in relation to other Amazon countries in the areas of empowerment and science and technology, even if it shows some fragility in relation to developed areas. The above programs aim at the identification of similarities in environmental, social and cultural Amazon characteristics and to fully achieve that we need consistent knowledge on the region and its peoples.

Qualified personnel

The region has 11 federal universities, four state universities, one municipal Institution, three federal Research Institutes and more than one hundred high-level education private schools.

The last years have been marked by an expansion in the number of doctors active in the Amazon region (VAL, 2006) and consequently by an increase in the number of postgraduation programs. The organization of these personnel in research groups has increased substantially and allowed for the fine-tuning of initiatives in the areas of Science, Technology and Education. We also stress the importance of private schools in contractual processes and in the organization of research groups in the region as well as in the interiorization of actions.

The above represents yet another challenge if we are to achieve a broadening of the proportion of doctorate personnel and their incorporation into local educational and research Institutions. The 2005 census undertaken by the Anísio Teixeira National Institute for Educational Studies and Research (INEP) showed only 2.780 doctor professors among the more than 23.000 professors in the cadres of local Amazon institutions. The efforts to broaden the cadres of professors in the region's institutions did not consider an increase in the number of doctorates in the same cadres. The lack of an effective settlement policy for the fixation of qualified personnel in the Amazon region is one of the main causes for the above mentioned disequilibrium. On the other hand, an empowerment program for the contingent of professionals already settled in the region would increase the region's current capacity.

3.9 BIODIVERSITY

Text written by Prof. Dr. Marcelo Tabarelli (UFPE) and Prof. Dr. Paulo Santos (UFPE) based on Ministry of Environment's data compilation and several other scientific documents.

Biodiversity is the richness of biological units found in nature and is composed of the biological life resources available for human use. This term is therefore associated to molecules, genes, organisms, populations, communities and ecosystems, the last being observed on different space scales. The dimensions of biodiversity are incalculable. We can only calculate its economic value and the environmental benefits it brings – as the basis for the biotechnology industry and agricultural, livestock, fishing and forest activities – an estimated 33 trillion USD/year, a number that represents almost half of the global GDP (MMA. 2012).

The current territorial expansion of human activities is rapidly and drastically changing natural landscapes, the workings and preservation of ecosystem biodiversity and threatening essential environmental services such as the sequestration and retention of carbon and the control over flooding and the production of potable water. This has led to an intense debate on the relationship between biodiversity, quality eco-systemic services and human welfare and the reduction of poverty. We are therefore faced with the challenge to develop technologies and create policies that safeguard the sustainable use of biodiversity (MELO et al. 2010).

The Brazilian government launched its National Biodiversity Policy in 2002 which generally aims to promote, in an integrated form, the preservation of biodiversity and the sustainable exploitation of its components through the just and egalitarian repartition of the benefits derived from the use of biological resources and of traditional knowledge associated with these resources.

The science of biodiversity has the mission to describe and understand the evolution and organization of biological diversity as well as provide society with concepts and tools that allow for the sustainable use of biologic patrimony or capital. Brazil holds the largest biodiversity found on the planet and is home to about 20% of existing species and is also a provider of important environmental services. Examples of these services are the country's carbon stocks which is the largest in the world and approximately 15% of the planet's fresh water. Brazil currently educates one doctor per day in subjects related to biodiversity.

However, in spite of its richness in natural resources and the empowerment of human resources and professional capacitation Brazil has some basic problems: (i) a considerable portion of Brazilian biodiversity is still unknown (has not been described or is not possible to collect); (ii) we still have a scarcity of knowledge on the organization of biological diversity and its reactions to anthropic activities; (iii) the country lacks conceptual models and the technological innovation that allows for the sustainable and economically competitive exploitation of biodiversity resources (ex. The opportunity costs for the Amazon forest remain high); (iv) the lack of communication between scientific knowledge on the subject and decision makers on different levels of public administration and entrepreneurial executives (biodiversity sciences vs. biodiversity policies) and (v) a large scarcity of professionals in the area of biodiversity management and conservation biology which hampers the incorporation by social actors of advances, formulations and scientific and technological discoveries.

Finally, Brazilian science on biodiversity must broaden its participation not only through an increase in the number of published studies (Brazil is ranked 8th in article publication on the subject) but more importantly through the establishment of new concepts and theories that allow for a better understanding of the natural capital and the implementation of interventionist measures in a context of rapid and drastic global changes.

The 10th Conference of the United Nations Convention on Biological Diversity was held during October, 2010 and specified goals that should be reached by 2020. These goals are related to the protection of certain areas, species preservation and sustainable agricultural and entrepreneurial practices and, among other, the empowerment of human resources. Even if Brazil is a signatory of Convention the attainment of the goals that have been set is still not a part of academic agendas and we continue to experience problems caused by the inappropriate use of natural resources (desertification, fishing stock collapse, species extinction and the biological weakening of Brazilian ecosystems on different spatial scales).

We are not proposing a research agenda and the capacitation of human resources on an exclusively national plane. Matters related to the science of biodiversity have a global interest and they are at the forefront of knowledge and play, undoubtedly, a decisive role for the economic competitiveness of tropical countries and for the quality of life of future generations. However, the effective handling of these questions demands new expressions (such as institutional and conceptual re-engineering) for the production and dissemination of knowledge as well as the empowerment of human academic and professional resources. Brazil must, as the holder of the largest

portion of global biodiversity and the possessor of a broad and competitive system for scientific production and the educations of youngsters, become the global leader of processes that harmonize the use and the preservation of natural resources with human welfare and wellbeing. However, the current profile of the strictly disciplinary models of postgraduation courses on the subjects of: (i) ecology; (ii) botany; (iii) zoology; (iv) biologic oceanography, rarely create an academic environment that can scientifically address questions posed by contemporary challenges.

Brazil is a very diverse country and its territorial extension is covered by a variety of ecosystems: humid tropical forests (mostly in the Atlantic and Amazon region), savannahs (Cerrado), humid zones (Pantanal), coastal and oceanic zones, southern fields and the Caatinga (BULLOCK, 1995; PENNINGTON et al., 2000).The Atlantic Forest and the Cerrado are today acknowledged as the hotspots for biodiversity preservation while the Amazon Forest, Pantanal and Caatinga have reached status of Global Desert areas (GIL, 2002). We cannot forget the significance of the coastal and oceanic areas in terms of biodiversity which hold their specific ecosystems such as mangroves, coral reefs, dunes, restingas, sand beaches, rocky coasts, lagoons, estuaries and tidelands. A short description of some of the above mentioned ecosystems will help us to characterize this enormous biologic asset.

Amazon

According to the Ministry of the Environment (MMA, 2012) the Amazon region is a quasi-mythical area: a green and vast world of forests that are the home for a third of the world's species that share the planet with the human race. The Amazon is Brazil's largest biome: a territory spread throughout 4.196.943 million sq/km, more than 2.500 tree species (or one third of the world's tropical timber) and 30.000 species of plants (of the 100 thousand found in South-America). The Amazon basin is the world's largest hydrographic basin: covering about 6 million sq/km and with 1.100 affluent rivers. Its largest river, the Amazon River, passes through the entire region before reaching the Atlantic Ocean where it delivers 175 thousand m^3/s of water.

It is currently estimated that the region is the largest reserve of tropical timber in the entire world. Its natural resources include, apart from timber, large stocks of rubber, chestnuts, fish and minerals and are an abundant source of natural riches. The region is also home to rich cultures and their traditional knowledge related to the uses and exploitation of these natural resources. In spite of all riches that region is a fragile ecosystem: the forest is nourished by its own organic materials and its delicate balance

is extremely sensible when exposed to external interferences. Damages caused by anthropic activities are often irreversible. The richness of the region is in direct contrast to its socioeconomic and is plagued by precarious economic development that is often based on non-sustainable practices such as the extensive exploitation of timber and livestock.

Atlantic Forest

According to Melo et al. the Atlantic forest stretches throughout about 4.000 km. from the Rio Grande do Norte State to the State of Rio Grande do Sul. Originally the Atlantic forest covered more than 1.360.000 sq/km of the national territory (12%). This large extension of tropical forests, baptized by the sea that it meets, is in fact an aggregation of large forests (humid and dry) and other types of vegetation (fields and restingas) which interact with each other and are exposed to the effects of other ecosystems. The "islands" of the Atlantic Forest are examples of this complexity as they are placed in a sea of xerophilous plants in the semi-arid regions of the Northeast, the Northeastern Marshes. And it is not restricted to this. The Atlantic Forest north of the San Francisco River has more species that are common to the Amazon region than those found in the south Bahia Atlantic Forest or the Serra do Mar (Sea Mountain). The biogeographic composition of the Atlantic Forest makes it one of the world's richest and diverse.

In fact, the Atlantic Forest is home to more than 21.000 species of vascular plants, amphibians, birds, reptiles and mammals. Apart from these riches, 40% of vascular plants and between 16% and 60% of invertebrates it is also home to some unique species that cannot be found anywhere in the world. Due to its high endemism rate and its enormous degradation the Atlantic Forest is today considered one of the hotspots of the world for the preservation of global biodiversity. These endemism's are not randomly distributed and are grouped by distinct regions. Five Atlantic Forest endemism centers are currently acknowledged: Northeastern Marshes, Pernabuco State's littoral, southern regions of the Bahia State, Chapada Diamantina and Serra do Mar (Sea Mountain).

Cerrado

The Ministry of Environment characterizes the Cerrado as the second largest biome in South-America. It occupies an area of 2.036.448 sq/km or 22% of the national territory. Its continuous area includes the states of Goiás, Tocantins, Mato Grosso, Mato

Grosso do Sul, Minas Gerais, Bahia, Maranhão, Piauí, Rondônia, Paraná, São Paulo and the Federal District of Brasília and some enclaves in the states of Amapá, Roraima and Amazon. The cerrado is home to the springs of the three largest hydrographic basins in South-America (Amazon/Tocantins, San Francisco and Prata) which offers a great aquifer potential and strengthens its biodiversity.

The Cerrado is also considered a global biodiversity hotspot due to its richness in endemic species even if it has experienced the loss of a lot of its habitat (i.e. more than 80% of its natural vegetation has been depleted). The Brazilian Cerrado is, from a biodiversity viewpoint, acknowledged as the richest savannah in the world and 11.627 of its native plant species have already been cataloged. It also holds a large variety of habitats which determine a notable alternation of species within different mapped regions. The Cerrado is home to 200 species of mammals and a rich bird fauna with about 837 species. The number of fish (1.200 species), reptiles (180 species) and amphibians (159) are also comparatively high. The number of endemic fish is not yet known but the rates are very high for amphibians and reptiles: 28% and 17% respectively. According to recent estimates the Cerrado is a refuge area for 13% of butterflies, 35% of bees and 23% of tropical ants.

The Cerrado is also of great social importance, apart from its environmental aspects. Large portions of the population depend on its natural resources including indigenous indians, ribeirinhos, babaçueiras, vazanteiros and quilombola communities which are all part of the historical and cultural Brazilian patrimony and possess traditional knowledge on the biodiversity of the Cerrado. More than 200 species of plants have medicinal properties and more than 416 can be used for the recuperation of degraded soil or function as windbreakers, protect against erosion and natural predators that plague agricultural activities. More than 10 different type of fruits are regularly consumed by the local population and some are also commercialized in urban centers. The Cerrado is, in spite of being acknowledged for its biological importance, the hotspot of the world with the smallest percentage of environmental protection. Only 8.21% of its biome is legally protected by preservation units of which 2.85% are integral preservation units and 5.3% are units for sustainable exploitation preservation.

Pantanal

The Brazilian Pantanal occupies and area of 150.355 sq/km (more that 1% of the national territory) and can be described as a large mosaic of savannahs, dry forests (Atlantic and Amazon) and floodable and dry fields. The Pantanal exists only in two

Brazilian States; it occupies 7% of Mato Grosso State and 25% of Mato Grosso do Sul State. The region is an alluvial plain subjected to the effect of rivers that drain the Alto Paraguai basin and is home to a rare, abundant and beautiful flora and fauna. The soil is predominantly arenaceous and is often covered by native forage which favors livestock activities.

The Pantanal is also home to approximately 3 million cows which are intensely exploited by large farms and cattle is, and has been for more than 200 years, the main economic resource of the region. This traditional exploitation has negative aspects for biodiversity and is a risk factor for the integrity of local ecosystems found within these vast inundation plains (MMA, 2012). The region is also home to a variety of species with various origins and the Pantanal is a mixed biome that shelters more than 1.000 species of vertebrates.

Southern Fields

The Southern Fields are the most extensive natural fields in South-America, typical of humid subtropical zones, and occupy an area of approximately 176.496 sq/km. This ecosystem is dominated by grass and it encompasses the south of Brazil, almost all of Uruguay and a good portion of northern Argentina. The fields can be divided into two main categories: the high-altitude fields, or mountain fields, which extend from the north of Rio Grande do Sul State to Paraná. These fields frequently coexist with patches of araucaria forests (Atlantic Forest) in mosaic formations. Another type is the subtropical field which mainly covers the southern half of Rio Grande do Sul state and into Uruguay and Argentina (pampas). Pampas commonly show large cordons of gallery forest as well as seasonal forest patches with a predominance of Atlantic Forests (MELO, 2010).

The Southern Fields are extremely rich in campestral plants many of which originated from the Chaco, Amazon and the Andean Patagonia regions. The richness of this group of plants may include up to 2.200 species (in Rio Grande do Sul alone) which is a high number if compared to natural campestral flora within similar areas. They can also be considered as endemic of the southern region of Brazil, with 21 species of vertebrates, which makes the Southern Fields a priority for the preservation of global diversity even if it is still quite neglected by public preservation policies.

Caatinga

The Caatinga is the only ecosystem that is restricted to Brazil and it also represents the type of vegetation that dominates the Brazilian semi-arid regions which

occupy approximately 826.000 (8% of the Brazilian territory) and cover almost the entire Brazilian Northeast region. As the Atlantic Forest, the Caatinga is home to various types of vegetation. These formations create species mosaics and forest physiognomies and steppe savannahs.

These ecosystems are composed of dry forests (with trees of up to 20 meters high) that thrive in humid and deep soils but the majority of the vegetation is the shrub physiognomy that dominates the sertanejo (backlands) enclaves. Caatingas can also hold enclaves of the Atlantic Forest (the Northeastern marshes) and Cerrado in areas with abundant rain precipitation. The Caatingas and the Cerrado form a diagonal corridor (Northeast-Southwest) of dry forests and savannahs which separate the two main areas of humid forests in South America: the Amazon and the Atlantic Forest.

Recent studies show that the biological diversity and the endemic level of the Caatinga are much higher than expected of a semi-arid ecology. It holds two thousand species of vascular plants and vertebrates reaching endemism levels between 10% and 30%, similar to those of the cactus family. These numbers have overturned the old thesis that the Caatinga offers a poor ecology and is therefore not relevant for the conservation of global biodiversity. The Caating is still the least studied Brazilian ecosystem from a scientific viewpoint; 30% of its territory is practically unexplored by science (MELO, 2010).

Santos et al. (2011) have assessed the current span of Caatinga studies in Brazil and arrived at the conclusion that it is the object of very few research initiatives when compared to other Brazilian ecosystem and only a few studies have been published in international publications. The Caatinga is also the object of the lowest amount of research group activities by senior researchers in comparison with humid forests (Amazon and Atlantic Forest).

Coastal and Ocean Area

According to the Brazilian Ministry of Environment (2012) the Coastal Zone of Brazil is a territory with an extension of more than 8.500 km, including the marine zone formed by territorial waters which is 12 nautical miles broad starting from the coastline which makes it one of the largest coastal zones in the whole world. It extends from the mouth of the Oiapoque River in Amapá state, and Chuí in Rio Grande do Sul state. Apart from this area and according to the provisions of the United Nations Convention on the Law of the Sea (UNCLOS) Brazil was granted an additional 900 thousand square kilometers by the United Nations Organization which increased the amount of Brazilian

territorial waters to 4.5 million sq/km, an area that was formally named the Blue Amazon by the Inter-Ministerial Commission on Ocean Resources (CRIM).

The environments of Brazilian coastal systems are extremely diverse even if we do not know much about them. The tropical and subtropical characteristics dominate the Brazilian coast and the regional phenomena define the climatologic and oceanographic conditions that allow for the determination of distinct traces of biodiversity. The coral reefs which are distributed throughout 3.000 kilometers represent unique ecosystems of the South Atlantic and present some peculiarities when compared to other coral reefs. The presence of the Central Waters of the South Atlantic over the continental shelf in the Southeast and South regions contributes to its rich productivity. More to the South, the dislocation of the tropical convergence provides the region with a more temperate climate which in turn has a large influence on the composition of the local fauna. In spite of its clear importance, available legislation and implemented marine conservation units we have still not achieved the effective preservation of the majority of Brazilian marine environments (AMARAL&JABLONSKI, 2005).

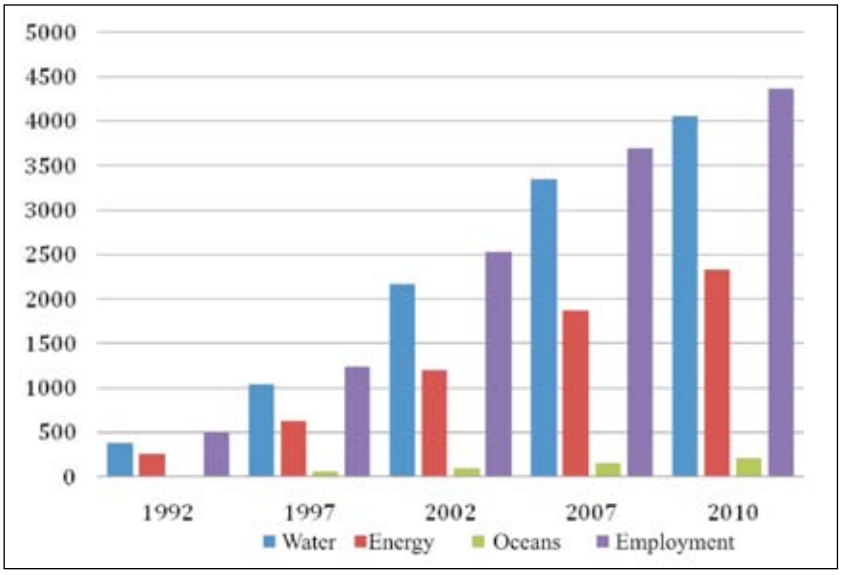
4 RIO+20 THEME'S: INDICATORS OF POSTGRADUATION PRODUCTION

Rio+20 topics are, in one way or another, inherent to practically all knowledge areas. This chapter aims to present a summary of the scientific production of Brazilian post graduate programs related to the themes of the Rio+20 Conference. Firstly, was carried out a scientific production survey from all scientific knowledge areas showing an overview of the academic-scientific contributions.

An overview of the performance of some scientific area from Capes, the coordinators have presented a synthesis of the performance of each area concerning the themes in the Rio +20 Conference, adding in some cases specific analyses of regional bases identified as relevant. To this aim, thesis and dissertations database available in Capes has been consulted.

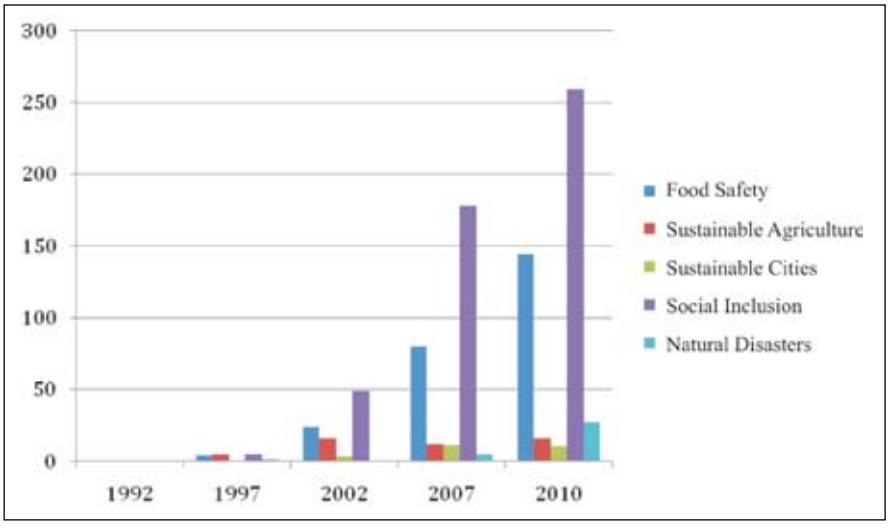
Graphic 4-1 shows notable increases for subjects such as water, energy and employment from 1992 and onwards. Graphic 4-2 shows the predominance of the subjects of social inclusion and food safety. Brazilian public policies have implemented inductive policies for the improvement of knowledge on these subjects.

Graphic 4-1: Scientific production related to themes water, energy, oceans and employment in the period 1992-2010



Source: Thesis Data Bank/CAPES (academic masters, doctorates, professional masters)

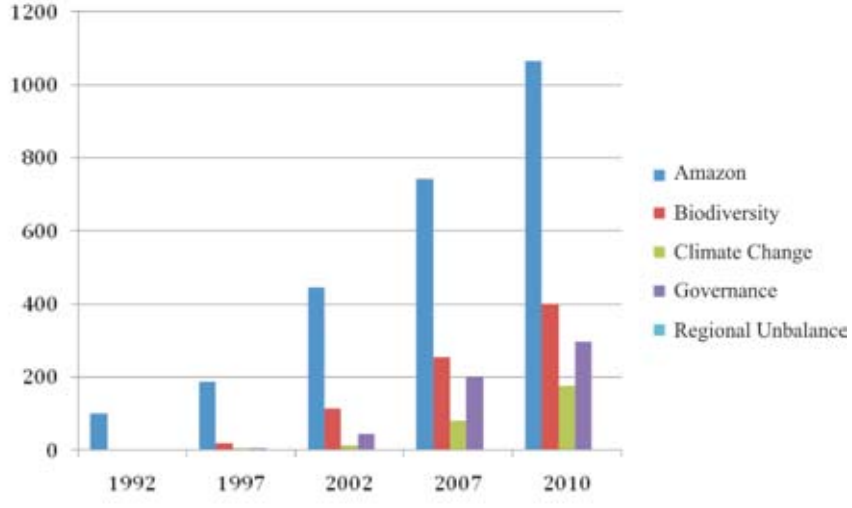
Graphic 4-2: Scientific production related to themes food safety, sustainable agriculture, sustainable cities, social inclusion and natural disasters in the period 1992-2010



Source: Thesis Data Bank/CAPES (academic masters, doctorates, professional masters)

Graphic 4-3 also shows an increase in the number of research studies on subjects such as the Amazon, biodiversity, climate change, regional unbalance or regional asymmetry and governance. Graphic 4-3 also shows an increase in research from 1992 and onwards.

Graphic 4-3: Scientific production related to themes Amazon, biodiversity, climate change, governance and regional unbalance in the period 1992-2010



Source: Thesis Data Bank/CAPES (academic masters, doctorates, professional masters)

In order to demonstrate the evolution of Brazilian postgraduation practices and their alignment with emerging subjects we will illustrate facts through the presentation of data supplied by the Coordination Areas by Capes of Environmental Sciences, Law, Engineering I, Geosciences, Chemistry, Sociology and Biotechnology, including the number of programs and their respective degree levels by region and the number of defended thesis and dissertations during the periods 1996-2000, 2001-2005, 2006-2010.

4.1 ENVIRONMENTAL SCIENCES AREA

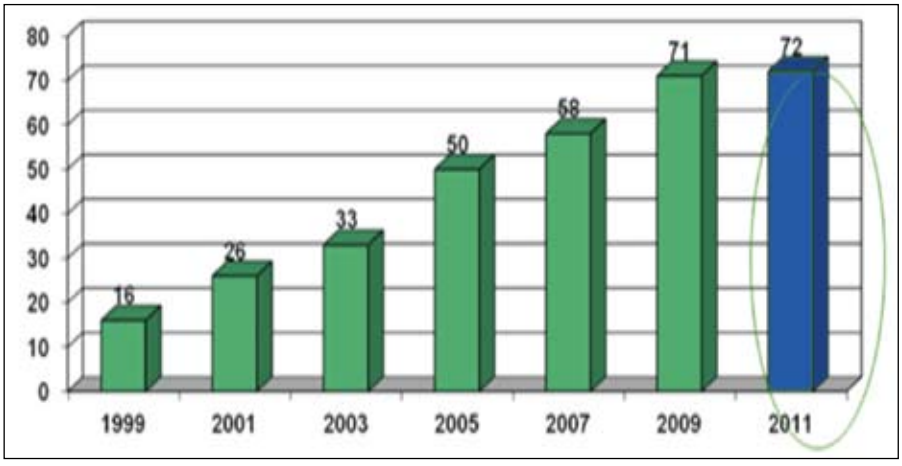
Document developed by the Coordination of Environmental Science Area of Capes, from text written by Prof. Dr. Arlindo Philippi Jr (USP), Prof. Dr. Maria do Carmo Sobral (UFPE) and Prof. Dr. Carlos Cioce Sampaio (UFPR), respectively Coordinator, Deputy-Coordinator and Professor Designate of this area.

The Environmental Sciences Committee (CACiAmb) was symbolically created on June 6, 2010, through a proposal debated and formulated by a work group that was specially appointed for this purpose and composed by members and consultants of the Interdisciplinary Area Committee (CAInter), in particular from Chamber I – Agrarian Sciences and Environment.

The creation of the Environmental Sciences Committee (CACiAmb) in the context of the Capes's System for the Assessment of Postgraduation was based on the need to address the complexity of environmental problems through interdisciplinarity in face of the indissociability of anthropic and natural systems in a contemporary world.

The CACiamb begins with a significant number of postgraduate courses due to the migration of almost all programs previously allocated in the Chamber I - Environmental and Agriculture – from Interdisciplinary Area of Capes. Currently, it is in the recognition process and procedures for migration of 72 programs that correspond to 92 courses (53 academic masters, 24 doctorates and 15 professional masters). Graphic 4-4 presents the evolution in the number of postgraduation courses provided by CAInter's Chamber I between 1999 and 2009 and CACiAmb courses in 2011.

Graphic 4-4: Comparative of the evolution in the number of postgraduation courses provided by CAInter's Chamber I between 1999 and 2009 and CACiAmb courses in 2011



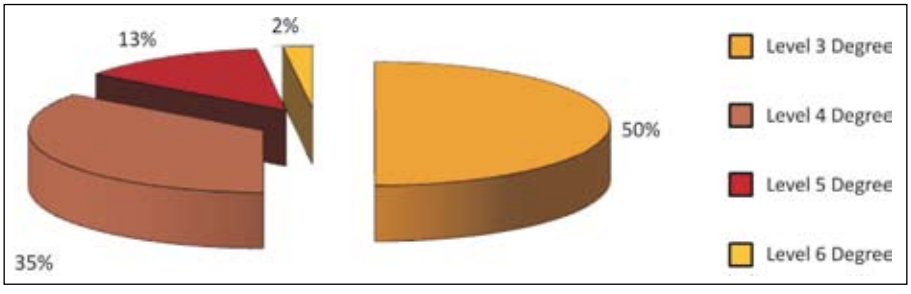
Agrarian and Environment Chambers CACiAMB

Table 4-1 and Graphic 4-5 show the number of CACiAmb courses and their distribution by degree level up to 2012.

Table 4-1: CACiAmb: Distribution by degree

Courses / Degrees 2012	3	4	5	6	Total
Doctorate	1	14	8	1	24
Academic Masters	31	17	4	1	53
Professional Masters	14	1	0	0	15
Total	**46**	**32**	**12**	**2**	**92**

Graphic 4-5: CACiAmb: Degree distribution percentages



The scope and the transversal characteristics of the knowledge areas in CACiAmb

courses form a broad universe of subjects that include basic key expressions that can be grouped according to their identities. An analysis of these groupings allows us to highlight the used basic key expressions, as presented by Table 4-2.

Table 4-2: CACiAmb: Key topics of Program research lines in 2011

Key Topics	Frequency	%
Development; Environment; Sustainability	29	51%
Natural Resources; Environmental Resources; Ecology	22	39%
Management; Planning ; Public Policies; Environmental Services	26	46%
Technology; Modeling	35	61%

Note: the percentage refers the number of key-words in the concentration areas, research lines related to 72 post graduation programs of CACiAmb.

There is a certain amount of equilibrium between the key subjects as the two largest groupings are Development; Environment; Sustainability and Technology; Modeling.

CACiAmb courses are distributed according to Table 4-3.

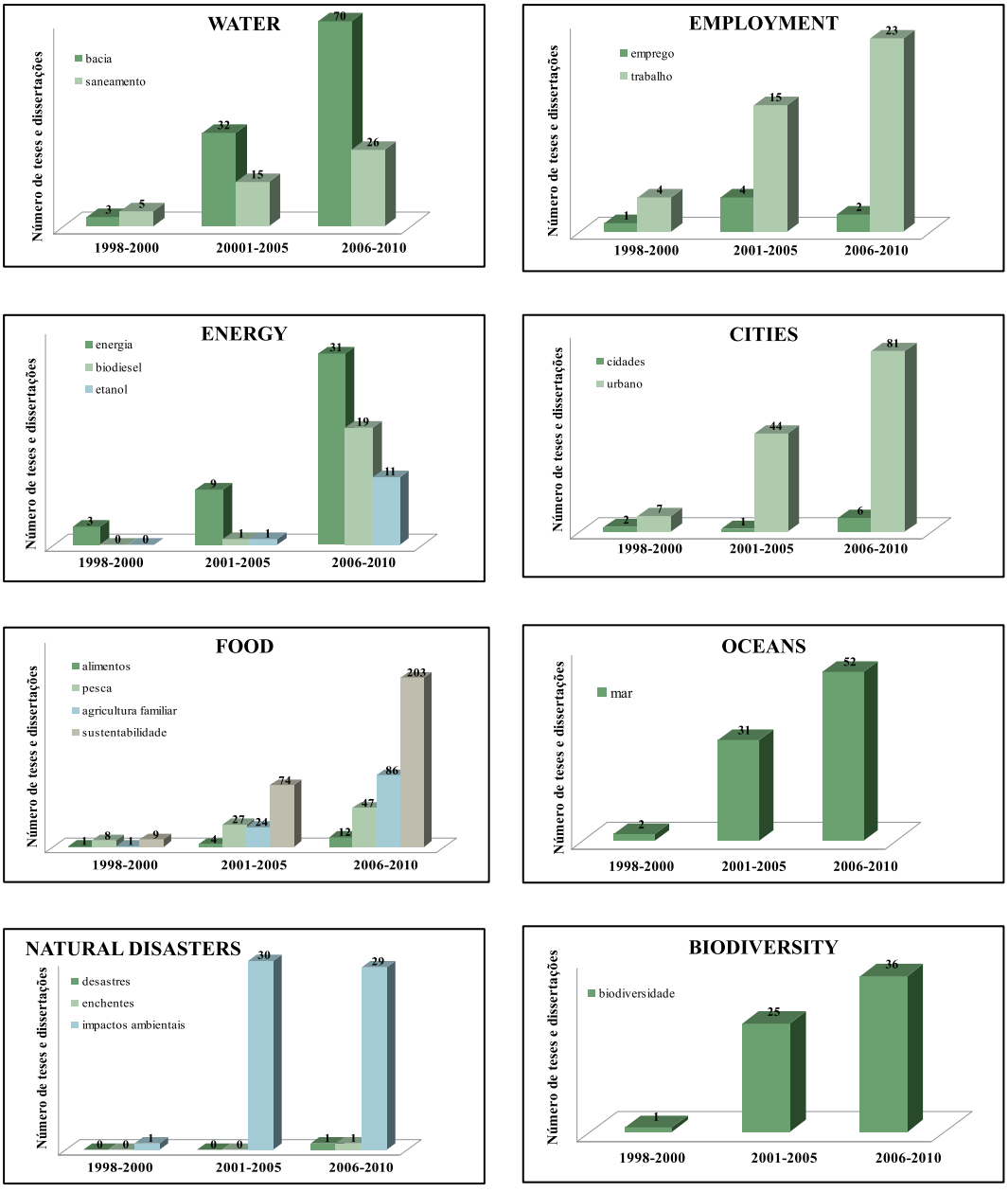
Table 4-3: Regional programs distribution

Regions	Quantity	%
South	15	21%
Southeast	21	29%
Center-West	8	11%
Northeast	18	25%
North	10	14%
Brazil	72	100%

The 72 CACiAmb programs are administered by Higher Education Institutions (IES) spread throughout 22 of the 27 Brazilian as the states of Acre, Alagoas, Amapá, Espirito Santo and Rondônia do not have any programs on the subject area. Furthermore, we point to a certain unbalance in regional course distribution and in particular in the Northeast, Southeast and South in comparison with the North and the Center-West regions.

We have identified key words in dissertation and thesis that were grouped according to their proximity to the topics of the United Nations Conference split into five-year periods. We have added two areas due to their relevance: sustainability and development (Graphic 4-6).

Graphic 4-6: Number of dissertations and thesis developed by the Environmental Science Area related to Rio+20 themes in the period 1998-2010



4.2 ENGINEERING I AREA

Document developed by the Coordination of Engineering I Area of Capes, from text written by Prof. Dr. Estevam Barbosa de Las Casas (UFMG), Prof. Dr. Neyval Costa Reis Junior (UFES) respectively Coordinator and Deputy-Coordinator of this area.

The areas of CAPES's Engineering I includes courses on Civil Engineering, Geotechnics, Sanitation and Environmental Engineering, Hydric Resources, Transportation and Urban Engineering. All of these subject areas are related to 3 of the primary Rio+20 topics: (i) sustainable cities, (ii) water, (iii) natural disasters, as the research lines of Engineering I courses focus on key questions related to urban planning and development, environmental impacts, hydric resource management, geotechnics and construction.

The Postgraduation Programs in the areas of Transportation, Urban Engineering, Civil Construction and Sanitary and Environment Engineering have provided important contributions for the solving of national and international problems related to the Sustainable Cities topic. The demographic concentration of metropolitan regions and other urban populous urban centers is the cause behind many urban problems, problems that are directly related to infrastructural and growth factors.

Postgraduation Programs in the area of Transportation have developed several studies related to urban mobility and transportation problems within large urban centers and have assisted in the development of various tools that can be applied to the real problems facing large cities as well as empowering qualified personnel for urban management and thereby contributing to increases in the sustainability of our urban centers.

Researchers linked to Postgraduation programs in the area of Urban Engineering have made important contributions in urban management and planning through a focus on urban planning, sanitation and transportation sectors and their respective integration with environment, geotechnics, social housing and geoprocessing areas.

Likewise, the Postgraduation Programs in the Civil Construction area have provided contributions for the development of sustainable construction techniques, including the minimization of construction residuals and the development of increasingly efficient and environmentally sustainable techniques. The Postgraduation Programs in the area of Sanitary and Environmental Engineering have provided significant contributions for the identification, correction and minimization of impacts on humans living in highly populated areas including specific studies of subjects

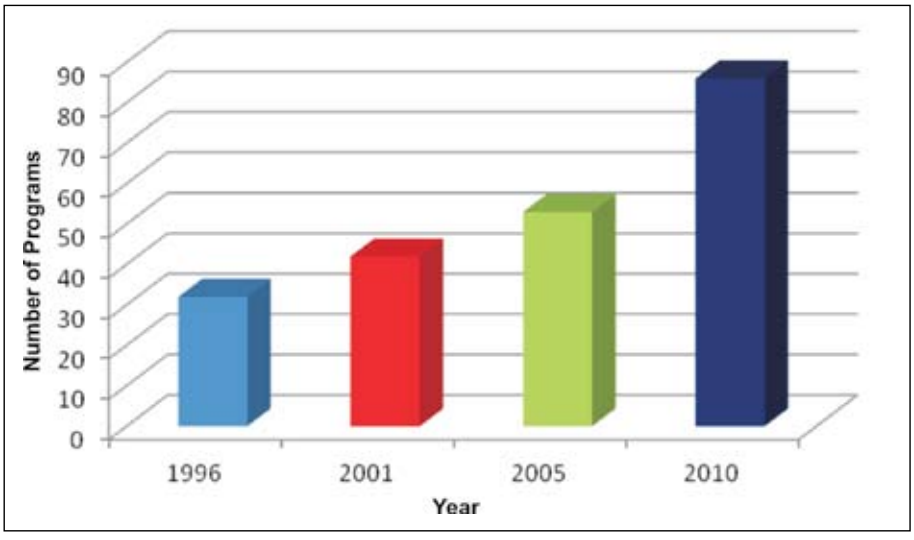
such as the reuse of water, residual management, basic sanitation and air pollution. In this context, the integrated work in all of the above mentioned areas has provided significant contributions not only in respect to the scientific advances needed for the understanding of problems and the search for possible applied solutions, but also in the empowerment of qualified personnel that can face up to these challenges which have a direct impact on the management and sustainability of Brazil's urban centers.

Water is the central focusing point of Postgraduation Programs on Hydric Resources and Sanitary and Environmental Engineering. Matters related to the availability of water and economic developments are the object of studies in courses on hydric resources that primarily focus on the management and preservation of Brazilian regional hydric resources. Courses in Sanitary and Environmental Engineering have also made important contributions for this knowledge area particularly through studies on innovative technologies for environmental sanitation, water and sewage treatment and the reuse of water. Some of the techniques developed in Brazil for the above purposes have achieved international recognition.

Postgraduation Programs in Geotechnics, Sanitary and Environmental Engineering and Urban Engineering have made significant contributions in the area of Natural Disaster management. Geotechnical and Urban Engineering programs have made considerable efforts to develop tools for the identification of risk areas and the mapping of geotechnically unsafe areas. Programs on Sanitary and Environmental Engineering are responsible for important advances on the understanding of the implications of environmental risks linked to anthropic activities. In this context, research lines have focused their efforts not only in the collection of knowledge of the current situation but also on transformations caused by climate change and the identification of new challenges linked to hydric availability and risks associated with meteorological factors.

Graphic 4-7 shows the number of Postgraduation Programs in the area of Engineering I since 1996 and their significant increase during the last 20 years. The growth implies an increase of research volume on the above mentioned topics which has a direct impact on the production of knowledge and the empowerment of professionals that are qualified to face up to the challenges. There are 4 courses in this area on a level 7 degree according to the latest CAPES assessment. Three of them are located in the Southeast and one in the South region. There are also 4 courses on a level 6 degree and three of them are located in the Southeast and one in the Center-West region.

Graphic 4-7: Evolution in the number of Postgraduation Programs in the area of Engineering I from 1996 and 2010.



4.3 CHEMISTRY AREA

Document developed by the Coordination of Chemistry Area of Capes, from text written by Prof. Dr. Luiz Carlos Dias (UNICAMP) and Prof. Dr. Adriano Lisboa Monteiro (UFRGS) respectively Coordinator and Deputy-Coordinator of this area.

In 2010, the area of Chemistry included 58 CAPES recommended Postgraduation Programs. The current number of CAPES recommended Programs is 61 (a total of 96 courses: 57 Academic Master's, 37 Doctor's and 2 Professional Master's) held in almost all of the Brazilian states. The area offers 22 Programs that only offer academic master's degrees, 2 Programs that only offer Doctror's degrees, 35 Programs for both Master's and Doctor's and 2 Programs for Professional Master's degrees.

Table 4-4 show the number of programs, and their respective degree level percentages.

Table 4-4: CA in Chemistry: Distribution by level of Degree

Degree level	3	4	5	6	7	Total
Programs	17	22	12	3	7	61

Older Programs have been consolidated and play a central role in various courses in the Center-West and North regions of Brazil, according to Table 4-5.

Table 4-5: CA in Chemistry: Distribution of Courses by Region

Regions	Quantity	%
South	12	17%
Southeast	26	36%
Center-West	8	11%
Northeast	12	17%
North	3	4%
Brazil	**61**	**100%**

The medium enrollment rate between 2007 and 2009 was 2.049 master students and 2.115 doctorates. The period also shows medium rate of 804/masters/year and 457/doctorates/year numbers that represent an increase of 38% and 36% respectively in relation to the previous three-year period.

Professors are involved in all subareas of Chemistry and interact strongly with affiliated areas (Medicine, Physics, Agronomy, Biology, Biotechnology, Biochemistry, Materials, Engineering, Education etc.) this multi- and interdisciplinary is reflected in the diversity and quality of scientific production.

During the above period 10.475 articles were published of which 62% (6.530) involved the participation of at least one student. 54% of the total number of teachers published 7 or more articles in international magazines during the same triennial period.

The area's technological progress can be measured through the number of patent applications – 272 during the triennial period 2007-2009, representing an increase of 55% in relation to the previous triennial period. Even if most masters and doctors in the area of Chemistry choose an academic carrier a significant number of them (20-25%) are active in the public and private sectors. The area has achieved international acknowledgement and has one of the rates of citations and published articles in Brazil.

The area's main challenges are the consolidation of courses in the North, Northeast and Center-West regions and the simultaneously increase in the number of doctors and the quality of scientific and technological production in these regions.

Table 4-6 and Graphic 4-8 show the evolution in the number of Programs in the area of Chemistry during the period 1998 to 2010 (1998; 2001; 2005 e 2010), and how many are considered excellent (5, 6 and 7 degree levels) by region.

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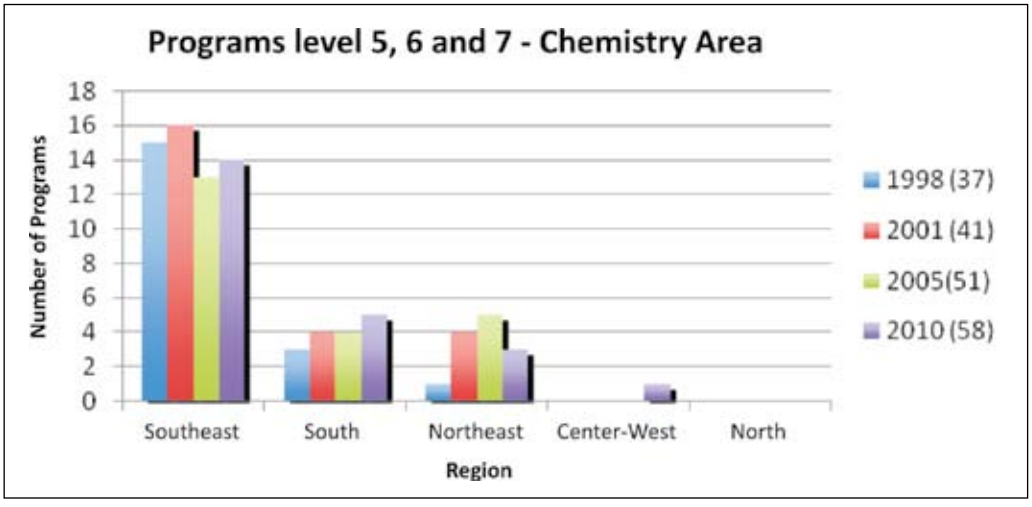
Table 4-6: CA in Chemistry: Number of post graduation programs during the period of 1998; 2001; 2005 and 2010, and how many are considered excellent.

Year	Total Programs	Southeast	South	Northeast	Center-West	North
1998	37	15	3	1	0	0
2001	41	16	4	4	0	0
2005	51	13	4	5	0	0
2010	58	14	5	3	1	0

Graphic 4-8: CA in Chemistry: Number of post graduation programs by level of excellence (5,6 and 7 degree levels) by region in the period of 1998; 2001; 2005 e 2010.



Bellow we present commentaries on some topics that are directly or indirectly linked to Rio+20: Water, Oceans, Environment, Energy and Food. Data was reached through a filtering process of key words that represent the above areas.

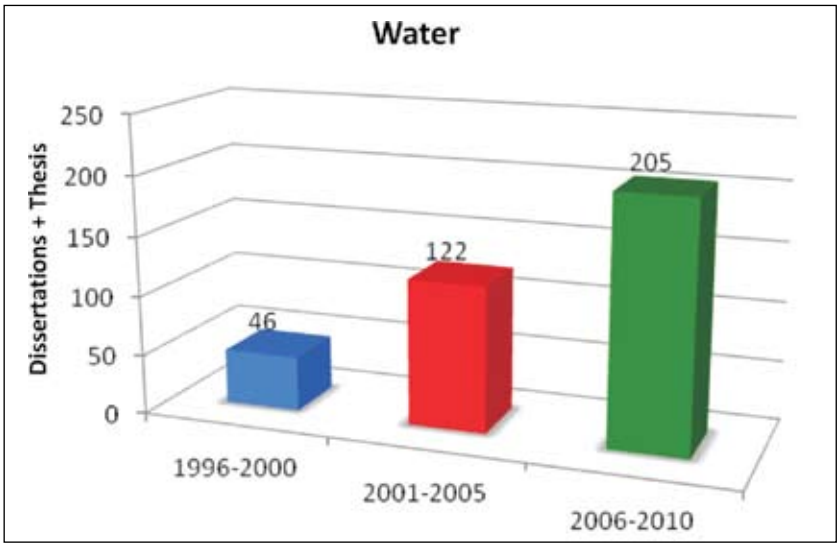
Theme: Water

We have searched for the word "water" in titles and research lines and its association to the environmental contexts, including oceans. Our search leads us to conclude that work on this area has shown some progress: development of analysis methods and analysis of contamination agents in fresh and salt water, marine animals and algae as well as studies on transformational processes and the evolution of

water contaminants, environmental monitoring, development of new materials for water recuperation and industrial and agricultural effluents, biosensors and oxidative processes.

Graphic 4-9 shows the number of Master's Dissertations and Doctorate Thesis defended during the periods 1996-2000, 2000-2005 and 2006-2010, that addressed the subject of water.

Graphic 4-9: CA in Chemistry: Dissertations and thesis addressing the subject of water in the period of 1996-2010

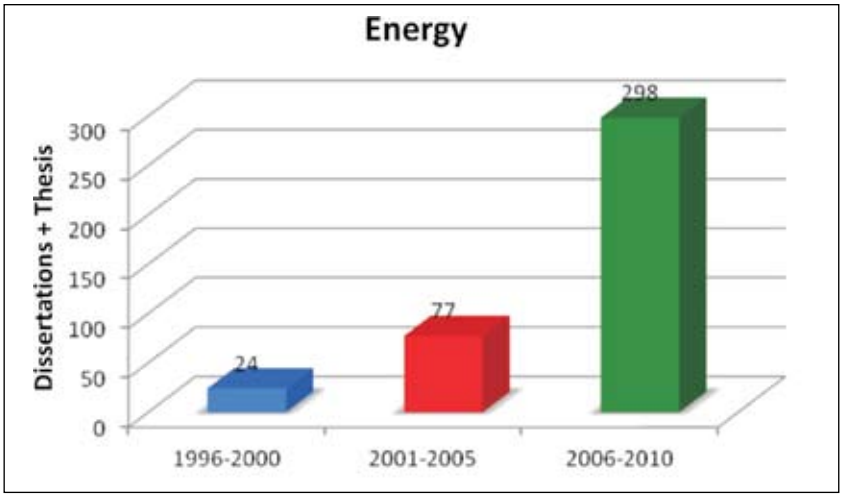


Theme: Energy

Energy is a topic that is increasingly present in a large number of Postgraduation programs in Chemistry. In order to survey existing data we undertook a filtering based on the key words (i) fossil combustibles (oil and derivatives) and biofuel (biodiesel and ethanol), synthesis and analysis of biofuel, (iii) hydrogen production, (iv) alkane and alcohol regeneration, (v) cells and combustibles, additives and antioxidants for combustibles and biofuels. The impressive increases during the last 5 years are due to the incentives in the area of research on renewable energy sources and clean processes.

Graphic 4-10 presents the number of Master's Dissertations and Doctorate Thesis focusing on the subject of energy and during the periods 1996 to 2000, 2000 to 2005 and 2006 to 2010.

Graphic 4-10: CA in Chemistry: Dissertations and thesis addressing the subject of energy in the period of 1996-2010

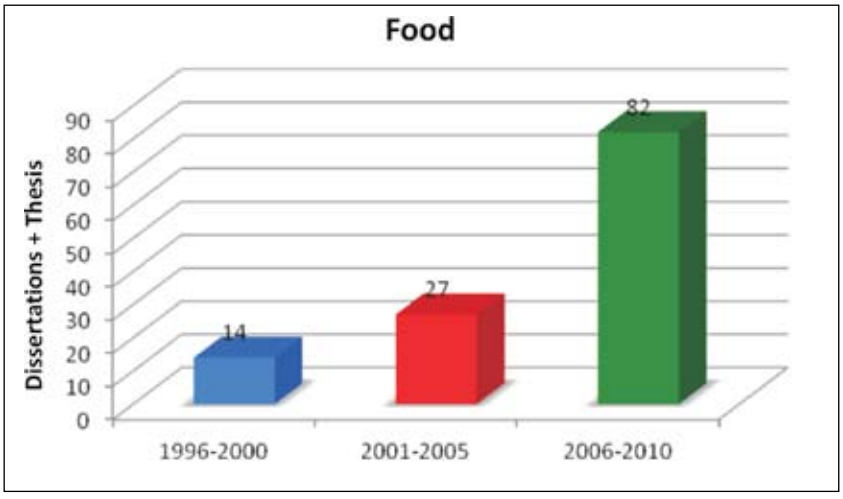


Theme: Food

We have also focused our search on studies and research lines which included the word food in their titles or as a key word. Studies in this area are spread in in subjects such as: food analysis, additions (color, conservatives, etc) micronutrients and contaminating agents, development of new food products, reuse of animal and vegetable materials, food degradation assessments, biologic activity of vegetables, determination of parameters for kinetic and thermal stability of packaged food, degradation analysis and interactions with foodstuffs.

Graphic 4-11 shows the number of Master's Dissertations and Doctorate Thesis defended during the periods 1996-2000, 2000-2005 and 2005-2010 and included subject of food.

Graphic 4-11: CA in Chemistry: Dissertations and thesis addressing the subject of food in the period of 1996-2010



4.4 GEOSCIENCES AREA

Document developed by the Coordination of Geosciences Area of Capes, from text written by Prof. Dr. Álvaro Penteado Crósta (UNICAMP) and Prof. Dr. Arí Roisenberg (UFRGS) respectively Coordinator and Deputy-Coordinator of this area.

Geosciences, or science of the earth, are traditionally composed by the subareas of geology, geochemistry, geophysics, oceanography, meteorology and by the group cartography/geodetics/remote sensing. Its purpose is the study of Earth systems composed by the atmosphere, geosphere, hydrosphere and biosphere. In relation to environmental matters we also include the pedosphere that is composed by the various types of soil and the anthroposphere, which includes human groupings and their relations in industry, agriculture, transportation, urbanization and other social contexts (CAPES, 2012b).

The Geosciences Area Committee (CA) is composed of 50 Programs and 18 are characterized as programs of excellence on degree levels 5, 6 and 7 (Table 4-7).

Table 4-7: Distribution of excellence programs by region

Regions	Quantity
South	2
Southeast	12
Center-West	1
Northeast	2
North	1
Brazil	18

For the definition of the number of dissertations and thesis related to the themes of Rio+20 through the key words as shown in Table 4-8.

Table 4-8: Key-words according to themes, used to define the number of Thesis and Dissertations defended during the period 1996 to 2010 and linked to Rio+20.

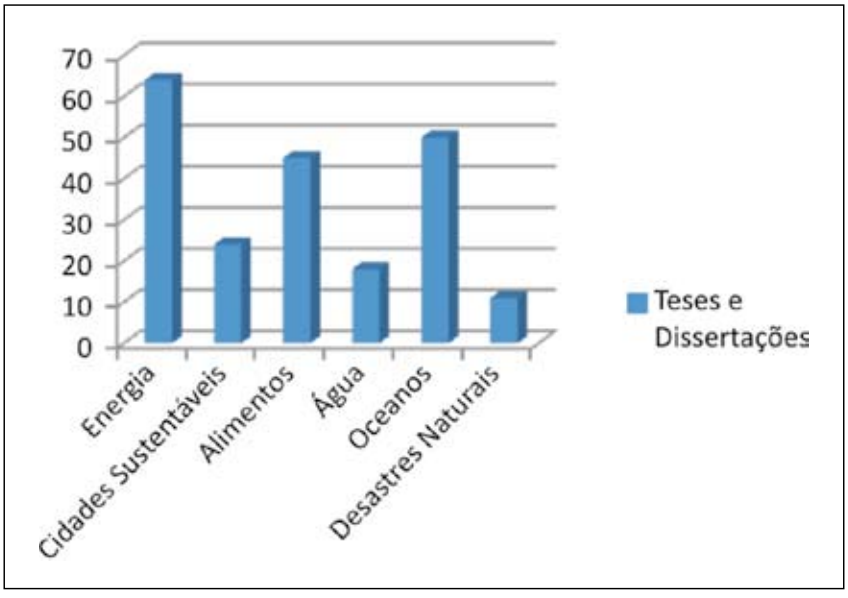
Subject	Key-words
Energy	Oil, gas, coal, uranium
Sustainable Cities	environmental geology, urban geology, environmental geochemistry, garbage dumps
Food	fertilizers, erosion
Water	subterranean water, aquifer
Oceans	oceanography
Natural Disasters	geological risk, urban geology

Table 4-9 and Graphic 4-12 show the number of dissertations and thesis defended during the period 1996-2010 related to the themes of Rio+20, using the key words.

Table 4-9: Thesis and Dissertations defended during the period 1996-2010 containing references linked to Conference Themes

Topic	Dissertations	Thesis	Thesis and Dissertations
Energy	49	15	64
Sustainable Cities	14	10	24
Food	33	12	45
Water	12	6	18
Oceans	34	16	50
Natural disasters	2	9	11

Graphic 4-12: Thesis and Dissertations defended during the period 1996-2010 containing references linked to Conference Themes



4.5 LAW AREA

Document developed by the Coordination of Law Area of Capes, from text written by Prof. Dr. Martonio Mont'Alverne Barreto Lima (UNIFOR) and Prof. Dr. Sérgio Augustin (UCS) respectively Coordinator and Professor Designate of this area.

The United Nations Conference on Sustainable Development – Rio+20, which will be held in Brazil in 2012 is centered on "a green economy in a sustainable development

context and the eradication of poverty" and on "the institutional structure of sustainable development".

The acknowledgements that a green economy, the eradication of poverty and the institutional framework in a sustainable development context – Conference topics – can only be completely reached through the active, coherent and committed participation of teachers, students and researchers involved in Master and Doctorate Programs, and in particular those that deal with the "environment", implies the logical social function of the Academy.

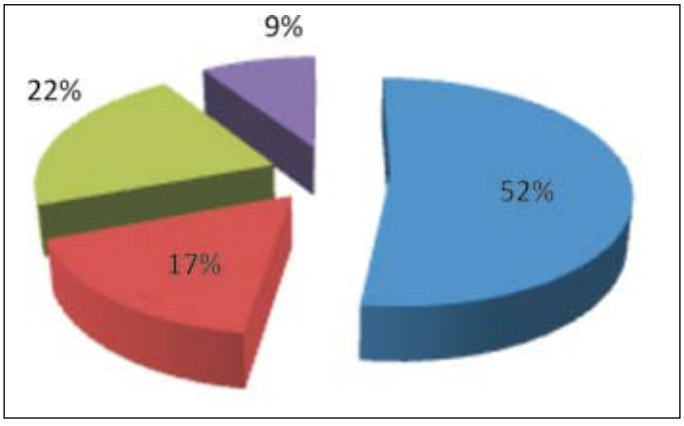
The Law Area Coordination is an umbrella for various experienced Programs for the study of the environment and has a long history of debate on the subject on an international level through partnerships with researchers in foreign universities (CAPES, 2012c).

The Law Area Committee is composed by 65 Programs of which 28 offer doctorate degrees. The Table 4-10 and Graphic 4-13 show the number of programs and their distribution by degree level.

Table 4-10: CA in Law: Distribution of number of programs by degree level

Level	3	4	5	6	7	Total
Programs	34	11	14	6	---	65

Graphic 4-13: CA in Law: Degree level percentages



The Programs are regionally distributed according to Table 4-11.

Table 4-11: Distribution of courses by region

Regions	Quantity	%
South	18	28%
Southeast	30	46%
Center-West	6	9%
Northeast	9	14%
North	2	3%
Brazil	**65**	**100%**

We identified, in accordance with Table 4-12, appropriate search codes for *dissertations* and *thesis* that were close to the topics of the United Nations Conference and yet nit "compatible" with the topics referenced in this verification. In these cases the computation was made through the *Other Topics* variable due to the understanding that such production also contributes to the debated on sustainable development.

Table 4-12: Computation of dissertations and thesis produced by Law Area Programs (period 1996-2010) and their linkage to Rio+20 themes

Nº	CONFERENCE THEMES	Key-words(samples)	Dissertations	Thesis
01	Labor and Employment (green economy)	Green economy, labor, employment, work environment, green taxes, economic development, poverty, misery, hunger, commerce, carbon..	237	17
02	Energy	Energy, natural gas, interaction	35	02
03	Sustainable cities	Urban planning, Basic Plan, zoning, sanitation, residuals, urbanism, pollution, City Statutes, sustainable cities, urban property, urban development, sewages.	184	25
04	Food (food safety and sustainable agricultures)	Food safety, agriculture, food, feeding, transgenic, hunger, labeling, information..	30	05
05	Water	Water, hydric resources, rivers, basins, aquifers, subterranean, pollution, garbage, sewage.	91	16

Nº	CONFERENCE THEMES	Key-words(samples)	Dissertations	Thesis
06	Oceans	Oceans, seas, coastal zones, littoral, navigation, oil, marine life, precautions, pollution, garbage, harbor	11	03
07	Natural disasters (risk reduction and resilience)	Natural disaster, sustainable occupation, favelas (shantytowns), poverty, pollution, earth, planet, global warming, nuclear Law, epidemic, landslides, risk, precaution, management, agro-toxic.	36	--
08	Other topics	Environmental education, animals, forests, environment, cultural, environmental law, biodiversity sustainable consumption, socio-environmental responsibility, eco-citizenship, environmental crime.	598	91
Total		--	**1.222**	**159**
			1.381	

Table 4-13 shows the number of Dissertations and Thesis defended during the periods 1996-2000, 2000-2005 and 2006-2010, that included Rio+20 Conference topics.

Table 4-13: Number of dissertations and thesis produced by Programs in the Law Area (period 1996-2010) organized by five-year periods

Nr.	CONFERENCE TOPICS	1996-2000		2001-2005		2006-2010	
		Dissertations	Thesis	Dissertations	Thesis	Dissertations	Thesis
01	Labor and employment (green economy))	21	01	68	02	148	14
02	Energy	01	--	06	--	28	02
03	Sustainable cities	13	--	68	05	103	20

Nr.	CONFERENCE TOPICS	1996-2000		2001-2005		2006-2010	
		Dissertations	Thesis	Dissertations	Thesis	Dissertations	Thesis
04	Food (food safety and sustainable agriculture)	--	--	14	--	16	05
05	Water	02	--	32	07	57	09
06	Oceans	--	--	07	01	04	02
07	Natural disasters (risk reduction and resilience)	01	--	09	--	26	--
08	Other Topics	49	06	244	35	305	50
Total		**87**	**07**	**448**	**50**	**687**	**102**
		94		**498**		**789**	

We consider this study as a preliminary stage that deserves specific research. Even if the production in the Area of Law of topics related to the United Nations Conference was significant during the period 1996-2010 we still have a long way to go. A large quantity of subjects demand more work; research has allowed us to identify the lack of, for instance, research studies related to hydric resources, oceans and energy.

An in depth analysis of environmental topics in the Area of Law demands a permanent cycle of debate and propositions focused on sustainable developmen in a joint and engaged effort by *Stricto Sensu* Postgraduation Programs in the Area of Law in cooperation with other knowledge Areas and through interdisciplinary practices.

4.6 SOCIOLOGY AND SOCIAL SCIENCE AREA

Document developed by the Coordination of Sociology Area of Capes, from text written by Prof. Dr. Jacob Carlos de Lima (UFSCAR) and Prof. Dr. Soraya Vargas Cortes (UFRGS) respectively Coordinator and Deputy-Coordinator of this area.

Sociology if intrinsically interdisciplinary, it deals with broad topics and flexible interfaces with all knowledge areas, following the continuous transformations of its

"object", society, and incorporation new ideas and approaches that are often marginalized by other sciences (CAPES, 2012d).

The area of Sociology and Social Sciences grew by 61% during the last 10 years, from 30 existing programs at the end of the triennial 1998-2000 to the current number of 50 Programs, a reflection of postgraduation expansion in Brazil. The production of dissertations and thesis has followed this expansion exponentially and increased from 1.641 defenses between 1996 and 2000 to 6.664 between 2001 and 2010, an increase of 406%.

The Sociology Area Committee is composed by 50 Programs and 35 offer doctorate degrees. The Programs are distributed regionally according to Table 4-14.

Table 4-14: Distribution of Sociology courses by region

Regions	Quantity	%
South	10	20%
Southeast	22	44%
Center-West	2	4%
Northeast	12	24%
North	4	8%
Brazil	**50**	**100%**

Data included in this text was extracted from the CAPES databank and refers to the number of dissertations and thesis defended between 1996 and 2010 in the area of Sociology and Social Sciences. Ten broad subjects were selected from the 8.305 studies presented during this period, studies directly or indirectly linked to the Rio+20 topics: labor and employment; energy; cities; food; water; fishing and oceans; disasters; Amazon; culture; globalization.

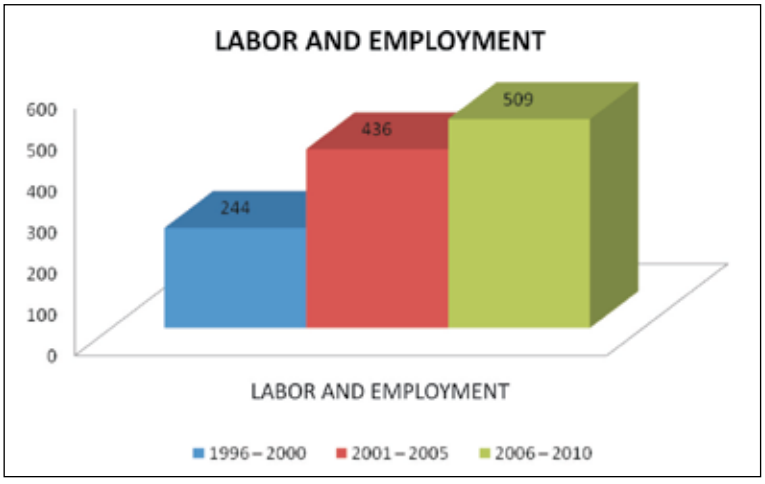
Data was collected through the filtering of key-words that represent the above areas.

Theme: Labor and Employment

Labor and Employment is a central subject in Sociology and is present in a large number of Postgraduation Programs. Studies on this subject have increased substantially during the period and represent 14.32% of all defended area studies. There was an increase of 64.1% during the period between 2001 and 2005, and a decrease to

57.6% during the following period (Graphic 4-14). The above increases can be explained by contemporary economic restructuration and the social implications of changes in labor and employment practices. Current debate is concentrated on the composition, organization and behavior of social classes, syndicalism, social and cultural identity and labor market inclusion, social rights and political action. The key-words used as filters were: labor; employment; insecurity; income.

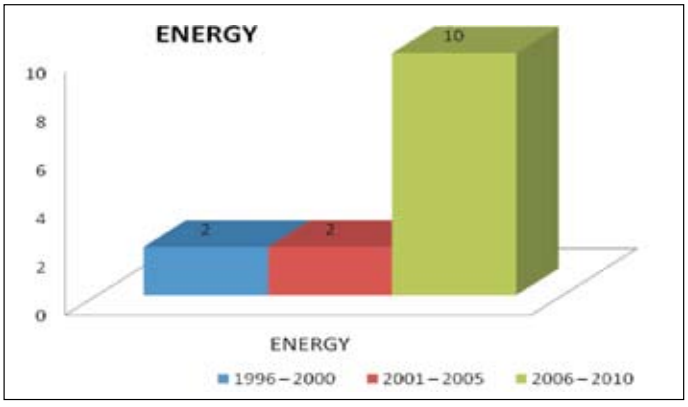
Graphic 4-14: Number of dissertations and thesis in the area of Sociology on the subject of Labor and Employment from 1996 to 2010.



Theme: Energy

The second subject, Energy, shows a small number of studies due to its specifics. In spite of this production went from two during the first two five-year periods to more than 10 during the last period (Graphic 4-15). Studies focused primarily on public policies for the sector, privatization, regional development and the impact of the arrival of energy on communities located within Brazil's peripheral zones. The key-words used for the filtering process were: energy; combustible(s); biofuel(s).

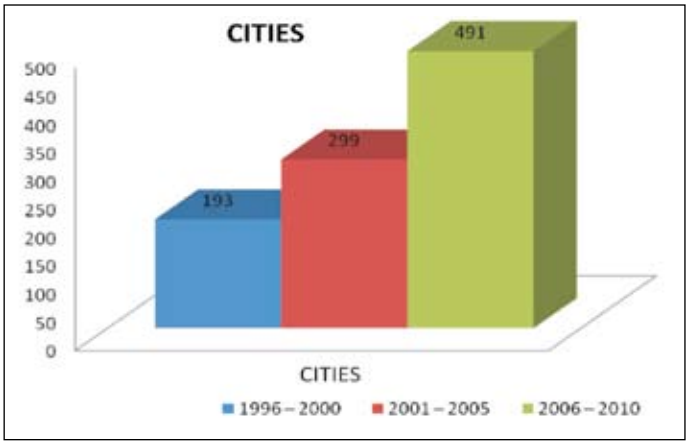
Graphic 4-15: Number of dissertations and thesis in the area of Sociology on the subject of Energy from 1996 to 2010.



Theme: Cities

The subject of Cities has a privileged position in sociological studies since the 60's and this is mostly due to the growth in urbanization, metropolization, expansion of peripheral zones and its social impact: lack of infrastructure, social movement demands, urban violence, socialization, spatial and social segregation, occupation of urban soil, "favelization" (expansion of shantytowns), popular revolts, political organization and participation (Graphic 4-16). The key-words used during the filtering process were: city; urban(ization); metropolis (metropolization etc.).

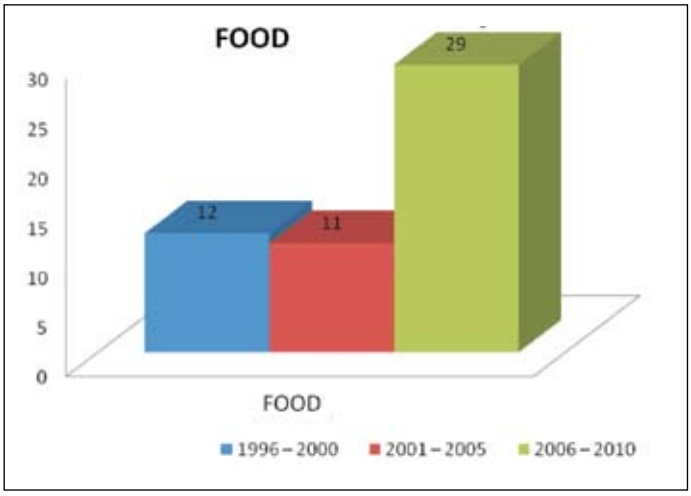
Graphic 4-16 – Number of dissertations and thesis in the area of Sociology on the subject of Cities from 1996 to 2010.



Theme: Food

Food is a recent research field that is closely related to the "new" economic and consumption sociology that focuses on food habits and on the commercialization and sociability networks connected to different lifestyles. Or even food linked to popular religiousness, the body as a determining social esthetics concept, the perspective of a healthy life based on specific feeding habits that are, again, connected to different lifestyles. The last five-year period shows a significant increase in research on this subject, namely three times the amount produced during the other two five-year periods (Graphic 4-17). The key-words used for the filtering process were: foodstuff(s); food; nutrition(al).

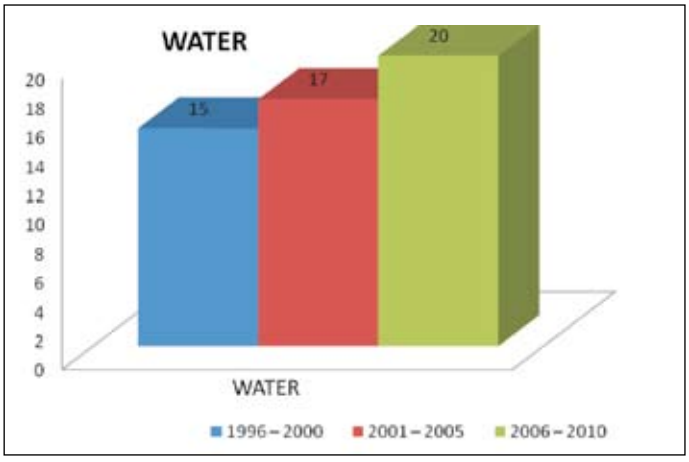
Graphic 4-17: Number of dissertations and thesis in the area of Sociology on the subject of Food from 1996 to 2010.



Theme: Water

The subject of Water is a recent arrival on the environmental debate scene but its increase has been slow as it is intrinsically multidisdicplinary and therefore spread over various knowledge areas. In Sociology, water is the subject of research in the area of hydric basins, public policies focused of the same basins, on the impact of electric plants on riverside populations, the use of rivers and lakes by neighboring communities and on socio-environmental change (Graphic 4-18). The key-words used in the filtering process are: water; basin; hydric (hydroelectric).

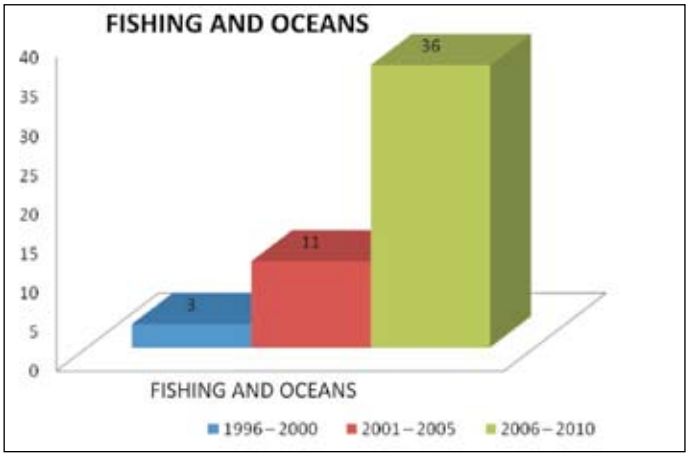
Graphic 4-18: Number of dissertations and thesis in the Area of Sociology on the subject of Water from 1996 to 2010.



Theme: Fishing and Oceans

Research on Fishing and Oceans often confuse one with the other, as in the case of Water, even if research is predominantly focused on sea workers and traditional fishermen, social and gender relations. Research has about tripled, as in the case of Water, during the last five-year period and mostly due to increases in the area of the environment (Graphic 4-19). The key-words used for the filtering process are: fishing; fishing vessels; riverine; ocean; sea.

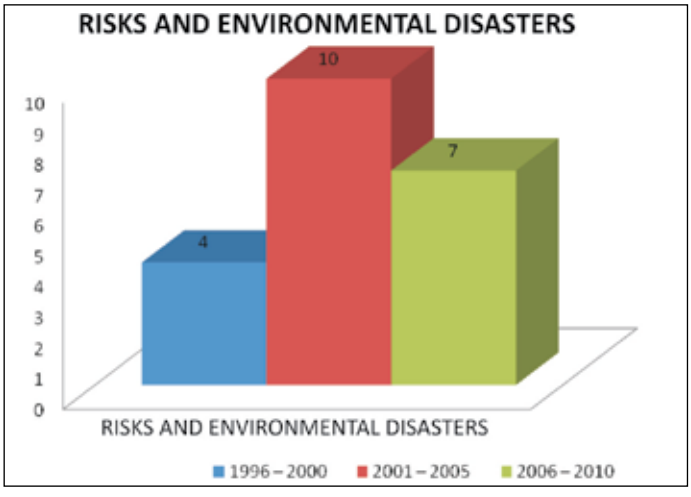
Graphic 4-19 – Number of dissertations and thesis in the area of Sociology on the subject of Fishing and Oceans from 1996 to 2010.



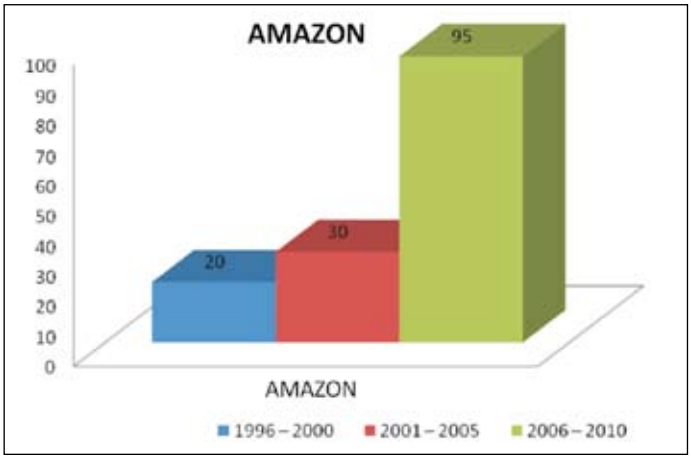
Other themes

Besides the themes above, were addressed other topics such as Risks and Environmental Disasters (Graphic 4-20), Amazon (Graphic 4-21), Culture (Graphic 4-22) and Globalization (Graphic 4-23). The following key-words were used for during the filtering process: Risks and Disasters (risk, disaster, floods and landslides); Amazon (Amazon, forest, Amazonia; Culture (culture); and Globalization (globalization, global).

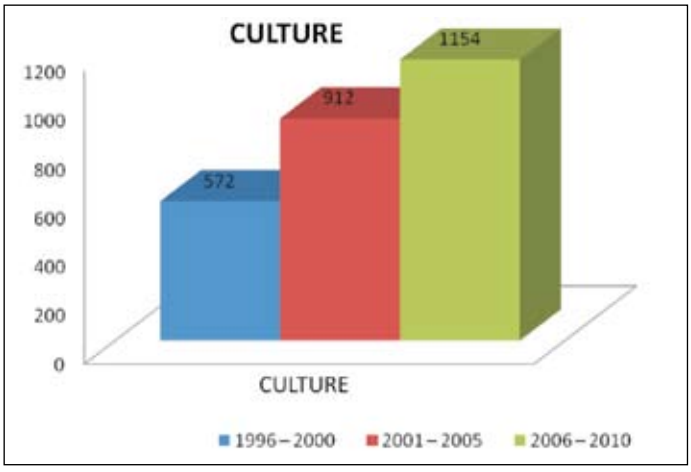
Graphic 4-20: Number of dissertations in the area of Sociology on the subject of Risks and Disasters from 1996 to 2010.



Graphic 4-21: Number of dissertations in the area of Sociology on the subject of the Amazon and from 1996 to 2010.



Graphic 4-22: Number of dissertations in the area of Sociology on the subject of Culture from 1996 to 2010.



Graphic 4-23: Number of dissertations in the area of Sociology on the subject of Globalization from 1996 to 2010.

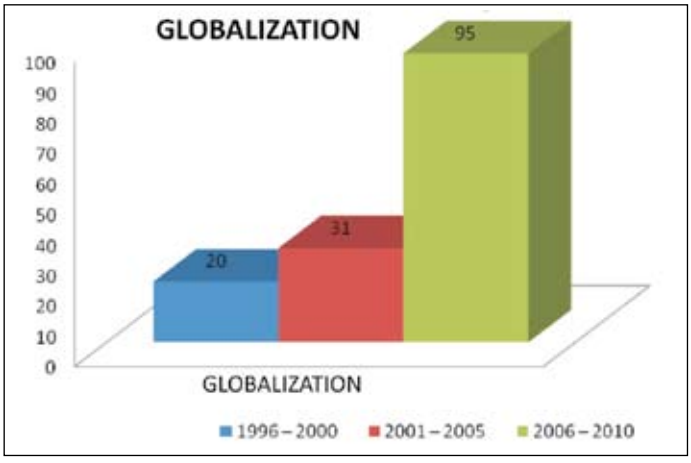


Table 4-15 presents a synthesis of the number of Dissertations and Thesis linked to the topics of the Rio+20 Conference and defended during the periods of 1996-2000, 2001-2005 and 2006-2010.

Table 4-15: Number of dissertations and thesis produced by Programs in the Area of Sociology (1996-2010) organized into five-year periods.

Nr.	CONFERENCE TOPICS	1996-2000	2001-2005	2006-2010
01	Labor and Employment	244	436	509
02	Globalization	20	31	95
03	Energy	2	2	10
04	Sustainable cities	193	299	491
05	Food (food safety and sustainable agriculture)	12	11	25
06	Water	15	17	20
07	Fishing and Oceans	3	11	36
08	Natural disasters (risk reduction and resilience)	4	10	7
09	Amazon	20	30	95
10	Culture	572	912	1.154
Total		**1.085**	**1.759**	**2442**

4.7 BIOTECHNOLOGY AREA

Document developed by the Coordination of Biotechnology Area of Capes, from text written by Prof. Dr. Maria Fátima Grossi de Sá (UCB/Embrapa) Coordinator of this area.

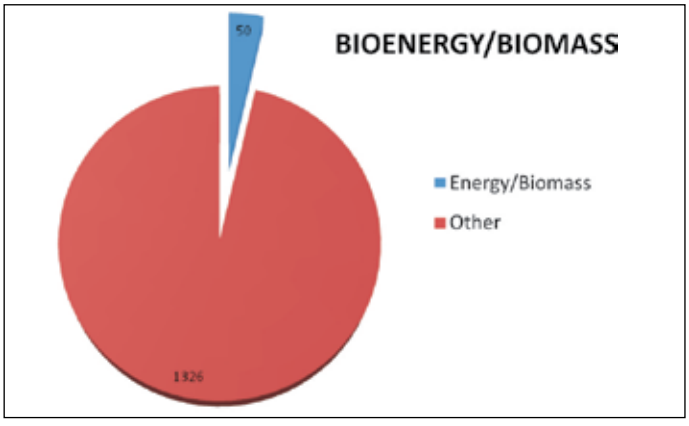
Data contained in this text was collected from the CAPES database on dissertations and thesis defended in Brazil during the years 2007 to 2010 in the area of Biotechnology. We have selected broad topics from 1.376 studies during these years which are directly or indirectly connected to Rio+20: energy; food (food safety and sustainable agriculture); water and the Amazon.

The collection of data was the product of a filtering process of key-words that represent the respective areas. References were analyzed as well as repetitions from previous filtering processes.

Theme: Energy

The production of energy through Biotechnological processes is a topic that has attracted a lot of attention. Of the 1.376 studies in the area of Biotechnology, 50 have included the subject of BIOMASS and the production of ethanol and other biofuel (Graphic 4-24).

Graphic 4-24: Number of dissertations in the area of Biotechnology on the subject of Energy from 2007 to 2010.

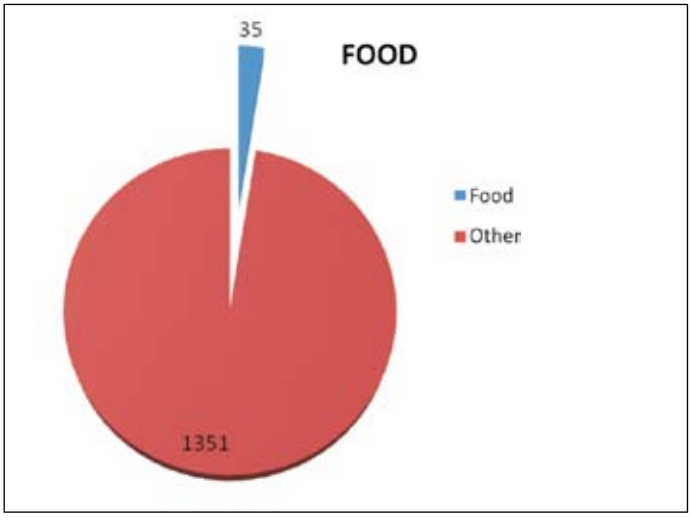


[Filter: Energy, Biomass - Total Production: 50]

Theme: Food (Food Safety and sustainable Agriculture)

Biotechnology has provided great contributions in the area of product development such as foods, either through transgenic or through the development of additives used in processed food. During the period 2007 to 2010 50 of a total of 1.376 thesis and dissertations touched the topic "food" (Graphic 4-25).

Graphic 4-25 – Number of dissertations and thesis in the area of Biotechnology and the topic of Food during the period 2007 to 2010.



[Filter: Food - Total Production: 35]

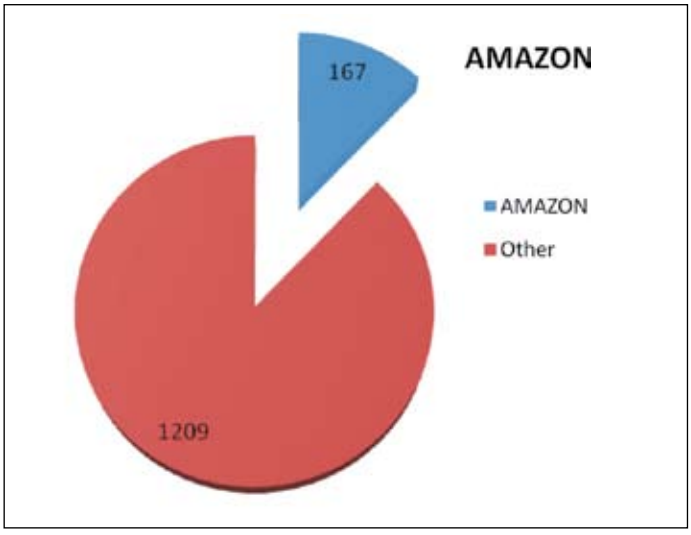
Theme: Water

The topic of Water is not a common topic in the area of Biotechnology; however, fishing resources are often approached by studies in this area. Seven of a total of 1.376 defended thesis and dissertations have studied the topic "fish" and focused in particular on aspects related to genetics, health and production.

Theme: Amazon

Biotechnology area is very active in the Amazon region and in particular in the study of the region's natural resources. Some postgraduation programs deal exclusively with this topic. 165 of the 1.376 thesis and dissertations defended during the period touched subjects related to the Amazon (Graphic 4-26).

Graphic 4-26 – Number of dissertations and thesis in the area of Biotechnology and the topic Amazon, from 2007 to 2010.



[Filter: Amazon, Amazonia - Total Production: 165]

5. INSTRUMENTS FOR THE FORMATION OF HUMAN RESOURCES

This chapter presents the following instruments for human resources formation which have been applied at Brazilian National Postgraduation System: evaluation system; interdisciplinarity and environmental and environmental sciences; basic education; regional imbalance; professional training; internationalization; financing and induction

5.1 BRAZILIAN GRADUATION EVALUATION SYSTEM

Text based on the compilation of the chapter "Brazilian graduation evaluation system" (PNPG Volume I 2011-2020).

The Capes evaluation system is a well succeeded experience, which may be improved by being adjusted to the changes and needs of the set of areas of knowledge. The Brazilian graduate evaluation presents some specificities and is accomplished by pairs, originated from different areas of knowledge and recognized by its intellectual reputation and containing a meritocratic nature, leading to the classification of disciplinary fields. It is associated to the knowledge and fomentation, defining practices and establishing criteria for the financing of programs.

The post-graduate system was implanted from the 70's, having as its legal basis the 1968 University Reform, based on the American university model (structured courses) and by mission and formation of professors and researchers.

From 1997 entered into force the number scale from 1 to 7, being considered courses of international pattern those classified with the 6 and 7 concepts. When the number scale was deployed, CAPES adopted the system of ratifying the 7 courses by international consultant's opinions.

Throughout this period, which lasted only 40 years, the emphasis of the Federal Government's policies was to promote the expansion of the system, while the emphasis of CAPES, responsible simultaneously for the financing of the system and for evaluating the performance of affiliated universities, fell on the combination of academic parameters (production of books and scientific articles, dissertations and theses of academic content etc.) and quantitative criteria.

In recent times, other parameters were introduced, such as nucleation and solidarity, making the Committees to consider the capacity or the interest of the stronger programs in cooperating with the weakest. And also for the ability of programs causing impact on the area of knowledge, contributing to the creation of other congeneric courses, inside and outside of their territorial boundaries, further tapering the valuation of the doctorate achieved in the 90's, when the federal system started to encourage more and more the hiring of doctors.

Finally, even before triggering periodic evaluations, the Agency and the Committees should bear in mind the type of professional or researcher to be formed, considering the diversity of the knowledge society and its demands. All areas should be eventually mobilized and put on the agenda for discussion about the *ethos* of the intellectual, researcher, technician and scientist that the universities have the incumbency to form. In this context, more than one path is feasible.

5.2 INTERDISCIPLINARITY AND ENVIRONMENTAL SCIENCES IN BRAZIL

Text based on the compilation of the chapter "The importance of Inter(multi) Disciplinarity for the Postgraduation" (PNPG Volume I 2011-2020).

The prospect of a development on a sustainable basis, brings a broad process of transformation of knowledge and a critique to the scientific rationality based on reductionist and fragmented models, inducing to the building of a knowledge of a more integrative interdisciplinary nature (FERNANDES and SAMPAIO, 2008). The challenge of sustainability is the search field inherent to all disciplines. From the interdisciplinary perspective, the disciplines should fit into this new field which requires integrated research.

The construction of an "environmental knowledge" is a dynamic process and is not a finished or homogeneous knowledge (LEFF, 2001). Interdisciplinarity inherent to this process, before being an area of knowledge, it is a way of knowledge integrating various disciplinary perspectives and a working posture in search of points of convergence between the disciplines and methods, without fragmentation of the phenomenon. The main result of interdisciplinarity is the revival of the vision of the *whole* enabling the revelation the complexity of this *whole* and of the many webs of relationships present. If applied spontaneously in all subject areas, it would naturally be

no need for an Interdisciplinary Area of Knowledge, which would be extinct as a result of the gradual maturing of research and its scientific and technological areas (PHILIPPI JR and FERNANDES, 2011).

According to the Interdisciplinary Area document – CAInter, triennium 2007-2009 (CAPES, 2010), the Multidisciplinary Area, created in 1999, became an Interdisciplinary Area in 2008, composing the new Great Multidisciplinary Area of CAPES. Since its inception in 1999, the CAInter has the highest rate of growth in CAPES (59%) (PNPG, 2010). The existence of the Area has led to the proposition of courses in innovative areas with interdisciplinary vision, following the world trend of increase of research groups and academic programs dealing with intrinsically complex and interdisciplinary issues.

This action should be understood as important to the National Post-Graduate System (SNPG), insofar as it serves as entry link incubator of an expressive number of universities in research and teaching activities at the highest level, contributing to the improvement of its faculty and providing advanced training opportunities in various parts of the national territory.

Interdisciplinarity is driven by the need to connect knowledge and broaden the scientific-technical cooperation, something that the researchers who act on an inter-disciplinary way learn to do naturally. Sharing information becomes something natural in this process in which there is no way to move forward without sharing them reciprocally between various disciplinary approaches which are fundamental for interdisciplinarity.

Institutionalization of Environmental Sciences in Brazil

In Brazil, since the recognition of environmental problems at the beginning of the 70s, there has been a process of building a system for environmental control and protection. A significant institutional and broad legal framework apparatus was developed, aiming at the management and conservation of natural resources. This process of institutionalization of the environmental issue was the basis for inclusion of the environmental dimension in other spheres, as in the National System of Education, with the insertion of crosscutting disciplines of environmental education. It was also created the National System of Environmental Education – SISNEA, attached to the Ministry of the Environment, which aims to give organicity to the environmental education set of environmental education actions in Brazil.

More recently, the environmental subject gains space on funding research, science and technology and the National System of Graduate Studies. In 2004 the National Council of Technological and Scientific Development -- CNPq creates the Special

Committee of Environmental Sciences. The theme became part of the teaching, research and extension agenda. Several disciplines began to contemplate various environmental issues involving treatment and prevention of the effects of polluting activities, planned usage of natural resources and waste disposal, use and occupation of soil and water conservation, air pollution and many other broad or specific aspects that have become part of the research agendas (RAYNAUT and ZANONI, 2011).

Within the ambit of Brazilian Scientific and Technological Development it should also be stood out the Support Program for Scientific and Technological Development (PADCT) of the Ministry of Science and Technology established in 1980, before the United Nations Conference on Environment and Development, held in 1992. This program, led by the Federal Government and the S&T community, included the Sub-Program of Environmental Sciences, which began to support research and teaching projects in various regions of the country, encompassing diverse disciplinary fields of knowledge.

The inclusion of Environmental Sciences as a subprogram was intended to induce initial scientific and technological consolidation of multidisciplinary teams of universities and research institutions, in dealing with environmental issues in order to insert it in the development process, in a sustainable perspective. The Sub-program also led to the adoption of the method based on systemic approaches to environmental issues by encouraging the transfer, adaptation and integration of technologies for the improvement of environmental quality. In its evolution, the PADCT III, already at the end of the 90s, clearly required interdisciplinarity in formulating any proposal (PHILIPPI Jr, 2000). It was therefore a new perspective, with an interdisciplinary vision, materializing projects that benefited several research teams and the country's education, of a multi-disciplinary constitution.

In the midst of Interdisciplinary Area, the "Environment and Agricultural Sciences" Chamber experienced a great growth, both in quantity and in quality and variety of proposals related to environmental issues. This development resulted in the creation in June 2011 of an Area of Evaluation in Environmental Sciences.

5.3 BASIC EDUCATION

Text based on the compilation of the chapter "The importance of Inter(multi) Disciplinarity for the Postgraduation" (PNPG Volume I 2011-2020).

The concept of quality currently adopted seems much more comprehensive than the one used in the past and requires education, to be considered of quality,

must comply with various assignments, including: ensuring access and permanence of students in school, promote significant learning from the point of view of social demands and individual development, meet the needs and characteristics of students from different social and cultural contexts, with different skills and interests and treat students differently, with a view to obtaining comparable developments and learning, ensuring all the equal right to education.

The practice of excluding education in Brazil, undertaken over many decades, has resulted in the accumulation of a large contingent of illiterate and an average rate of education lower than that required for the development of the country. In recent years, this placement has been modified in order to make education accessible to everyone. The knowledge of these modifications can be useful for understanding the complexity of the problem.

From a legal point of view, there have been significant changes such as the enactment of the Federal Constitution of 1988, when the same defined in its article 205 that: "education, right of all and duty of the State and of the family, will be promoted and encouraged with the collaboration of society, with a view to the full development of the person, his/her preparation for the exercise of citizenship and his/her qualification for work". The presence of these guidelines in the Federal Constitution was decisive for the taking of other attitudes towards achieving the great goal of providing a quality education for all.

In December 1996, law No. 9394 was approved, which establishes the Guidelines and Bases for National Education (LDBEN), incorporated the ideas set out in the Federal Constitution and set out guidelines to make viable the transformations proposed in that legal text. Another important document is the National Plan for Education (PNE2001-2010), approved on January 9, 2001. In addition to establishing goals and objectives for each modality and educational level, the PNE also dealt with the training of professors, financing and school management.

In 2007, the Ministry of Education (MEC) launched the Education Development Plan (EDP) for the purpose of providing the conditions to achieve the goals set at the PNE. In an explanatory document, MEC identifies the PDE as a step toward the construction of a national education policy which promotes the individuation and socialization intended for autonomy.

The PDE assumes that the national policy of education should harmonize with the fundamental goals of the Republic set out in the Federal Constitution of 1988: build a free, fair and solidary society; ensure national development; eradicate poverty and marginalization and reduce social and regional inequalities and promote the well

being of all, without prejudices of origin, race, gender, color, age and any other forms of discrimination.

Working within the systemic vision of education, the PDE defines actions for basic education, higher education, vocational and technological education, literacy, continuing education, and diversity. Among the actions defined for basic education, it stand out teacher training, the floor salary, financing, evaluation, the targets plan and educational management planning.

In the context of Capes, an administrative restructuring was made with the creation of new boards intended for taking care of teachers' training and assistance to basic education. The realization of the National Education Conference (CONAE) and the beginning of discussions in the National Congress about the construction of the new National Plan for Education served as stimulus to an assessment was of the processes of evolution that the Brazilian basic education has been facing.

5.4 REGIONAL IMBALANCE

Text based on the compilation of the chapter "Regional Imbalance" written by Prof. Dr. Luiz Antonio Barreto de Castro (PNPG Volume II 2011-2020).

Currently, Brazil is among the ten largest economies in the world. However, considering the relationship GDP/capita in countries, Brazil's is on the 101st place.

Brazil adopts some policy instruments to mitigate the described regional imbalances. Both in the training of human resources and a direct investment in the North, Northeast and Midwest regions. Of these, stands out the Federal Government's decision to allocate resources 30% of the resources of public notices for the mentioned regions. To stimulate a more effective participation of Member States in their S&T investments, in a more recent decision the Federal Government opened space in the PRONEX Program for specific public notices in the States in exchange for a counterpart by these States. The guarantee of investments for Research and Development (R&D) should be a priority for each State in the poorest or less developed regions. However, it appears that there is an integrated effort of regional character.

The regional imbalance and the regional research and post-graduate networks

In 2005 it was initiated the establishment of Research and Graduate Studies Networks starting with the RENORBIO, as a differentiated instrument of public policies

operating to mitigate the regional imbalance. Regional networks are created by the regions, particularly by the States' S&T administrators, their Secretaries of S&T strongly linked to States ' FAPS. Subsequently, the region's Academy of the States has to assume responsibility for building the network. The role of the MCT is of a catalyst in the process, recognizing him formally by Ministerial Ordinances, if the previous assumptions are met. Thus, over the past five years were created four networks: RENORBIO, BIONORTE, COMCERRADO, PRO-CENTRO OESTE.

The Pro –Midwest Network, the latest one , does not yet have a defined logic. The proposal of the Pro-Midwestern Network, will probably be addressed to the technological development of the region. It is still not clear whether it will make an option for a multi institutional graduation as in the North and Northeast. However, without graduation involving several institutions, the technological development institutions can be more challenging because of the difficulty of convergence of critical mass of S&T, which this instrument makes it possible.

The other three networks have more in common. In addition to the limited critical mass, they have concerns with sustainability, with the development or poverty. Cerrado and Amazon have common environmental concerns, although the Amazon has regionally a very low per capita income. RENORBIO has social responsibilities of great relevance and environmental sustainability must be the logic of COMCERRADO network.

GP networks have as first advantage the promotion of the convergence of critical mass. Such convergence that results in strong cross institutional relationship reduces the redundancy in the infrastructure investments and contributes to increased productivity of groups funded in its projects. Finally the GP regional networks could mitigate the growing impetus of graduate courses and limited curricula which usually have enormous difficulty in climbing a prominent position in CAPES' ranking.

The Brazilian Semiarid and RENORBIO

The Brazilian semiarid extends to an area that covers most part of the States of the Northeast region (86.48%), the northern region of the State of Minas Gerais (11.01%) and the North of Espírito Santo (2.51%), occupying an area of 974,752 km^2 where 36 million people live, being the most populous in the world, which includes 17% of the planet with such characteristics. The Caating biome predominant in the Semi-arid has an exuberant biodiversity still little known and a rainfall of 300 to 800 mm of rain. The interest in the caatinga has grown among scientists in the region.

RENORBIO will use the best available Biotechnology in the world to resolve the most serious social problems of the semi-arid. Biotechnology has this capability, but has not put it into practice. Practically, there are no projects devoted to the most important crops for the poorest populations such as cassava, vigna and sweet potato. On the other hand, RENORBIO must provide a better quality of life for the region by the effective possibility in progress to establish a subnet in RENORBIO to ovinocaprinoculture.

RENORBIO's Post-Graduate Nucleus approved with level 5 in CAPES in is one of the most successful Biotechnology courses in the country. The network's professors are distributed among 31 Northeastern institutions developing projects in the network. CAPES agreed that, in the case of Biotechnology, permanent teachers of two graduate courses may include a third one. This way, several of the current RENORBIO's collaborators today may become permanent professors.

An important highlight with respect to ongoing research in RENORBIO concerns the public call for funding of theses in progress in the program. Of the theses in progress 83 have been selected. It was detected a clear trend to theses that have selected natural resources as a theme (49%). It is observed the possibility of establishment of a subnet or even a National Institute for Science, Technology and Innovation (STI) in this area that may give rise to phytotherapic formulations among other products that integrate Bioeconomy, an area that is an unfolding of Biotechnology and that broadens its horizons.

The Amazon and the BIONORTE Network

The Amazon biome spreads to all countries of Northern South America, covers 60% of Brazilian territory, occupying approximately 4 million km2. With a population of over 20 million inhabitants, the Brazilian Amazon is occupied by more than 180 indigenous tribes and traditional populations as *caboclos* and *quilombolas*. It contains the largest biodiversity of the planet regarding plants, freshwater fish and mammals.

Through environmental policies and government actions Brazil spends considerable efforts for the preservation of the Amazon biome. The region is currently in a process of intense momentum toward a fundamental consolidation of fundamental impact and strategic importance to its development and to the national matrix of agricultural and energy production.

In order to promote the conservation of the Amazon biome the following is indispensable: adding value to forest products, creation and implementation of protected areas, biodiversity monitoring, maintenance, monitoring and improvement

of conservation actions, strengthening of productive chains, local empowerment, use of the extraordinary potential of natural resources, with a range of options for natural resource management and sustainable agricultural and forestry production systems.

In this great territorial extension, the scientific development index is very low. According to data from Capes, in the year 2008 were granted to the nine States of the Amazon region, a total of 2,681 graduate scholarships, while the Southeast region received 22,715 scholarships, almost 10 times more. The number of professors and students also reveals the huge discrepancy between regions. Currently, there are only 2,821 professors doctors and 5,753 students in the Legal Amazon while the Southeast region has 29,508 professors doctors and 87,900 students. Therefore, the relationship of doctors in the Northern region is approximately 1/4,600 inhabitants, while in the Southeast this relationship almost doubles (1/2,500 inhabitants), which indicates the need to double the number of doctors in the Amazon so that this discrepancy is reduced.

The evaluation of post-graduate programs made by Capes also reveals the fragility of the region. Of the total of 4,356 Brazilian academic master's degree and PhD courses, only 175 (4%) are in the Northern region. Of the courses evaluated in the Biodiversity and Biotechnology areas, only four of them have grade 5, indicating that these programs are already consolidated, with qualified technical and scientific staff and some well equipped laboratories. Nevertheless, the vast majority of other programs was evaluated with grade 3 or 4, indicating that they need to be strengthened, by improving infrastructure, supporting research, scientific productivity and, above all, the human resources of the Northern region.

The intent was to create a mechanism that would allow a better knowledge of the regional biodiversity, in addition to using that knowledge to generate new bioproducts, allied to the training of more doctors needed for the sustainable development in the Amazon. It was then created the Network of Biodiversity and Biotechnology of the Legal Amazon (BIONORTE Network), with the objective of intensifying the training of doctors. It is important to note that the BIONORTE Network was established by the secretaries of the Amazon S&T and by its academy, motivated by reasons completely different from those that motivated the creation of the RENORBIO. Although the limitation of critical mass for S&T is a factor common to both networks, the Amazon has three Research Institutes linked to the Ministry of Science, Technology and Innovation (MCTI), some ten federal universities, five state universities, more than ten universities centers and several local initiatives with the goal of designing the ST&I system.

This structure is distributed in a vast territorial area, under intense social and environmental pressure. The BIONORTE network will seek to expand and consolidate

the S,T&I system in the Amazon so to provide the institutions existing in the region with conditions to respond adequately to current and future challenges. Its focus is on understanding the human culture and promote the sustainable use of natural resources with the resulting harmonious socioeconomic and cultural development. To do this, it is necessary to expand and modernize the infrastructure; train and retain qualified personnel; support interaction with enterprises; expand the research networks and structure them into thematic institutes and deploy through it a Management Forum on S,T&I, enabling appropriate advice in Political and Socioeconomic Sciences in the Amazon. The Scientific Council of BIONORTE Network is preparing a presentation to CAPES of a graduate proposal similar to what was prepared by RENORBIO.

Brazilian Cerrado and the COMCERRADO network

The COMCERRADO Network differs from the two previous ones in that its action is not confined to one region, but a strongly threatened ecosystem by antrophic actions predominantly in a rich region for Brazilian standards. Everything indicates that, unlike the others, the COMCERRADO network will promote the convergence of the strongest groups, acting in the *cerrado* in a way that is not yet clear because the Network has not yet received resources.

With approximately two million km^2 of original area, the Brazilian Cerrado presents the greatest biological diversity among the worldwide savannas. In addition to the biodiversity, the region is of strategic importance for the conservation of water resources, since their distribution includes a large number of springs and a considerable portion of the main river basin regions of South America. In particular, approximately 78% of the area in the Araguaia-Tocantins basin, 47% of the São Francisco and 48 of% the Paraná /Paraguay, are found in the *Cerrado* biome (Lima & Silva, 2008). The CERRADO is multi-regional comprising much of the Center West, Southeast, Northeast and Amazon regions.

In spite of its biological and environmental importance, that domain has been suffering in recent decades an intense process of conversion of plant cover by productive activities, such as livestock, agriculture, charcoal plant and mining. Estimates indicate less than 17% of the Cerrado remaining areas and about 50% of the biome already in used for cattle breeding (Mantovani & Pereira, 1998; Eva et al., 2004; Sano et al., 2007; Sano et al., 2008).

The Cerrado presents a great heterogeneity translated into complex environments that alternate each other at the regional level (Felfili et al. 2008) and

require specific management and conservation practices, as well as production systems suited to such heterogeneity. The Cerrado also has a great socio-cultural wealth , marked by the presence of dozens of indigenous ethnic groups, traditional peoples. Each of these human groups adopts different ways of life in the Cerrado's ecosystems, requiring studies and participatory actions. Particularly, the traditional knowledge can greatly contribute to the development of strategies that combine production and conservation of natural resources in the biome.

5.5 PROFESSIONAL TRAINING FOR ENTERPRISES

Text prepared on the basis of the compilation of chapter "Professional Education" written by Prof. Dr. Tânia Fischer (UFBA); and chapter "Technological Development and Innovation" written by Prof. Dr. Evando Mirra de Paula e Silva (PNPG 2011-2020-Volume II), together with chapter ""Human Resources for Enterprises: the Role of Graduate Studies" (PNPG 2011-2020 -Volume II).

The globalized world market competitiveness begins to encourage the insertion of scientists and engineers with high graduation in the body of officials of the industries. Currently, the focus prioritizes the occupation of positions of business leadership, linked to research and development projects of new technologies and products.

Considering the need to support the qualification or re-qualification of frames to meet the demands of Brazilian development in the next decade, it is proposed that vocational education is valued as an axis of training with a strong identity and singularity, achieved with the academic training.

The industrial park has successfully carried out its phase of "import substitution" and has dominated the Quality mechanisms. Its exposure to fierce foreign competition, coupled to some favorable factors, promoted in some quarters an incipient culture of innovation, as in metal-mechanics,, oil and gas, aeronautics, agribusiness, steel industry, some areas of information technology, industrial automation, biotechnology, vaccines, medicines and others. These are also the sectors where the isolation between the academic systems and production was overcome, resulting in some in the fact that some of the successful Brazilian achievements, both in the economic and in the social field, are supported by a long-term collaboration with one or more universities and research institutes.

Alongside the need for the establishment scientific staff, policies are also required to induce the allocation of these scientists in business and industrial sectors, avoiding, for example, situations in which most of these staffs are concentrated on the academy.

The specific place of the university in the knowledge economy grants it a specific role in the architecture of innovation. It's not just absorbing and processing the existing knowledge. The innovative activity also poses new problems – what is of the utmost importance to graduate studies – and is also a major producer of knowledge.

According to the latest IBGE census, Brazil has 302 thousand professionals with a master's or doctor's degree, and, according to the MEC, 136 thousand (corresponding to 45%) are in the institutions of higher education. In addition to the concentration of these masters and doctors in institutions of higher education, it should be noted that it is in the public university that contain the vast majority of doctors (63%).

Although each triennium noted an increase of 1 in the quantity of master's and doctoral degrees in Brazilian industry IBGE data (2005) as can be seen in the chart above, indicate that, in Brazil only 9.1 of the persons employed in activities of RD are graduates, and that most of those involved with these activities are undergraduates (about 48% second data recent terms).

With respect to the registration of patents, according to the partial balance of the number of patents deposits of the World Intellectual Property Organization (WIPO) made until November 2009, Brazil is in the 25th place (480 patents deposited) in the international ranking of patents[1]. The United States occupy the first place with 45,790 patents deposited, followed by Japan, with 29,827, Germany, with 16,736, South Korea with 8.066 and China with a strong growth, with 7,946.

As to the ability of innovation identified in Brazil, ot os noteworthy the example of Companhia Petróleo Brasileiro SA-Petrobras. The investment made by the company on research allowed, in 20 years, the company to move from a daily production, in sea wells, of little more than exceeding 300 thousand barrels to about 2.0 million barrils/ day. Investments in R&D and innovative management have granted Petrobras the world leadership in technology for deepwater and opened new possibilities to turn it into a leading energy. To do this, in addition to the developments generated in its Research Center and in other sectors of the company, Petrobras has deployed a resolute policy of strategic alliances and cooperation with universities, research institutes and companies-among suppliers, partners and competitors - including several international partnerships.

[1] For comparison purposes, Toyota, Sharp, LG, Dupont and Microsoft severally recorded more patents than all corporations and research institutes together in Brazil.

According to the ANPEI's data, in developed countries like the United States and Germany, 63% of expenditures on technological innovation are made by the business sector, while in Brazil the business investments correspond to only 37%.

It is also important to highlight the experience of FINEP, who initially sought to increase University-Enterprise integration through the so-called Cooperative (in which the funds were intended for the University for cooperative projects with the enterprises). More recently, with the creation of the Economic Subsidy Program, this integration is ocurring more effectively, because companies receive resources for hiring teachers and doctors for the increment of genuinely Brazilian R&D. This is a program of success by promoting the incorporation of masters and doctors in enterprises.

In addition, with the creation of the Technological Innovation Nucleus (TIN) at the universities and research institutes in the country, as determined by the Law of Innovation, the cooperation with companies started following clearer rules and efforts were intensified for overflow of inventions generated i the academy for the market. Currently, the National Forum for Managers of Innovation and Technology Transfer

5.6 INTERNATIONALIZATION OF POSTGRADUATION AND INTERNATIONAL COOPERATION

Text based on the compilation of the chapter "Internationalization of postgraduation and international cooperation" (PNPG 2011-2020 Volume I).

The progress of Brazilian science in qualitative terms has been remarkable in recent decades. The average impact on all areas of knowledge together, in relation to the corresponding global average in the period 1997-2001, evolved from 0.53 to 0.63 in 2005-2009, which corresponds to an advance of 19%.

Regarding the relative impact, in terms of averages of citations of scientific articles for all fields of knowledge together, Brazil was ahead of the other BRICS countries (China, India, Russia and South Africa), however the position of Brazil is threatened by China and India.

In terms of the number of scientific articles published in indexed journals, the growth has been extraordinary, well above the world average. Between the years of 1981-1985, Brazil had 11,560 articles published by active scientists, representing 0.47% in relation to the world. Between 2005-2009 it jumped to 118,239, the equivalent of 2.27%. As a result of so favorable numbers, in 2009 Brazil overtook Russia and the Netherlands and assumed the 13th place in the ISI and Scopus base.

The global average of relative impacts of scientific articles in all areas of knowledge is of 4.86 and for Brazilian publications 3.04. The best indexes are on Engineering (2.07 compared to 2.19 global), Mathematics (1.34 compared to 1.51 global) and Physics (3.97 compared to 4.36 global). Therefore, quite close to the corresponding world averages, that focus on scientifically more advanced countries. It is important to note that areas of Engineering and Mathematics, as well as Marine Biology and Oceanography, are among those that are likely to grow more in the country in the coming years.

International Presence of Brazilian Science

Below is a list of examples that embody the international recognition of science and scientific-technological advancements and achievements: G8+5, International Forum on Science and Technology for the Society (STS Forum), World Forum of Sciences, Academy of Sciences for the Developing World – TWAS, International Council for Sciences – ICSU, Inter-Academy Panel-IAP: the global network of science academies, Inter-Academy Council – IAC, and Inter American Network of Academies of Science (IANAS).

International cooperation is of vital importance to the scientific advancement of any nation. Scientists, institutions, ministries and their promotion agencies, and the FAPs, share with enthusiasm this principle, reflecting the fact that the scientific collaboration of Brazil is growing side by side with the advancement that the Brazilian science has experienced in recent times. The main partners of Brazil, including traditional countries of recognized scientific level, such as: United States, England, France and Germany, and several countries in Latin America, particularly Argentina. Taking into account only the mentioned countries, international collaboration involves 34,1% of the scientific work published in the period 2003-2007, certainly a very expressive percentage.

Science without Borders Program - CAPES, CNPq and private sectors

The Science without Borders Program aims to promote the consolidation, expansion and internationalization of science and technology, innovation and competitiveness in Brazil through the exchange of undergraduate and postgraduate students, and international mobility. The project provides for the transmission of 101 thousand Brazilians abroad by 2015, of which 75,000 with public funds from the Federal Government and 26,000 with private funds.

Capes will be responsible for providing 40,000 scholarships. This initiative is the result of efforts of the Ministries of Science, Technology (MCT) and the Ministry of

Education (MEC), through their respective funding agencies, CNPq and Capes, together with the Departments of Higher Education and Technological MEC.

The objective of this program is to promote, in a fast way, technological development and stimulate innovation processes in Brazil through international mobility of researchers, undergraduate and post-graduate students, post-doctoral students and Brazilian researchers, encouraging the inclusion of the researches done in Brazilian institutions to the best international experiences (CAPES, 2012)

The priority areas of the program are: Engineering and other technology areas; Pure and Natural Sciences; Biology, Biomedical and Health Sciences; Information and Communication Technologies; Aerospace Technology; Pharmaceuticals; Sustainable Agricultural Production; Oil, Gas and Coal; Renewable Energy Minerals; Biotechnology, Nanotechnology and New Materials, Technologies for Prevention and Mitigation of Natural Disasters, Biodiversity and Bioprospection; Marine Sciences; Creative Industry (focused on products and processes for technological development and innovation); New technologies for constructive engineering; and Formation of technical personnel. The program provides scholarships abroad and in the country.

The types of scholarships abroad are to graduate, technologist, training abroad, doctoral sandwich, full doctorate, post-doctorate. In Brazil, the types of scholarships are "attracting scientists to Brazil," "visiting researcher" and "young talents". The priority institutions are those most well known for each major area of knowledge. These institutions are listed in the major international rankings in their best positions (BRAZIL, 2012).

CAPES and International Cooperation

Capes' Directorate of international Relations (DRI), was established at the end of 2007, being responsible for the programs of scholarships abroad (CGBE) and international cooperation (CISC). Association have been incremented with various fellow agencies of other countries, with the aim of awarding scholarships under a partnership and on an induced way, around not only of individual applications, but also from the demands of research groups and institutions of higher education and also Government demands, these particularly through interaction with the Ministry of Foreign Affairs.

Capes' Scholarship programs abroad, developed by CGBE, lie on the first two strands. The full PhD. intended to cover research projects in areas not yet consolidated in Brazil, fitting therefore in the first strand, while the sandwich-type modalities may be considered in the second strand.

Sandwich mode necessarily involves partnerships with good level institutions abroad, and can therefore be considered in the borrower strand. The doctoral stage of these fellows, allied to the concessions of postdoctoral fellowships and senior probation certainly contributes to a significant presence of Brazilian scientists abroad. It is also expressive the participation of Brazilian researchers in events abroad, as can be seen by the demand. The countries of destination preferred by fellows are: United States, followed by France and Portugal, United Kingdom, Germany and Spain. More detailed information can be found on e-Capes - www.capes.org.br

CNPq and International Cooperation

International cooperation is a traditional activity that takes place at CNPq since its creation in 1951. Currently, is coordinated and implemented in the Advisory Office of International Cooperation (ASCIN), directly linked to the Presidency of CNPq.

A number of opportunities is offered to Brazilian researchers to: (i) begin a new collaboration through the mobility of researchers inserted into joint research projects; (ii) consolidate effective institutional partnerships; (iii) coordinate collaborations through international networks; or (iv) structuring partnerships with virtual labs as the International Associated Laboratories (LIAs).

Backed by Action Plan 2007/2010 - Science, Technology and Innovation for National Development, the CNPq international cooperation seeks to improve and stimulate the management of instruments for cooperation, diversify and expand strategic partnerships with developed and developing countries.

CNPq holds agreements with more than 35 countries with foreign S&T institutions, which may be

FINEP and International Cooperation

The international performance of the Financing Agency for Studies and Projects-FINEP, a public company linked to the Ministry of Science, Technology and Innovation (MCTI), is aligned with the priorities of Brazilian foreign policy, prioritizing the diversification of partnerships, with the establishment of cooperative projects and programs in all continents

The main focus lies in the promotion of actions of cooperation with the Latin America countries, African countries, China and India. With Europe, the United States and other "core" countries, priority is given to actions of cooperation on issues of

national interest, based on the principle of reciprocity. In order to reinforce joint projects with international partners, actions had been promoted to establish different programs according to the following detailed issues.

The FINEP/OSEO program is intended for small and medium-sized French and Brazilian companies, acting in a joint venture for the development of joint projects on technological innovation, whose instrument of support at FINEP is the *Inova Brasil* Program. The Program INOVAR Latin America, from an agreement with the IDB-FUMIN aims to identify Latin American institutions interested in developing specific Venture Capital activities. The main objective is to promote the dissemination of good practices and implementation of programs similar to project Inovar in other countries.

Of the actions financed with countries of the African continent, it stands out the financing to the Hydrological and Environmental Monitoring System in Mozambique using Brazilian satellites and the A-Darter – Agile Darter Project, short-range air-to-air missile developed jointly with South Africa, totaling investments of about US$ 50 million.

5.7 POSTGRADUATION FINANCING

Text based on the compilation of the chapter "Postgraduation Financing" (PNPG 2011-2020 – Volume I).

In Brazil, the basic science is carried out mainly in public universities, mostly federal and State, in higher education institutions and research centers. Thus, the research activities that happen under graduation as a whole and the training of doctors in particular are part of correlated knowledge production and science made in Brazil.

According to Hollanda (2003), since the beginning of the 80's, the CNPq used to estimate investments in Research and Development within the federal sphere from data relating to budget implementation in the Union's General Balance, the information available being restricted to those of the public sector until the early 90 's. With the surveys made by the National Association of Industrial R&D Companies (ANPEI), from 2003, it was possible to rely on data relating to investments by industries and, only from the year 2000, with the performance of the Industrial Research – Technological Innovation (PINTEC), were made available information relating to investments made in Research and Development (R&D) of Brazilian companies.

By adopting international standards, the Ministry of Science and Technology

(MCT) examines investments in S&T and R&D considering three sectors: federal, state and corporate, observing the recommendations from UNESCO and from f the Frascati Manual that propose guidelines for collecting and interpreting technological innovation data and experimental research.

From these analyses it can be noticed the facing of two challenges that are still valid for Brazil presently. The first relates to the effort to increase investments in the area of ST&I; the second, to encourage the business sector to invest more in the training of their managerial staff, a pre-condition for increasing national competitiveness.

Direct investments made in Postgraduation are mostly coming from federal funding agencies, CAPES and CNPq, which have stimulated the formation of masters and doctors and the consolidation of the Brazilian scientific research activities, continuously and consistently. These features are complemented by Foundations for the Support to Research - FAPs, which broadened the conditions for growth of national scientific production

The following is considered the volume of resources for graduate studies in each of these organs.

Investments made by Capes

Until 2007, the annual budget of the CAPES was intended exclusively to graduation. From the passage of the law 11502/2007, there were the restructuring institutional of its institutional tasks and expansion of its activities, which also started inducing and encouraging the initial and continued formation of professors, to improve the quality of basic education. Such additional assignment, however, did not change the role of main and paramount function of CAPES which is the financing of graduation in Brazil and abroad.

From 2011 there is an expressive budget growth of graduate actions – scholarships, support to research, journals portal, system of evaluation and administration -which was intensified by new actions linked to the tasks of quality improvement of primary education.

The increase in the granting of graduate scholarships was the result of budgetary growth. To the expenditure on scholarships , usually 70% are for tuitions and 30% for promotion in the form of aid tied to the scholarships, such as tickets, academic fees and aid to research. In addition to awarding scholarships at the master's degree, doctor's degree levels, sandwich doctor's degree and post-doctoral , CAPES is also responsible for supporting graduate programs through direct transfers of financial resources to

partner universities.

The actions of the institution, for a long period, were to finance the demands originated directly from the academic community and graduate programs. However, in recent years the key differentiator that has marked its performance were the inductive actions aimed at developing projects with training of human resources in areas considered strategic by the Government, as in terms of economic, scientific and technological development, and national security. As an example, it is worth mentioning the Pro-equipment Program, aimed at improving the scientific and technological research infrastructure of graduate courses.

Investments made by CNPq

In addition to the resources invested with the Scholarship Program, CNPq has put in place a program for the Aid to Research aiming to finance the implementation of projects. With this, CNPq contributed to assemble and maintain an infrastructure indispensable to the implementation of scientific and technological research projects. Thus, in a simplified view, the actions of the institution can be summarized in these two great programs. The great predominance of investments in stock markets is notable in almost all series, but additional resources from sectoral funds, mostly in partnership with the Financing Agency for Studies and Projects (FINEP)[3 XXXX], for research have increased gradually from 2001**.**

As for indirect investments made in postgraduation by CNPq, consideration should be given to the Scientific Initiation Program and the Research Scholarships Program, in which most scholars of productivity consists of dissertations and theses advisors. Productivity scholarships also include figures regarding bench fees for level 1 researchers, which are characterized as resources invested indirectly**.**

There are even resources with impact on graduation that are not granted through scholarships, but through aids to research. An example is the program known as "married" (casadinho), which encourages cooperation between consolidated and non-consolidated graduate courses.

State investments made by Foundations for the Support to Research

To seek greater success in graduate policy, the actions to be taken at national level cannot prescind the participation of the Research Support Foundations (FAPs). These State entities can and should fulfill a more participative role in the process of

strengthening the formation of highly qualified personnel. It should be highlighted that some FAPs, totaling today 23 active institutions, have allocated significant resources in national science and have a good capillarity in their states of operation. One of the important elements of participation by states, through their FAPs and SECTs, is the real possibility of increasing resources devoted to postgraduation.

5.8 INDUCTION MECHANISMS

Text based on the compilation of the chapter "Induction: A new role for the Agencies" (PNPG 2011-2020-Volume I).

Along its course, since its creation in 1951, CAPES served predominantly in the counter service system to meet capacity building goals of human resources for academic teaching and support to the formation of researchers to the Brazilian institutions. Such a procedure also happened with the other agencies with performance similar to that of CAPES, like CNPq and the first FAPs. As a result it appears that several areas of knowledge achieved considerable development by consolidating the structuring of research groups. It is noted that today many segments of ST&I are trained, fully qualified to respond to induced demands that can promote advances in areas of R&D and services in the interest of the State in the public and private sectors.

Induction policies in graduation financing represent an important tool in meeting the objectives and achieving the goals of the National Postgraduation Plans (PNPG), providing important advances of national graduate system (SNPG), especially in strategic areas for the development of the country.

Whereas one of the main objectives of PNPG is the equal growth of national graduate system, and with the purpose of meeting, with quality, the various demands of society, aiming at the scientific, technological, economic and social development of the country, the PNPG 2005-2010 sought to establish induction directives to guide the actions of CAPES in the period.

This document was fertile in its induction guidelines and CAPES, over the past five years, provided the SNPG induction opportunities through public notices and promotion actions, by investing capital and costing resources for research at the frontier of knowledge and training of people.

Induction actions stimulated in CAPES from 2005, sought to meet demands identified by the community, scientific societies, area coordinators, by the board itself,

by the demands generated by ministries, States and their FAPs, and even, to a lesser extent by the business sector. The actions, whose implementation involved all four directorates of CAPES directly associated to the graduation, can be classified into the axes detailed below: (i) Programs for reduction of regional imbalances; (ii) Programs for areas of knowledge; (iii) Programs for strategic areas; (iv) Programs for institutional partnerships; (v) Programs for international partnerships; and general program for improving the quality of graduation.

Programs for reducing regional asymmetries

These programs have been devised to expand the number of lecturers doctors and the number of master's and doctorate courses in the North, Northeast, Center-West and admittedly having major human resource shortages. Procedures created allowed the use of mechanisms for reducing intra-regional asymmetries and between states in other regions.

In the same line of procedures mechanisms were created to decrease intra-regional disparities and between states. Among the programs belonging to this guideline are: *Acelera Amazônia* (expanding the number of researchers and research groups for the formation of networking); DINTER *Novas Fronteiras* (provides at the doctoral level in the country, the training of professors at the federal or state Higher Education Institutions (IES), located in the North, Northeast or Center-West regions, via in-company training; PRODOUTORAL (replaces the former Institutional Program for Professors and Technical Training (PICDT), is a program that stimulates the planning of doctoral training of professors in Higher Education Federal Institutions (IFES); PROCAD *Novas Fronteiras* (consolidate young graduate programs, usually with 3 concept, located in the North, Center-West and Northeast).

Induction programs in the areas of knowledge

These programs aim to broaden the activities of existing graduate programs and create new programs in strategic areas. The public notices released by CAPES in recent years, more significant to induction in areas of knowledge are: *Pré-Ciências do Mar* (human resources training at graduate level and complementary to graduation on the topic); *Pró-Comex* (stimulate in the country, the conducting of research projects using human resources and infrastructure available at different IES and other research institutions, so as to enable the production of scientific, marketing and technological

researches and training of graduate human resources in foreign trade and related areas); *Pró-Ensino de Saúde* (to stimulate the Country in conducting research projects and support Education in Health); *Pró Botânica* (support joint research projects using human resources and infrastructure available at different IES, enabling interdisciplinary research focused on the characterization of botanical species and the creation of conditions for stimulating projects association to increase training at graduate level in the area of Botany in the country).

Induction programs in strategic areas

The programs listed below aim to stimulate the creation of new research groups and new courses of master's and doctoral degrees in subjects not studied or understudied until then, and considered strategic to national development and sovereignty: *Pró-Defesa* (encourage, in the country, the carrying out of research projects on the subject, using human resources and infrastructure available at different IES and other public, civil or military, private research institutions); Nanobiotechnology (stimulate and support joint research projects, using infrastructure and human resources from different IES, research institutes and enterprises, in order to carry out research at the frontier of knowledge with a focus on training of staff in the undergraduate, graduate and postdoctoral levels, in Brazil and abroad); *TV Digital* (form skilled HR; creation, strengthening and expansion of graduate programs and areas of concentration; expansion of technological and scientific production; promotion the exchange of knowledge in the academic community; encouragement to Brazilian innovation in the area of TVD); and *Pró-Engenharia* (contribute to the strengthening and expansion of *stricto sensu* graduate programs in the country, to promote the exchange and stimulate partnerships between several Research and Education Institutions, and support the formation of human resources at the *stricto sensu* graduate level).

Programs for encouragement of institutional partnerships

They were created to induce the approximation between the various funding agencies and promote better local planning and deploying a system of collaboration between the federated entities for the development of science in Brazil. In addition, programs of this line are responsible for national planning improvement of science and technology as they join to plan the actions, various ministries and stakeholders in national scientific and technological development: *Pró-Cultura* (create, strengthen

and enlarge PPGs and concentration areas related to the study of culture; expansion of scientific production and promoting the exchange of knowledge in the academic community and between cultural and research institutions not necessarily academic; incentive to the dialogue between experts, and artists); *Prodoc SUS* (investigate priority subjects for the *Sistema Único de Saúde*; support Productive Development Policy – PDP and law No. 11,487; and contribute to the development of graduation and health research groups in the country and stimulate the renewal of the staff at the universities and research institutions, involved in strategic issues for the National System of Science, Technology and Innovation in Health).

Programs for the general improvement of the quality of graduation

Acts on different ways, granting funds to purchase equipment, mobility of researchers and attraction of specialized human resources, all of these programs are aimed at the promotion, i.e. change of level of post-graduate courses in the evaluation of Capes. Therefore, some examples show this initiative, as detailed below:

- PROCAD Nacional (promote the consolidation of PPGs in all areas of knowledge; stimulate the academic-scientific interaction by building cooperation networks; urge new areas within the PPGs established; contribute to the regional balance of Brazilian graduation; expand the training of masters and doctors and the academic-scientific production; and provide professors and students mobilization);
- Programa de Apoio à Excelência -PROEX (keep quality pattern of graduate programs with 6 or 7 concept, in two consecutive triennial reviews, through meeting their needs and specificities);
- Pró-Equipamento (support the acquisition of small and medium size equipment for research laboratories linked to Graduate Programs recommended by Capes, prioritizing the common and shared use in the development of research projects from a same and/or neighboring institutions);
- Support Program for Institutional Projects of Recent PhD's - PRODOC (stimulate the development of graduate programs of public higher education institutions, institutional projects that contribute to the complementation of the training of new PhDs and the acquisition by these professionals, of academic practice with professors teams of the respective PPGs);
- National Program for Post-Doctorate – PNPD (temporarily absorb new doctors, with relative experience in research, development, innovation and research.

as well as support corporations of technological base and innovation in enterprises);

– New Portal of Journals (expand the number of titles, databases and other types of documents, improved the search process and increased the number of users, providing Brazilian researchers a faster and complete access to the world scientific production).

6 PROPOSALS FOR STRENGTHENING BRAZILIAN POSTGRADUATE STUDIES FOR SUSTAINABLE DEVELOPMENT

Text written from the compilation of chapters of PNPG 2011-2020 Volume I e II, together with some proposals drawn up by experts.

The planned expansion in the National Policies System for Graduate Studies, for the period of 2011-2020, to meet the demands for the country's development determines the apprehension of targets compatible with those of developed nations. The goals planned for expansion of the SNPG by 2020 include: (i) increase in the number of doctors/1000 inhabitants, aged 25 to 64 years, from the current 1.4 to 2.8; (ii) annual graduation of 19,000 doctors, 57,000 academic masters and 6,000 professional masters.

A significant portion of these doctors will be graduated in areas related to the subjects discussed in the Rio+20 Conference. To orient this expansion of Post Graduate National System, this chapter presents proposals for development of researches in the areas of: (i) water; (ii) sustainable energy; (iii) oceans; (iv) food security and sustainable agriculture; (v) sustainable cities; (vi) green employment-economy and social inclusion; (vii) climate changes and natural disasters; (viii) the Amazon and (ix) biodiversity.

It has been presented also proposals for improving the instruments for human resources training, detailed at Chapter 5.

6.1 WATER

Surface and underground water resources in Brazil are strategic for the economic and social development and for the sustainability of the public and private sector. Human resources training at the graduate level, "stricto sensu" and specialized, is of prime importance for the country's scientific and technological development in this area and to deepen and improve the management of river basins, which is the primary goal of the National System of Water Resources. In order to expand the country's strategic capacity to train masters, doctors and managers on water resources it is required to:

- Broaden and deepen the interdisciplinary vision of integrated training of biogeophysical, economic and social processes at the river basins level.
- Deepen the databases, develop scenarios and predictive capacity with the

introduction of ecological modeling and mathematics, assessing impacts at the watershed level.

- Prioritize areas of study and spatial strategies: watershed basins, toxicology of surface water and groundwater, water reuse, desalination, studies on the introduction of exotic species, aquatic ecosystem services valuation and studies on biodiversity and ecosystems recovery, as well as modernization and improved coverage with interdisciplinarity of training in basic sanitation.
- Promote the creation of centers for advanced studies in water resources to stimulate innovation, introduce new areas of study and integrate researchers and managers in interdisciplinary, systemic, integrated and predictive training modules.
- Promote the formation and a permanent integration at the program's level between engineers, hydrologists, limnologists, environmentalists, geographers, sociologists and economists with case studies in which the interdisciplinary vision is prioritized.
- Promote training of managers with the support from private enterprise (and private initiative funding) to establish new management and financing training paradigms based in interdisciplinary research and case studies.
- Deploy integrated, predictive and adaptative management systems of watershed basins with solid scientific basis promoted by studies and projects developed at research centers and institutes and universities.
- Promote the control, identification, studies and projects related to eutrophication, contamination and toxicity.
- Study global changes and their impacts on water resources.
- Valuate the environmental services of continental aquatic ecosystems.
- Support the funding and the participation of the private sector (industries, agribusiness) in the training of managers, professional masters, doctors and post-doctors.

6.2 SUSTAINABLE ENERGY

It is noticed a growing importance of environmental issues in graduation related to the energy planning sector, as a result of climate change and greenhouse gas emissions in the energy system. Among the important aspects relating to energy and climate

change it stands out: carbon capture and storage in thermoelectric plants, hydroelectric emissions, comparative advantages of renewable and low-carbon economy.

In addition to these last topics the following subjects also have great importance for the country's development:

- Develop studies related to the areas of oil and gas, including off-shore exploration.
- Expand research on hydroelectric plants, as well as alternatives to energy generation in the Amazon.
- Propose studies to produce second generation biofuels and ethanol.
- Assess potentials and environmental impacts of thermoelectric and nuclear power.
- Study interactions of transport and energy sector, including new technologies for vehicles.
- Evaluate alternatives for waste energy uses.
- Expand studies aimed at conservation of energy in the various urban, rural and industrial activities in the country, in order to reduce the need for high rates of expansion of power generation sector. Surveys are fundamental to the development of more efficient equipment, more intelligent processes and products in terms of energy.
- Promote studies and monitoring for energy eco-efficiency policy orientation, leading to the decoupling of GDP growth and social development in relation to energy consumption.
- Carry out studies on capacity of national ecosystems in relation to the energy issue, in order to subsidize planning of generation alternatives compatible to environmental, sociocultural and economic diversities of the different regions of the country.
- Encourage research to identify and quantify the socio-environmental impacts and costs of investments in electro-intensive sectors, aimed at providing support to the drawing of strategic policies for discouraging the of high energy cost production.
- Develop studies to better planning of electric power network aiming at reducing energy losses in the transmission system.
- Expand the planning capacity for increasing sustainable energy supply to meet demand growth rates.
- Develop studies aimed at the generation of nuclear energy, in particular as to the risks of accidents and solutions of radioactive waste final disposal.

– Develop integrated studies in relation to biomass energy matrix, in view of the possibilities of employment generation, rural development, family agriculture, even of recovery of degraded areas.

6.3 OCEANS

The concept of "Blue Amazon" is a current movement for protection of valuable resource and maritime environmental. This requires an effort by several actors to act competently in the diplomatic field, development of scientific knowledge about the sea and construction of technological capacity, necessary for the use and exploitation of the sea that belongs to us. These agents have the tasks of: (i) using and protecting the Brazilian sea and those who use it; (ii) preventing the degradation of the ocean; and (iii) ensuring the Brazilian sovereignty on that legacy in its territory.

There are many challenges to overcome in all expressions of National Power: politics, psycho-social, scientific and technological, economic and military. Specifically the priorities related to Research, Development and Innovation in Strategic Areas, the following actions are proposed:

– Support awareness-raising actions of Brazilian society, under the economic and strategic significance of the immense sea that belongs to all citizens, arousing interest in the production of needs for the exploration, monitoring, control and defense of the interests of the country in the maritime area that represents the "Blue Amazon".
– Encourage national and regional investments actions in technology, infrastructure and training of human resources for adaptation, both public and corporate, to the environmental patterns and on participatory management with a view to sustainable development and to the control of pollution at the "Blue Amazon".
– Expand the infrastructure and the capacity building of human resources necessary for technological modernization of ports and the uplifting of the Brazilian sea and multimodal transport in search of Brazil cost reduction.
– Support the establishment of the technological infrastructure necessary for the implementation of the management system of the "Blue Amazon" focused on the monitoring and control of maritime space as key action for the achievement of the National Defense Strategy vision of medium and long term.

– Promote the implementation of the actions proposed in the Brazilian Nuclear Program, in particular those related to the establishment of the technological infrastructure to support the Construction Program of the Brazilian Nuclear Propulsion Submarine.

6.4 FOOD SECURITY AND SUSTAINABLE AGRICULTURE

To meet present and future demands, the country needs a national agenda on Science and Technology focused on the agricultural sector, with the active and robust participation of graduation for the training of human resources, aiming to generate new scientific and technological knowledge and innovations. As the Brazilian graduation and the whole academia establish a stronger interaction with the business sector, in line with new public policies, the answers will be faster, innovative and effective, thus ensuring the sustainability of the sector and securing the country's future.

To develop the tropical world's most advanced agriculture, there is a need for new knowledge and skills at masters and doctors level with a qualified profile to:

– Ensure technological and intellectual contribution to the agroindustrial complex, aiming at sustainable development, food security and exports, the technological independence and the development of the sector.
– Play strategic roles in the changes of a new agrarian-extractivist economy for the agrarian-exporting, efficient and sustainable.
– Contribute to the equating of the conflict between the development of agribusiness and environmental preservation, as well as to combat the distorted visions and the enhancement of production with social responsibility.

The new programs should reflect the regional needs with new and more flexible, dynamic models of Post Graduate Studies, with more realism and strategic vision of the future. The courses should include thematic trends required by a cutting-edge science, such as:

– Include and emphasize in graduate courses the following subjects: (i) low carbon economy; (ii) sustainable agricultural production; (iii) alternate energy sources; (iv) water resources; (v) agricultural defense; production economy (gases emissions, use of water, nutrients and soil); (vi) life cycle assessment of production systems; (vii) fish resources; (viii) animal health and nutrition; (ix) functional foods.

- Involve active partnerships with qualified programs via cooperative networks, such as the Biotechnology Northeast Network (RENORBIO) and the Biodiversity and Biotechnology Network of Legal Amazon (BIONORTE) for the less developed regions.
- Stimulate and intensify training abroad, both at the doctoral or postdoctoral level, aimed at the maintenance of the quality of some programs and to enable the necessary progress in others.

6.5 SUSTAINABLE CITIES

Proposal divided in two parts: the first written by Prof. Dr. Benamy Turkienicz (UFRGS); the second part is the result of Capes International Seminar "*Brazilian Metropolization and the Challenge of Urban Management: the role of postgraduation*".

Part1

The country has, albeit unevenly, invested in the production of knowledge in several areas which are vital for the development of Urban Science and Technology. The aggregation of these investments can generate, in a short term, impact on the qualification of Brazilian cities. Some examples of interdisciplinary cooperation through scientific and technological innovation "clusters" focused on different problems that could be associated to the urban qualification are:

Production of information for planning and control

- Consolidate databases with official data on: safety, health, education, land ownership situation, infrastructure, natural environment, urban mobility, urban legislation, consistent with census sectors.
- Promote access and assure quality and timeliness of data.
- Ensure urban data and information collection through information technologies linked to space, time and event.
- Build indicators, monitoring, simulation and scenario building.
- Municipal intelligence: strategic planning and ownership of Information Technology in urban management.
- Investigative intelligence on interfaces of drug and weapons trafficking networks with the urban environment.

- Assess impacts on urban security of the complexes of criminal execution.
- Generate data on impacts concerning social security of privatization of urban space: increase in gated communities (closed condominium) and escalation of urban violence.
- Promote strategies for community participation in the planning process: incorporation of society's knowledge to technical knowledge (techniques of participation in public hearings, witnesses and open conferences).

Management and urban economy

- Promote the integrated management of public policies (municipal/state/federal) involving different scales of intervention.
- Propose strategies for management of public works: hierarchization/coordination
- Manage the control of growth thresholds of cities.
- Propose the regulation of transport models at all levels.
- Promote the management of infrastructure networks inserted into networks of cities.
- Develop studies for fiscal management: specific features of the scale and role of each city and the region.
- Recommend the management of Metropolitan Development Funds.
- Develop measures to control the price of urban land.
- Assess total costs of urban options (including social and for what groups): urban setting x land condition.

Development of studies

- Develop studies of new ways of integrating urbanism, architecture, design of vehicles and urban mobility solutions.
- Apply templates, existing planning methods and tools involving environmental skills, use of soil and urban mobility: thematic axes integrating accessibility, security, urbanity and sustainability.
- Implement new Metropolitan Management models aimed at the economic and social development: metropolises as protagonists of regional and national development.
- Apply technologies for the integrated monitoring of water, air soil occupation and urban climate behavior.

- Study technologies and methods for measure and predict costs, maintenance and expansion of existing infrastructure networks.
- Propose integrated solutions of engineering, architecture and urbanism to mobility problems, sanitation, housing and urban security.
- Elaborate structuring urban projects: national and international experiences.
- Promote urban renewal: investments in declining central areas.
- Propose Private Public Partnerships in metropolitan areas.

The Post Graduation in Brazil, specially in the area of Architecture and Urbanism and Urban and Regional Planning can acquire an important role in overcoming these difficulties in the short and medium terms through strategies that involve: (i) identification of knowledge necessary to solve matrices of major urban problems, (ii) immediately increase in the demand for resources for researches involving directly the production, management and project methodologies of urban spaces, (iii) use of human resources trained in this course for the training of municipal technicians with assignments of planning, control, monitoring and design of urban spaces, and (iv) settlement of qualified technicians in the neediest regions.

Part 2

Proposals from the International Seminar "Brazilian Metropolization and the Urban Management Challenges: the Role of Post Graduation"

As a result of this International Seminar organized by Capes at May 2012, the following subjects were identified to be incorporated into the graduate programs that act on the metropolitan issue and its urban management challenges:

- Redefinition of the Brazilian urban system, considering: urban concentration, deconcentration and centralization; analysis of forms of production and appropriation of urban spaces; state, social organization and urban public policies; perception and behavior of the population against the climate changes.
- Production of the contemporary metropolis, contemplating production and requalification of housing, public transportation as articulator of urban mobility and accessibility; urban projects in the solving of multiscale metropolis's problems
- Planning and improvement of urban infrastructure: water supply, sewage, solid waste management, urban drainage.

- Embedding topic of uncertainties, the decentralization-centralization dichotomy of the solutions, community participation and empowerment.
- Analysis and propositions to confront violence and crime including; symbolic violence; insecurity; fear; domestic violence; violence and values, violence and cities: violence and conflict; languages of the violence.

In this context, the following lines of action are proposed:

- Develop lines of research and post graduate programs that consider: (i) thematic and inter-university issues; (ii) international post graduate training (Latin America, emerging countries, BRICS); University and Society relationship, from the perspective of social autonomy and emancipation; university and public administration, in the preparation of plans, projects and programs.
- Prepare surveys to assist on: people's perception about natural disasters of short, medium and long terms, as well as improved risk management techniques to increase their adaptive capacity to changes of nature, particularly on climate changes; formulation and implementation of public policies to prevent environmental disasters; develop metrics and encodings for measuring the adaptability of people, as well as metrics that allow the valuation of services and environmental losses.
- Promote studies to subsidize the public power in formulating regulatory instruments in favor of improving the environmental sustainability of urban areas, whilst respecting, at the same time, the legislation concerning the Union's federated entities.
- Implement incentive policies and strengthening of programs and research projects in the network, with specific focus on the sustainability of urban clusters and metropolitan areas.
- Expand national and international training and cooperation enabling the building of research networks, keeping the specificities;
- Stimulate development lines in graduate studies towards a greater social interaction with the project professional, participative and pluridisciplinary practice, aimed at the institutional strengthening in the specialization and capacity building, training of managers, like the Professional Residency, Technical Assistance programs, preparation of Participatory Master Plans, among others.
- Ensure the transfer to society of the results of the surveys and also of appropriate forms of training of metropolitan managers, at the graduate level,

on the basis of contemporary concepts to be appropriated by the universities and research institutions.

- Expand the Post Graduation and Research Funding, with training of managers through professional master's degrees; comparative studies (countries, states, regions, successful practices); national Exchange of researchers.
- Ensure the induction, compilation and dissemination of day-to-day knowledge regarding conflict prevention and resolution; studies able to redeem the metropolis while single city, while region, while space whose functioning affects its development process and that of the Brazilian nation.

6.6 EMPLOYMENT: GREEN ECONOMY AND SOCIAL INCLUSION

The concept of green economy emerges as a possibility for questioning the current forms of production, since it aims to reduce carbon emissions, improve efficiency in resource utilization and promote social inclusion. In this context, there is a strong incentive to the design, evaluation and use of green technologies that reduce or eliminate socio-environmental impacts, with emphasis on the Brazilian reality. However, there are major educational challenges at all levels and forms of education in the country to meet increasingly complex national demands and problems, interdisciplinary in nature, especially those linked to sustainable socio-environmental issues.

This way, the following actions should be observed and implemented:

- Stimulate the networking of research and graduate studies, involving national and international partnerships between various sectors to research at the frontier of knowledge.
- Emphasize environmental issues associated with the social sustainable and use of clean technologies.
- Ensure support for the growth of the SNPG, ensuring significant portions of the budget of the agencies as a tool for implementation of innovative policies;
- Consider the cultural characteristics of the target populations in different graduate programs that deal with the subjects: development, economy, health and education in Brazil.
- Ensure attention to current generations of children and young people, particularly in the areas of health and education in actions directed to basic and higher education with the participation of graduate studies, as these

will depend on the performance of the Brazilian economy generations in the coming decades, as members of the working age population, in a context of rapid growth, in absolute and relative terms, and strong growth in the elderly population.

6.7 CLIMATE CHANGES AND NATURAL DISASTERS

Given the complexity of the processes involved in the science of climate changes and its political, economic, social, environmental and natural dimensions, the strategies established in the past decade are still necessary today. However, the new theoretical and applied perspectives already allow Brazil to invest, more decisively, on research and programs devoted to climate adaptation and management of places and territories.

Recently a high-level team of experts on climate changes prepared the Program of Research on Global Climate Changes (PFPMCG). This program translated the demands of the scientific community, detailing the main lines of research which may contribute with policy makers and decision makers at all levels, and which represent the main challenges of graduate studies to be faced as can be seen in the following topics:

- Advance in quantification and separation of climatic signals about South America by the detection and attribution of causes: natural climate variability, climate change in response to changes in land uses, including aerosol associated emissions, and climate changes resulting from global warming).
- Identify political arrangements and institutional mechanisms and cultural values through which human activities causing climate change and other environmental changes are an essential step to respond to these changes.
- Evaluate social innovations introduced in some experiments, measuring the differential impacts on different social groups.
- Propose effective public policies that consider the competitive values and conflicting objectives related to the topic.
- Develop detailed knowledge of regional and local climate changes resulting from a general level of climate change, by applying future climate changes scenarios for various sectors and activities such as: natural ecosystems, agriculture and forestry, renewable energy, coastal areas, flooded areas, cities, human health, industry, among others.
- Develop predictive models of impacts of agro-ecosystems and natural ecosystems on the climate generating increased understanding of

biogeochemical cycles (carbon, nitrogen, trace gases, aerosols and nutrients) and biogeophysical (water, radioactive energy etc.) is required for terrestrial, marine and aquatic systems.

- Promote measures to adapt to the best combination of climate scenarios and assessment of impacts and vulnerability.
- Contribute to the establishment of an environment for the development of Earth System science, as part of an effort to develop national and international observations and models of the Terrestrial System, especially the global climate models.
- Promote the development of modeling of various components of the earth system and computational capacity to allow researchers in Brazil performing simulations of global climate models with global change and earth system models.
- Support the construction and availability of environmental data with search quality from paleo-climate reconstructions, going through contemporary climatic data and satellite observations of the Earth, to census socio-economic data.
- Develop and apply technological innovations related to renewable energy (biofuels, wind, solar, hydraulic power etc.) and power efficiency and conservation, involving the private industrial and agroindustrial sector, considering also technological development in geoengineering, such as the geological sequestration of carbon dioxide.

Based on the forecasts of increased frequency and intensity of natural disasters, associated with the framework of social vulnerability, particularly of urban spaces, post graduate studies are faced with interdisciplinary and multi-disciplinary challenges in the field of research, teaching and extension. This is because the subject of natural disasters lies in the interface area of environmental, social and economic studies. In this sense, the proposed strengthening of research, teaching and extension contribute to the reversal of the vulnerability before the context of natural disasters is:

- Broaden the dialogue on scientific knowledge with the spaces of public policy formulation and decision-making, in the various areas of local, regional and national stages. This means promoting studies and tools to make information and knowledge produced in the academic context on products and tools applied in real life.

- Strengthen research focused on the recovery of urban environments, with a view to increasing the resilience of these spaces outside the context of natural disasters.
- Develop tools for accounting of natural disasters in the perspective of sustainable development, i.e., that look at this issue from the focus of social and environmental justice.
- Encourage studies and research at the medium and long terms that can therefore capture and better respond to chronic problems associated with environmental, social, economic and institutional issues.
- Encourage the permanent integration of national institutions in permanent international programs, such as those related to climate change, systemic evaluation of the millennium, environmental services, among others.

6.8 THE AMAZON

Considering all challenges and the long history of the Amazon region outside the national development process, in part related to the history of territory occupation, it stands out a common issue: the shortage of qualified staff to produce robust information required by the Amazon for income generation, social inclusion and environmental conservation. The following proposals, if deployed and encouraged, will help to reduce the regional fragility, leading the country to a hegemonic position with respect to the Amazon. This way, actions are needed in three main aspects: (i) scale; (ii) income generation and social inclusion; (iii) capacity building in all areas of knowledge and (iv) the Amazonian cooperation.

Scale

- Expand significantly the population of professionals able to meet graduate programs.
- Develop cooperation processes with consolidated programs in other regions of the country.
- Review the regulatory framework for the establishment of qualified personnel in the region.
- Deploy programs to improve quality in graduation and preparation of students for scientific research in all areas is crucial.

- Expand capacity building at graduate level of staff of the northern region requiring a well articulated process for the involvement of consolidated programs in other regions of the country as well as the consolidation of existing programs in the region and the induction of new ones.
- Adoption of financing especially designed for this purpose, through which it is possible to extend the mobility and the initial settlement of doctoral candidate is essential.
- Predict the formation of research groups that could, in a short space of time, still under the supervision of advisors, install the foundations of new graduate programs in the region.

Income generation and social inclusion

- Generate and allocate new technologies to deal with new products and processes arising out of natural resources in the region.
- Strengthen the technological areas in the region, train engineers in all areas, socializing information and innovating.
- Direct efforts to broaden such actions to produce information about the Amazon's natural resources by adding value to them.
- Propose the creation of Technological Institutes specifically designed and located according to the vocation of the installation locations.
- Socialize information and meet the demands of society, by training the population in social areas related to the full implementation of this activity.
- Stimulate the creation of Professional Master's Degrees in the region.
- Promote social inclusion in order to improve the quality of life in the region, creating a virtuous circle with environmental conservation and income generation.

Capacity building in all areas of knowledge

- Induce the creation of Inter-institutional PhD. Programs (DINTER) in these areas with already consolidated programs.
- Stimulate doctoral training in programs in other regions, national and foreign, by adopting an Amazonian theme for theoretical or experimental study, to keep the link with the region.
- Deploy a program dedicated to professionals from research institutions hired by the institutions of the region.

Amazon Cooperation

- Expand the training of staff at the graduate level for all countries that are signatories to the treaty for Amazonian cooperation.
- Include actions for staff capacity building under cooperation agreements with developed countries.

6.9 BIODIVERSITY

The sustainable use of biodiversity is first of all a challenge of scientific policy and technological development. To illustrate this challenge is the fate of the Amazon rainforest: with a high opportunity cost, the forest gives room for other forms of land use, regardless of the damages to biodiversity, environmental services and the social reproduction of traditional communities. This process has already occurred in the Atlantic Forest and the Cerrado, and now it is repeated on a faster and more intense way in the Southern Fields, Pantanal and Amazon rainforest.

In this context, there is a need to develop technological, economic models and social organization capable of ensuring: (i) persistence of biodiversity and integrity of environmental services in landscapes dominated by agrosilvopastoral activities (Atlantic Forest and Cerrado); (ii) generation of jobs and income through exploitation of forest products allowing the persistence of the forest at long-term (Amazon); (iii) valuation and trade of environmental services, so as to ensure the permanence of native vegetation cover and enable small rural enterprises (Caatinga, Pantanal and Caatinga); (iv) sustainable use of marine resources not exclusively in the form of fishing resources, but also in terms of their potential biotechnological use, ensuring the persistence of marine biodiversity (coastal zone and Oceanic ecosystems), and (v) reduction of vulnerability of ecosystems and human populations before climate change. These challenges require high-quality science and highly qualified human resources, both in prospect and in the management of biodiversity.

In this way, the Biodiversity Coordination Area by Capes must represent a core of strategic thinking, able to dialoguing with the other areas of evaluation, promotion and scientific policy agencies, but also with customers of knowledge about biodiversity. From an operational point of view, the area of Biodiversity should: (i) stimulate graduate courses within a supportive environment to form masters and doctors who have content about biodiversity, producing not only new knowledge base (e.g. description of organisms, biological processes), but also by generating the necessary information

for the management of biodiversity (e.g. required applied knowledge); (ii) establish an identity for the area from the common evaluation criteria and strategic planning of the courses and research topics; and (iii) bring and plead with the ST&I management bodies, mechanisms and support needed to the expected developments in graduate programs.

Some initiatives are already being planned, but new mechanisms should be proposed from a closer dialogue between the actors interested in the sustainable use of Brazilian biodiversity. In this context the following actions are proposed:

- Create a permanent forum for discussion to promote frequent meetings and workshops involving coordinators of Evaluation Areas of CAPES and researchers in order to induce advances in search quality and training of human resources.
- Promote research and training of human resources on topics related to goals for 2020 of the Convention of Biological Diversity and other issues considered strategic by the area.
- Encourage the formation of networks between the GPs for treating important agendas, so as to provide the interaction between disciplines of biodiversity (e.g. systematics, ecology, conservation biology) and serve as a test for the creation/fusion of courses with a multidisciplinary character.
- Promote the reorganization of courses affiliated with new area of Biodiversity in order to extend the production of qualified scientific knowledge and human resources training.
- Establish mechanisms to encourage mergers of courses, as for example, by granting a larger number of scholarships to support the management of courses or program activity.
- Stimulate the creation of networks of GPs, involving one or more higher education institutions, so that supplementary programs are able to broaden the agenda for research in biodiversity and the quality of science produced, as well as training professionals within profiles that require multidisciplinary training (e.g. conservation biologist).

6.10 INSTRUMENTS FOR HUMAN RESOURCES TRAINING

Evaluation System of Brazilian Postgraduation

Once the observations are made and the general principles presented above are established, it is recommended that:

- Evaluation of Graduate courses with 6 and 7 concept be carried out in a wider range of time, the other courses being submitted to triennial periodicity, with a more frequent monitoring to assess the approach or detachment of the indicators required for improvement of concept.
- Capes should adopt as one of the parameters for evaluating the comparison with international programs considered of reference.
- The country's economic and social development should lead to the formation, increasingly numerous, of graduate individuals dedicated to extra-academic activities. This involves the incorporation, in the assessment process, of parameters that are not exclusively those of the basic and academic areas.
- Evaluation of programs may use criteria that include asymmetry, particularly in the case of masters located in regions in a state of incipient development.
- Evaluation of applied nature programs should incorporate parameters that encourage the building of partnerships with the extra-academic sector, aimed at generation of technology and training, in fact, professional dedicated to business: this guideline leads to the consideration of other items in addition to articles and books as well as the recognition of theses and dissertations adjusted to their demands and needs.

Interdisciplinarity

A considerable evolution may be noticed of the institutionalization of interdisciplinary in the context of graduate programs inserted in Multidisciplinary Area of Capes, which covers the following Areas of Evaluation: (i) Interdisciplinary; (ii) Environmental Sciences; (iii) Materials; (iv) Biotechnology and (v) Teaching of Science. However, efforts are still needed in order to consolidate an attitude and interdisciplinary practice in the institutional context of universities, research groups and the system itself of fostering research in Brazil. Therefore, they imply important challenges to be overcome which justify the following proposals:

- Establish thematic research networks, intra and inter-institutionally, in order to transpose disciplinary and departmental walls and amplify efforts, eliminating duplication and establishing complementarity in understanding complex phenomena related to the objectives of construction of sustainability.
- Promote restructuring policies within higher education institutions, in order to shelter programs and interdisciplinary groups in their structures. It is important to mention that these are not second line programs and groups, but pioneers that arise in the gaps left by unidisciplinary knowledge and lack of integration between the various areas.
- Induce, through mechanisms of distribution of resources and assessment, the integration between the present areas of knowledge in order to promote interdisciplinarity in knowledge production;
- Assimilate the mode of interdisciplinary knowledge, required by the real problems, in the policies and programs of research promotion.
- Draw up thematic public notices that meet real needs, without inducing fragmentation of knowledge, but rather leading to their integration.

Basic Education

The creation in Capes of the Directorate of Basic Presencial Education and the Directorate of Distance Education, responsible for Brazilian Open University System, and the Scientific Technical Council of Basic Education, opened a new front of work directed to the formulation of policies for the promotion and training of teaching professionals. These initiatives enabled Capes to expand its actions for improving the quality of basic education and also mobilize the full potential of graduate courses at the master's and doctoral levels.

Based on the above, it is recommended that in the validity of the 2011 -2020 PNPG, in conjunction with the actions from the new National Plan for Education, the following proposals are carried out:

- To extend public notices for research in basic education, along the lines of ongoing programs, such as the Observatory of Education and the Observatory of Indigenous School Education.
- To extend public notices intended for valuation and training of professionals in the teaching of basic education like PRODOCÊNCIA, PIBID, New Talents, among others;

- To extend the interaction of graduate programs and of Brazilian Open University with graduate courses in promoting the improvement of the quality of teachers' training.
- To promote the interaction with state and municipal teaching systems, in particular as regards the actions of the National Plan for Training of Teachers of Basic Education – PARFOR;
- To encourage the participation of graduate courses from other areas of knowledge, in addition to Education, on issues relating to improving the quality of basic education;
- To promote the development of studies aimed to the formatting of science education in basic education, a basic tool for the building of citizenship.

Regional imbalance

The reduction of regional imbalances existing in the country demand a relevant role of Brazilian graduation, in order to form qualified personnel with awareness and training to work in the sector. In this context, the following actions are proposed:

- Prioritize investments for Research and Development (R&D) in the poorest or less developed regions.
- Invest in the University's work with small rural producers/ breeders, enabling the targeting of research to the real social demands.
- Establish a subnet on RENORBIO for the ovine/caprine culture.
- Establish a subnet of RENORBIO or even a National Institute for Science, Technology and Innovation (ST&I) in this area that may give rise to phytotherapic products among other products that integrate Bioeconomy, an area that is the unfolding of Biotechnology and that broadens their horizons.
- Promote interaction and solidarity among consolidated graduate programs located in the more developed regions with others acting in lacking regions.

Professional training

University-corporate partnerships should enrich the academic project, while contributing to innovation. The university, without prejudice to its other functions, is able to join the collective effort of innovation, with a strong interest in this field, and may establish partnerships for that purpose.

Below are listed proposals for improvement of formation of human resources for companies:

- To integrate the ST&I policy to the industrial policy so that companies are encouraged to incorporate innovation in its production process, the most efficient way to increase their global competitiveness.
- To support the maintenance and expansion of university patents deposited, as an incentive to promote university-corporate interaction.
- To create new forms of insertion into the labor market of young people with technical level, as well as of staff formed by institutions of non-university higher education or by initial cycles of university institutions.
- To stimulate training in intellectual property, technological innovation and entrepreneurship, opening new perspectives for the country, with encouragement for the participation of enterprises in long-lasting scientific and technological research lines.
- To promote research activity on corporations, fostering and/or inducing the creation of graduate courses and encouraging a greater absorption of masters and doctors by companies.
- To extend substantially the Brazilian graduate programs with an emphasis on engineering and technology areas: the deficit is great in these areas and, properly stimulated, they can strategically contribute to the development of the following sectors: (i) power; (ii) water management (iii) cities; (iv) biodiversity; (v) agribusiness, (vi) food, (vii) petro-chemical, among others.
- To create an agenda for the training of talents, at graduate level, to support the processes of innovation in the country's industrial park, defeating the hiatus in the conversion of science into technology and observing future trends of the world economy, so as to strengthen the skills and competencies.
- To support the initiatives of graduate programs that include a better integration between universities, government and corporations, through the building of networks of knowledge production, based on interdisciplinarity, applicability and social responsibility of knowledge, with leading policies for research in social technologies and linked to the concern for sustainability.
- To create a special program of scholarships for technicians in support of scientific research, with the objective of preparing qualified human resources and supporting the development of research component in the Brazilian graduate program..

- To support the dissemination of graduate offerings in professional education taking into account equalization criteria of offers in the different poles of the country's development; with incentives for the creation and development of professional programs with public resources and under public-private partnerships, to form specialists, masters and doctors who meet the needs of developing general and specific professional skills.
- To insure the quality of vocational nature courses offerings in graduation elaborating criteria and indicators from the identity of these courses (specialization, master's degree, doctor's degree) and effective impacts that the training and scientific and technological production have on the country's development in multiple scales (from local to national).

Internationalization and international cooperation

In the expansion of graduate courses and activities it must be taken into account in the pursuit of excellence and new knowledge and endogeny should be avoided. One way to achieve these goals is the more intense interaction between Brazilian and international institutions. Such interaction, besides promoting the growth of science, shall increase the role of the country on the international scenario. In this context, the following proposals are suggested:

- Send more students abroad to pursue doctor's degrees, in view of the stimulation of the system and capture of new knowledge.
- Stimulate the attraction of more foreign visiting students and researchers.
- Increase the number of publications with foreign institutions.

Post Graduation financing

Graduate funding depends on the federal Government's expressive subsidies, involving different ministries and agencies, with partnerships of FAPs in specific programs and of segments of private initiative. In the next decade, to meet the growing and diversified demands of the economy and the society, with the purpose of establishing a welfare society focused on the set of the Brazilian population, the investments should be even higher, requiring a complex financial engineering and an efficient and appropriate regulatory framework. To this end, we recommend the following proposals:

- Increase the percentage of the GDP invested by the Government in S, T&I and of private investment in S,T&I.
- Promote the integration between government bodies to compose a national strategic agenda for sustainable development, extrapolating its individual promotion programs in order to provide robustness to investments under development and use of knowledge in S,T&I.
- Implement a reform of the legal framework, so that the federal and state funding agencies have greater flexibility in the use of resources for S,T&I and have correlation with the mechanisms adopted by the organs of external control.
- Review and simplify import procedures, to give world competitiveness to Brazilian research, since the difficulty of importing raw materials or spare parts causes Brazil to be in a competitive disadvantage and pay high maintenance contracts, which have been labeled generically as "Brazil cost", and which negatively impact search performance and the maintenance of the infrastructure of S,TI of the country.
- Eliminate bureaucratic barriers which impede the activities of consultancy and advisory by researchers from the Single Legal Regime to public and private companies, as well as curtail the hiring by public system of national and international consultants and experts.
- Reduce the bureaucratic activities required from researchers in the management of resources transferred by the agencies.
- Expand investments in ST&I so that, parallel to the guarantee of maintenance and expansion of the groups of excellence emerging groups of recognized academic merit are supported.

Induction instruments

Induced actions have been very effective in supporting the training of human resources through Post Graduate programs. Despite the large number of actions performed during the period, many of which are in full effect, many segments, themes and lines of research and even whole areas of knowledge, require additional action by the agency, meaning that the wider adoption of induced actions will become routine activity of Capes as well of other agencies.

In view of the volume of resources applied and the number of courses and students involved, then proposals are:

- Create a commission in Capes, linked to the Presidency, composed of specialists to follow-up and evaluate the induced programs as a result of PNPG 2011-2020.
- Provide autonomy to this commission to suggest modifications in the induced programs and have working conditions that enable its interaction with higher education institutions, encouraging them to participate in the mentioned programs.

The proposals presented in this chapter may help policies implementation for the expansion of Brazilian Post Graduate Program for the period of 2012-2020.

7 FINAL CONSIDERATIONS

The holding of the United Nations Conference on Sustainable Development, known as Rio+20 is an opportunity for identifying and negotiating solutions to meet the challenges in recent years: economic, for the financial crisis faced by the developed countries and which threatens the growth of developing countries; social, since the guarantee of jobs and access to basic needs still does not reach much of the world's population; and protection of the environment, by the pressures on natural resources and consequences resulting from climate change.

Sustainable development based on three dimensions to be reconciled in a enduring perspective: economic viability, social justice and environmental conservation, will assume the role of major relevance in the technological and economic policies, as well as in the training of staff for the public and private sectors. In this sense, the Brazilian graduate program has a broad space for expansion in order to meet the new determinations of development on a sustainable basis. The same will occur with other segments of the economy and society, requiring the preparation of highly qualified technical staff, along with the need to improve the educational system as a whole.

In the scenario for the next 10 years, Brazil will face the major challenge of forming and educating specialized and qualified persons to meet, among others, demands such as: desirable development in the areas of energy, population growth in cities, environmental preservation, expansion and improvement of food production, monitoring and prediction of extreme weather phenomena, use and protection of water resources, sustainable use of biodiversity, among others.

The expansion of the National Postgraduation System should take into account the following aspects: encouragement of multi-interdisciplinary training programs; use of solidarity indicators as an instrument for expanding the national graduate park to reduce asymmetries among regions; nonlinear expansion of areas of knowledge and establishment of centers of excellence in teaching and research at the international level; incentive to the building of networks of research and graduate studies, involving national and international partnerships, at the frontier of knowledge level, unpublished projects; investments in children and young people, particularly in actions directed to basic and higher education, since the performance of the Brazilian economy in the coming decades will depend on them; inclusion in the development process,

the economy, health and education in Brazil, as well as the cultural characteristics of populations and environmental issues.

Brazil is rich in natural resources and science should be developed in order to take advantage of this wealth, thus assuring protection. This means the production of naturally multi and interdisciplinary knowledge, in order to include subjects that are not only disciplinary, but that demand multiple areas and interdisciplinary approach. In this context, Brazilian graduate program has increasingly contributed to the training of professionals with systemic vision and development of high-level research, creating new technologies, rethinking management processes and promoting integral education. Therefore, processes aligned with the subjects emerging from the Rio + 20 Conference, presented throughout this document illustrate the contribution of Brazilian Post Graduation Studies to sustainable development.

In order to assure the negotiation, implementation of these proposals presented in this document, it is proposed the creation of a Commission in Capes, linked to the Presidency, composed of Coordinators of Area by Capes, or by their representants, together with specialists related to the themes of the Rio+20 Conference. This commission should promote the interaction among public and private institutions in order to improve the Brazilian Post Graduation Education System in the context of sustainable development.

Finally, emphasis is given to the valuable role of Brazil as the host country of the Rio+20 Conference to revert this opportunity into concrete actions for the strengthening of national post graduation and, therefore, contributing to improve the quality of life of the Brazilian people.

REFERENCES

ABRAMOVAY, R.; VEIGA, J.E. **Novas Instituições para o Desenvolvimento Rural: o caso do Programa Nacional de Fortalecimento da Agricultura Familiar (PRONAF)**. Texto para discussão n. 641. Convênio FIPE/IPEA 07/97. ISSN 1415-4765.

ACADEMIA BRASILEIRA DE CIÊNCIAS. **Amazônia: desafio brasileiro do século XXI**. Academia Brasileira de Ciências: Fundação Conrado Wessel. Rio de Janeiro, 2008.

BRYANT, E. **Natural Hazards**. Cambridge University Press, 2001.

BULLOCK, S. H.; MOONEY, H. A.; MEDINA, E. **Seasonally dry tropical forests**. Cambridge University Press, Cambridge.

BUSTAMANTE, M. M. C. ; LENZA, E. **Impacto das atividades agrícolas, florestais e pecuárias nos recursos naturais**. In: Faleiro, F.G.; Farias Neto, A.L. (Org.). Savanas - desafios e estratégias para o equilíbrio entre sociedade, agronegócio e recursos naturais. 1. ed. Brasília: Embrapa, 2008. p. 647-669.

CABRAL JR, W. & ALMEIDA, O.T. **Avaliação do mercado da indústria pesqueira na Amazônia**. In: A indústria pesqueira na Amazônia. O. T. Editora Almeida. IBAMA/Provarzea. Manaus, 2006. p. 17-39.

CAPES - Coordenação de Aperfeiçoamento de Pessoal de Nível Superior. **Plano Nacional de Pós-Graduação**. Vol. I Capes, 2011

CAPES - Coordenação de Aperfeiçoamento de Pessoal de Nível Superior. **Plano Nacional de Pós-Graduação**. Vol. II Documentos Setoriais Capes, 2011

CARDOSO, M.S. 2004. **Formação e fixação de pesquisadores na região Norte do Brasil: O Projeto Norte de Pós-graduação e pesquisa/CAPES**. Universidade de Brasília. Brasília, 2004. [Dissertação de Mestrado]. Programa de Pós-Graduação em Sociologia, 2004.

CGEE. **Um projeto para a Amazônia no século 21: desafios e contribuições**. Brasília, 2009.

CHESNAIS, C. **Comunicação Pessoal em: Seminar on Age-Structure transition: Demographic Bonuses, but emerging challenges for population and sustainable development**. Paris France/CICRED, 23-26 February, 2004.

CIMINELLI; U.S.T.; BARBOSA F.A. **Água industria mineral conservação do meio ambiente e biodiversidade**. In: Barbosa F.A. (Org). Ângulos da água. Desafios da integração. Editora da UFMG. 2008.TUNDISI; STRASKRABA, 1995. 39-64 p.

CLAY, J.W.; SAMPAIO, P.T.B. & CLEMENT, C.R. **Biodiversidade Amazônica: Exemplos e estratégias de utilização**. Sebrae, AM, 1999.
CLEMENT, C.R. & VAL, A.L. A future Amazonia. **Live Better**, 2009. 5: 14-15.

CMMAD - Comissão Mundial sobre Meio Ambiente e Desenvolvimento. **Nosso futuro comum**. Rio de Janeiro: Editora Faculdade Getúlio Vargas, 1988.

CONSELHO NACIONAL DE DESENVOLVIMENTO CIENTÍFICO E TECNOLÓGICO. **Séries históricas: Distribuição dos grupos de pesquisa segundo a região geográfica - 1993-2004**. Disponível em: <http://dgp.cnpq.br/censo2004/series_historicas/index_grupos.htm>. Acesso em: 05 mai 2012.

CONSTANZA, R.; D'ARGE, R.; GROOT, R.; FARBER, S.; GRASSO, M.; HANNON, B.; LIMBURG, K.; NAEEM, S.; O'NEILL, R.V.; RASKIN, R.G.; SUTTON, P. & VAND DEN BELT, M. The value of the world's ecosystem services and natural capital. **Nature**, 1997. 387: 253-260.

COSTA, M.H.; BOTTA, A.; CARDILLE, J.A**.** Effects of large-scale changes in land cover on the discharge of the Tocantins River, Southeastern Amazonia. **Journal of Hydrology**, 2003. v. 283, p. 206-217.

DAGNINO, R. **Por que tratar de capacitação em C&T para o desenvolvimento social na IV CNCTI?** (2009). Recuperado do endereço http://www.rts.org.br/artigos em 23 mai 2010.

DINIZ, E.; BERMANN, C. **Economia verde e sustentabilidade**. Estudos Avançados, 2012. v. 26, n. 74, p. 323-329.

DUARTE, R. M; MENEZES, A. C.; RODRIGUES, L. S.; ALMEIDA-VAL, V. M. F. & VAL, A. L. Copper sensitivity of wild ornamental fish of the Amazon. **Ecotoxicology and Environmental Sensitivity**, 2009. 72: 6930-698.

DUARTE, R.M.; HONDA, R.T. & VAL, A.L. Acute effects of chemically dispersed crude oil on gill ion regulation, plasma ion levels and haematological parameters in tambaqui (Colossoma macropomum). **Aquatic Toxicology**, 2010. 97: 134-141

EMBRAPA. **O Desafio da Agricultura Familiar**. 2004. Disponível em: http://www.embrapa.br/imprensa/artigos/2002/artigo.2004-12-07.2590963189/ Acesso em: 08 mai 2012.

EVA, H. D. & HUBER, O. **Proposta para definição dos limites geográficos da Amazônia: Síntese dos resultados de um seminário de consulta a peritos organizado pela Comissão Europeia em colaboração com a Organização do Tratado de Cooperação Amazônica – CCP ISpra 7-8 de junho de 2005**. European Commission e OTCA. 2005. Disponível em: <http://ies.jrc.ec.europa.eu/uploads/fileadmin/Documentation/Reports/Global_Vegetation_Monitoring/EUR_2005/eur21808_bz.pdf>. Acesso em: 18 abr 2010.

EVA, H. D.; BELWARD, A. S.; DE MIRANDA, E. E.; DI BELLA, C. M.; GOND, V.; HUBER, O.; JONES, S.; SGRNZAROLI, M.; FRITZ, S. A land cover map of South America. **Global Change Biology**, 2004. 10, 731- 744.

FEARNSIDE, P. Amazon forest maintenance as a source of environmental services. **Anais da Academia Brasileira de Ciências**, 2008. 80: 101-114.

FELFILI, J.M., CARVALHO, F.A. e HAIDAR, R.F. **Manual para o monitoramento de parcelas permanentes nos Biomas Cerrado e Pantanal**. Brasília: Departamento de Engenharia Florestal, Universidade de Brasília. Brasília, 2008.

FERNANDES, V. & SAMPAIO C. A. C. Problemática ambiental ou problemática socioambiental? A natureza da relação sociedade/meio ambiente. **Revista Desenvolvimento e Meio Ambiente**. Editora UFPR, jul/dez 2008. n. 18, p. 87-94.

FOPROP-Norte. **Ciência na Amazônia para o Brasil**. Programa Acelera Amazônia. Belém, 3-5 mai 2005.

FRAGOSO, C. R. JR.; FERREIRA T. F. e MARQUES D. M. **Modelagem ecológica em ecossistemas aquáticos**. Oficina de textos, 2009.

GIL, P. R. **Wilderness: earth's last wild places**. CEMEX, S.A. Cidade do México, 2002.

INPA. **Parecer da comissão Interna para avaliar a valoração dos serviços ambientais no Estado do Amazonas**. Manaus, 2009. 26p. A comissão esteve constituída por Luizão, F.J. (presidente); Graça, P.M.L.A.; Manzi, A. O.; Clement, C. R.; Piedade, M. T. F. e Higuchi, N.

INPA & STRI. **Desenvolvimento Inteligente: Doze princípios para maximizar o estoque de carbono e a proteção ambiental nas florestas da Amazônia.** Manaus, AM, 2009.

IPCC. **Climate change: Synthesis report. An Assessment of the Intergovernmental Panel on Climate Change. Plenary Section XXVII**. Valencia, Spain, 12-17 nov 2007.

JORGENSEN, S. E.; LOFLER, H.; RAST, W. & STRASKRABA, M. **Lake and reservoir management**. Elsevier, 2005.

LEIS, H. R. A **Modernidade Insustentável: As críticas do ambientalismo à sociedade contemporânea.** Petrópolis/Florianópolis: Vozes/UFSC, 1999.

LIMA, J.E.,F.W. & SILVA, E.M. **Estimativa da produção hídrica superficial do cerrado brasileiro**. In: Scariot, A.O., Sousa-Silva, J.C. & Felfili, J.M. (org). Cerrado: ecologia, biodiversidade e conservação. Brasília: Ministério do Meio Ambiente, 2008. p 63-72.

LINDH, T.; MALMBERG, B. Age structure effects and growth in the OECD, 1950-1990. **Journal of Population Economics**, 1999.12(3), p. 431-450.

LLAMAS, M.R. & MARTINEZ-SANTOS, P. **Significance of the silent revolution of intensive use in world water policy**. In: Rogers P.P; Llamas R.M. Martinez Cortina L. (Editors). Water Crisis; myth or reality? Taylor & Francis, 2006. 331p (163-180).

LLERAS, E. Os cursos de pós-graduação do Instituto Nacional de Pesquisas da Amazônia. **Acta Amazonica**, 1981. 11(1): 117-123.

MACHADO, J.A.C. **Objetivos de uma política externa do Brasil em relação a Amazônia: proposta para discussão**. In: O Brasil no mundo que vem aí. J. Moscardo & C.H. Cardim (orgs). Fundação Alexandre Gusmão. Brasília, 2009.

MANTOVANI, J. E. & PEREIRA, A. **Estimating the integrity of the Cerrado vegetation cover through the Landsat-TM data**. Simpósio Brasileiro de Sensoriamento Remoto,9, Santos. São José dos Campos, SP: Instituto Nacional de Pesquisas Espaciais – INPE, 1998. p.11–18. In CD-ROM.

MARCELINO, E.V. **Desastres naturais e geotecnologias:conceitos básicos**. INPE: Santa Maria, 2007.

MELO, F.P; PINTO, S.R..; TABARELLI, M **.** Abundância de biodiversidade. **Scientific American Brasil**, 2010. v. 39, p. 60-65.

MMA – MINISTÉRIO DO MEIO AMBIENTE. **Biomas**. Disponível em <http://www.mma.gov.br/sitio/index>. Acesso em: 03 mai 2012.

MOTTA, R. S.; HARGRAVE, J.; LUEDEMANN, G; GUTIERREZ, M.B.S (Eds). **Mudanças no clima no Brasil: Aspectos econômicos, sociais e regulatórios**. Brasília: IPEA, 2011.

NAVANEETHAM, K. **Age structural transition and economic growth: evidence from south and southeast Asia**. In: Proceedings - IUSSP General Conference. Salvador, Brasil, 2001.

ONU. Declaração da América Latina e Caribe no décimo aniversário da "Conferência Mundial sobre a Ciência", 2009.

PENNINGTON, R. T., PRADO, D. A. AND PENDRY, C. Neotropical seasonally dry forests and quaternary vegetation changes. **Journal of Biogeography**, 2000. 27:261-273.

PHILIPPI JR, A. & FERNANDES, V. **Caminhos da Interdisciplinaridade na Pesquisa e na Pós-Graduação. Anais da 63ª Reunião Anual da SBPC -** Goiânia, GO. Jul 2011.

PHILIPPI JR, A. **Interdisciplinaridade como atributo da C&T**. In: PHILIPPI JR, A.; TUCCI, C. E. M. e HOGAN, R. Interdisciplinaridade em Ciências Ambientais. São Paulo: Sígnus Editora, 2000.

POTTER, C.; KLOOSTER, S.; HUETE, A. R; GENOVESE, V.; BUSTAMANTE, M. C.; FERREIRA JR, L. G.; OLIVEIRA JR. R.C.; ZEPP, R. Terrestrial carbon sinks in the Brazilian Amazon and Cerrado Region predicted from MODIS Satellite Data and ecosystem modeling. **Biogeosciences Discussions**, 2009. v. 6. p. 1-23.

RAYNAUT, C., ZANONI, M. **Reflexões sobre princípios de uma prática interdisciplinar na pesquisa e no ensino superior**. In: PHILIPPI JR., A. & SILVA NETO, A. J. Interdisciplinaridade em ciência, tecnologia & inovação. Barueri: Manole, 2011.

RODRIGUES, I. & BARBIERI, J. C. A emergência da tecnologia social: Revisitando o movimento da tecnologia apropriada como estratégia de desenvolvimento sustentável. **Revista de Administração Pública**, 2008. 42(6), 1069-1094.

SANTOS J. C. ; LEAL, INARA R. ; CORTEZ, J. A.; FERNANDES, G. W.; TABARELLI, M. **Caatinga: the scientific negligence experienced by a dry tropical forest**. Tropical Conservation Science, 2011. v. 4, p. 276-286.

SANTOS, G. M.; FERREIRA, E.G. & VAL, A.L. Recursos pesqueiros e sustentabilidade na Amazônia: fatos e perspectivas. **Hileia**, 2010. 8: 43-77.

SECRETARIA DO MEIO AMBIENTE DO ESTADO DE SÃO PAULO. **Brasil 92 - Perfil ambiental e estratégias**. São Paulo: a Secretaria, 1992.

SILVA LEME, M.C.; WAJNMAN, S. **A alocação do tempo dos adolescentes brasileiros entre o trabalho e a escola**. ENCONTRO NACIONAL DE ESTUDOS POPULACIONAIS, 12, Caxambu, 2000. Anais... Belo Horizonte: ABEP, 2000.

TADEI, W.P. **Relatório parcial**. II Workshop do INCT Adapta. Manaus, abr 2010.

TUNDISI, J.G. **Coupling surface and groundwater research: a new step towards water management**.. In: Integrating Science and Technology into development policies: an international perspective. OECD, 2007. 163-169 p.

TUNDISI, J.G. e MATSUMURA-TUNDISI, T. **Limnologia**. Oficina de Textos. 2008.

UN-ISDR - International Strategy for Disaster Reduction. Terminology on Disaster Risk Reduction, 2009. Disponível em: http: <//www.unisdr.org>. Acesso em: mai 2012.

UNEP-UNITED NATIONS ENVIRONMENT PROGRAMME. **Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication**. Disponível em <www.unep.org/greeneconomy>. Acesso em: 04 mai 2012.

VAL, A. L. Formação e fixação de recursos humanos: ações essenciais para a Amazônia. **Ciência e Cultura**, 2006. 58: 79-86

VAL, A.L.; ALMEIDA-VAL, V.M.F.; FEARNSIDE, P.M.; SANTOS, G.M.; PIEDADE, M.T.F.; JUNK, W.; NOZAWA, S.R.; SILVA, S.T. & DANTAS, F. A. C. **Amazônia: Recursos hídricos e sustentabilidade**. Academia Brasileira de Ciências, 2010.

ZALEWSKI, M. Flood pulses and ecosystem robustness. **Frontiers in Flood research**. IHAS Publications, 2006. 305 p. p 143-154.

ZUIN, V. G. **A inserção da dimensão ambiental na formação de professores de Química**. Campinas: Átomo, 2011.

LIST OF ACRONYMS AND ABREVIATIONS

A-DARTER	Agile Darter
AKA	Finnish Academy of Science
ANR	National Research Agency (Agence Nationale de la Recherche)
ANP	National Agency of Oil, Natural Gas and Bio-combustibles
ANPEI	National Association for the Research, development and establishment of Innovative Enterprises
ANPROTEC	National Association of Institutions for the Promotion of Advanced Technology Enterprises
AU	Architecture and Urbanization
ASCIN	International Cooperation Support
BID	Inter-American Development Bank
BIOMAR	Program for the Survey and Assessment of the Bio-technological Potential of Marine Biodiversity
BIONORTE	Biodiversity and Biotecnology Network within the Amazon Region
BRAFITEC	Brasil-França Ingénieur Technologie (Brazil-France Engineering Technology)
CAPES	Coordination of Higher Level Personnel Improvement
CENBIO	Biomass Reference Center
CDTI	Center for the Development of Industrial Technology
CGBE	General Scholarships for Studies Abroad Coordination Bureau
CGCI	International Cooperation Coordination Bureau
CIDA	Canadian International Development Agency
CIRM	Ocean Resources Inter-ministerial Commission
CITMA	Science, Technology and the Environment
C,T&i	Science, Technology and Innovation
CVRD	Vale do Rio Doce Entreprise
CYTED	Science and Technology and Development
DAAD	Deutscher Akademischer Austauschdienst
DCR	Regional Scientific Development
DFG	Deutsche Forschungsgemeinschaft
DINTER	Program New Frontiers (Novas Fronteiras Program)

DLR	German Space Agency
DRI	Directorate of International Relations
EFEI	Itajubá Federal University
EMBRAER	Empresa Brasileira de Aeronáutica SA (Brazilian Aeronautics Enterprise SA)
EPE	Energy Research Enterprise (Empresa de Pesquisa Energética)
FAPs	Research Support Foundations
FAPEAM	Research Support Foundation for the Amazon
FINEP	Study and Project Funding
FNRS	National Fund for Scientific Research
FORTEC	National Forum of Managers for Innovation and Technological Transfer
FUMIN	Multilateral Investment Fund
FUNCAP	Ceará State Foundation for Scientific and Technological Development
GeDIg	Network of Digitally Integrated Topic Management
GOSS/Brasil	Global Ocean Observing
IAC	InterAcademy Council
IANAS	InterAmerican Network of Academies of Science
IAP	InterAcademy Panel: The Global Network of Science Academies
IDEB	Basic Education Development Index
ICSU	International Council for Sciences
IDH	Human Development Index
IEAPM	Admiral Paulo Moreira Sea Research Institute
IEE	Electrotechnics and Energy Institute
IIRSA	Initiative for the Integration of South-American Regional Infrastructure
INCRA	National Colonization and Agrarian Reform Institute
INCT	National Science and Technology Institute
INPA	National Institute of Amazon Research
INEP	Anísio Teixeira National Institute for the Study and Research of Education
INPI	National Industrial Property Institute
INRIA	Institut National de Recherche en Informatique et Automatique

INSERM	Institut National de la Santé et de la Recherche Médicale
IPCC	Intergovernamental Panel on Climate Change
IRD	Institut de Recherche pour le Développement
ISI	Institute for Scientific Information
KOSEF	Korea Science and Engineering Foundation
LIA	Associated International Laboratory (Laboratório Internacional Associado)
LDBEN	National Education Directives and Basis
LOSAN	Organic Law for Food and Nutrition Safety
MDIC	Ministry of Development, Industry and Foreign Trade
MDS	Ministry of Social Development and Fight Against Hunger
MEC	Ministry of Education
MMA	Ministry of the Environment
MC	Ministry of Cities
MCT	Ministry of Science and Technology
MES	Ministry of Higher Education (Ministerio de Educación Superior)
MHEST	Ministry of Higher Education, Science and Technology
NIT	Technological Innovation Centers
NSF	National Science Foundation
OGI	Iberoeka Management Organization
OMPI	World Intellectual Property Organization (WIPO)
PAR	Articulated Action Plan
PARFOR	National Plan for the Empowerment of Basic Education Teachers
P&D	Research and Development
PBDCT	Basic Plan for Scientific and Technological Development
PDE	Plan for the Development of Education
PEA	economically active population
PEP	Population aging process
PET	Special Training Programs
PFPMCG	Fapesp Program for Global Climate Change Research
PIBIC	Scientific Initiation Program
PINTEC	Industrial Research – Technological Innovation
PND	National Development Plan
PNDR	National Regional Development Policy

PNDU	National Urban Development Policy
PNOT	National Territorial Organization Policy
PNPD	National Post-Doctorate Program
PNQP	National Professional Empowerment Program
PNRM	National Ocean Resource Policy
PNSAN	National Food and Nutritional Safety
PRH-ANP	Human Resource Program
PROANTAR	Antarctic Program
PRO ARQUIPÉLAGO	São Pedro and São Paulo Archipelago Program
PROCAD	Program New Frontiers
PRO-CENTRO OESTE	Center-West Post-Graduation Network
PRODOC	Support Program for Institutional Projects with the Participation of New Doctors
PROEX	Academic Excellence Program
PROMINP	Program for the Mobilization of the National Oil and Natural Gas Industry
PROVOC	Scientific Vocation Plan
PSEC	Sectorial Education and Culture Plan
RECODISA	Network of Ovine Caprine Farms and Child Diarrhea in the Brazilian Semi-Arid Region
REMPLAC	Program for the Assessment of the Mineral Potential of the Continental Shelf
RENORBIO	Northeast Biotechnology Network
RNP	National Research Network
REVIMAR	Program for the Assessment of Sustainable Potential of Marine Life
SEGIB	Ibero-American General Secretariat
SESAN	Food and Nutritional Safety Secretariat
SisGAAz	Blue Amazon Management System
SNPG	National Post-Graduation Policy System
STS Fórum	International Forum on Science and Technology at the Service of Society
TCA	Amazon Cooperation Treaty

TWAS	Academy of Sciences for a Developing World
UFCE	Ceará Federal University
UFAM	Amazon Federal University
UFPA	Pará Federal University
UNAMAZ	Association Of Legal Amazon Universities
UNIFACS	Salvador University

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ANNEX: ADMINISTRATIVE ORDER CAPES 11/2012

COORDENAÇAO DE APERFEIÇOAMENTO DE PESSOAL DE NÍVEL SUPERIOR

PORTARIA Nº 11, DE 13 DE FEVEREIRO DE 2012

O PRESIDENTE DA COORDENAÇÃO DE APERFEIÇOAMENTO DE PESSOAL DE NÍVEL SUPERIOR - CAPES, no uso das atribuições conferidas pelo Estatuto aprovado pelo Decreto nº 6.316, de 20.12.2007, publicado no DOU de 21 subseqüente, e considerando a participação da CAPES na Conferencia das Nações Unidas sobre Desenvolvimento Sustentável - RIO+20, evento organizado pela ONU (Organização das Nações Unidas), e que marcará o 20º aniversário da Conferência das Nações Unidas sobre Meio Ambiente e Desenvolvimento (UNCED), resolve:

Art. 1º Instituir Comissão responsável pela elaboração de documento base e pela organização da participação da CAPES no evento.

Art. 2º A Comissão será composta pelos seguintes membros:

a) Livio Amaral, Diretor de Avaliação da CAPES, que a presidirá;

b) Arlindo Philippi Junior, Coordenador da área de Ciências Ambientais da CAPES;

c) Ricardo Triska - Coordenador da área de Arquitetura e Urbanismo da CAPES;

d) João Lima Sant'Anna Neto, Coordenador da área de Geografia da CAPES;

e) Rainer Randholf, Coordenador da área de Planejamento Urbano e Regional/Demografia da CAPES;

f) Estevam Barbosa de Las Casas, Coordenador da área de Engenharia I;

g) Marcelo Tabarelli, Coordenador da área de Biodiversidade da CAPES;

h) Benamy Turkienicz, da UFRGS;

i) Maria do Carmo Sobral, da UFPE;

j) José Seixas Lourenço, da UFOPA;

k) Neyval Costa Reis Júnior, da UFES;

l) Fábio Scarano, da ONG Conservação Internacional.

Art. 3º A Comissão de Apoio Técnico será composta pelos seguintes servidores da CAPES:

a) Sandra Fátima Amaral da Cunha, Coordenadora da Secretaria Executiva dos Órgãos Colegiados - SECOL;

b) Fabiana Santos Pereira, Assessora da Assessoria de Comunicação Social - ACS;

c) Cristina Haeffner, Assessora da Assessoria de Planejamento e Estudos - APE.

Art. 4º Esta Portaria entra em vigor nesta data

JORGE ALMEIDA GUIMARÃES