The Forest Code and Science: Contributions for the dialogue

The scientific considerations contained in this document contribute to the dialogue which society is currently having about possible alterations to the Brazilian Forest Code. Nevertheless, we would like to point out that this is not a detailed analysis of the provisions of the current Forest Code, nor of the substitute to the Bill number 1.876/99 and its respective appended bills.

What inspired this work was the perspective of new concepts and new technological instruments for territorial planning and organization focused on stimulating the increase of production and of agricultural productivity in synergy with environmental sustainability.

The document makes explicit the scientific reference utilized for the analysis of several themes of rural and urban environment, which cannot be disregarded in reviewing the legislation, citing examples of provisions of the current Forest Code and of the substitute Bill being discussed. The Brazilian Society for the Advancement of Science (SBPC) and the Brazilian Academy of Sciences (ABC) remain available to mobilize competencies of society who can scientifically support the dialogue, participating in agendas of various sectors.

PRESENTATION

The Brazilian Academy of Sciences (ABC) and the Brazilian Society for the Advancement of Science (SBPC), founded respectively in 1916 and 1948, are representative bodies of the scientific community of the country, both entities are free from political party bias and are non-profitable organizations.

Among their objectives are:

- Represent the Brazilian scientific community, both nationally and internationally, aiming towards the implementation of a policy of Science, Technology and Innovation (ST&I) that promotes the development of science in benefit of society;

- Promote the mobilization of the scientific community in order for it to act within the constituted powers, aiming towards the national scientific and technological advance and incentives to innovation;

- Ensure the maintenance of the high standards of ethics among scientists in their relationships with society;

- Fight towards removing the obstacles and the misunderstanding that impede the progress of science;

- Take a stand on scientific, educational and cultural issues and in scientific and technological development programs which meet the real interests of the country.

Responding to a demand of society, particularly of the scientific community for a more effective participation of science in the reformulation of the Forest Code (FC), the Brazilian Academy of Science (ABC) and the Brazilian Society for the Advancement of Science (SBPC) formed a work group to provide data and technical scientific arguments that can support the discussions on the proposed changes to the Forest Code in the Substitute of the Bill 1.876/99.

The first Brazilian Forest Code was established by Decree No 23.793 of January 23, 1934, subsequently revoked by Law 4.771 of September 15, 1965, which established the Forest Code in force today. Both the original legislation and all subsequent amendments took into account the scientific knowledge available so far. At the present moment, when the discussions on the subject are reopened, the scientific community, supported by the legitimacy of its most ample and representative associations, ABC and SBPC, request that the National Congress continue to take into account the advances in scientific knowledge and technological development to the debate on the Brazilian Forest Legislation

Aside from members of ABC and SBPC, several research institutions, universities, professional representations and civil organizations were invited to participate in the Work Group (WG), among which are:

Brazilian Agricultural Research Corporation (EMBRAPA); Butantan Institute; National Institute for Space Research (INPE); National Institute for Amazon Research (INPA); Brazilian Institute of Environment and Renewable Natural Resources (IBAMA); Emilio Goeldi Museum from Pará (MPEG); Ministry of Environment (MMA); Federal Council of Engineering, Architecture and Agronomy (CONFEA); National Confederation of Workers in Agriculture (CONTAG); Brazilian Society of Forestry Engineers (SBEF); Brazilian Society of Forestry (SBS); Brazilian Association of Forests (ABRAFLOR); Brazilian Agroforestry Network (REBRAF) and the universities: UNICAMP(State University of Campinas), UFRJ(Federal University of Rio de Janeiro), UFRPE (Federal Rural University of Pernambuco), UFV (Federal University of Viçosa) and USP (ESALQ) (University of São Paulo – College of Agriculture Luiz de Queiroz).

Several of these institutions indicated representatives. Later, at the suggestion of WG members, other names were added to the group. The methodology adopted for the works was to subdivide the topics of the document by areas, and that the members of the WG would write their contributions which would then be shared with the other members for analysis, corrections and suggestions. One coordinator was nominated to articulate the actions of the WG.

All the meetings were held at the headquarters of SBPC in São Paulo. The first one occurred on the 7th of July 2010. Goals to be achieved were defined and a diagnosis of the state of the art of the Forest Code and the aforementioned amendment was made.

The second meeting was held on the 26th and 27th of August 2010. The deputy Aldo Rebelo (PCdoB/SP) rapporteur of the substitute Bill number 1.876/99, explained his project to the WG members and guests. The ex-secretary of the Biodiversity and Forests of the Ministry of the Environment, Maria Cecília Wey, gave a presentation on the perceptions of the MMA (Ministry of the Environment) with regards to the subject. Upon the closing of the presentations, the WG elaborated a first letter which was forwarded to Congressmen and Senators. The letter was signed by Jacob Palis Junior and Marco Antônio Raupp, respectively presidents of ABC and SBPC.

At the third meeting, on the 7th and 8th of October of 2010, the works on the construction of the document were continued. Another letter was elaborated and forwarded to the presidential candidates. In the month of December, on the 2nd and the 3rd, another meeting was held with the WG, which counted with the participation of the Deputy Ivan Valente (PSOL/SP), member of the Environmentalist bench in Congress. Another meeting was held on the 28th and 29th of January 2011, at which an executive summary was elaborated and forwarded to the congressmen and the senator, and advertised at a national level.

During these meetings, several people expressed their points of view about the theme, and in more than one occasion cited: Aziz Ab'Saber (USP); Aldo Malavasi (Board of Directors of SBPC/Moscamed); Alysson Paulinelli (Ex-minister of Agriculture); Antoninho Rovaris (CONTAG); Claudio Azevedo Dupas (IBAMA); Gustavo Curcio (EMBRAPA Forests); Helena Bonciani Nader (UNIFESP – Vice-president of

SBPC); Helton Damin da Silva – (General head of EMBRAPA Forests); Jacob Palis Júnior (President of ABC/IMPA); João de Deus Medeiros (MMA); José Raimundo Braga Coelho (Board of Directors of SBPC); Luiz Antônio Martinelli (CENA/USP); Marco Antônio Raupp (MCT – currently President of SBPC); Maria Cecília Wey (MMA); Otávio Velho (Vice-president of SBPC/UFRJ);Rinaldo Augusto Orlandi (Advisor of Dep. Aldo Rebelo); Rute Maria Gonçalves Andrade (Board of Directors of SBPC/ Butantan Institute); Sourak Aranha Borralho (IBAMA).

The work group that organized this document was constituted by:

Antonio Donato Nobre (INPA/INPE) – Engineer Agronomist (ESALQ USP), Masters degree in Tropical Ecology (INPA UA), PhD in Earth Science (UNH – USA);

Carlos Alfredo Joly (UNICAMP – BIOTA) – Graduated in Biological Sciences (USP), Masters degree in Plant Biology (UNICAMP), PhD in Plant Ecophysiology from the Botany Department - University of Saint Andrews Scotland/GB, Post-Doctorate degree (Universität Bern, Switzerland);

Carlos Afonso Nobre (INPE – MCT) – Electrical Engineer (ITA), PhD in Metheorology (MIT- USA), Post-Doctorate degree (University of Maryland - USA);

Celso Vainer Manzatto (EMBRAPA – Environment) – Engineer Agronomist UFRJ), Masters in Soil Science (UFRJ), Doctorate degree in Plant Production (Universidade Estadual do Norte Fluminense);

Elibio Leopoldo Rech Filho (EMBRAPA – Genetic Resources and Biotechnology) – Engineer Agronomist (UnB), Masters (MSc.) in Phytopathology (UnB), PhD. in Life Sciences (University of Nottingham, England), Post-Doctorate in manipulation of yeast artificial chromosomes (YAC s) (University of Nottingham/Oxford, England);

José Antônio Aleixo da Silva (UFRPE – SBPC) – Engineer Agronomist (UFRPE), Masters in Forest Sciences (UFV-MG), PhD and Post-Doctorate in Biometry and Forest Management (University of Georgia- -USA) – Coordinator of the WG;

Ladislau Araújo Skorupa (EMBRAPA - Meio Ambiente) – Forest Engineer (UnB), Doctorate in Biological Sciences (Botany) (USP);

Maria Manuela Ligeti Carneiro da Cunha (University of Chicago) – Graduated in Pure Mathematics, Faculté Des Sciences, France, Doctorate in Social Sciences (UNICAMP), Post-Doctorate (Cambridge University, École des Hautes Études en Sciences Sociales, Collège de France), Associate Professor (USP);

Peter Herman May (UFRRJ and ECOECO society) – Graduated in Human Ecology from The Evergreen State College, Masters in Urban and Regional Planning and PHD in Economy of the Natural Resources, Cornell University;

Ricardo Ribeiro Rodrigues (ESALQ/USP) – Graduated in Biological Sciences (UNICAMP), Masters in Plant Biology (UNICAMP), Doctorate in Plant Biology (UNICAMP);

Sérgio Ahrens (EMBRAPA Forests) – Forest Engineer (UFPR), Graduated in Law (PUC- -PR), Specialization in Management of Forests and Wood Industries by the Swedish University of Agricultural Sciences, Masters in Forest Resources (Oklahoma State University–USA), Doctorate in Forest Engineering by the Federal University of Paraná;

Tatiana Deane de Abreu Sá (EMBRAPA – Executive Director) – Graduated in Agronomy (Escola de Agronomia da Amazônia), Masters in Soil Science and Biometeorology (Utah State University), Doctorate in Plant Biology (Plant Ecophysiology) (UNICAMP).

ABC and SBPC would also like to thank Professors Oswaldo Ferreira Valente, from the Federal University of Viçosa, Eleazar Volpato, from the University of Brasília and Luiz Antônio Martinelli, from the College of Agriculture Luiz de Queiroz for their excellent revisions to the document and for the valuable critical contributions.

This document is the result of extensive revision and prospective research by the members of the WG, which attempted to, in light of the science and technology available, collaborate towards a vigorous dialogue about the Forest Code. Nevertheless, due to the complexity of the issue, it should be made clear that the findings here reported can and should be further developed, which clearly welcome other contributions with scientific foundation which would improve the current legislation, and would result in the enhancement both to the preservation and conservation of environment, as well as to the agricultural sector of the country.

EXECUTIVE SUMMARY

POTENTICAL LAND USE

- The adequate use of land is the first step towards the preservation and the conservation of the natural resource and for the sustainability of agriculture; it should therefore, be planned, in accordance with it ability, its sustainability capacity and its economic productivity, so that the potential use of the natural resources is optimized while its availability is still guaranteed for future generations.

- Brazil has a vast territorial area for agricultural production: approximately 5.5 million km2 with potential use for different types of crops and levels of use of agricultural technologies. However, 76% of the total of this suitable land, present some type of fragility due to soil limitation – a condition that requires meticulous planning with regards to agricultural occupation, with adoption of conservation management practices which also take into consideration the emissions of greenhouse gas deriving from these activities.

- The last Agricultural Census, in 2006, found that the Brazilian agricultural areas consisted of 329.9 million hectares occupied by rural properties, corresponding to 38.7% of the national territory. Of the lands with agricultural potential (5.5 millions of km2), 42.6% (231 million hectares) were being utilized for the main agricultural activities. The analysis of the country´s productive structure revealed that the main soil occupation was livestock, with 18.6% of the Brazilian territory (158.8 million hectares), or 48.1% of the agricultural space, occupied by natural and planted pastures, corresponding to 2.7 times the quantity of land destined to the production of permanent or temporary plantations (59.8 million hectares).

- In the last years, the tendency of Brazilian agriculture has been one of systematic growth of production, especially due to the constant earnings in productivity. Therefore, from 1975 to 2010, the area utilized for grains increased in 45.6%, but production increased 268%, in other words, almost six times more than the area planted. Although earnings have also been registered recently in livestock productivity the stocking rate of pastures in livestock farming is still low, about 1.1 head/ha as per the Agriculture Census of 2006. A small technological investment, especially in areas with stocking rates lower than half a head per hectare, can increase this capability, freeing land for other productive activities and avoiding further deforestation. The Ministry of Agriculture, Livestock and Supply (MAPA) anticipates that the growth in agricultural production in Brazil will continue to occur based on productivity gains, with a greater increase in production than in occupied area. Part of the productivity gains obtained by agribusiness have been passed on, in order to benefit several other segments of society, with the fall of the relative prices of agricultural produce and the increase of production. Some studies indicate that from 1975 to 2008, the sum transferred was of approximately R$837 billion.

- Thanks to the Brazilian agricultural research and to the entrepreneurial activities of our farmers, Brazil ranks first in exports of soybeans; has the largest herd of commercial cattle; is the biggest exporter of coffee, sugar, orange juice and beef; occupies and important position in several other agribusiness production chains and is also one of the world's largest producers of biofuels.

- However, even considering the advances in conservation agriculture and the success of tropical agriculture, the historical occupation process of the Brazilian territory resulted, in some cases, in increasing the pressures on the environment, on the erosive processes, in the loss of biodiversity, in the environmental contamination and in social imbalances. Thus, the waste of natural resources resulting from inadequate land use is an issue which needs to be dealt with, leading us to rethink the occupation to avoid the mistakes of the past and promote a gradual environmental suitability of the rural activity. The Brazilian agriculture, which currently has a new socioeconomic and environmental dimension, and is responsible for the Brazilian trade surplus, demands science, innovation, modern technologies and increased attention with regards to its impacts on the natural resources.

- The diagnoses show that there is a liability of 83 million hectares of preservation area that are occupied irregularly, as per the current environmental legislation. It is estimated that the impact of erosion caused by the use of agricultural land in Brazil is around R$9.3 billion per year, which could be reversed by the use of conservation technologies and landscape planning, generating environmental benefits.

- There is a need for urgent measures from the decision makers to revert the actual stage of environmental degradation. In order to halt this situation, the Permanent Preservation Areas (PPAs) and the Legal Reserves (LRs) should be considered essential parts of the conservationist agricultural planning of the properties. The perception of LRs and of PPAs as an opportunity should be followed by State policies that support agriculture, which simplify and facilitate bureaucratic procedures. To implement this proposal, it is essential to have an articulation among federal, state and municipal organs, for the implementation of the environmental legislation, which cannot be placed under the exclusive responsibility of the proprietor or the rural owner. The states and the municipalities play an important role in the structuring of the agencies responsible for the regularization of the LRs and PPAs.

- It is estimated that, due to inadequate use, there are today in Brazil, 61 million hectares of degraded land which could be recovered and used in the production of food. There is knowledge and technology available for this recuperation. In this regard, we can highlight the recent initiative of the federal government, for their Low Carbon Agriculture Program (ABC), which takes the passive emission of greenhouse gas and transforms it into opportunities in the agricultural production and into environmental services. Yet, despite the great merit of this initiative, a much greater political effort is needed.

- It is recommended that more consistent public policies be implemented in order to guarantee that all the producers, especially those who have less access to the available technologies, effectively integrate into productive systems which are technically and environmentally correct.

- The scientific data available and the projections indicate that the country can recover environmental liabilities without hurting the production and the supply of food, fibers and energy, while still maintaining the continued increase of productivity of the last decades, as long as more consistent policies of income in agriculture are implemented.

- For harmony and progress of land use in Brazil, a careful planning of integrated use is needed, aligning the agricultural and ecological-economic zoning with territorial organization and the revision of the Forest Code, within a new concept of sustainable productive landscape.

BIODIVERSITY

- Brazil is one of the countries with the biggest biological biodiversity in the world, for it hosts at least 20% of all species of the planet, with high rates of endemism for different taxa. This implies in ample opportunities, especially economical (for example, the development of new foods, drugs, biotherapy, woods and fibers, biomimetic technologies and ecological tourism), but also a greater responsibility. The environmental legislation, which has already achieved important progress, needs revisions in order to further reflect over the importance and the economic potential of Brazil´s unique natural asset. Setbacks at this moment will have severe and irreversible environmental, social and economical consequences.

- Perceiving the importance of the conservation and of the sustainable use of this priceless natural asset, Brazil has become a signatory of international commitments, such as the Convention of Biological Diversity (CDB) and the Convention of Wetlands (RAMSAR). It has also assumed the commitment at the United Nations Convention on Climatic Changes, to reduce in 38% the emission of greenhouse gas by 2020.

These commitments not only require compliance with the environmental legislation but also the recovery of rural and urban environmental liabilities.

PERMANENT PRESERVATION AREAS (PPAs)

- Among the researchers, there is a consensus that the marginal areas to bodies of water, whether wetlands or riparian forests, and the tops of hills occupied by alpine pastures and rocky areas are irreplaceable due to their biodiversity and their high level of specialization and endemism, aside from the essential ecosystem services they perform, such as hydrological regulation, stabilization of slopes, the maintenance of pollinator populations and fish species, natural control of pests, of diseases and of invasive alien species. In the riparian zone, in addition to sheltering biodiversity with the provision of environmental services, the wet soils and its vegetations in the catchment areas of rivers and lakes are ecosystems of extreme importance in mitigating ebbs and flows, in the reduction of surface erosion, in the conditioning of water quality and in the maintenance of channels for the protection of banks and the reduction of siltation. There is ample scientific consensus that they are ecosystems which need to be preserved and restored for their own stability and functionality, if they have been historically degraded. When mature natural ecosystems flank bodies of water and cover lands associated with hydromorphic soils, the carbon and the sediments are laid down, the excess water is contained, the erosive energy of currents is dissipated and the flow of nutrients in the percolation of water undergo a chemical filtration and a microbiological processing, which decreases its turbidity and increases its purity.

- The efficiency of these bands of remnant vegetation depend on various factors, including the width and the state of conservation of the preserved vegetation and the type of ecosystem service considered, including in its evaluation, the role of the riparian areas in the conservation of biodiversity. A marginal gain for the landowners in the reduction of vegetation in these areas can result in a huge burden to society as a whole, especially to the urban population that lives in that basin or region. Even with all the evolution of scientific and technological knowledge, the costs to restore the most degraded areas are still very high, especially in the cases of wetlands. Moreover, not all the ecosystem services are fully recovered.

- A possible alteration to the definition of riparian PPA, from the highest level of the watercourse – as determines the current Forest Code – to the lowest edge of the bed – as proposed in the substitute bill, would represent a great loss of protection for the sensitive areas. This change proposed in the board of reference would mean a loss of up to 60% of protection for these areas in the Amazon, for example. The reduction of the riparian strip from 30 to 15 m in the rivers of up to 5m of width, which make up more than

50% of the drainage network extension, would result in a reduction of 31% of the area protected by the riparian PPAs. A recent study determined that riparian PPAs represent, according to the current Code, only 6.9% of private areas.

- The presence of vegetation on the tops of hills and slopes play an important role in the conditioning of the soil, for the attenuation of rainfall and for hydrological regulation, decreasing erosion, floods, landslides and mass land slips in urban and rural areas.

LEGAL RESERVES (LR)

- The Legal Reserves have environmental functions and biological characteristics, distinct from the APPs in terms of the composition and the structure of its biota. In the Amazon, the reduction of LRs would decrease the forest covers to levels which would compromise the physical continuity of the forest due to probable climatic alterations. Therefore the reduction of LRs would significantly increase the risks of extinction of some species and compromise the effectiveness of these areas as functional ecosystems and their ecosystem and environmental services.

- In biomes with higher rates of anthropogenic, like the Cerrado, the Caatinga and in some areas such as the highly fragmented Atlantic Forest and parts of the Amazon, the remnants of native vegetation, however small, have an important role in the conservation of biodiversity and in reducing the isolation of a few fragments of the landscape. Such remnants act as stepping stones in the displacement and dispersal of species across the landscape. These characteristics require that eventual compensations be made in the water shed or river basin. The reference for the compensation should be the phytoecological characteristics of the area– and not the biome as a whole, given the high heterogeneity of vegetation within each biome.

- The restoration of the LR areas, viable thanks to the advances of scientific and technological knowledge, should be done preferably with native species, because the use of exotic species compromise their role of conserving biodiversity and does not ensure the restoration of ecological functions and ecosystem services. The use of exotic species can be permitted, but in the condition of pioneers, in accordance to the current legislation. It is in the LR that one perceives the biggest environmental liabilities of the Brazilian agricultural sector. New techniques of LR restoration, utilizing the areas of lower agricultural potential and incorporating the concept of sustainable management of native species for the production of wood and fibers, medicinal plants, native fruit trees and other species permitted by the legislation are viable alternatives to diversify the production with a significant economical return.

ECOSYSTEM SERVICES AND AGRICULTURAL PRODUCTION

- The understanding of the importance of maintaining natural areas such as the PPAs and LRs in the rural property is crucial, since there is a misconception that the native vegetation represents a non productive area, with an additional cost and no economic return for the producer. However, these areas, aside from offering a wide range of possibilities for economic return, they are critical in maintaining productivity in agricultural systems, given their direct influence in the production and conservation of water, of biodiversity and soil, in maintaining a shelter for pollinators, seed dispersers and natural enemies of pests, among others. Therefore, the maintenance of remnants native vegetation in properties and landscapes transcend the ecological benefits and allows for a glimpse, beyond their economical potential, of a sustainability of agricultural activity and its social function.

- Scientific research confirms the significant benefits of pollination as an ecosystem service for the productivity of important crops. Pollinators may be responsible for 50% of the production of soybeans; of 45 to 75% of the production of melon; 40% of the production of coffee; 35% of the production of orange; 88% of the production of cashew; and 14% in the production of peach. With regards to Passion fruit, the production depends entirely on biotic pollinators.

- The services rendered by pollinators are highly dependent on the conservation of native vegetation, where they find their shelter and food. Reciprocally, the majority of the native species require specific pollinators in order to perpetuate.

- With regards to sustainable agriculture, Brazil has great possibilities of transforming part of the natural resources which exist on the property, into income for the farmer. The main natural resources would be the conservation of the production of water and the maintenance of the stock of carbon in the areas of native vegetation. For the areas defined as LRs and PPAs in small properties pertaining to rural families, there is also the possibility of exploitation of wood products and non-timber that can generate additional income for farmers.

URBAN ENVIRONMENTS

- In urban areas, the occupation of wetlands and natural flood plains of streams and hillsides with steep slopes has been one of the main causes of natural disasters, causing mortality and morbidity to thousands of victims every year, and economic losses in terms of infrastructure and buildings.

- Parameters for urban areas with regards to PPAs along and around bodies of water and in areas with steep slopes should be specifically established in order to prevent natural disasters and preserve human life. The Forest Code should, thus, define principles and differentiated limits for urban areas without consolidated occupation, while the municipal master plans for land use would address the areas of risk with consolidated occupation.

- In general, the risk becomes very big for any land with slopes superior to 25 degrees in hillside areas of Brazilian cities. Slopes above this limit, in areas which inevitably will lose their natural vegetation due to expected occupation represent a great risk of repeated landslides and mud slides in hillsides.

- In the case of the riparian PPAs, one should attempt to define the area denominated as the passing of the flood as one which should not be occupied. This zone has a technical criterion of definition which depends on the local hydraulic and hydrological conditions. The strip of passage can, for example, represent the limit reached by the flood in a recurring period of 10 years, and can be narrow or wide, depending on the topography.

CONCLUSION AND REFERRALS

It is therefore necessary to ensure the continuation of scientific and technological advances in favor of improving and expanding the environmental compliance of productive activities. The results achieved should become policies that ensure and integrated action between S&T and the productive sectors. It is of the country´s utmost interest to implement an intelligent and fair territorial organization.

The scientific community recognizes the importance of agriculture in the Brazilian and worldwide economy, as well as the importance of improving the Forest Code to meet the new reality in Brazil and in the world. Any improvement should be carried forward in light of science, with the definition of parameters which consider the multifunctionality of the Brazilian landscape, compatibilizing production and conservation as pillars of a development model that ensures sustainability. By doing so, it will be possible to reach decisions guided by scientific recommendations which are agreed upon by rural producers, legislators and civil society.

SBPC and ABC wish to continue contributing towards the improvement of the Forest Code, providing scientific and technological support for the debate. The critical review of the topics covered in the Forest Code should also be made in light of science and of the most advanced technologies, in a careful analysis of the virtues and of the problems of the current law, because it is essential to advance the Brazilian environmental and agricultural legislation.

Brazil is the country that hosts the largest number of species of plants, animals and microorganisms of the world. This represents an enormous difference in natural capital, strategic for the country´s socioeconomic development, which needs to be preserved and utilized in a sustainable way. At the same time, technological innovation is at the root of the success of Brazilian tropical agriculture and is the most powerful asset for qualifying countries in the global market. The improvement of the Forest Code should be the basis for innovative public policies within the concept of territorial organization and landscape planning.

SUMMARY

1. SCIENTIFIC KNOWLEDGE RELATED TO THE CONSTRUCTION OF AN ENVIRONMENTAL LEGISLATION

Brazil witnesses an intense debate about its new Forest Code. In essence, what is being discusses is the future of Brazilian flora, with its implications to human activities and the consequences of political decisions, over the environmental, social and economical dimensions in the entire national territory and for the entire society.

Prerequisites for the existence of a Forest code are the preservation of the floristic heritage and the establishment of rules for using them. The rationale behind the legal framework of the Forest Code holds a cause and effect relation between its implementation and the protection of elements of the natural environment (soil, air, waters, flora, fauna, as well as its functional relations) and incorporates an anthropocentric perception of protecting life and productive activities in the long run.

The elaboration of a public policy about any asset of collective interest, such as the Brazilian floristic heritage, should be the result of a consensual agreement among all the levels of government and all the interested parties, including the scientific community. In this process, it is also necessary to consider the public policies which have already been elaborated for other themes such as the environment, agriculture and energy, as well as the international commitments already agreed upon by society by means of the government.

Because of this, and in response to a demand of the Brazilian Scientific community, the Brazilian Academy of Sciences (ABC) and the Brazilian Society for the Advancement of Science (SPBC), instituted a Work Group to support the debate with perceptions strictly technical-scientific. This document presents a summary of the works performed by the WG which focused, in the form of examples, on the following themes:

1. Agricultural use of national land: potentialities and challenges of the Brazilian Legislative structure;

2. Loss of soil and water as a result of the land use: erosion and its impact;

3. The impacts of the Forest Code on biodiversity;

4. The importance of the Permanent Preservation Areas (PPAs) and of the Legal Reserve (LR) in the rural property, including the environmental and economic benefits of the PPA and the LR;

5. The natural risks associated with land use in urban areas.

The subject is extensive and very rich. The production of scientific knowledge is growing and has its own dynamics. For this reason, this document indicates the need for subsequent, more ample, more profound and detailed work about the topics already analyzed, and about other topics which need to be properly addressed.

1.1. AGRICULTURAL USE OF NATIONAL TERRITORY: POTENTIALS ANC CHALENGES OF THE BRAZILIAN LEGISLATIVE STRUCTURE

1.1.1. Land use Potential

The adequate use of lands is the first step towards the preservation of the natural resources and the sustainability of agriculture (MANZATTO et al., 2002a). Therefore, one should allocate each piece of land in accordance to its ability, its expected sustainability capacity and its economic productivity, with a minimal environmental degradation, so that the potential use of the natural resources is optimized while its availability is still guaranteed for future generations (LEPSCH et al., 1991).

Table 1 presents a global vision of the potential Brazilian land use of agricultural, livestock and forestry, by region, without considering restrictions of the legal nature, but highlighting the different technological levels of management, ability classification and types of use. From the analysis of this table, elaborated based on Ramalho Filho and Pereira (1999), one notices that there is a great predominance of land suitable for farming in comparison to the other activities. Taking into consideration the different technological levels, the country has approximately 65% of its territory (5,552,673 km2) with land suitable for agriculture.

Table 1. Suitability of Brazilian land, by region and by level of management for the different types of use indicated

Type of Utilization	Region	Class of aptitude by level of management (km2)								
		Level of Management A			Level of Management B			Level of Management C		
		Good	Regular	Restricted	Good	Regular	Restricted	Good	Regular	Restricted
Crops [1]	N	25.850	204.982	2.046.873	106.878	1.751.585	427.377	30.032	1.731.001	326.120
	NE	13.394	145.079	435.307	15.555	421.06	321.15	7.482	436.452	267.025
	SE	22.715	118.648	147.506	102.929	130.785	330.767	78.23	266.287	45.966
	Ctr W									
	SE									
	Total									
Planted pasture[2]	N									
	NE									
	SE									
	Ctr W									
	SE									
	Total									
Forestry[3]	N									
	NE									
	SE									
	Ctr W									
	SE									
	Total									
Natural pasture4	N									
	NE									
	SE									
	Ctr W									
	SE									
	Total									

[1] Land suitable for crops is also suitable for other less intensive uses such as pasture and forestry.
[2] Land with the exclusive suitability for planted pastures; not suitable for crops.
[3] Land with the exclusive suitability for forestry; not suitable for crops or plants pastures.
[4] Land with the exclusive occurrence of natural pasture.
Source: Ramalho Filho (1985), Ramalho Filho and Pereira (1999), Manzatto (2002b).

However, when we analyze the crop activities as a whole for all the regions of Brazil, we can observe that the levels of management interfere in the definition of the potential of the lands suitable for this purpose. For the Management level A, there is a predominance of land with serious limitations (Restricted Class) in all the regions of the country, meaning that the low use of technologies limits the plantation of certain crops by farmers (Table 1).

At the management level B (not very developed), one can observe a certain balance among the land with moderate and strong limitations (classes of Regular and Restricted suitability) in most Brazilian regions, while at the management level C (developed: highly technological) there is a strong predominance of land with moderate restrictions, considering the current level of technology existent in the country.

It is worth mentioning, that even the areas considered suitable for the growing of crops, with regular or restricted potential, present soil limitations, indicating the fragility of these lands for agricultural use and the need for meticulous land use planning, with the adoption of conservationist management practices.

The great territorial extension, the variation of the productive potential of lands and the environmental and socioeconomic diversity determine patterns of land use, characterizing the regions by the different pressures of land use and by the current intensity of degradation. However, when looked upon globally, the changes in land use and in the land cover are so important that they even affect essential aspects of the functioning of the global Earth system.

The impact of these changes, as cited by Lambin et al. (2001), reflects on biotic diversity (SALA et al., 2000), contributes to local and regional climatic changes (CHASE et al., 1999), as well as to the global climatic changes (HOUGHTON et al., 1999), aside from directly influencing towards the degradation of soil and water. (TOLBA and EK-KHOLY, 1992).

1.1.2. Changes in Land Use

Land use can be understood as the changing form in which the geographic space is utilized by the human race. In general, the changes of land use occur due to market demands for fibers, energy and food, new agricultural technologies and environmental regulations. They represent an important factor, conditioning the global climatic changes (MEYER and TURNER 1996) and can bring serious implications for sustainability in their three dimensions (social, economic and environmental) and for the production of food, fibers, biofuel and raw materials.

That is why the need to understand the causes of changes of land use in agriculture has been an issue which the Committee on Global Change Research (1999) has been stressing now for a long time. Lambin et al. (2001) emphasize that such alterations to the use and the covering of land are related to the environmental and development policies.

These authors concluded that the alterations are not solely due to the increase in population nor to poverty, but are also a response of the population to the economic opportunities mediated by institutional factors. Therefore, opportunities and limitations for new land uses are created by markets and local and national policies. Yet, global forces are the main determinants of the alterations of land use, potentialized and enhanced by local factors, such as productivity earnings, infrastructure and public policies (Forest Code and Ecologic Economic Zoning – ZEE).

In addition, according to IPCC (Intergovernmental Panel on Climate Change), the emission of Greenhouse gas (GHG) deriving from the LULUCF (Land Use, Land Use Change and Forestry) sector, represent 17% of the total emission in the world. In Brazil, this sector is responsible for approximately 55% of the total of emissions, basically as a result of deforestation. A common practice following the cutting of vegetation is the burning of vegetation, which is another factor of impact on the natural and water resources, and on biodiversity.

On the other hand, reforestation, avoided deforestation (Reduced Emissions Deforestation and Forest Degradation – REDD) and the conservation of forests are important ways of land uses for the mitigation of climate changes and are closely related to the occupation of land by agriculture. Such changes also constitute a spacial, transversal phenomenon, intrinsically cross-correlated with most of the processes of environmental deterioration and consequent impairment of ecosystem services associated with energy balance, essential to the sustainability of agricultural production activities.

The regulation of the hydrologic cycle, the maintenance of climatic seasonality, the mitigation of Greenhouse gas emission (GHG) and the carbon dioxide (CO_2) sequestration from the atmosphere and its accumulation on the biomass and the soil, as well as the minimization of energy consumption in the agricultural activities are environmental benefits which require spacial monitoring of the land use and the land cover for its quantification (ANDRADE et al., 2010; DUMANSKI et al., 2010a, 2010b; FREITAS et al., 2007), aiming towards eventual financial compensations deriving from environmental services rendered in rural areas.

Current Land Use

Table 2 presents, in a summarized way, the main forms of land use as per the Agricultural Census of 2006 (IBGE, 2006). The total amount of land occupied by rural properties is 329.9 million hectares, corresponding to 38.7% of the national territory. Of these lands, the main agricultural activities respond to approximately 27.1% of the territory. The lands are occupied for several agricultural uses, as we can also see from the data presented by MMA/Probio for the year of 2002 (Figure 1).

The analysis of the productive structure of the country reveals that the main soil occupation is for livestock with 18.6% of the Brazilian territory (158.8 million ha). This implies that 48.1% of the agricultural area specified by the census is occupied with natural and planted pastures, which corresponds to 2.7 times the lands destined for the production of permanent and temporary crops (59.8 hectares).

The areas of pastures of the Central West stand out in comparison to the other regions with around 58.5 million hectares, followed by the Northeast region, with around 30.5 million hectare; Southeast, North and South (Table 03).

It’s pointed out however, that the use of natural pastures is still widespread, despite the differences in terms of climate, value of land, cultural patterns and territorial dimensions. In general, one can infer that this type of activity is the result of the land use with a low utilization of technology and/or marginal lands, with climatic and/or pedological limitations or of degraded, abandoned or underutilized areas.

Considering only the aspects of the soil, the area currently used for crops is relatively small if compared to the potential area that the country has, especially in the Central West. The increase of production verified in the last two decades resulted in an area occupied with crops of 59.8 million hectares. Of these, in the harvest of 2010, the estimate of areas planted with cereals, legumes and oilseeds was of 46.7 million hectares, being a result, greatly of the conversion of areas previously occupied by pastures, mainly in the states of Maranhão, Mato Grosso, Mato Grosso do Sul, Tocantins, west of Bahia, south of Pará and the Cerrados of Piauí.

The association of this expansion with the earnings in productivity resulted in an increase of more than 100% in the production of grains when compared to the harvest of 1996, reaching about 148 million tons in 2010. Among the grains, the soybean was the one with the greatest expansion in terms of area and production thanks to agricultural research which developed and introduced new varieties, adequate to the conditions of the soil of the Cerrado biome, especially in Goiás, Mato Grosso do Sul and Mato Grosso.

Table 2. Current Brazilian land use

Types of Land Use	Area (hectares)	% of land in use
Permanent crops	11,612,227	3.52
Temporary crops	44,019,726	13.34
Crops with area planted with forage cutting	4,114,557	1.25
Crops with cultivation of flowers (including hydroponics and plasticultures), nurseries, greenhouses and vegetation houses	100,109	0.03
Natural Pastures	57,316,457	17.37
Degraded Planted Pastures	9,842,925	2.98
Planted pastures	91,594,484	27.76
Natural woods and/or forests destined to permanent preservation or legal reserve	50,163,102	15.2
Natural woods and/or forests (excluding areas of permanent preservation and those in agroforestry systems)	35,621,638	10.8
Natural woods and/or forests planted with forest species	4,497,324	1.36
Agroforestry systems	8,197,564	2.48
Tanks, lakes, reservoirs and/or public waters for agriculture	1,319,492	0.4
Buildings, improvements or paths	4,689,700	1.42
Degraded lands (eroded, desertified, salty etc.)	789,238	0.24
Fallow land for agriculture or livestock (marshes, beaches, quarries etc.)	6,093,185	1.85
Total of land in use	329,971,728	100

SOURCE: Agricultural Census (IBGE, 2006).

Table 3. Current use of lands with pastures by regions of Brazil

Region	Type of Use			Total
	Natural Pastures	Degraded planted pastures	Planted Pastures in Good Condition	
Center West	13731189	3338809	41448215	58518213
Northeast	16010990	2233350	12295265	30539605
Southeast	10853455	1653121	15054568	27561144
North	5905157	2168266	18450751	26524174
South	10815667	449378	4345683	15610728
Total	57316458	9842924	91594482	158753864

SOURCE: Agricultural Census (IBGE, 2006).

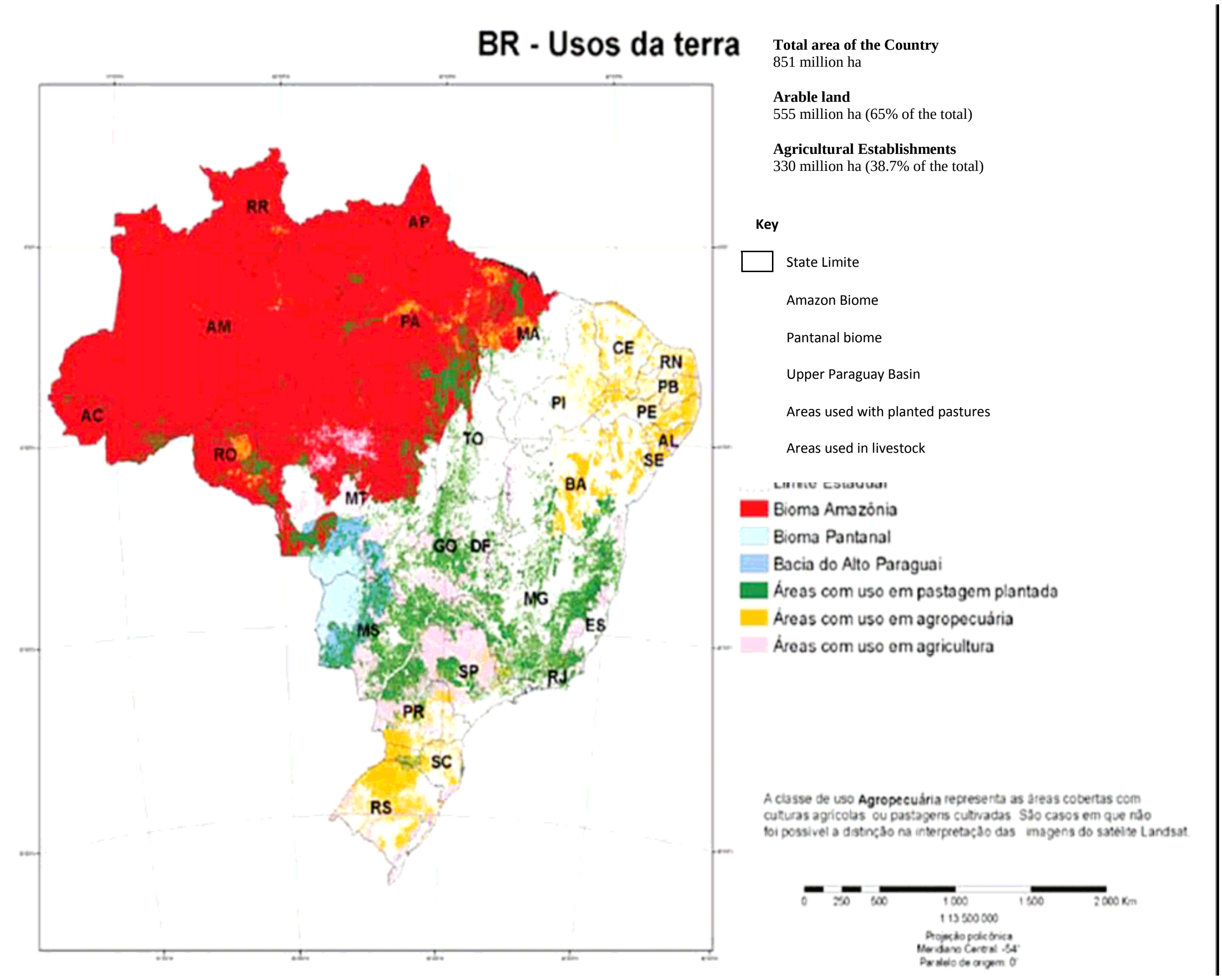

Figure 1. Current land use in Brazil (MANZATTO et al., 2009).

Based on the data on Table 4, it is possible to reach conclusions about the appropriateness of the land use in the country in comparison to the data on the capability of the lands. We can notice that the agricultural activity is more intense in the regions of the South, Southeast and Central West, although quite anthropized, it presents intensive intermediate use, due to the climatic limitations in part if its territory, recently registering, nevertheless, a strong expansion in the production of grains. On the other hand, the South region presents the highest percentage of area with high intensity of use (41%), differentiated from the rest of the regions in the country for is predominance of small rural properties and an increasingly more technical agriculture, usually organized into cooperatives.

In the North, there is low intensity of land use in 95% of its territory, with the states of the Amazonas and Amapá showing low levels of anthropization. In this region, the areas with the greatest intensity of use comprise the east of Pará, Tocantins, north of Mato Grosso and Rondônia, which demarcate the agricultural frontier. The types of land use in this area have included the exploitation of timber and the formation of pastures. Currently there is a demand for the production of grains, eucalyptus and perennial oilseeds (palmae) in the region.

These data confirm the estimates about the agricultural suitability of the lands of the country, its fragility and the great potential for agricultural intensification, by adopting appropriate technologies, with an increase in production by means of increased productivity. Considering the environmental value of the Amazonian forest – the biggest remnant tropical forest of the world – and the great availability of anthropized lands which can be used more intensely, in other regions, we can conclude that its utilization with great intensive agricultural systems can represent an unnecessary risk to the sustainable use of its natural resources. (LUNZ and FRANKE, 1997, 1998).

Table 4. Intensity of Agriculture, forestry and livestock land use per regions in Brazil

Intensity	**Region**									
	N		**NE**		**CW**		**SE**		**S**	
	Surface									
Class of pressure	km²	%	km²	%	km²	%	km²	%	km²	%
Low	3682512	95	1214470	78	761442	47	291792	32	136168	24
Medium	148679	4	233031	15	500558	31	360400	39	200116	35
High	35722	1	104275	7	359367	22	271244	29	240472	41

SOURCE: *Manzatto et al. (2002b)*

The country has a considerable area with soils apt for irrigation, estimated in 29.5 million hectares (Table 5). Yet, the use of irrigated agriculture in Brazil is still low compared to rain fed agriculture, even though the production obtained from irrigated crops is already expressive.

In this regards, a study by the National Agency of Waters (ANA, 2004) informs that:

[...] even though we have a small percentage of irrigated areas in our lands, in comparison to the area that is planted, irrigated crops produced 16% of our food harvest and 35% of the sums of production in

1998. In Brazil, each irrigated hectare equals to three hectares of rain fed land in physical productivity and seven hectares in economic production.

A more precise notion of the percentage of irrigated lands in comparison to the total planted surface in Brazil, can be obtained from the work developed by Cristofidis (2008), who considered the data from the 62 main crops from the SIDRA/IBGE listing in 2005, regarding the harvest of 2003/04, mainly for showing the greatest number of permanent crops in which the use of irrigation was adopted.

The author highlights that the fruit plantations and, more recently, sugar cane utilize irrigation technologies. The total planted area was 58.461 million hectares, of which 11% were permanent crops and 89% were temporary crops. The country´s irrigated surface in 2003/2004, estimated in 3.44 million hectares, was equal to 5.89% of the total planted area destined to the production of the 62 main crops (Table 5).

This is very below the standards in the world and the opportunities the country offers, which configures an alternative for the intensification of the lands currently being used in agriculture by means of adopting sustainable systems of rational use of water.

Irrigation in the country experienced great expansion up until mid 1990. After this, there was a stagnation of growth which persists until today. The exponential growth in irrigation, especially in the decade of the 80´s was a result of the National Program of Rational Utilization of Irrigable Wetlands (PROVÁRZEAS) instituted by the decree nº 86,146 on June 23rd, 1981, and the Financing Program of Irrigation Equipment (PROFIR), in the same year. The programs enabled the utilization of more than a million hectares of drained and/or systematized wetlands, benefiting about 40 thousand producers and creating more than 150 thousand jobs in the period of its validity (1981-1988). On the other hand, this activity occupied Permanent Preservation Areas (PPA), as per the specifications of the Forest Code, which generated a great environmental liability. More recently, other programs are being implemented in this area, which should have been oriented not to generate further environmental liabilities.

Table 5. Indicators of Irrigation in Brazil

Region	Planted Area (Temporary and Permanent)*	Soils suitable for irrigation	Irrigated Area	Irrigated Area/ Planted Area
	1.000 ha			%
North	2,560	11,900	100	3.89
Northeast	11,975	1,104	733	6.12
Southeast	11,751	4,429	988	8.41

South	19,222	4,407	1,302	6.77
Central-West	12,953	7,724	318	2.46
Total	58,461	29,564	3,441	27.65

SOURCE: Cristofidis Adaptation (1999, 2008). (*) Area of 62 crops, harvest of 2003/2004

The areas already defined as Units of Conservation currently represent about 120 million hectares of territory (Table 5 and Figure 2), being divided into areas of integral protection (approximately 5.5% of the territory) and areas of sustainable use (about 8.9%).

With regards to Indigenous Lands, the areas which have already been approved represent around 98.47 million ha in 2010 (estimates from Embrapa Satellite Monitoring) or 11.6% of the national territory.

The areas of agricultural establishments with forests/ natural woods/agroforestry systems verified by the Agricultural Census (about 85,8 million hectares) added to the areas of the Conservation and Sustainable Use Units can represent a regional alternative for the adoption of regional policies in eventual environmental compensations of agricultural activities, as for example the Legal MT Program.

Considering the lands raised by the Agricultural Census, the Indigenous lands and the lands with restrictions of use (Integral Conservation Units), the country has already allocated about 475 million hectares, in other words 56%, of its territory for the several forms of occupation.

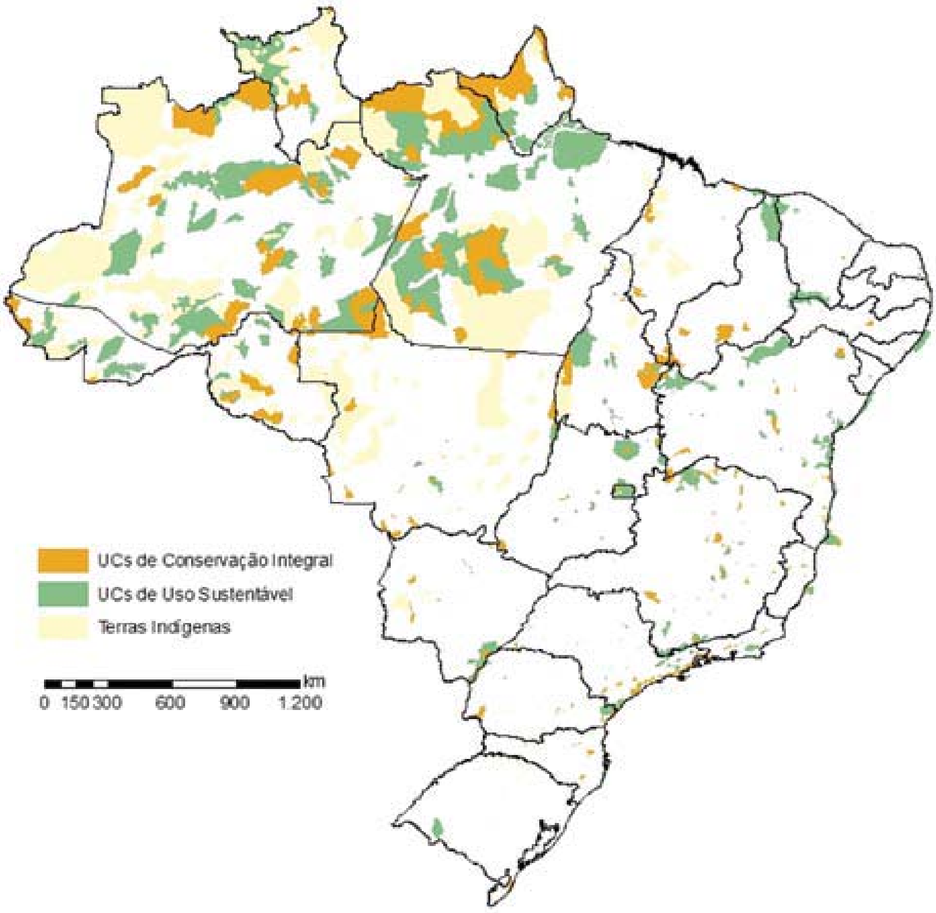

Figure 2. Units of Conservation of Nature and Indigenous lands in Brazil
(Source: Embrapa Satellite Monitoring)

Table 6. Estimates of areas with native vegetation cover and Conservation Units.

BIOME	PROBIO Mapped Area	Area with Vegetation/ Water Covering		Conservation Unit of Integral Protection(²)		Conservation Unit of Sustainable use(²)	
	(M ha)	(M ha)	% (¹)	(M ha)	% biome	(M ha)	% biome
Amazonia	423.50	382.86	90.51	38.13	9.12%	60.04	14.35%
Caatinga	82.58	52.61	63.72	0.81	0.99%	4.29	5.19%
Cerrado	204.72	124.92	61.02	5.15	2.53%	7.32	3.59%
Atlantic Forest	105.9	30.77	29.05	1.91	1.73%	3.69	3.34%
Pampas	17.82	9.15	51.3	0.09	0.49%	0.32	1.80%

Pantanal	15.12	13.38	88.46	0.44	2.91%	0	0.00%
Total	**849.64***	**613.69**	**72.27**	**46.54**	**5.49%**	**75.66**	**8.92%**

SOURCE Adapted from MMA/PROBIO - www.mma.gov.br/probio. (* Area considered in the study). (1) Relative to the area of the country. (2) Embrapa Satellite Monitoring Estimate.

General aspects of the dynamics of agricultural land use

Analyzing the Agricultural Census of 1970, 1975, 1980, 1985, 1995-1996 and 2006, Gasques et al. (2010) observed that the number of rural establishments grew considerably up until 1980, showing the ample expansion process and the occupation of new areas until then. From that year on, there is certain stability in the number of establishments at about 5.1 million in the year of 2006. The reduction of the average area observed since the beginning of the period reflects, among other things, the increase of the productivity of the land and of the production factors in general, achieved by means of investments in research, qualification of human resource and due to the results of agricultural policies.

The authors note as well that the utilization of lands show an expressive increase in percentage, of areas destined to crops, which has been systematically growing every year. In 2006, its participation with regards to the total area was of 18.14%. But the most relevant issue with regards to land use is the weight of the areas for pastures, which has been maintained at 44.0% and 50% of the total area of the establishments.

With regards to the relation between the total area of pasture and the total number of cattle, the authors emphasize the strong decrease in the years analyzed. The ratio changes from 2.56 ha per animal in 1940 to 1.96 ha in 1970, and 0.93 ha in 2006. This ration indicates the carrying capacity of the pastures and indicates that the increase of this capacity can release lands to be used for other purposes.

Therefore, in the last years, the Brazilian agricultural tendency has been one of systematic growth of production, especially due to productivity earnings. Contini et al. (2010) evaluated the historic aspects of production, of the area and of the productivity for grains in the period between 1975 and 2010 (figure 3.). While the area increased 45.6% during this period, production increased 268%. The trend has been one of rapid increase of productivity during the period analyzed. The decreases found, are mostly due to periods of droughts, as in 2004 and 2006. The productivity index for grains rose from 1,258kg/ha in 1977, to 3,000 kg/ha in 2010.

With regards to the production of meat, Contini et al., (2010) noticed that production also increased extraordinarily in the last three decades. From 1979 to 2009, the production of beef increased 5.42% per year, pork increased 4.66%, and poultry 8.45%. From 2002 to 2009, the production of beef, poultry and pork meats had a growth of 3.1%, of 7.25% and of 1.97% per year respectively. This dynamic is related to the evolution of exports. It could have had a better performance if it weren´t for the international economical crises which started in September 2008

Although earnings from productivity in agriculture have also been registered recently, in the extensive livestock, the rate of carrying capacity of the pastures is still low, about 1 head/ha, as per the Agricultural

Census of 2006. A small technological investment, especially in the areas of low stocking rates (<0.5 head/ha), can increase this capacity, releasing lands for other productive activities, as well as avoiding new deforestations.

As an example of supporting modernization and productivity earnings in livestock, we can cite the official private programs of genetic improvement of the national breeding, which include programs of genetic improvements, artificial insemination and embryo transfers, integration of crop – livestock – forest, confinement and semi confinement, good practices in livestock and, recently, the ABC Program (Low Carbon Agriculture – TRECENTI, 2010). This program stands out as a policy of intensification of land use in compliance to what was establish by the law (12187 – December 29, 2009), which instituted a National Policy of Climate Change (PNMC) in its article 11 that declares that: "by means of specific decrees, we shall establish sectoral plans for mitigation and adaptation to the global changes of the climate, aiming toward the consolidation of an economy of low carbon consumption"

PNMC provides important instruments, in a financial aspect, for organizations who develop actions to reduce GHG emissions, such as: a) stimulating fiscal and tax measures; b) credit lines and financing from specific public and private agents; c) formation of a Brazilian market of emissions reductions, with the carbon credits being considered active securities in the stock exchange.

The initiatives developed in the activities program of the group, of which this work plan is a part of, aims to support the achievement of targets of the ABC program, among them: a) recuperation of an area of 15 million hectares of degraded pastures (reduction of 101 Mt C_{equiv} – millions of tons in GHG carbon equivalent); b) adoption of an integration system of crop-livestock-forest (ILPF) in 4 million hectares (reduction of 20 Mt C_{equiv}); c) expansion of no-tillage system (SPD) in 8 million hectares (possible reduction of 16 to 20 Mt C_{equiv}) (TRECENTI, 2010).

Even considering the earnings in productivity in the last decades (Figure 3), Brazil was one of the few countries in the world to increase its agricultural areas, estimated in around 278 million hectares or 37.1% of its territory. According to Sparovek et al. (2010), of this amount, about 61 million hectares with low and medium agricultural productivity could be used in the intensive production of food. Of the general total, at least 83 million hectares are not in conformity with the Forest Code and should be recuperated.

However, the payment of possible environmental liability of the agriculture, should take into consideration its payment capacity and the benefits the activity brought to society by means of productivity earnings and food security, without mentioning the positive surplus in the trade balance.

In this sense, França (2001) says that the gross income from crops (rice, potato, onion, beans, cassava, corn, wheat, cotton seed, peanut and soybean),in other words, the monetary value of the production obtained by the producer had a decrease of about 40% in the decades of the 80s and the 90s, showing that all the efforts of productivity income was, in the end, utilized to offset the fall in relative prices paid to farmers, benefitting other segments of society.

Other authors like Souza and Viana (2007) and Geraldine (2005) also observed this trend of decrease of the amounts paid to the producers and the transfer of resources from the agricultural sector, understood as gain or loss of income in relation to the changes of relative prices. Silva (2010) reports that in the period from 1995-2008, the evolution of the product has always been superior to the evolution of the Gross Domestic Product (GDP), at current prices. Therefore, the product grew at decreasing real prices. This, added to the increase in the agricultural production, represented a loss of income of the agribusiness, absorbed by society.

Silva (2010) estimated that the transfer of accumulated income was of about R$837 billion, being more noticeable in the livestock than in crops. Of this total, 47% were from the primary sector (46% from crops and 54% from livestock), 38% from the distribution segment, 20% from the agro-industry (62% of the plant based industry and 38% from animal), of which the input sector was net receiver of R$41 billion. The study indicated still that the greatest direct transfer to society was from the primary sector, of about R$641 billion, of which 67% were from crops, and the rest from livestock.

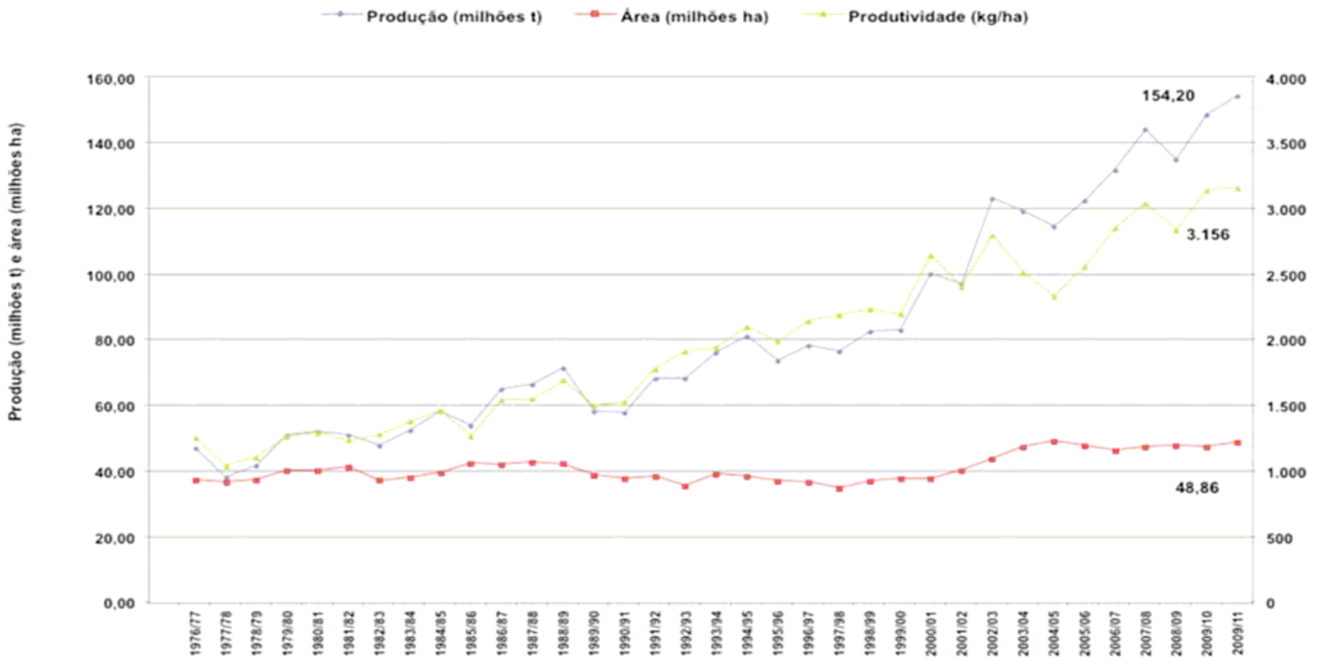

Figure 3. Evolution of the cultivated area (red), of production (blue) and of productivity (green) of grains between 1975 and 2010 (CONTINI et al., 2010).

Aspects about the use and the changes in use of land

Estimates of the Ministry of Agriculture, Livestock and Supply (BRAZIL, 2010), indicate that the growth of the agricultural production in Brazil will continue to occur, based on the earnings in productivity, with a greater increase of production than of occupied area.

The projections made by the Ministry indicate a considerable increase in the consumption of food in the planet, especially of corn, soybean and wheat, for the period of 2009/2019. According to the projections, the production of grains in the country (soybean, corn, wheat, rice and beans) shall go from 129.8 million tons in 2008/2009 to 177.5 million in 2019/2020, in other words, an increase of 36.7%. The production of meat should also undergo an increase of 37.8% in the analyzed period.

The studies indicate still that the average annual rate of increase in the production of crops shall be 2.67%, while the expansion of the occupied area shall be 0.45% annually, going from 60 million hectares in 2010 to 67.7 million hectares in 2020. The expansion shall be concentrated in soybean – with an additional 4.7 million hectares – and in sugar cane – with an additional 4.3 million hectares. Corn is expected to have an increase of about one million hectares and the remaining crops shall remain with stable cultivation areas or even suffer a retraction.

In a recent study performed by the World Bank with the objective of supporting Brazil in its efforts to identify opportunities to reduce the GHG emissions, while still promoting an economic development, Gouvello et al. (2010) modeled the future demands for land for agricultures and the generated emissions due to the change of land use, in several different ways, considering criteria such as suitability of the lands for agriculture, the distances from the highways, urban concentration, cost of transportation to the ports, the slope of the land and the distances to the converted areas.

According to the Scenario of Reference, constructed for the study, an additional 17 million hectares approximately, would be necessary to accommodate the expansion of all the activities during the period of 2006 to 2030. In all of Brazil, the total area allocated for productive uses, estimated in 257 million hectares in 2008 shall endure an expansion of 7 percent – reaching about 276 million hectares in 2030; 24 percent of this growth shall occur in the Amazon region.

In 2030, just like in 2008, it is expected that lands used for pasture occupy most of this area (205 million hectares in 2008 and207 million in 2030). The verified growth over time, of this total amount, makes it necessary to convert native vegetation into land used for production, which occurs mainly in the regions bordering the Amazon region and on a smaller scale, in Maranhão, Piauí, Tocantins and in Bahia.

In the scenario of Low Carbon in Agriculture, built by this study, the amount of additional land necessary for the mitigation of the emission and for the removal of carbon is more than 53 million hectares. Of this quantity, more than 44 million ha – more than double the amount of lands for the expansion projected in the Reference Scenario – would be destined to the recuperation of forests.

Along with the additional land in the Reference Scenario, the total volume of additional land necessary is of more that 70 million hectares, more than twice the total extension of land planted with soybean (21.3 million ha) and with sugar cane (8.2 million ha) in 2008, or more than twice the area of soybean projected for 2030 in the Reference Scenario (30.6 million ha). In order to obtain the volume of additional land necessary in the Projected Scenario, the option was to increase the productivity of livestock, considering three options: (a) Promote the recuperation of areas of degraded pastures; (b) stimulate the adoption of productive systems which involve fattening confinement; (c) encourage the adoption of crop-livestock systems.

The increase in the stocking rate resulting from the recuperation of the degraded areas, together with more intensive integrated crop-livestock systems and fattening confinement reflects a considerable reduction in the demand for lands, projected to be of approximately 138 million ha in the Low Carbon Scenario, in comparison to the 207 million hectare in the Reference Scenario for the year of 2030. The difference would be enough to absorb the demands for additional lands associated both to the expansion of the agricultural and livestock activities in the Reference Scenario as well as to the expansion of the mitigation and the removal of carbon, in the Low Carbon Scenario.

Technically, this option is considered possible, seeing that the Brazilian Livestock productivity in general is low and the existent confinement of cattle and the crop-livestock systems could be enhanced. In addition, the use of more intensive production systems could trigger higher economic returns and net earnings for the economy of the sector. The potential represented by the release and the recuperation of areas of degraded pastures would be sufficient to accommodate the most ambitious growth scenario in agriculture.

The study also looked into two important options of carbon removal: restoration of the native vegetation and of the production forests for iron and steel. In the case of the restoration of forests, the Low Carbon Scenario took into consideration the legal observations regarding mandatory reconstitution in accordance to the legislation on riparian forests and Legal Reserves. With this, the Low Carbon Scenario gave origin to the “scenario of legality”. Using these defined areas for reforestation, the study modeled its positional for CO_2 reduction. According to what was demonstrated by the legality scenario, the potential of removal of carbon is high: a cumulative total of 2.9 Gt of CO_{2equiv} in a period of 20 years, or an average of approximately 140 Mt of CO_{2equiv} per year (GOUVELLO et al., 2010).

Such projections indicate that the country can recover environmental liabilities without affecting production and the future supply of food, fibers and energy, maintaining the trend of the last decades, as long as policies of income and territorial organization are implemented. They cite as an example, the high cost of new technologies in the field in comparison to the cost of agricultural incorporation of new lands in the agricultural frontier especially in the Cerrado, where the cost of deforestation is very low due to the use of practices such as fire, which make any environmental planning impossible.

It is noted, nevertheless, that thanks to Brazilian agricultural research and to entrepreneurial activities of farmers, Brazil occupies the first place in export of the soybean products; has the largest commercial cattle herd in the world; is the greatest exporter of coffee, sugar, orange juice and beef, occupying a prominent position in several other productive chains. Brazil is also one of the greatest producers of biofuel in the world.

Yet, even considering the advances in conservationist agriculture and the success of tropical agriculture, the historical process of Brazilian territorial occupation resulted, in some cases, in the increase of pressures and negative impacts on the environment. Therefore, the wastes of natural resources deriving from the inadequate use of the land is a reality which needs to be looked into, leading towards a new way of land occupation in order to avoid the mistakes of the past and promote a gradual environmental adequacy of rural activities.

Brazilian agriculture today, has a new socioeconomic and environmental dimension and is responsible for the Brazilian trade surplus. The activity demands science, innovation and modern technologies and a reinforced attention with regards to the impacts on the natural resources aiming towards a green economy.

1.2. ENVIRONMENTAL IMPACT RESULTING FROM LAND USE: LOSS OF SOIL AND WATER DUE TO WATER EROSION.

Land use for agriculture, livestock and forests can promote the removal of the natural vegetation cover and the exposure of the soil to the stung effects of tropical rains which occur in practically all of the national territory. The environmental impact of the land use for agricultural have as a consequence, the loss of soil and of water. It is understood that this impact is not exclusive to the presence or non presence of LRs and PPAs in greater or smaller proportions in the agricultural property.

What is understood is that the areas to be protected are part of a productive strategy which enhances the conservation of water, of soil and of the agro biodiversity in any rural property. Such a statement is supported by the fact that, in lands covered by forests, the root systems, the leaf litter and the dense vegetation can, together, hold an average of 70% of the volume of rainfall, regulating the flow of rivers and improving the water quality.

Therefore, the negative environmental impact of agricultural land use causes a strong loss of soil and of water, being the main factor of degradation of lands in tropical and humid subtropical environments (HERNANI et al., 2002). The water erosion, a natural process which occurs in a geologic time scale, tends to be accelerated by the anthropogenic activity, to the point of making their effects visible through the formation of ravines and gullies and by the siltation and eutrophication of creeks, rivers and lakes.

Due to this being a continuous process, the degradation of lands is ignored when it occurs in smaller scales, until catastrophic events occur, such as floods and landslides under high intensity rainfall or due to long periods of drought – which occurs frequently – and which resulted in 2001 in one of the greatest energetic crises ever registered in the country, causing huge losses to the Brazilian society.

Several studies indicate that alteration in the vegetation, such as its substitution for agricultural harvests or pastures, represent changes to the flow of water. Analyzing 94 experiments performed in hydrographic micro-basins around the world, Bosch and Hewlett (1982) showed that the removal of the forest cover increases the annual discharges of the rivers. The same effect was noted for the tropical region. (BRUIJNZEEL, 2004).

In studies performed in the State of Pará, Prado et al. (2006) showed that the runoff of forested areas correspond to less than 3% of the rainfall, while in areas of pastures, the percentage can reach up to 17%.
A greater runoff results in faster hydrologic responses and a lower infiltration of water in the soil, increasing the rate of peak flows with potential to generate big discharges and even floods in the rain seasons and the reduction of discharges in the drought seasons. In addition, the increase in the runoff has a greater potential for erosion, hauling soil particles, organic matter, fertilizers, pesticides and seeds to the streams and the reservoirs. This process is enhanced in steep slopes.

The importance of the maintenance of riparian PPA to minimize the loss of soil caused by runoff erosion and the consequent silting of streams, creeks and rivers was experimentally demonstrated by Joly and collaborators (2000), working in Jacará-Pepira river basin, in the municipality of Brotas (SP). The group of researchers determined on location, based on the parcels of erosion, that the annual loss of soil in the pastures is of about 0.24 t ha^{-1}, while in the same type of soil, with the same slope and distance to the river, the annual loss of soil in the interior of the riparian forests was of about 0.0009 t ha^{-1} (JOLY et al., 2000).

Therefore, the maintenance of areas with forests in the middle of rural properties has positive effects on the infiltration of water and in the protection of the soil, helping to stabilize the hydrologic regime, helping water quality and reducing runoff and the entrainment of soil particles to the bodies of water.

That is why it is necessary to adopt a conservationist agricultural production strategy, where soil management practices such as the No-Tillage system and the integration crop-livestock – forestry provide increased productivity and profitability to farmers. When these practices are allied to the distribution of native forest cover on the landscape, they favor the reduction of soil loss in fragile areas and the mitigation of these impacts on superficial water resources, and still generate environmental and ecosystem services to society.

In the context of livestock production, the degradation of the lands is related to the actions which contribute to the decrease in the sustainability of agricultural production, because of the decrease in the quality of physical, chemical and biological attributes. (FREITAS et al., 2007).

This concept can be applied to any area in which the basic principles of soil and natural resource conservation were not obeyed during the implementation of the agricultural activity following the deforestation or any other use (CASTRO FILHO et al., 2001). The degradation of land is also related to the loss of quality and availability of water, especially for human consumption, besides the definite loss of biodiversity due to the processes utilized in the initial management or the anthopization of the soil, as well as the lack of planning and the use of fragile and permanent preservation areas (HERNANI et al., 2002).

1.2.1. Impacts related to water erosion in Brazil

The economic value of the damages caused by erosion is complex, especially in Brazil, because of the difficulty in defining and quantifying the forms and the extensions of the effects and the impacts of the erosion processes. Therefore the evaluation of the impacts of water erosion deriving from the agricultural land use results in partial and incomplete estimates which should only be considered to illustrate the magnitude of the problem in the country and the alternatives for its mitigation, in a perspective of socioenvironmental sustainability of agriculture.

Utilizing soil loss data for different crops and in experimental conditions of soil and climate in the state of São Paulo, and extrapolating these values to the respective cultivated areas in Brazil, Vergara Filho (1994) estimated that the average annual loss of soil is of 1.1 billion tons.

The environmental damages caused by the process of soil erosion, according to Marques (1998) can be looked upon in two ways: the internal (those within the rural property) and those external to the areas of agricultural production or place of origin. The author estimated the economic value of the environmental damages based on the concept of the value of its use and on the methods of measuring the cost of reforestation and of sacrificed production or reduction in productivity. Yet he points out that he might have underestimated the total impacts, since he did not take into consideration several components such as the values of option, of existence and others.

Even though the estimates of the costs of erosion were based, almost always, on the cost of the nutrients which were removed from the surface layers of the soil or on the cost of the replacement of these nutrients in the form of fertilizers and correctives, other costs should be considered, such as the degradation of the surface layer itself, where the growth of roots and the main exchange of gas and water occur, and are limiting factors for achieving high economic and sustainable productivities. The internal costs (within a rural property) of erosion becomes higher when one considers the loss of the productivity capacity in the long run and the cost of inputs like water (irrigation), fuel, fertilizers, pesticides and human resources (CASTRO FILHO et al., 2001; LANDERS et al., 2001).

On the other hand, one should add to these costs, the external costs (out of the property), such as the need for maintenance of the local and rural roads and of irrigation canals, the increase in the cost of water treatment for human consumption, the loss of the capacity of storing water in reservoirs for the production of electric energy and irrigation, the decreased recharge of aquifers as natural reservoirs of water for different uses and the increased emission of carbon to the atmosphere caused by soil management, today considered inappropriate. (LANDERS et al., 2001)

In an estimate considered preliminary, Hernani et al. (2002) illustrate the magnitude of the potential loss of soil by water erosion in the areas with agricultural activities in Brazil. They took into consideration the areas occupied with crops (annual and perennial) and pastures (natural and planted) as per the Agricultural Census

of 1996 (IBGE, 1997) and accepted as an annual soil loss average a value of 15.0 t ha^{-1} for crops, based on Bragagnolo and Pan (2000) and De Maria (1999) – under a conventional management with intensive soil preparation and of 0.4 t ha^{-1} for pastures based on Bertoni and Lombardi Neto (1990) in artificial pastures with some level of degradation.

With this, they estimated that the potential annual soil loss in Brazil is 822.6 million t, of which 751.6 million t were due to the areas occupied with crops and 71.1 million t of lands covered with pastures. In the same way, the potential loss of water was estimated in 171 million m^3. Considering the internal costs and those external to the agricultural property deriving from erosion processes, the authors estimated that erosion can generate and annual loss of about R$9.3 billions to the country.

The values estimated by Hernani et al. (2002) to illustrate the potential loss of soil and water in the areas with agroforestry are elevated and alarming. However, the actions of farmers and technicians who are knowledgeable on tropical soils and the adoption of a no-tillage system represents today a response to water erosion of more than 50% of Brazilian agricultural area (FEBRAPDP, 2011), which can be rapidly enlarged through public policies.

In the last years, the environmental legislation has been amplified and improved, and in the last decades, the integrated soil management programs in hydrographic basins has been a success in some states (BERTOLINI et al., 1993; BRAGAGNOLO and PAN, 2000), always counting on the participation and commitment of most sectors of society, resulting in a substantial improvement of environmental quality.

In this sense, evaluating the dynamics of the production of sediments in Rio Grande do Sul as a consequence of the evolution of the no-tillage system based on the large scale modeling of secondary data (Agricultural Census 1985, 1996 and 2006 and state monitoring of no-tillage adoption), Lino observed that the production of sediments did not vary in the hydrographic basins with a predominance of land use for pastures and decreased in the basins with agricultural uses in the years of 1996 and 2006, when it equaled to the production in the basins with pastures. The adoption of no-tillage systems showed an average reduction in the sediment load of 82%, a value close to the reduction of erosion rates in experiments with not tillage.

In addition, the sequestration of carbon from the atmosphere for the soil operated with no-tillage is a relevant additional contribution, being yet another indication of the possibility of building a highly sustainable agriculture in the tropics (FREITAS et al., 2007). In a work elaborated based on the data of the authors themselves and on the revision of other data previously published in the country, Bayer et al. (2006) showed that, on average, in grain crops grown under no-tillage in the Cerrado, there was an accumulation of carbon in the soil, sequestrated from the atmosphere, of about 350 kg ha^{-1} $year^{-1}$, with the possibility of reaching 480 kg ha^{-1} $year^{-1}$ in the South region, at a depth of 20 cm.

In the areas of conventional management, however, there is the emission of carbon into the atmosphere. Converting these values into quantities of carbon dioxide (CO_2) there is for the Cerrado and for the South region, respectively, approximate totals of 1.28 t ha^{-1} $year^{-1}$ and 1.76 t ha^{-1} $year^{-1}$ of CO_2 removed from the atmosphere.

Therefore, the adoption of practices and techniques which cause a lower environmental impact and that imply in reorganization of land use and of the activities in the rural properties – including the maintenance of PPAs and of LRs – has as their main product, the minimization of the degradation of natural resources.

It is really a clear question of choice, which lies in the hands of society: opt for the agricultural activities in its most traditional forms, incorporating the related environmental costs or generalize the examples which guarantee agricultural profitability and sustainability through the full use of technological knowledge, through the planning of land use, the management of the soil and the water and through the minimal degeneration of the plant – soil – climate system. This is how it is possible to promote an agricultural activity in harmony with nature, through the use of biological and agronomic principles adapted to our edaphic and environmental reality.

The international, and certainly also the Brazilian community, recognize that the preservation and the conservation of the natural resources are the responsibility of all sectors of society. Thus, assumptions such as increasing production per unit area and per input, maximizing production factors, optimizing the use of inputs and of human resources and coexisting pacifically with nature, require that society takes on the responsibility of compensating the farmers, the environmental managers and those responsible for the sustainable management and use of the natural resources, for the environmental services they rendered, as suggested by Landers and Freitas (2001) and by Landers et al. (2002), in particular for the production of clean and plentiful water.

1.3. THE IMPORTANCE OF THE PERMANENT PRESERVATION AREAS (PPAS) AND OF LEGAL RESERVES (LR) FOR THE CONSERVATION OF BRAZILIAN BIODIVERSITY[1]

Brazil is a country with the biggest biological diversity in the world, for it hosts at least 20% of all species of the planet, with high rates of endemism for different taxa. This implies in ample opportunities, especially economical (for example, the development of new foods, drugs, biotherapy, woods and fibers, biomimetic technologies and ecological tourism), but also a greater responsibility. The environmental legislation has already achieved important progress, reflecting the importance of Brazil´s unique natural

[1] This text was adapted and/or partially reproduced from the following published documents: Impactos potenciais das alterações propostas para o Código Florestal Brasileiro na biodiversidade e nos serviços ecossistêmicos, elaborado por pesquisadores do Programa BIOTA/FAPESP e ABECO (http://www.abecol.org.br/wordpress/?p=185); Metzger (2010); Martinelli et al. (2010); Joly et al. (2010); Metzger et al. (2010).

asset. Setbacks at this moment will have severe and irreversible environmental, social and economical consequences.

Perceiving the importance of the conservation and of the sustainable use of this priceless natural asset, Brazil has become a signatory of international commitments, such as the Convention of Biological Diversity (CDB) and the Convention of Wetlands (RAMSAR). It has also assumed the commitment at the United Nations Convention on Climatic Changes, to reduce in 38% the emission of greenhouse gas by 2020. These commitments not only require compliance with the environmental legislation but also the recovery of rural and urban environmental liabilities.

Among the researchers, there is a consensus that guaranteeing the maintenance of the Permanent Preservation Areas (PPA) along the marginal areas to bodies of water, of tops of hills and of hillsides with slopes superior to 30 degrees, as well as the conservation of LR in the different biomes is of extreme importance for the conservation of the Brazilian biodiversity.

Among the negative impacts of the reduction of PPAs and LR are the extinction of species of many groups of plants and animals (vertebrates and invertebrates); the increase of CO_2 emission; the reduction of ecosystem services, such as the control of pests, the pollination of cultivated or wild plants and the protection of the water resources; the spread of diseases (hantavirus and others transmitted by wildlife, as in the case of the tick associated to the capybaras); intensification of other disturbances (fires, hunting, predatory extraction, impact of domestic and feral cats and dogs, effects of agrochemicals); the siltation of rivers, reservoirs and ports, with clear implications to the supply of water, energy and flow of production in the entire country.

Next, we have highlighted a few aspects of alterations to the environmental legislation which would have direct reflections on biodiversity.

1.3.1. The width of the riparian Permanent Preservation Areas (PPA)

The current legislation stipulates a series of minimum widths of riparian Permanent Preservation Areas and around reservoirs and springs. Such limits were determined based on the scientific knowledge available when the Forest Code of 1965 was altered in 1989.

The smaller rivers, aside from being of great importance to the Brazilian hydrographic network, they are host to a unique fauna. Studies on anurans (frogs and toads) in the Atlantic Forest indicate that 50% of the species are concentrated in the streams less that 5m wide (TOLEDO et al., 2010). Just on the last list of endangered species of the state of São Paulo, of the 66 species of fish classified in some level of threat, 45 shows a high fidelity to streams and, therefore, is dependent on the quality of the surrounding and internal habitat.

There are a great number of species of semi-aquatic mammals, like the giant otter and the otter who depend on riparian forests (GALETTI et al., 2010), aside from several species of birds (DEVELEY and PONGILUPPI, 2010), reptiles (MARQUES et al., 2010), butterflies (FREITAS, 2010) and fish (CASSATI, 2010) endangered species, who live exclusively in these areas.

The effectiveness of these strips of remnant vegetation depend of various factors, among them the type of ecosystem service considered and the width of the preserved vegetation. For example, there is data that indicates that widths of 30m would be sufficient for the riparian forests to maintain a good part of nitrates coming from the agricultural fields (PINAY and DÉCAMPS, 1988). Yet, given their multiple functions, including the fixation of soil, the protection of water resources and the conservation of fauna and flora, one should consider the minimum sufficient width necessary, for this strip, to satisfactorily perform all of its functions.

Consequently, on a scientific point of view, the definition of this width should respect the most demanding ecosystem service, including in this evaluation the conservation of the biodiversity. Aside from the local conservation, in biological terms, the corridors formed by riparian forests are recognized as elements which facilitate the flow of individuals.

The importance of the maintenance of riparian PPA to minimize the loss of soil caused by surface erosion and the consequent silting of streams, creeks and rivers was experimentally demonstrated by Joly and collaborators (JOLY et al., 2000) working in the Jacará-Pepira river basin, in the municipality of Brotas (SP). The group of researchers determined on location, based on the parcels of erosion, that the annual loss of soil in the pastures is of about 0.24 t ha^{-1}, while in the same type of soil, with the same slope and distance to the river, the annual loss of soil in the interior of the riparian forests was of about 0.0009 t ha^{-1} (JOLY et al., 2000). Nevertheless, it was not possible to determine the capacity of this strip of native vegetation of retaining solid particles of erosion generated outside of it.

The survival of many vertebrates of the native fauna depends on their own capacity of moving, maintaining populations genetically viable, especially in areas where the native vegetation is found to be fragmented. In the regions highly altered by anthopic action, the native vegetation is reduced to small isolated islands in an agricultural or pastoral matrix. In this situation, invariably, the populations of wild animals are small and the genetic variability tends to decrease, making them vulnerable to local extinction. In this situation, corridors of native vegetation are of crucial importance to connect fragments, establishing a positive synergy between the increase of the populations, of the genetic variability, and consequently, of the survival of the species. (DEVELEY and STOUFFER, 2001).

As proposed by the researchers of the BIOTA/FAPESP Program (RODRIGUES et al., 2008) for the state of São Paulo, the registration of the areas of LRs should be made in order to facilitate the connectivity between remnants of native vegetation. This way, it would be possible to create a network of corridors of native vegetation linking LRs and PPAs. Locally, the positive synergy of the connection between fragments, enables this network to have a capacity of native fauna conservation significantly superior to the simple sum of the capacity of each isolated fragment (AWADE e METZGER, 2008; BOSCOLO et al., 2008; MARTENSEN et al., 2008; PARDINI et al., 2010). In a broader spatial and temporal scale, this network also has a greater potential of mitigating the impacts of climatic changes (MARINI et al., 2009).

1.3.2. The importance of wetland areas as PPAs

The wetlands are highly relevant areas in ecological terms and that is why it is important to include them in the concept of PPAs. Contrary to the investment needed for the conservation of these areas, the cost for the recuperation of its functionality – usually paid for by society – is extremely high (GUTRICH and HITZHUSEN, 2004). These same authors calculated that the cost for the restoration of the ecological functionality of anthropized wetlands is of US$5,000 per hectare in processes which can take over 20 years. A cost quite superior to the cost of recuperating riparian forests.

Aside from hosting specific fauna and flora, including endemic species – which live exclusively in these environments-, the wetlands render several ecosystem services of great importance for mankind (JUNK et al., 2010; TUNDISI and TUNDISI, 2010).

The wetlands dissipate the erosive forces of surface runoff of heavy rainfall, acting as important controllers of flooding (like large pools, as those constructed in big cities which try to imitate the function of the wetland area). The wetlands also facilitate precipitation and the deposition of sediments suspended in water, substantially lowering the costs of potable water treatment. It also has a high biological importance because it provides food, shelter and feeding and breeding sites for several species, and can even have unique aesthetic and cultural values.

To the riverine population of the entire Amazonian region, the wetlands are crucial, not only on an economic point of view – since they help to maintain fish stock, guaranteeing a site for feeding and shelter for the young faze of several important species on the diet and the economy of families - , as on the social and cultural point of view. For these reasons, there are programs all over the world for the protection of the humid areas and their ecosystem services.

As a signatory to the RAMSAR Convention (rectified by the federal government by Decree 1905/1996), Brazil is committed to the development of a special policy of humid area protection. The removal of the condition of PPA of wetlands goes against the national and international commitments assumed, reiterated in the Declaration of Cuiabá in 2008 (INTECOL WETLAND WORKING GROUP, 2008). The environmental legislation should encourage the recuperation of these areas instead of reducing its protection and making them more fragile and vulnerable.

In the long run, to reduce the size of PPAs in their widths and extension or by the exclusion of fragile areas which are today protected, generate irreversible environmental impacts, placing even the human life at risk. Even with all the evolution of scientific and technological knowledge, the costs to restore these areas are extremely high and not all the ecosystem services would be fully recovered.

1.3.3. The biological importance of hilltops and areas with more than 1,800m of altitude

The areas with more than 1,800 m of altitude represent a tiny portion of the national territory (less than 1%), yet they are of extreme ecological importance, due to being areas with high rates of endemism, a result of a long process of speciation due to geographical isolation (RIBEIRO and FREITAS, 2010). These areas of higher elevation host species particularly sensitive to disturbance of their habitat, since this rarely occurs.

1.3.4. Extension of Legal Reserves (LRs) in the different Brazilian biomes

There are many reasons for maintaining the current LRs. First, they are relevant areas for the conservation of biodiversity and, together with the PPAs, they should maintain a native vegetation cover of over 30%. According to recent scientific studies (PARDINI et al., 2010), this percentage represents an important threshold, below which the risks of extinction of species increase very rapidly.

In the “Amazônia Legal”, due to the Ecological-Economic Zoning (EEZ) of each state, they suggest the possibility of reducing the LR of forest areas from 80% to 50% and of areas without forests, like Cerrados and Fields, from 35% to 20% of each property. Despite many states still not having approved zonings, one can foresee that, under the pressure of interested groups, everyone will tend to sanction such percentage of reduction, becoming important inducers or facilitators of deforestation in ample areas of the Amazonia.

This alteration will have an especially striking effect, for it might favor the reduction of the forest cover in the Amazonia to below 60%, a percentage today regarded as a critical threshold for the maintenance of the physical connectivity (or continuity) of the forest (STAUFFER, 1985; WITH and CRIST, 1995; WITH and KING, 1999). Below this threshold, the environment tends to be more fragmented, with smaller fragments, more isolated and with a higher risk of extinction of species and deterioration of the fragments themselves, aside from the loss of its effectiveness as functional ecosystems.

Aside from the biological issues and the ecosystem services, small fragments of native vegetation kept as LR have an important role in decreasing the isolation of the few bigger fragments, working as ecological trampolines in the moving of species through the landscape. Without these fragments, the biological fluxes would be greatly harmed, accelerating even more the process of extinction.

In regions with high human occupation, the small fragments (<100 ha) represent a considerable portion of what remains. In the case of the Atlantic Forest, the small fragments represent 90% of the total number of mapped fragments. Added, they correspond to 30% of the toil area of remnant forest (RIBEIRO et al., 2009). Although small, such fragments represent relevant areas and render important service to mankind and the species which live there.

1.3.5. The need to separate LR from PPA and of maintaining LR predominantly with native species

One of the proposed alterations to the Forest Code expands the possibilities of incorporating the PPA in the computation of LR of all properties. The main objective of this alteration is to reduce environmental liabilities, since this mechanism shall not be authorized if it implies in the suppression of new areas of native vegetation. With this alteration, a property (with more than four fiscal modules) that includes 10% of the PPA will only need to maintain an additional 10% as LR; the property with more than 20% of PPA will not have to maintain any LR. There would therefore be a substitution of LR for PPA.

This combined calculation does not make sense in biological terms. PPA and LR areas have distinct characteristics and functions, conserving different species and ecosystem services. Areas of riparian PPA differ from the areas between rivers maintained as LR; Similarly, PPAs in steep slopes are not equivalent to the close by areas in flat soils which still maintain native vegetation, conserved as LR.

The PPAs protect the more fragile or strategic areas, like those with the greater risks of soil erosion or that serve as aquifer rechargers, regardless of the vegetation which covers them, aside from having an important role in the conservation of biodiversity. Due to being located out of the fragile areas which characterize the PPAs, the LR is an additional instrument which expands the variety of ecosystems and conserved native species. They are complementary areas which should coexist in the landscape to ensure their biological and ecological sustainability in the long run.

In addition, it is worth pin pointing that, contrary to the PPAs, the LR can be managed by the proprietors who can extract wood, essences, flowers, fruits and honey. Therefore, the LRs are a source of work and income for the owner, as long as the activities performed do not compromise the survival of the native species which they host.

Among other reasons, the non-compliance of the current Forest Code with regards to the PPAs and the LRs is one of the main factors responsible for the continued increase in the number of vulnerable Brazilian species threatened with extinction on the lists periodically updated by the scientific societies and utilized by the organs and institutions of the environmental area[1].

In the amazonic region, the reduction of the LR would decrease the level of forest covers to levels which would compromise the physical continuity of the forest, significantly increasing the risk of extinction of species, compromising its effectiveness as functional ecosystem and its ecosystem services.

[1] See IBDF Ordinance No 303, from May 29, 1968; IBAMA Ordinance No 1522, of December 19, 1989; MMA Instruction No 03, of May 27, 2003; MMA Instruction No 05, of May 21, 2004 and MMA Instruction No 52 of November 8, 2005.

The restoration of the LR areas, viable thanks to the advances of scientific and technological knowledge, should be done, preferably, with native species, since the use of exotic species compromise their function of conserving biodiversity and does not ensure the restoration of their ecological functions and of their ecosystem services. It is in this component (LR) that one notes the largest environmental liability in the Brazilian agricultural sector. New techniques of restoration and sustainable management of native species should be utilized for the legal and environmental compliance of the rural property.

The survival of the species depends on their ability of moving through the landscape. Where the original vegetation is found to be reduced and dispersed into many fragments, isolating and reducing the sizes of the native populations that live there, corridors of native vegetation can have a crucial role, because many wild species cannot cross open areas created by man, not even when it's just a narrow interference like a road (DEVELEY e STOUFFER, 2001).

1.3.6. The possibility of grouping LRs of different owners into bigger fragments and/or compensating a LR in another property or region

A possibility to be considered is the stipulation of a percentage value of the total vegetation to be maintained per proprietor or hydrographic basin, privileging those with a greater biotic and functional value. This percentage should guarantee both, spaces for economic activities, and spaces for the conservation of ecosystems and their services, benefitting even the areas of agricultural productivity in the vicinity. Within the extension guaranteed for native vegetation, mandatorily all the PPAs should be included, complementing the total stipulated percentage with LR.

The compensation of LR out of the property should be restricted to areas situated in the same biogeographic regions and equal phytophysiognomic formations. Thus, it is impossible to think of all compensation within one biome. These compensations should only be possible in more restrict geographical areas, possibly like those managed by the Basin Committees. In this case, the arrangement of LRs would allow us to not only think of the best areas for the conservation of biodiversity, but also on the areas which would bring the greatest benefits for the protection of the water resources and of the soil or the restoration of native forests in the areas inadequately made available for agriculture in the past, areas today which are marginalized due to their low suitability.

It is also necessary to define a maximum quota of compensation within a region in order not to create ample contrast with landscapes depleted of vegetation in certain basins and others with a high concentration of LR. These contrasts are not desirable, not only because they create poor landscapes in biological terms, but also because the ecosystem benefits of the LRs are more intense if they are near productive areas.

In addition it is necessary to re-think the use of exotic species in a LR. They can be useful to accelerate or facilitate the restoration of these areas in the first stages of restoration of the LR, but they should not be considered permanent elements of the LRs. The sustainable use of natural resources should be the priority, and it can even become a more profitable economic alternative of the agricultural use of the soil, in the case of the Amazonia.

1.4. THE IMPORTANCE OF THE PERMANENT PRESERVATION AREAS (PPAs) AND OF THE LEGAL RESERVES (LR) IN THE RURAL PROPERTY

1.4.1. Environmental Benefits Associated to the Presence of Permanent Preservation Areas and Legal Reserves in the Rural Property

The scientific and technological advances obtained by agricultural research in the last decades allow for expressive increases in the indexes of agricultural production and productivity. The dynamics of the demands of the sector over time has also called for diversified responses considering the socioeconomic and environmental diversity of the country.

There are areas where agriculture has a long history, as is the case of the Atlantic forests and the Caatinga biomes, with environmental problems associated to the long historical process of occupation and of evolution of its agricultural systems. They contrast with the Amazonia and Cerrado biomes, in which the heavy agricultural occupation is relatively recent, with trajectories of a few decades and production systems in different development stages.

With regards to the technical base, this production depends on the diversity of technologies, cultures and geographic areas, particularly of the Brazilian Central-South, where the agriculture with intensive use of inputs and machines predominates. In many cases, it is found consolidated in agro industrial chains such as the sugarcane, soybean, corn, coffee, rice, cotton, planted forests, vegetables, citrus fruits and other temperate/tropical fruits, cattle, swine, poultry etc.

On the other hand, there are areas of predominantly traditional agriculture, especially in the Northeast and in the North – the later with a strong presence of natural systems, despite the urgent need for organized activities in terms of agricultural intensification.

Given the diversity of scenarios and of the technological options of production, there is a consensus in the agricultural research that ongoing adjustments are needed in the conventional productive systems to overcome the problems of difficult solutions due to their diffuseness and their multifaceted nature, such as: pollution and environmental contamination; erosion of the soil and its physical, chemical and biological degradations, with a consequent loss of resilience, reduction of its productive capacity, aside from the risks of desertification and the loss of biodiversity and of environmental services.

While many of the problems faced by research can be perceived as technological development issues, others require differentiated approaches due to their still intangible nature, unpriced in terms of economic returns, as is the case of the ecosystem services offered by the natural areas and by biodiversity. Some of these services generate worldwide benefits, but others are essential for the production system itself and for its profitability

One of the priorities of the sciences which deal with the interface between productive systems and environmental management is to evaluate the consequences which changes in land use and in the composition of the landscape promote over the human well-being, and establish the scientific basis for the conservation and the sustainable use of the ecosystems. Among the components of this interface, are the ecosystem services.

They can be distributed into four categories: a) provision: essentially deals with the production of food, fibers, fuel and water; b) regulation: of the climate, of hydrology and of environmental health; c) cultural: relates to the spiritual, aesthetic, recreational and educational dimensions; d) support: the primary production, soil formation, maintenance of biotic flux.

Methods of economic valuation of these services are already available and amply used in Brazil (MAY et al., 2000) and the remuneration to producers is already becoming a reality (cases of carbon market, charging for the use of water, “Ecological ICMS” (taxes) etc.) (VEIGA and MAY, 2010).

It is worth emphasizing here the two matters approved by the Environment Commission of the House of Representatives on December 1, 2010 to regulate the mechanism of Certified Reduction of Emissions from Deforestation and Degradation (Draft Bill 5586/09) and which creates the National Policy on Payment for Environmental Services (Draft Bill 792/07 and joined documents). They allow for the Payment of Ecosystem Services (PES) associated to the protection of natural resources per private properties and Conservation Units, as well as the commercialization of carbon credits linked to the maintenance of the standing forest and under sustainable management (REDD+) and its contribution towards the national goals of greenhouse gas reduction.

Table 7 shows the categories of ecosystem services referred to previously and the factors which contribute to the well being of the citizen. Both maintain an intrinsic relationship and should therefore not be considered independently.

At least four ecosystem services rendered by the natural areas are considered to be important to the current society and to its future generations, as well as for the sustainability of the production systems: a) hydrologic regulation (the increase of storage, transference and recharge of aquifers); b) atmospheric regulation (a bigger sequestration of carbon and reduction of greenhouse gas); c) control of erosion; d) services offered by biodiversity (pollination and agricultural pest control).

Aside from these services, we can also mention those rendered by the native vegetation which borders the and protects the slopes, working as corridors of gene flow and important filters in retaining particles which would eventually enter the water bodies.

As any other agricultural input, the ecosystems and their services constitute a capital asset for the nation, the state or the property. They are already being defined in international literature under the name of Natural Capital (ARONSON et al. 2007, NEßHöVER et al. 2009, ARONSON et al. 2010). The cost associated to the inadequate management of these assets is implicit in the official economic indicators (loss of nutrients and pollinators, resulting in low productivity for example). The benefits can be explained by specific methods of valuation, indicating the gains potentially obtained from their protection.

Shortage in the provision of ecosystem services has been increasingly perceived by the economic actors, resulting in the creation of specific markets for such services (carbon, water). Yet, due to the lack of explicit prices for most of these services, it is necessary that society defines the importance of its maintenance for human survival, placing limits on the expansion of the economic activities.

The understanding of the importance of the maintenance of the natural areas like PPAs and LRs in the rural properties is essential, since there is the wrong conception that the areas with native vegetations represent areas of non-productivity, areas of additional cost, without any return to the producer. These areas, strictly speaking, are fundamental to maintain productivity in agricultural systems, in view of their direct influence on production and in the conservation of water, of biodiversity, of the soil, in the maintenance of the shelters for the pollinating agents, for dispersal and for natural enemies of the pests of the property´s specific crops.

Therefore, the maintenance of remnant native vegetation in the properties and in the landscape goes beyond a mere environmental and ecological discussion, envisioning, aside from its economic potential, the sustainability of agricultural activity.

Table 7. Relationship between biodiversity, ecosystem services and human well-being.

<table>
<tr><th colspan="2">ECOSYSTEM SERVICES</th><th colspan="2">CONTRIBUTING FACTORS FOR HUMAN WELL BEING</th></tr>
<tr><td rowspan="4">Support

* nutrient cycling
* Soil Formation
* Primary Production</td><td>Provisioning

* food
* Potable water
* Wood and fibers
* Fuel</td><td>Safety

* Individual safety
* Safe access to natural resources
* Safety against disasters</td><td rowspan="4">Freedom of choices and of actions
Opportunities to achieve that which individuals value doing and being</td></tr>
<tr><td>Regulation

* Climate regulation
* Flood regulation
* Diseases Regulation
* Water Purification</td><td>Raw material for a good life

* Adequate income
* Sufficient and nutritious food
* Shelter
* Access to assets</td></tr>
<tr><td rowspan="2">Cultural

* Aesthetic
* Spiritual
* Educational
* Recreational</td><td>Health

* Strength
* Feel good
* Access to pure air and water</td></tr>
<tr><td>Good Social relationships

* Social coercion
* Mutual respect
* Capacity of helping others</td></tr>
<tr><td colspan="4">LIFE ON EARTH - BIODIVERSITY</td></tr>
</table>

Source: Adapted from Millennium Ecosystem Assessment

1.4.1.1. Ecosystem Services Associated to the Riparian Permanent Preservation Areas (PPAs)

The ecosystem services rendered by the riparian PPAs are well known. Among them we can site (a) its role as a barrier or filter, avoiding that sediments, organic matters, nutrients from the soil, fertilizers and pesticides used in agricultural areas reach the aquatic environment; (b) facilitating the infiltration of water in the soil and the recharge of aquifers; (c) the protection of the soils in the banks of waterways, avoiding erosion and silting; (d) the creation of conditions for the gene flow of flora and fauna (BATALHA et al., 2005); (e) the supplying of food for the maintenance of fish and other aquatic organisms; (f) a place of refuge for pollinators and for enemies of crop´s natural pests.

The organic matter present in the leaf litter on the soil of riparian areas can be leached by the infiltration of rain water and reach the rivers via the superficial surface or subsurface hydrological flows or even reach the rivers by being dragged by the runoffs or by leaves simply falling into the river channels. Therefore the forests can be seen and sources of organic matters and of energy for the aquatic systems, playing an essential role for the functioning of these ecosystems (McCLAIN and ELSENBEER, 2001).

Among the potential impacts of the decrease of the width of the PPAs, are the alterations in the capacity of water storage along the riparian strip with a consequent reduction of flow during the dry seasons (LIMA and ZAKIA, 2000).

It is worth mentioning that hydrological interactions occur between surface and subsurface of streams, considering that the water does not flow solely by the river channel but also through the interstices of the sediments along the banks of the canal and under the canal. This compartment is known as the hyporheic or riparian zone (JONES and HOLMES, 1996; TRISKA et al., 1989). Important biogeochemical processes occur in this compartment, which determines the importance of the marginal areas of the waterways in mitigating the supply of nutrients from fertilized agricultural soils, and in the conversion of molecules and metabolites coming from the use of pesticides on the agricultural crops.

Thus, the vegetation present in the riparian areas, serves as a biogeochemical barrier for the entrance of organic and inorganic chemical species into the rivers, a fact which makes the woody riparian areas extremely important for the maintenance of the water quality and the health of the aquatic ecosystem (CORREL et al., 1992; FORTESCUE 1980; TRISKA et al., 1993). Gilliam (1994) reports the reduction of 90% of the concentration of dissolved sediments and nitrogen species as a consequence of the filtering action of riparian forests. In addition, Emmett et al. (1994) verified that the riparian forests reduced the concentration of total nitrogen, phosphate and phosphorus dissolved to be 38%, 94% and 42%

The recent expansion of the agricultural frontier in the Amazonia for the planting of grains associated to the deforestation of riparian vegetation has promoted impacts on the functioning of the aquatic ecosystems and in the water quality of small Amazonian streams (igarapés) used by the riverine communities as reported by Figueiredo (2009) with regards to several studies conducted by Embrapa and partners.

In these studies, one reaches the conclusion that even the secondary vegetation of the riparian areas is most likely performing an important function in the conservation of water quality and in the maintenance of aquatic ecosystem services of the basins with a predominance of familiar agriculture.

Yet, in the areas of headwaters, where the forest has been severely altered, significant alterations have been noticed regarding the concentration of potassium, calcium, magnesium, ammonium, chloride, sulfate and organic carbon dissolved, as well as significant alterations in the parameters of water quality such as turbidity, conductivity, pH, temperature, and dissolve oxygen, when compared to the headwater areas where the forest is relatively conserved.

In addition, the studies indicated that, with the decrease of forest areas for the increase of pastures, there is an increase in temperature and in conductivity and a decrease of concentration of sulphate and nitrate in river waters. Whereas the increase of areas for the agriculture of grains associated to the absence of riparian forests resulted in reducing the oxygen dissolved and increasing the turbidity and the concentrations of sodium and chloride in the waters of the streams (igarapés) of the studied basins.

With the objective of supplying evidence for public policies on the management of hydrographic basins, Figueiredo et al. (2010) concluded that the turbidity, the temperature, the pH and the dissolved oxygen are the simplest parameters indicated for the detection of the effects of changes in land use on the quality of river water.

Other studies report the great importance of maintaining these riparian vegetations in any type of agricultural activity adopted, because the riparian forest can determine the magnitude of the flow of rivers, creeks or streams in small basins, feeding the water flux of the bigger basins (WICKEL, 2004). With regards to the role of the riparian forests as filters of nutrients which enter the streams, the existence of a “buffer” function of the riparian forests was noted based on the evaluation of the chemical composition of the underground water of riparian areas with pastures and forests.

Studies performed in Rondônia also indicate how the substitution of riparian forests for pastures affect the functioning of streams, altering the concentrations of nitrogen (N), phosphorus (P) and oxygen (O) dissolved in their waters, due to the N:P ratio also being altered, the aquatic biota is impacted (NEILL et al., 2001). Ballester et al. (2003) identified in the river waters, an increase of concentrations of sodium, potassium, chloride and phosphate, besides the increase of the electric conductivity of the waters due to the deforestation and the implementation of pastures.

A study performed by Zocolo (2010) aimed towards investigating the concentrations of isoflavones in surface and subsurface waters in big soybean plantations in Mato Grosso do Sul. Also called phytoestrogens, the isoflavones are composed of natural estrogenic compounds found in plants, mainly in soybean. These compounds have a similar structure to the estrogenic hormones produced by mammals, being classified as endocrine disruptors (ED).

Studies about these substances indicate effects of alterations such as intersex in fish. There is therefore, an increasing interest related mainly to the isoflavones of greater estrogenic potential, found in high concentrations in soybean: genistein, daidzein, genistin, formononetin and biochanin-A, aside from the degradation product, the equol, obtained from these metabolic.

The environmental impact of these substances in the aquatic environment has been significantly less investigated and there are very few studies in the rural areas. The post-harvest of soybean yields a large quantity of straw, a source of isoflavones for the soil. Leaching processes can cause the surface runoff of isoflavones to the rivers, due to the solubility of these compounds in water.

The research revealed that the phytoestrogens were present in the river and in the upwelling of water tables, in concentrations which varied from 12 to 1957 ng L_{-1}, values considered high for a rural region, of which the highest concentrations were obtained for equol and genistein in samples collected during rainy seasons in the region being studied.

The concentrations found in the water of the rivers were similar to those verified in big metropolis like Osaka, in Japan, yet the sources in Japan were domestic wastewaters. A very relevant data lies in the fact that the highest concentrations of isoflavones were detected in areas of low density riparian forests, which certainly contributed towards the entrainment of these substances to the river.

Studies headed by Embrapa Pantanal in the Taquari river basin, located in the states of Mato Grosso and Mato Grosso do Sul found that, as a result of the removal of the riparian forest associated to poorly managed livestock, without the use of soil conservationist practices, there were high levels of soil erosion and siltation of rivers. The Taquari River is one of the main tributaries of the Pantanal.

In the Alto Taquari basin, the greatest impact with regards to land use comes from the pressures resulting from livestock, followed by agriculture, since with the expansion of these activities in the areas of the Cerrado, of forests and in the transition areas, the sources of erosion are enhanced, leading towards degradation of water and soil resources. This process causes considerable water loss and an increase in the rate of siltation of the Taquari River, leading to new meanders and an increase in floods in its lower course.

Additionally, as a result of the erosion caused by deforestation, an increase was registered, of up to 70% in the entry of suspended solids and nutrients in the upper Taquari River during the rainy seasons, causing impacts on the peryphyton communities and on the trophic chains in the aquatic ecosystems with direct consequences on the small fish and micro crustacean. Such fact was reflected in the studies of biology and ecology of fish in the same basin. The research found alteration in the breeding and feeding of these animals, harming the fish industry, an activity which was once important in the economy of the region.

The increase of floods due to land use is also impacting the riparian forest in the lower parts of the basin, affecting the regional socioeconomy with the migration to cities, the isolation of human communities and the compromising of commerce of local products. Among the recommendation from Embrapa Pantanal and its partners for the mitigation of the environmental and socioeconomic impacts in the Taquari river basin is the restoration of the riparian forests. (GALDINO e VIEIRA, 2005).

In the Cerrado biome, the hydrographic basins are formed by a few large rivers and dozens of narrow streams, along which, due to the topography and the depth of the water table, the riparian forests – known as gallery tables in that area - of

Studies performed in these landscapes indicated that the concentration of nutrients in the river water are very low because the gallery forest works as a barrier against the exiting of nutrients from the system, contributing to the maintenance of water quality in the waterways. The removal of these forests would compromise the protection of biodiversity, the volume and the quality of the water necessary for the social well-being in the region.

An example of protection of riparian forests for the rivers in the Atlantic Forest can be seen by the work developed by Moraes et al. (2002). In the study, the authors found that, in the Jundiaí-Mirim river basin, the total concentration of ammonia nitrogen and of phosphorus were above the limit established by the environmental legislation of the state of São Paulo. These elevated levels of phosphate are directly related to the contamination from fertilizers, carried during the erosive process of agricultural areas near the river and without riparian forests.

One of the current challenges of the research is to identify the conditions that can support decision making in determining the dimension of the marginal widths which is adequate to enable these areas to accomplish their expected ecosystem services. For such, a few key characteristics need to be considered in this process, among which, the depth of the water table, the texture and thickness of the soils and the steepness of slopes adjacent to the waterways, aside from the sufficiency of vegetation in order to guarantee the genetic flow of species and the conservation of biodiversity.

Because of the climatic, geological, pedological and biological diversity of the Brazilian territory, a consistent effort is necessary to gather the needed information for possible differentiated and justified treatments with regards to the width of the marginal strips of PPAs.

1.4.1.2. Other ecosystem services associated to the Permanent Preservation Areas (PPAs and to the Legal Reserve (LR)

1.4.1.2.1. Carbon stock in vegetation

When dealing with sustainable agriculture, one of the main opportunities which Brazil has ahead of it is the possibility of transforming part of the natural resources that exist in the property into income for the farmer. The main opportunity being the maintenance of carbon stock in the native areas which, if maintained as Legal Reserves, can bring additional remuneration to the farmer.

The values presented on Table 8 refer to the carbon stock in various Brazilian biomes. In general, they are considered to be120 t C/ha in Amazonia and 38 t C/ha in the Cerrado biome. This carbon is valuable in the Global market. For the countries in Attachment 1_1 the modeling used, indicate that it is possible to reach the cost of US$ 10 to 60 for each ton of reduced CO_2 emission. In the case of Latin America, for CEPAL – which has the most conservative posture, **-** the value of the ton would be around US$ 10 to US$ 20 for projects associated with carbon sinks in activities of the forestry sector. The expansion of deforestation both in the Amazonian biome as well as in the Cerrado would be decreasing the capacity of diversifying the income of agrobusiness for the environmental services.

The lack of obligation of recovering legal reserves in areas of up to four fiscal modules – which vary in size according do municipality – can also decrease the opportunities of other sources of income for farmers. For example: considering that part of the areas of Legal Reserve in the Amazonian region would no longer be recomposed by secondary forests, the loss would be, in average, of 57 t C/ha; by riparian forest, the value would increase to 94 t C/ha ; with agroforestry systems, 87 t C/ha.

These facts contrast to the recent public policies of the government of encouraging low carbon emission agriculture, seeing that the non recomposition of reserves would only maintain the emissions (GOUVELLO et al., 2010).

Data from the Agricultural Census of 2006 (IBGE, 2006) estimate that Brazil has today, at least 60 million hectares of pastures with a low cattle stocking rate (less than 0.4 units animal/ha). These areas can increase their efficiency or, if used in conjunction with grains, could generate a surplus of more that 2.4 million head of cattle and an additional of about 120 million tons of grains.

To reduce PPA or LR to increase the planted area would not be the priority to increase agricultural productivity. Much to the contrary, it is necessary to reinforce the public policies aimed at the intensification of land use already being used through the adoption of adequate technologies, such as the integration crop-livestock, recuperation of pastures and adoption of quality tillage, all of these with a high capacity of reducing CO_2 emissions and increasing the carbon stock.

Table 8. Dry epigeal biomass and carbon stock in different types of plants in the North and South regions.

Type	EBE ($Mg.ha^{-1}$)	CS* ($Mg.ha^{-1}$)	Sampling (cm)	Source	Place
SF	56	25	DBH ≥ 5	Lima *et al*. (2007)	Manaus, AM
SF	125	56	DBH ≥ 2.5	Batistella (2001)	Machadinho d'Oeste, RO
SF	199	90	DBH ≥ 5	Pereira (2001)	Paragominas, PA
AV	127	57			
RF	213	96	DBH ≥ 10	Stadtler (2007)	Barcelos, AM
RF	108	49	DBH ≥ 10	Keller *et al.*(2004)	Paragominas, PA
RF	307	138	DBH ≥ 5	Tsuchiya and Hiraoka (1999)	Abaetetuba, PA
AV	209	94			
UF	466	210	DBH ≥ 1	Silva (2007)	Manaus, AM
UF	269	121	DBH ≥ 2.5	Batistella (2001)	Machadinho d'Oeste, RO
UF	289	130	DBH ≥ 5	Tsuchiya and Hiraoka (1999)	Abaetetuba, PA
AV	341	154			
AS	153	69	DBH ≥ 2.5	Bolfe *et al.* (2009)	Tomé-Açu, PA
AS	298	134	DBH ≥ 5	Santos *et al.* (2004)	Cametá, PA
AS	126	57	DBH ≥ 5	Montagnini and Nair (2004)	Amazonia
AV	192	87			
MAF	195	88	DBH ≥ 10	Socher *et al.* (2008)	Araucária, PR
MAF	210	95	DBH ≥ 10	Vogel (2006)	Itaara, RS
MAF	210	95	DBH ≥ 10	Caldeira (2003)	General Carneiro, PR
AV	205	92			
SFIE	1	...	...	Fonseca *et al.* (2007)	Bagé, RS
SFIE	3	...	...	Herringer and Jacques (2002)	André da Rocha, RS
SFIE	1	...	...	Santos *et al.* (2008)	Eldorado do Sul, RS

Obs: (EBE) epigeal biomass; (CS) values of carbon stock estimated in 45% of the epigeal biomass; (AS) agroforestry systems;

(SF) Secondary Forests; (RF) riparian forests; (UF) upland forests; (MAF) Mixed Araucária Forest; (SFIE) Southern fields

1.4.1.2.2. Pollination

Just like the PPAs, the LRs also render important ecosystem services which guarantee the sustainability of agricultural production. Among the most important are those which allow for the maintenance of the fauna in charge of the pollination of crops and of the control of natural agricultural pests, especially the insects. Among all the environmental services rendered by the PPAs and the LRs, these are certainly the most tangible and the most important related to the success of agricultural production and productivity of several crops. The services rendered by pollinators are highly dependent on the conservation of native vegetation, where they find shelter and food.

On the other hand, the native vegetation depends on the services of this same pollination to become viable in the long run by means of the maintenance of its floristic diversity, seeing that the majority of these species require specific pollinators in order to perpetuate in the native vegetation.

In a relevant revision of the importance of crop pollinators, Klein et al (2007) concluded, based on the evaluation of 107 important crops in terms of their volume of production and their purpose for human feeding (fruits, vegetables and grains) that 91 on them depend on some level on biotic pollination (Figure 4). When one takes into consideration the crops which contribute to the highest volumes of production, 35% of them depend directly on the action of these pollinators.

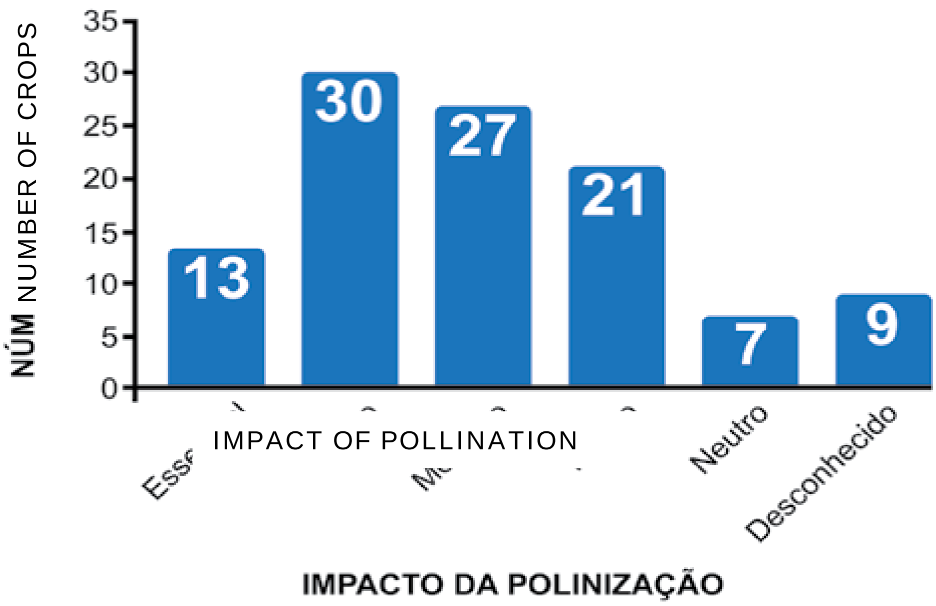

Figure 4. Levels of dependency on biotic pollination based on the potential decreases in production in the absence of pollination in 107 crops of global agricultural importance. Essential: up to 90% of reduction; High: 40 to 90%; Modest: 10 to 40%; Little up to 10%; Neutral without interference of biotic pollination in the production; unknown: no information available. Adapted from Klein et al. (2007)

In the Brazilian case, the impacts of pollination on crops are still poorly studied. A great part of the data available is concentrated on a reduced number of crops, yet of great relevance for the national agriculture, among them: melon, coffee, passion fruit, peach, orange, soybean, cotton and cashew. According to data from IBGE (IBGE, 2008), these 8 crops yield R$59.8 billion annually, cover an area of 26,242,361 hectares and yield to Brazil, in exports, including processed products, U$25.9 billion. (Table 9).

Table 9. Planted area, production, value of production and of export of some Brazilian crops, in 2008

Crop	Planted Area (ha)*	Production (t)*	Values of Production* (R$ x 1000)	Export Values** (U$ FOB)
Soybean (grain)	21,252,721	59,833,105	39,077,161	18,021,957,851 (b)
Coffee (grain)	2,250,491	2,796,927	10,468,475	4,763,068,651 (d)
Orange	837,031	18,538,084	5,100,062	2,087,191,169 (a)
Cotton seed (woody and herbaceous)	1,067,444	3,983,361	3,927,671	696,058,104 (c)
Passion fruit	49,112	684,376	483,588	[illegible]
Peach	21,326	239,149	263,742	[illegible]
Melon	15,788	340,464	257,515	152,132,031
Cashew (nut)	748,448	243,253	213,299	196,074,102

* Produção Agrícola – (a): Frutos frescos e secos, sucos, Municipal 2008/Sistema IBGE de Recuperação Automática (IBGE, 2008). ** Ministério do Desenvolvimento Indústria e Comércio Exterior/Secretaria de Comércio Exterior/AliceWeb , (BRASIL, 2008) – (a): Óleos essenciais; (b) Grãos, óleos, farinhas e pellets, bagaços e outros resíduos sólidos e proteínas da soja;
(c) Debulhado ou não, não cardado nem penteado; outros tipos de algodão não cardado nem penteado; (d) Em grão, solúvel, extratos, essências e concentrados, cascas películas e sucedâneos do café.

Examples of the importance of these pollinators on agricultural crops in Brazil are available for soybean (CHIARI et al., 2005); melon (SOUSA et al., 2009); coffee (AMARAL, 1972; MALERBO-SOUZA et al., 2003c), orange (MALERBO-SOUZA et al., 2003c), passion fruit (FREITAS and OLIVEIRA FILHO, 2003), cotton (SANCHEZ JÚNIOR and MALERBO-SOUZA, 2004) and peach (MOTA and NOGUEIRA- COUTO, 2002).

These researches demonstrate that even for crops considered self-pollinating crops the cross-pollination with pollen from other plants and mediated by pollinators, can bring substantial increases in production. In addition, the action of pollinators can increase the efficiency of the pollination process (transport of pollen from the anther – the masculine structure of the flower – to the stigma – the female structure of the flower), even in flowers which possess mechanisms which favor the self-fertilization. The examples below illustrate these contributions.

Soybean

Chiari et al. (2005) evaluated the influence of pollination in the production and in the quality of the soybean seeds (*Glycine max (L.) Merr.)* (BRS133) in the Maringá (PR) region. The research concluded that the production of grains was 50.64% superior in the experimental areas where the plants were exposed to pollination, when compared to the areas isolated from any contact with insects. The results were similar to those obtained by Moreti et al (1998), who registered increases of 58.58% in the number of pods and of 82.31% in the number of seeds.

Melon

The melon plants (*Cucumis melo L.)* have masculine and feminine flowers placed separately. Each one of them remains open for only one day and the pollination is done by insects, especially by bees (*Apis mellifera L*.). Due to the limited period of time of the opening of the flowers, the success of pollination is crucial for the production and the productivity of the crop. (DUARTE, 2001). A research performed by Souza et al (2009) in the Acaraú (CE) region demonstrated the importance of pollination performed by insects (entomophilus) in the quantity and the quality of the fruits in the cultivation of melon.

The results indicated that the manual pollination was the most effective in terms of fertilized flowers, or initial fruit set (98.3%), followed by the open pollination with bees (75.7%) and by free pollination (39.3%). The treatment with restricted pollination (with the isolation of the flowers from biotic pollinating agents) did not present any fertilized flower.

Coffee

Malerbo-Souza et al. (2003a) analyzed the effects of the presence of pollinators in a coffee plantation (*Coffea arabica L*., var. Mundo Novo) in Jaboticabal (SP). Among the variables studied, there was the monitoring of the fruit being treated by artificially covered plants, to avoid the access of any insect, and the monitoring of those uncovered. The research concluded that the uncovered treatments, in which the flowers of plants were visited by insects, presented a greater production of fruit. This increase was of 38.79% in the first year of experiment and 168.38% in the second, when the plants were more developed. The results obtained by Malerbo-Souza et al. (2003c) confirmed the trend already registered by Amaral (1972), who verified the increase in the production of cherry coffee beans of 72% in plants pollinated by insects.

Orange

Malerbo-Souza et al. (2003b) performed studies in areas cultivated with orange (*Citrus sinensis L*. Osbeck,var. Pera-Rio) in Jaboticabal (SP) to investigate among other aspects of its reproductive biology, the visiting insects, as well as their effects on the quantity and the quality of the production of fruits. The results demonstrated that the percentage of fertilized orange flowers was 57.4% superior in those exposed to insect pollination. In this case, the production of fruits was 35.3% superior when compared to the treatment where the pollination was prevented. The study also concluded that the pollination by insects resulted in obtaining fruits which were heavier, sweeter and with a greater number of seeds per slice.

Passion fruit

Brazil is the largest producer of yellow passion fruit (*Passiflora edulis*) in the world. However, the productivity of the culture of passion fruit of 13.9t/ha, as observed in 2008 (table 9), is considered low. According to Ruggiero (2000), the potential productivity of the culture in the country is of 40 to 45t/ha. The low productivity is attributed to the lack of natural pollinators of the culture, the main one being the carpenter bee (Xylocopa spp). One of the factors accounted for this reduction in the occurrence of carpenter bees is the reduction of native vegetation in the proximities of the plantations and the abusive use of pesticides in the crops. In order to overcome the low occurrence of pollinators in the natural environment, producers have resorted to techniques of hand-pollination, increase the costs of productivity.

An assessment of the requirements of pollination of passion fruit performed by Freitas and Oliveira Filho (2003) in São Luis do Curú (CE) demonstrated that the culture of passion fruit is entirely dependent on biotic pollination, with no fruit set in flowers isolated from pollinators. In the flowers with open pollination (without barriers for the access of insects in general), there was an observed fruit set of about 25%. In controlled treatment, in which the flowers were visited only once by the carpenter bee, fruit set was of 68.3%.

Cashew

The cashew tree (*Anacardium occidentale*) is widely distributed in Brazil. The contribution of the biotic pollination in the production of cashew was investigated by Freitas and Paxton (1998) in the Beberibe (CE) region. The research concluded that in the treatments where the cashew flowers remained exposed to open pollination, production was 88% superior, when compared to the treatment with flowers isolated from pollinators.

Cotton

Alongside the soybean, the culture of cotton (*Gossypium hirsutum L.)* is one of the most important for Brazil. The economic importance of the culture goes beyond the supply of fibers in the textile industry, seeing that its seeds are also used in the production of edible oil and the meal in the manufacture of animal feed. The cotton plant is generally considered a culture of self fertilization, there is however, a variable percentage of cross-pollination, depending on the population of insects in the plantation area (CARVALHO, 1999; PEDROSA, 2005). Sanchez Júnior and Malerbo-Souza (2004) performed a research in Ribeirão Preto (SP) to evaluate the presence and the effects of pollinators in the plantation of cotton.

The flowers in the treatments which were open to pollination obtained 92% of fruit set against the 88% of those in covered treatments (without insects). In addition, the average number of seeds per cotton square (cotton fruit when green) in the treatments open to pollination was 42.6% superior to that of the treatment isolated from pollinators.

Peach

Mota and Nogueira-Couto (2002) performed an experiment in Jaboticabal (SP) to verify, among other factors, the performance of insects in the production and in the quality of peach fruit (*Prunus persica L.*). The experiment evaluated treatments on protected branches to avoid the access of insects, and also on treatments with exposed branches. The results of the research indicated that there was an increase of 14% in the numbers of fruits produced in the treatments in which the flower of the peach was exposed to pollination.

Synthesis

In all the above cases, although it is admitted that the percentage of gain in production can vary according to the varieties of the crops and the regions of production considered, the benefits of pollination are expressive, particularly if confronted with the values of production and of export obtained in Brazil in 2008 (Table 9).

Although restricted and still limited to a few crops, the examples supply good indications of the importance of the ecosystem service of pollination to the Brazilian agriculture. The results also warn about the risks in the decrease of the populations of pollinators caused by alterations in the areas and in the distribution of vegetation which compose the several biomes. The information clearly indicates that any damage to the population of pollinators can represent high losses to the national agricultural production.

Recognizing the strict relationship between the composition of the flora and the fauna and also of the fact that biological diversity possesses a very heterogeneous spacial distribution brings an alert about the potential risks of reductions of the groups of native vegetation present in the PPAs and the LRs.

In global terms, the moment is one of great valuation of natural capital. The importance of the responsibility of adequate use of biotic and abiotic natural resources grows more and more each day. (ARONSON et al. 2007, 2010; LAMB et al. 2005; TEEB, 2010).

The different national biomes are also responsible for the mega diversity existent in the country (MITTERMEIER et al., 2005). Brazil, as a signatory to the Convention on Biological Diversity (CBD), assumed before the international community the implementation of the Global Strategy for Plant Conservation (GSPC). Among the 16 goals established by GSPC, the first one is the elaboration of a "widely accessible working list, of known species of plants in each country, as a step towards developing a complete list of the world's flora". Thus, in the Amazonia, Cerrado, Pantanal, Atlantic Forest and the Pampa biomes, there are almost 41,000 species of plants (http://floradobrasil.jbrj.gov.br/2010/), registered on the official lists.

In the Cerrado, for example, more than 12,000 species are described (MENDONÇA et al. 1998) distributed in forest, savanna and grassland environments. Several species have been used with significant economic returns, showing good prospective of success in extractive use or in agroforestry systems. Among the fruit trees identified are the baru (Dipteryx alata Vog.), the araticum (Annona crassiflora Mart.), the mangaba (Hancornia speciosa Gomes), the pequi (Caryocar brasiliense Camb), and the cagaita (Eugenia dysenterica Mart. ex. D.C.) which have been regionally commercialized with reasonable success.

Other species of economic potential of the Cerrado physiognomy (restricted sense) are widely distributed in the biome (RATTER et al. 2003) with great potential of sustainable use through restoration. Some clear examples are the black sucupira (Bowdichia virgilioides), the faveira (Dimorphandra mollis), the pacari (Lafoensia pacari), the pequi (Caryocar brasiliense), the mama-cadela (Brosimum gaudichaudii), the pimenta de macaco (Xylopia aromática), the gonçalo-alves (Astronium flaxinifolium), the mangaba (Hancornia speciosa) and the murici (Byrsonima verbascifolia).

In addition, the breeding of wild animals, the domestication of some native species, the sustainable harvesting and management of the standing Cerrado are ways of diversifying the activities in the rural property and of achieving sustainable ways of use of the natural resources (RIBEIRO et al., 2003).

The same economic potential has also been exploited for other Brazilian vegetation types, like the Atlantic Forest, in restoration actions (RODRIGUES et al., 2009). However, to achieve the sustainable use of the different species and landscapes of the national biomes it is necessary to improve planning and management of the land, value and appropriately manage these resources and recuperate the altered and degraded areas, in other words, organize, integrate and implement these actions within the concept of sustainable productive landscapes.

1.4.1.3. Services to the climate

There is increasing evidence that global climate is finely regulated by the biosphere, in other words, by the integrated and homeostatic functioning of the natural ecosystems (FOLEY et al., 2003; GORSHKOV et al., 2000; KLEIDON, 2004). In the Amazon basin, several studies reveal climate regulating mechanisms mediated by the forest, as for instance, in the promotion of rainfall through biogenic cloud seeding (PöSCHL et al., 2010) or in the active pumping of atmospheric humidity into South America from the equatorial Atlantic (MAKARIEVA and GORSHKOV, 2007).

Marengo et al. (2004) described atmospheric vapor rivers (low level jets) that link the hydrological capacity of the Amazon forest to the rains which irrigate productive regions in South America. In contrast to these benign effects, the continued deforestations have been associated to the alarming alterations in the rainfall patterns (MALHI et al., 2008; SAMPAIO et al., 2007).

Several researches with climatic simulations found thresholds in the reduction of rainfall, which if surpassed can hinder the continuation of the Amazon forest (NOBRE et al., 2009; NOBRE and BORMA, 2009). Probably, as a witness to these projected effects, recent studies demonstrate that the drought in Amazonia are reaching a record intensity and seem to be increasing in frequency.

In its interaction with the climate, the activities of the agricultural sector have more liabilities than demonstrated regulatory capacity (DeFRIES et al., 2004; FOLEY et al., 2005). In the majority of the cases, the agrosystems do not substitute the natural ecosystems in their function of supporting the climate, due to, among other reasons, the genetic manipulation (which remove natural evolutionary capabilities and settings); the small number of plant species used (which reduces the complexity and functional complementarities); the ephemeral and shallow rooting of the short cycle crops and pastures (which hinders effective hydrological regulation); the mechanic intervention in soils with the application of fertilizers and agrochemicals (which alter the biogeochemical cycles) and the removal of products and use of fire (which buffer stocks of organic compounds).

Crops and livestock tend to be biologically and ecologically fragile systems, whose success is only achieved, many times due to technological manipulation and cultural interventions. Even so, they are systems which, in order to exist, to produce, and to render profit, firstly and fundamentally depend on the natural inputs provided by the regulated and benign functioning of the climatic system.

Despite not substituting the natural systems, the agricultural systems can be considerably perfected to contribute towards the mitigation of climatic changes through good practices which take into consideration the emission of gas and other effects in its interaction with the climate (FOLEY et al., 2005).

The extension and the integrity of nearby and distant natural ecosystems have an important role in the productive functioning of agriculture and are of the highest interest of all economic activities in the benefitted regions. In view of this, it is important that the rural producer, regardless of the size of its property, understands the importance of his role in maintaining the climatic support system and environmental integrity.

With the ample environmental services to the climate demonstrated, it becomes increasingly justifiable the economic valuation of natural ecosystems within the private property and its acknowledgement as a productive element of the landscape.

In Georgia (USA), a state of the size of Acre, collaboration between forestry companies of the agrobusiness and environmental organizations, recently concluded a study that estimated in US$37 billion annually the value of the environmental services to the climate and to the environment, exported from PPAs of forests in private lands (MOORE et al., 2011). How much then would the environmental services of the natural areas in private lands in Brazil be worth?

A paleontological study (HECKENBERGER et al., 2008) revealed that pre-Colombian societies which habitated the Xingu river region in the Amazonia reached high levels of urbanization, with elevated environmental manipulation which included agriculture, roads and dams, without however, generating large deforestations.

The same region in Mato Grosso demonstrates today that the destruction of PPAs and LRs in rural properties had terrible consequences. On the other hand, there are also projects in that state which unite farmers and environmentalists who are recovering part of the environmental liabilities of PPAs and LRs in the headwaters of the Xingu river, with the utilization of cutting-edge technology, modest and accessible investments and with good perspectives of financial returns for the aggregation of environmental services to the mix of products of those properties (Globo Rural video, “Muvuca” technique accelerates reforestation in the headwaters of the Xingu river). Such examples show concrete actions to contain and mitigate environmental changes, in a viable and profitable way.

1.4.1.4. Potential physical impacts of the elimination of PPAs of hilltops and slopes

Just like for other PPAs and LRs, the PPAs of hilltops and slopes compose areas of protection for the natural vegetation within the properties with all the environmental services and benefits previously listed. With yet two additional unique characteristics with regards to the partitioning of the water flows: the presence of the protective vegetation in these circumstances increases the structuring of the soil, and with that, the permeability, which results in a greater damping of inflow and in infiltration of water. This leads to a slow recharge of aquifers.

With a greater vertical infiltration at the top of the hill, less water will drain from the surface along the downstream slopes, increasing its stability. Both one effect as the other are important for the geological integrity of the slopes. The landslides on the valley of the Itajaí river in 2008 and on the mountainous region of Rio de Janeiro in 2011, have an important connection, but not exclusive, to the state of conservation of the natural vegetation on the hilltops and on the slopes and even on the foothills. The specificity of the fragility of these areas to excess water results in the combination of various heterogeneous factors, like those linked to geology, geomorphology and to the soil, not all of them expected or addressed by the forest legislation

The implementation of the Forest Code involves the incorporation of a few definitions which are liable to be questioned due to their lack of clarity with regards to their meanings and/or due to the difficulty in its implementation in the field. The term “top”, for example, refers to a portion of the relief which would be located 2/3 from its minimum distance from the bottom of the slope. It is worth mentioning that, aside from the difficulty in defining the position of the bottom of the slope (which can vary according to the topographical representation scale of the referred area or even field), one should consider that the limit superior to 2/3 rising from the foothill of the slope can be at a variable distance from the ridge zone in the case of the strands of asymmetric interfluves, for example. Despite the existence of elaborate topographical analysis to supply mathematical support.

to the descriptions of hilltops (for example CORTIZO, 2007),the semantic difficulty of laws and its regulations remain. aos descritivos de topo de morro (por exemplo CORTIZO, 2007), permanece a dificuldade semântica da lei e de suas regulamentações.

The lack of clarity, as well as the ambiguity of interpretations of the guiding terms of the legislation tends to make terms vulnerable in their interpretation and implementation, neglecting its crucial importance as a guide for land planning and management. Yet, despite its conceptual fragility, one cannot deny the importance of considering the potentials and the limitation of land use in any position of a relief on the land surface.

Although the definition of the top of the hill is an issue with some controversy, the fragilities and the potentialities of the soils can be accurately mapped with new technical means. This would allow us to evolve in the generic field of the not at all accurate geomorphologic definition and go on to a new accurate quantitative parameter of describing use potential versus fragilities and risks. As an example, a new model of land the uses a normalization of the landscape with regards to the drainage system (NOBRE et al., 2011a) has shown great capacity in indicating the depth of the water table, an important parameter in the definition of the relative fragilities of the soil (see Attachment I).

Extensive tests performed for varied terrains in Brazil revealed great strength for this terrain model (HAND), surprising with the indication of terrain and of the water table, for its independence form geology, of geomorphology and of the soils. In other words, with such a terrain model, it is possible to map in the landscape the fragile areas which need to be protected, using only the remote images of topography as its raw material. It is therefore, a clear example of innovative approach in the scientific and technological point of view, already available and which can be used at a low cost, relatively fast, in the improvement of the environmental legislation, particularly for the protection of fragile terrain in difficult topographical conditions.

1.4.2. Economic benefits associated to the Permanent Preservation Area and Legal Reserves in the rural property

The economic use of the Permanent Preservation Areas and of the Legal Reserves in the rural property have some peculiarities strictly related to its use, as defined in the environmental legislation, specifically in Law 4.771/65 and Provisional Measure 2166-67/2001 and in the CONAMA \Resolutions (2002, 2006). The allocations referred to both areas are complementary.

The Legal reserve is for the sustainable use of natural resources, for the conservation and rehabilitation of the ecological processes, for the conservation of biodiversity and for the shelter and protection of native fauna and flora; the Permanent Preservation Areas, on the other hand are for preserving the water resources, the landscape, the geological stability, the biodiversity, the gene flow of fauna and flora, aside from protecting the soil and guaranteeing the well being of the human populations.

While in the Legal Reserve areas, the sustainable use of natural resources is allowed (with the exception of clear cutting) – regardless of the dimensions and characteristics of the rural property - , in the Permanent Preservation Areas, the economic and sustainable use of natural resources is conditioned and allowed only in agroforestry systems in small properties or in rural family possessions, in which such a use is considered to be of social interest (CONAMA, 2006).

Additional to the concessions given to small properties or rural family possession for the use of Permanent Preservation Areas, there is yet another, which refers to the compliance of the maintenance or compensation of the legal reserve area in the property, where one can add to the calculation of the computation the areas planted with ornamental or industrial fruit trees composed by exotic species, harvested in intercropping systems or in consortium with native species (Law 4.771/65, Art. 16 § 3).

The use of Legal Reserves, despite having been poorly explored in terms of research, has an enormous economic potential. The examples with the greatest volume of data available for the economic use of Legal Reserves refers to the sustainable use of the remnant Amazon Forest, in the so called Sustainable Forest Management for multiple use.

The economic use of the remnant forests in intensely anthropized landscapes is still an issue of controversy, given the impact of this management on biodiversity and due to the importance of these fragments in the conservation of remnant biodiversity (METZGER et al., 2010). Yet, areas of low agricultural suitability, which were historically used inadequately by agricultural activities, can be restored with native forests for the production of timber, for medicinal purposes, for honey, for the production of native and ornamental fruit trees etc. Undoubtedly these plantations allow for a superior economic return than the current one, mainly due to the current agricultural use with no technology and especially due to livestock with low occupation capacity (RODRIGUES et al., 2009, SPAROVEK et al., 2010).

1.5. SITUATION OF RISKS IN URBAN AREAS

With regards to the PPAs along or around bodies of water in areas with steep slopes, the empirical observation, supported by scientific studies (ACKERMAN, 2010; AUGUSTO FILHO, 2001; FARAH, 2003; RODRIGUES e LEITÃO FILHO, 2000; ZUCCO et al., 2011), indicates that parameters for urban areas and human occupations should be established, in a way to avoid natural disasters and preserve life. As a general principle, all the valleys of headwater drainage should be targets of severe restrictions of usage and should be prioritized as areas of biodiversity reserve, of water storage and of slope stabilization.

The recent disasters driven by the heavy rain falls in the mountainous region of the State of Rio de Janeiro corroborate this assumption since, among the hundreds of landslides mapped by GEOHECO-IGEO/UFRJ in the municipality of Friburgo (COELHO NETTO et al., 2011), more than 50% occurred on the superior portions of the slopes, including what would be classified as the top of the hills or ridge area.

These studies also indicate that the landslide scars where largely associated to areas covered by graminoid vegetation, aside from the formation of shrublands and degraded forests. In view of the extreme nature of the rains which caused the runoffs, the areas with more conserved forests were also affected, a natural process of the landscape metabolism of rugged mountainous terrain. However, the scale of occurrence in this case shows the amplifying effect of vegetation degradation on the frequency of such events.

Previous studies on the Maciço da Tijuca (COELHO NETTO et al., 2007; OLIVEIRA et al., 1996) had already indicated that, among the more than 100 runoffs on the mountainous slope of Jacarepaguá, only 14% occurred in the areas of conserved forests, while 43% occurred in the areas with graminoids and 42% in areas with degraded forests.

Still in comparison with the previous studies, it is worth mentioning that the rains of 1996 were just as intense as the recent rains in the mountainous regions of Rio de Janeiro, however in the first case, they were only located over the hilltops and ridge areas, whereas in the most recent disasters they extended over a greater area.

The events here mentioned indicate that, if on one hand the slopes surpassed their respective threshold limits of resistance due to the high intensity of the destructive rains, on the other, it became evident that the presence and the conservation of the Atlantic forest on the slopes of mountainous terrain, largely promotes the mitigation of the disastrous effects of situation of extreme rainfall. The studies show therefore that the conservation and the functional rehabilitation of the forests in the hilltops and ridge areas should be considered a priority.

1.5.1. Protection against floods and flooding

In urban areas, the occupation of wetlands and natural flood plains of waterways and of the areas around the lakes and natural and artificial ponds has been one of the main causes of natural disaster, causing death, morbidity in hundreds to thousands of victims every year, major economic losses in infrastructure, houses, buildings etc. The floods are greatly amplified due to the impermeabilization of urban areas.

Usually, in the case of natural disasters, the poorer populations are the most vulnerable and affected. This justifies maintaining natural vegetation in most of the wetlands in the form of PPA in urban areas or, more generically, areas destined for human occupation, to serve as a natural screens for floods and flooding of the waterways and natural and artificial lakes and ponds. They would therefore work as of buffering and dampening of waters zones when the river beds overflow.

Due to the enormous variation of the lengths of floodplains for the different reliefs and hydrological regimes, a fixed strip based on the width of the waterways would be less effective. For urban areas, the riparian PPAs should cover a reasonable limit of the flood plain – defined hydrologically by the flood with a recurrence period of 100 years. One should therefore, seek to define a small area, so-called passage of the flood, as one which should not be occupied.

This zone has a technical criterion of definition which depends upon the hydraulic and hydrological conditions of the place. The passage strip can, for example, represent the limit reached by floods in a recurrence period of 10 and 20 years, resulting in being small or large, depending on the topography. Defining such a parameter requires knowledge about the hydraulic and hydrologic regime of the waterway, of the natural or artificial lake or pond and of the topography of the floodplain.

However, it is probable that this knowledge exists for waterways which go through urban areas. For rivers with dams to prevent floods, where these do not occur, the parameters for PPAs would be the same as those for non-urban areas, as well as for the cases in which the topography causes the flood passage strip to be smaller that the limits of PPA for non-urban areas.

1.5.2. Protection against landslides and mudslides in slopes

In urban areas destined to human occupation, the maximum acceptable level for the use of slopes for houses, buildings or similar uses of human settlement, should be one in which the landslides and mudslides is minimized. In general terms, the risk becomes very high for slopes above 25 degrees in hillside areas of Brazilian cities, although there are other geological parameters which control the susceptibility of these types of natural disasters.

In areas which necessarily will lose their natural vegetation due to occupation, slopes above this limit represent a great risk of suffering repeated processes of landslides in hillsides, as has been the case in the country, year after year, resulting in hundreds to millions of deaths and victims.

Thus, the slope limits determined for the rural areas where the hillsides host agricultural or livestock activities are not valid for human occupation in urban areas. Following the same logic, areas of hilltop close to steep slopes should remain with natural vegetation due to the risks of landslides and mudslides.

2. CONTRIBUTIONS FOR THE IMPROVEMENT OF THE LEGISLATION: CASE STUDIES

Based on the scientific knowledge considered in this study, as a preliminary methodological exercise, and to serve as an example, some provisions of the current Forest Code and of the proposed substitute bills were analyzed, at this moment without proposals of new provisions. The following subjects were elected based on their relevance in terms of spatial, environmental and social scope:

a) the environmental legislation in urban areas;

b) the proposal of alteration of the width of PPA for the rivers of up to 10 meters of width;

c) the proposal of incorporating the PPAs in the computation of LR;

d) the compensation for LR out of the rural property (in the micro basin or in the biome).

Summary

The analysis showed evidence that the current Forest Code needs to be improved. Great advances can be introduced in the legal framework by adopting a process of solidary construction of the productive activities and the use of the spaces, in order to comply with the environmental legislation, and even with measures of encouragement and incentives.

This enhancement would allow for the overcoming of outdated perceptions – such as the unfounded conflict between agricultural production and conservation of natural resources – by means of the creation of new collaborative concepts among all the human activities which generate in its synergy, productive and sustainable landscapes. The revision of the law shall also incorporate the socioeconomic evolution, always founded on dialogue, on science and on equity.

2.1. THE ENVIRONMENTAL LEGISLATION IN URBAN AREAS

With regards to the Permanent Preservation Areas (PPAs) in urban areas, we mention Paragraph 3 of Art. 4 of the Substitute bill below, followed by a similar text of the current Forest Code.

Substitute bill:

> Paragraph *3: In the case of urban areas consolidated in the terms of the Law number 11.977, of July 7th, 2009, alteration to the limits of the Permanent Preservation Areas shall be provided for in the master plans or in the bylaws of soil use, respecting the principles and the limits to which this article refers. (Emphasis added).*

Current Forest Code:

> *Sole Paragraph*: *In the case of urban areas, those understood as being in the urban perimeters defined by the municipal law, and in the metropolitan regions and urban agglomerations, in the whole territory, will observe the provisions in the respective master plans and laws of soil use, <u>respecting the principles and the limits to which this article refers.</u> (Included by Law number 7.803 of July 18th, 1989) (Emphasis added).*

Both, in the current Forest Code as in the Substitute bill, unless the master plans and the bylaws establish more rigorous parameters for the urban areas, the same principles and limits established for the rural areas apply. The underlying logic is that, for urban areas, the same principles of the other areas should apply, in order to protect the soil, the water resources and the biodiversity.

One cannot ignore the importance of the current restriction of use and of human occupation provided in the current Forest Code, especially in the hillsides of mountainous regions, where mass movement tends to initiate on the superior portions of the hillsides, both ion what is considered the hilltops as well as on the ridges.

However, for urban areas and for human occupation in general, the principle of protecting life should rank with prominence and with equal hierarchical to the other guiding principles enshrined in the Forest Code. The best way of protecting life is to avoid the occupation of areas of risk of natural disasters, especially those resulting from floods, flooding in areas of wetlands and landslides and mudslides in slopes.

The Forest Code should therefore establish different principles and minimum limits for urban areas without consolidated occupation, since the master plans of soil use would deal with the areas of risks with consolidated occupation or would determine more rigorous limits in the parameters of riparian PPAs, in hillsides or hilltops.

Conclusion

By means of the creation of PPAs in urban areas, new corridors and green areas would be established along the rivers, lakes and ponds, and green steep hillsides, increase the usually extremely low level of green areas in the Brazilian cities. This would bring additional benefits, such as the decrease of impermeabilization, erosion and siltation, mitigation of the maximum temperatures and the minimum air humidity, increasing the thermal comfort of the population and reducing air pollution.

2.2. ALTERATION OF THE EDGE OF REFERENCE AND THE WIDTH OF RIPARIAN PPAs

The Substitute bill alters the width of the PPA for rivers of up to 5m width, reducing width from 30m to 15m, maintaining the width of 30m for the rivers between 5 to 10m width and the other measurements for bigger rives remains the same to that established in the current code.

Current Code

Art. 2 Are considered of permanent preservation, by effect of this Law, the forests and the other forms of natural vegetation located:

a) – along the river or of any waterway, from its highest level in marginal strip, whose width is (Wording by Law number 7.803 of July 18th, 1989):

1 – of 30 (thirty) meters for the waterways with less than 10 (ten) meters in width (Wording by Law 7.803 of July 18th, 1989);

Substitute bill

Art. 4. Are considered Areas of Permanent Preservation Areas, in rural or urban zones, by effect of this Law:

I – the marginal strips of any natural waterway, from the lower edge of the bed, in a minimum width of:

a) 15 (fifteen) meters for waterways of less than 5(five) meters in width;

b) 30 (thirty) meters for waterways which have from 5 (five) to 10 (ten) meters in width;

CONSIDERATIONS

The soil and the vegetation in the catchment areas of rivers and lakes are systems of major importance in the conditioning of flows, in the regulation of mineral nutrients and in the conditioning of water quality, in the shelter of biodiversity, with its provision of environmental service and in the maintenance of channels. There is scientific consensus that these strips need to be maintained as close as possible to their natural state.

These are also areas susceptible to water depth coverage with sediment deposition during the flood tides and erosion with removal of sediments during ebb tides. The continuous presence of water saturating the soil has several physical, chemical and biological implications. Such soils, when covered by dense vegetation, favor the deposition o layers of organic material or the export of dissolved carbon which will end up at the bottom of the sea, both extremely important sinks for the atmospheric carbon sequestrated by the vegetation. When deforested, they cease to sequestrate carbon. With its progressive drainage, they become susceptible to rapid releases of great volumes of carbon dioxide in the atmosphere.

The soils of the riparian strip are especially susceptible to erosion due to its physical characteristics and the elevated energy contained in this strip, which becomes even more critical due to the extensive catchment area on the upstream slopes.

Both, the physical erosion of particulates, as the chemical erosion of dissolved compounds generate contaminants which compromise water quality, aside from promoting siltation of canals and lakes. The key factor for its stability and functionality lies in the natural vegetation working in the protection of theses fragile environments.

When mature natural ecosystems border the bodies of water and cover the terrain saturated with associated humidity, the carbon and the sediments are laid down, the excess water is contained, the erosive energy of currents is dissipated, the flux of nutrients in the percolation waters undergo a chemical filtering and a microbiological processing, which reduces its turbidity and increases its purity.

The importance of riparian forests was scientifically proven in different Brazilian biomes and for different groups of organisms. The majority of the studies were conducted in the Atlantic Forest, but there are also data for Amazonia, Caatinga, Pantanal and the Cerrado. With regards to the taxonomic groups, there is data for trees, amphibians, birds, large mammals, small mammals and bees. There is no doubt that, regardless of the biome or of the studied taxonomic group, the entire landscape should maintain riparian corridors, due to their benefits for the conservation of the species.

The benefits of the riparian corridors can be related to width, extension, continuity and quality of the corridors, to the topography and width of the riparian areas of influence, among other factors. But without a doubt, the width of these corridors is the most important factor.

Studies which considered the biological functionality of the corridor with regards to the width, indicate the minimum values superior to 100m. In the Amazonia, widths of 140 to 400m were necessary for there to be a certain similarity among the fauna communities (small mammals, amphibians, birds and mammals). There is a large number of semi aquatic mammals, like the giant otter and the otter, which depend on the riparian forest, aside from several endangered species of birds, butterflies and fish that live exclusively in these areas.

In Amazonian rivers, leachate of leaves from adjacent vegetations inhibits microbial growth, in turn it restricts the occurrence of mosquitoes whose larvae feed on these bacteria, causing direct implications on public health. Many other species use these strips as dispersal corridors across the landscape, which make them important elements in the connection between fragments of remnant forests in the regions altered by activity or human occupation.

Alteration to the edge of reference proposed in the substitute bill

The allocation of the riparian protection strip, set as of its highest water margin (FC) or its lowest edge of the bed (substitute bill), use varying levels of water as their base to allocate geographically defined strips (temporally fixed), a problem common to both approaches. The area within the highest margin of water and the lower edge of the bed includes the wetlands, the flooded forests, the mangroves and other floodplain ecosystems, which constitutes the oscillating parts of the water bodies.

Scientifically, the riparian forests located beyond the highest water margins cannot be considered separately from the perennial water bodies, defined by the lower edge of the bed, because functionally, among other reasons, the wetlands in between present the edaphic condition typical of a surface water table, even in the periods of low tide.

Vast regions undergo periodic floods (in the Amazon, a study estimated a total of 11.9% of wetlands), and these areas are presently protected by the current FC, according to predominant interpretation, where its inclusion is implicit in the definition of water bodies. With the transposition by the substitute bill of the riparian strips from the highest water margin to the lower edge of the bed, the wetlands would lose in the Amazonia up to 60% of its protection.

This change of margin of the substitute bill hides a serious aggravation: the riparian strips of the current FC do not overlap with the wetland marginal strips proposed by the substitute bill, which implies in the elimination of a great part of the area defined in the current FC as a protected area. The loss of protection of 60% of the wetlands and the disappearance of riparian PPAs indicate the significant impact proposed by the alteration

Reduction of the riparian strip proposed in the substitute bill

The first-order rivers, of up to 5 m in width, compose more than 50% in extension of the drainage network. The proposal of the substitute bill of reducing the riparian strip from 30 to 15 m in these rivers, results in a 31% gross reduction in protected area in comparison to the current code.

According to a study done in INPE covering more than 300 thousand km^2 in four region of Brazil (NOBRE et al., 2011b), on average, 17% of the land in private areas are hydromorphic soils, with surface water table. The riparian strips of riparian areas defined as PPA by the current Forest Code protect less than 7% of these areas. 60% of the fragile hydromorphic soils remain, without protection.

The scientific knowledge accumulated up until now indicates that the maintenance of the ecological corridors (riparian forests) of 60m of width (30m on each side of the river), as per the current legislation, already denoted a very limited capacity of maintenance of biodiversity, which could reach values of 50% of the remnant diversity. As such, the reduction of diversity is expected if the width of the riparian corridors is changed to half its value (15m) in the rivers of up to 5m, as proposed by the substitute bill. Therefore, the reduction of this protection strip might have an enormous impact on biodiversity, seeing that these rivers present a great part of the Brazilian hydrographic network and contains a unique fauna.

Studies on anurans (frogs and toads) in the Atlantic Forest indicate that 50% of the species are concentrated in the streams less that 5m wide. Just on the last list of endangered species of the state of São Paulo, of the 66 species of fish classified in some level of threat, 45 shows a high fidelity to streams and, therefore, is dependent on the quality of the surrounding and internal habitat. In addition, a great portion of these streams is already highly degraded, with its margins being frequently occupied by pastures, without any remnant riparian forest.

In these conditions, the rivers tend to become biologically impoverished, dominated by few species, with a high abundance of exotic species and with a lower biomass of fish and other organisms.

Conclusion

The Forest Code contains minimum values of protection, still insufficient to protect the riparian zones in a scientifically substantiated way. The scientific knowledge obtained over the last years allows for us to not only sustain the values indicated in the current Forest Code, with regards to the extension of the PPAs, but also indicate the need in several riparian situation for the expansion of these values to a minimum thresholds of at least 100m (50m on each side of the river), regardless of the biome, the taxonomic group, the soil or the type of topography.

2.3. INCORPORATE THE PPAS IN THE COMPUTATION OF LR

Current Code

Art. 16. The forests and other forms of vegetation, except those situated in permanent preservation areas, as well as those not subject to the regime of limited use or object of a specific legislation, are susceptible to being removal, unless they are kept at least as a legal reserve:

Paragraph 6: It shall be admitted, by the competent environmental agency, the computation of the areas of existing native vegetation in the permanent preservation area in the calculation of the percentage of legal reserve, as long as it does not imply in the conversion of new areas for the alternative use of the soil, and when the sum of the native vegetation in the permanent preservation area and the legal reserve exceed:

I – eighty percent of the rural property located in the Amazonia Legal;

II – fifty percent of the rural property located in other regions of the country; and

III – twenty five percent of the small property defined by the subparagraphs b and c of item I of Paragraph 2 of article 1.

b) fifty hectares, if located in the drought polygon or to the east of the 44th meridian W, of the state of Maranhão; and

c) thirty hectares if located in any other region of the country.

Substitute bill

Art.15. It shall be admitted, the computation of the permanent preservation area in the calculation of the percentage of legal reserve in the property as long as:

I – the benefit provided in this article does not imply in the conversion of new areas for the alternative use of the soil;

II – the area to be calculated is conserved or in the process of recuperation, according to statement from the owner to the state agency or local member of Sisnama; and

III – the owner or possessor has requested the inclusion of the property in the environmental registry, under the terms of art. 24.

Paragraph 1 The protection regime of the Permanent Preservation Areas is not altered in the hypothesis provided in this article.

Paragraph 2. The owner or possessor of property with preserved and annoted Legal Reserve, whose area exceeds the minimum required by this Law, may establish easement over the exceeding area, under the terms of art 9-A of Law 6.938, of August 31st, 1981.

CONSIDERATIONS

The scientific substantiation for LRs is the fact that, before the existence of a property, there was once a natural landscape there. Thus, upon recognizing the importance of a source of raw materials, especially timber, within the property, the State proposed the maintenance of a specific portion of the total area of the property to satisfy local needs.

Today, however, the realization that the vegetation which composes the LR also fulfills other relevant functions other than that of being for use, is widely established. The historical origins and the basis behind stipulating forest properties as reserves can be seen in Ahrens (2007). The substitute bill, as a proposal for discussion, keeps the requirement of maintaining a LR in each rural property, but exempts however, properties with up to four fiscal modules from this requirement.

The current Forest Code, in its Art. 16, Paragraph 6, accepts the possibility of uniting the PPAs with the LR areas in its computation of LR, subsequently adding up the percentage area to the total area of a rural property. Such possibility however, constitutes an exception to the general rule. The substitute bill, on the other hand, in its Art 15, contemplates that possibility as a new general rule although conditioned to observing a few pre-requisites, maintaining the fixed percentages established in Art. 13, even in this hypothesis. One notes that the proposal present in the substitute bill is unfounded.

Note that the PPAs and the LR were legally instituted to fulfill different, although complementary, socioeconomic functions. In this regard, Ahrens (2010) examines the organic structure of the current Forest Code and suggests that its foundations be further assessed. The PPAs result from the occurrence of certain geographical features, within the rural property, like the presence of springs, waterways, lakes, terrain with slopes superior to 45º, hills and mountains, as well as the soils, the waters and the biodiversity.

On the other hand, the conservation of the vegetation which composes the LR emerged from a legal imposition. Aside from enabling the sustainable use of the vegetation, the LR complements the PPAs, such as in the recharge of springs and in the conservation of biodiversity (indispensible to allow for the pollination of several species used in agriculture). In both cases, the one who benefits the most from the conservation of vegetation is the owner of farmer himself.

Additionally, the substitute bill does not contemplate the rural family property itself, as stated in the Brazilian legal territorial planning, it just defines small rural properties as one with a total area of up to four fiscal modules.

With that said, one omits in the proposed definition, the requisites which characterize the intrinsic nature of a rural family property, such as the need for the family to reside on the property, to work the land predominantly with family human resource and that it is their only property. The presence of these characteristics - and not only the areas of plots – is what constitutes the basis to justify a differentiated approach in the legislation.

Based on what was said, it becomes evident that the proposed hypothesis proposed in the substitute bill should be further analyzed and debated in order to concretely constitute an advance or an improvement.

2.4. COMPENSATION OF LR OUT OF THE RURAL PROPERTY IN THE WATERSHED OR IN THE BIOME

The proposal in the substitute bill creates new possibilities of compensation of LR, in the form of purchase of quotas of environmental reserve, of lease areas bonded under forests, or by donation to the government of areas within the protected areas. The biggest problem is that this compensation will be allowed to be done in any place within the same biome.

Current Code

Art. 44. The owner or possessor of a rural property with an area of native, natural, primitive or renegated forest or any other form of native vegetation, with extension inferior to that established in items I, II, III, and IV of Article 16, except as provided in its Paragraph 5 and 6, shall adopt the following alternatives, isolated or together:

III – compensate the legal reserve for another area equivalent in ecological importance and extension, as long as it belongs to the same ecosystem and is located in the same micro basin, as per criteria established by regulation.

Paragraph 1. In the recomposition of that stated in item I, the competent state environmental agency shall technically support the small property or rural family property.

Paragraph 2.The recomposition of that stated in item I can be done by means of temporary planting of exotic species as pioneers, aiming towards the restoration of the original ecosystem, in accordance to general technical criteria established by CONAMA.

Paragraph 3. The regeneration referred to in Item II shall be authorized by the competent state environmental agency when its viability is proven by means of a technical report, in which the isolation of the area may be required.

Paragraph 4. In the impossibility of compensation of legal reserve within the same hydrographic micro basin, the competent state environmental agency shall use the criterion of greatest possible proximity between the property devoid of legal reserve and the area chosen for compensation, as long as it is in the same hydrographic basin and in the same state, in compliance to the Hydrographic Basin plan, if there is one, and respecting the other conditions set forth in Item III.

Paragraph 5. The compensation referred to in Item III of this article, shall be submitted for approval by the competent state environmental agency, and may be implemented by means of lease of the area bonded under forests or legal reserve, or by means of purchasing of quotas referred to in article 44B.

Paragraph 6. The rural property owner may be released from the obligations set forth in this article, for a period of 30 years, by means of donation, to the competent environmental agency, of any area located in a National or State Park, National Forest, Extractive Reserve, Biological Reserve or Ecological Station pending land settlement regularization, in accordance to the criterion set forth in Item III of this article.

Substitute bill

Article 26. The owner or possessor of a rural property with Legal Reserve inferior in extension to that stipulated in Article 13 will be able to regularize their situation, regardless of their adherence to the Program for the Environment, by adopting the following alternatives, isolated or together:

I – recompose the Legal Reserve;

II – allow for the natural regeneration of the vegetation in the Legal Reserve area;

III – compensate for the Legal Reserve.

Paragraph 5. The compensation mentioned in the caput can be made by means of:

I – acquisition of Environmental Reserve Quota (CRA);

II – leasing of areas bonded under forests or legal Reserves equivalent in ecological importance and extension, in the same biome, in accordance to the criterion established by regulation; or

III – donation to the government, of any area located within the in Conservation units of the integral protection group pending land settlement regularization, or contribution to a public fund which has this purpose, in accordance to the criterion established by regulation.

CONSIDERATIONS

As per the proposal presented in the substitute bill, an owner from the interior of São Paulo who should conserve a LR of Seasonal Semideciduos Forest can compensate the irregular destruction of this LR by purchasing an area of Tropical Rain Forest in the Serra do Mar, or even a forest area in Pernambuco.

In the two examples, the forests are not equivalent, since they are situated in very different environmental and climatic conditions, with very different vegetations and ecosystems, which do not compare. This new legal provision ignores that the forests and the other Brazilian vegetation formations are heterogeneous, being the result of complex biogeography processes, which is precisely the reason why these areas should be recognized internationally for their high biodiversity.

The majority of the species have a limited geographic distribution within each biome, whether it's in endemism centers or biogeographic zones, or in different physiognomies. Compensation areas not adjacent or in different phytoecological regions are not suitable to conserve the species of the lost region.

In addition, the possibility of compensation of LR by means of donation to the government of an area located within the Conservation Unit distorts the function of the LR and transfers to the owner a responsibility which belongs to the State: the maintenance of biodiversity in the Conservation Unit under their responsibility.

The compensation should be done only in areas ecologically equivalent, considering not only the endemism areas, but also the different composition of species and structures of the ecosystems which occur within the subdivisions of each large Brazilian biome.

Even so, it is important to note that any compensation of loss of LR of one region, with one of another region does not restore the ecosystem services which the lost LR rendered to its original area, nor does it impede progressive environmental degradation which results from such a loss.

In Brazil, the studies on ecosystem services of LR in a rural property are still in their initial phases, yet there is evidence already of an increase in agricultural production due to the services of biotic pollination. But the forest areas need to be close to the landscape in order for these ecosystem services to be efficient.

Importance of fragments in regional landscape

Aside from the biological issues and the ecosystem services, small fragments of native vegetation, kept as LR in the same micro basin or basin have an important role in the isolation of the few bigger fragments, working as ecological trampolines in the moving of species through the landscape. Without these fragments, the biological fluxes would be greatly harmed, accelerating even more the process of extinction.

In regions with high human occupation, the small fragments (<100 ha) represent a considerable portion of what is left over. In the case of the Atlantic Forest, the small fragments represent 90% of what is left and 30% of the total area of remnant forest. Although small, such fragments represent relevant areas and render important service to mankind and the species which live there, especially if they are planned spatially, considering the parameter of the regional landscape.

Environmental and agricultural planning in the regional landscape

Many scientific data indicate the existence of a significant percentage of areas of low agricultural suitability and high forest suitability in landscapes of several Brazilian regions. Due to its condition of low agricultural suitability, a part of these areas was kept with its natural cover which can and should be use in the compensation of LR of regions of higher agricultural suitability within the micro basin or basin, thereby defining a very effective legal and available instrument for the protection of these natural remnants.

Aside from enabling an economic profit for the owners, these areas would already be compensating a deficit of LR in the regions with elevated agricultural suitability. However, many of these areas historically and inadequately were reversed for agricultural activities and are today used marginally with production activities of low technology, which consequently renders very low economic profit.

These areas could be reverted into production forests, using native species, within the principles defined by the LR, not only allowing for the compliance of the Forest Code, but also using the LR compensation mechanisms available today, and with such would render a significant amount of economic profit for the owners.

Pastures in areas of steep slopes in the mountainous regions are examples of marginal agricultural areas. In the Atlantic forest, the pastures with slopes between 25º and 45º total more than 6 million hectares and could be reverted to production forests, being that the deficit of LR in the Atlantic forest domain is less than 3 million of ha.

Conclusion

Thus, it is clear that the permission to compensate a LR in the biome and not the micro basin or basin as proposed by the substitute bill, certainly demands for a greater scientific knowledge to sustain the definition of the adequate parameters for the standardization of this permission, aiming towards guaranteeing that this compensation ensures at least that they meet the same benefits promoted by the maintenance of a native vegetation cover in the micro basin or basin.

Based on the knowledge available, the most pertinent recommendation is to advise that the compensation of the LR be done in the closest possible way to the area with deficit, considering its own micro basin or even close by micro basins or basin, but with an ecologically equivalence, and not indistinctively allow for a compensation in the biome, without any clearly defined mechanism to ensure the ecological and even the economical aspects of this compensation.

3. PROPOSAL OF FUTURE REFERRALS

SBPC and ABC wish to continue contributing towards the improvement of the Forest Code, offering scientific and technological subsidies for a broader dialogue. The critical revision of the themes discussed in the Forest Code should also be done in light of science and the most advanced technologies, in a careful prospection of the virtues and of the problems of the current law in force, for it is necessary to advance in the environmental legislation and in Brazilian agriculture.

In item 2, a first exercise was developed in this type of analysis, demonstrating based on the scientific knowledge available, which are the pros and the cons of the current law and of one of the proposed alterations, trying to advance with predictions for the improvement of the law.

Brazil is the country that hosts the largest number of species of plants, animals and microorganisms of the world. This represents an enormous difference in natural capital, strategic for the country´s socioeconomic development, which needs to be preserved and utilized in a sustainable way. At the same time, technological innovation is at the root of the success of Brazilian tropical agriculture and is the most powerful asset for qualifying countries in the global market.

It would e desirable that in the improvement of the Forest Code, a new public policy could encourage the concept of intelligent and fair territorial organization, as a result of careful and informed planning of the landscape. The elaboration of a new Forest Code, further improved, would derive from a few basic premises considered essential for the consolidation of a sustainable environmental policy, such as:

A) It shall be based on a participatory construction, of consensus, with consultancy of all sectors directly involved in the subject. No sector of the rural or urban area shall be unilaterally privileged in these alterations, but undoubtedly the family property needs special attention, in view of their social and economic particularities. All the sectors should be able to have a saying and influence the decisions on the proposed alterations.

B) All the suggested proposals shall be made based on a scientific knowledge of the specific subject. In the event that the required knowledge to support some of these proposals is still controversy, or not available, they would be placed as pending scientific support, for future revision, and included in a program of fulfillment of knowledge gaps, fostered by public funding institutions.

C) Shall be grounded in a plural and purposeful vision, which integrates the rural area with the urban area, respecting the environmental particularities of each biome, within the concept of territorial planning and landscape planning, utilizing for this, the most current and advanced resources of imaging and computational modeling of land;

D) It shall be based on the integrated vision of the rural property, within the perspectives of its environmental adequacy, considering the areas of agricultural productivity, the areas of preservation and areas of mixed use, incorporating for these, all the possibilities of Payment for Environmental Services (PSA);

E) The technological appropriateness in the occupation of agricultural areas shall be made based on its suitability, aiming towards potentializing productivity with the lowest environmental impact possible, respecting all the local limitations and particularities of these production systems, including the cultural ones. The objective expressed in this theme, which appears to be palatable to all involved, is to introduce a new technological intelligence in the landscape and improve justice in optimizing the uses to increase production without threat to sustainability[1].

F) The main concept shall be that of the construction of an environmental legislation which stimulates good practices and guarantees a future, one which provides for, as a public policy, the construction of rural landscapes with social, environmental and economic sustainability.

G) In the urban areas it shall establish principles and differentiated limits for the areas with no consolidated human occupancy, while the municipal master plans for land use would address the areas of risk with consolidated occupation.

[1] This adaptation of the agricultural area shall result in the provision of areas of lower agricultural suitability in the rural property or in the regional landscape. These areas will be able to be reoccupied with native vegetation. This concept will consider the possibility of compensation of Legal Reserve deficit outside the rural property, following the reestablishment of the connectivity of the remnant fragments of the respective property, thus creating an efficient mechanism of protection of the natural remnants of the regional landscape. Despite the current low agricultural suitability, these areas were at some point of the history of the Brazilian agricultural occupation, transformed into production areas, but usually of low economic return due to its low technological level, and could be reconverted to its natural formations. But this conversion needs to have an economic component. The proposal would be to restore natural formations capable of sustainable management, as permitted today for the Legal Reserves, enabling a superior economic income than those of areas occupied with poorly technified agriculture. Additional benefits would be the sustainable use of the natural products such as timber, phytochemicals, ornamental plants, native fruits etc. and other Ecosystem services – such as the sequestration of carbon or the maintenance of terrestrial carbon stocks, protection and production of water, habitat for pollinators etc. – encouraged by annual compensation taxes paid by the property of the region with elevated agricultural suitability and most probably with a deficit of Legal Reserve.

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ATTACHEMENT 1

New Geospatial Technologies
to support Land Management

Summary

Tridimensional images of Earth, generated by advanced technologies like the radar or the laser allow for the construction of virtual models of the landscape which can easily be analyzed in computers. Combining into mathematical models, the diagnostic and quantitative functional knowledge of geology, geomorphology, soils and hydrology, it is possible to identify and accurately map the potential use, the fragilities and the risks of each property on the landscape.

The cross analysis of the maps indicating potentials and fragilities with the maps on uses and land cover of the terrain allows us to evaluate the different levels of sustainable use, if the use is adequate and where it can be improved. It also allows us to plan for an objective use of the soil, substantiated by the functional specifications of the terrain.

As already occurs with the prediction of the weather, the high resolution mapping of the entire territory can also be made transparent and placed at the disposal of society via the internet. In the dialogue about the Forest Code, the availability of new accurate and verifiable diagnostic maps offers an unprecedented potential of simplifying the definition of areas for production, for conservation and for environmental recuperation.

With these new technologies – many of which were developed in Brazil **-** , it will be possible to build a new era of soil use based on intelligence, justice and responsibility, with regards to the potentials and limits of nature.

Introduction

The territorial organization of the 21st century can already count on powerful technological tools of terrain diagnosis and spacial distribution of the potential use and of environmental risks. Sophisticated techniques of aerial or orbital remote sensing have been extensively used to describe and quantify properties on Earth´s surface. The majority of these techniques makes use of the spectral signatures (color) of the surface to classify the covers and the land use and is based on images that capture bidimentional characteristics of the landscape. However, to only know what the cover or the use of the land is, makes the diagnosis insufficient to estimate the suitability and the potentials of use or the areas of risks of natural disasters. It is common that the horizontal proximity to a river or of its riparian zone for example – attributes capable of being extracted from a cover and use map by means of buffers (marginal strips) along the drainage network – has some relation to aptitude or fragilities and risks. But due to the physics of water in the gravitational field of Earth, the definition of aptitude and real risk depends directly on the topography, in other words, of the combination of the horizontal and vertical dimensions.

To incorporate the vertical dimension or the volume to the images of the surface there are tridimensional imaging techniques like those used to generate Digital Elevation Models (DEM). DEMs are virtual maquettes (or numeric) of the landscape from which one can computationally extract many physical attributes, descriptive and functional, relevant to define the aptitudes and the areas of risk.

The DEMs can be Digital Surface Models (DSM), which illustrate the most extreme surface on the landscape, and includes the design of the top of the vegetation canopy and the rooftops of buildings; or they can be Digital Terrain Models (DTM) which illustrate the real or hydrologically relevant topography of the soil: directly when its uncovered and visible; or, when there are vegetations and buildings, by means of penetrating remote imaging and/or a processing to remove obstacles. Some DEMs are available for continental areas in the entire globe, such as the active imaging by radar of the SRTM (Shuttle Radar Topographic Mission, vertical resolution of 1m and horizontal of 90m). Both the SRTM and the ASTER are DSMs, which represents a few restrictions with regards to the mapping of zones with islands of dense forests occupying valleys and grottoes or dispersed amidst deforestations or of urban areas with tall buildings. Potential DTM for accurate mapping of areas of risk are starting to become available, with techniques of active remote sensoring, like the imaging laser (LIDAR) and the P band synthetic aperture radar, both with resolutions from a few meters to less than 1 meter horizontally and on the vertical scale of centimeters. Even though the ample availability of elevation models with compatible resolutions meet the basic requirements of data used in several types of mapping, for the definition of land use potential and areas of risk, these models alone are not sufficient, despite being a necessary resource.

The DSMs and the DTMs represent respective surfaces in a quantitative way, allowing for the mathematical manipulation of the topography in the computing environment. In these manipulations, one can utilize logic derived from fundamental physical principles and with such, highlight and reveal the properties on the landscape associated to aptitudes, fragilities and specific risks.

HAND model Terrain

One of the appropriate mathematical models for the analysis of the DSMs or DTMs is the HAND (Height Above the Nearest Drainage). It is a revolutionary model of land developed in Brazil, which has the capacity to, among other things, predict the depth of the water table based upon the digital topography or elevation mode alone. It is a model which solves the puzzle of soil humidity through topographical maps of hydrologically relevant environments. It was developed in collaboration between the INPA group working in the Igarapé Asu instrumented microbasin, in Manaus (Project LBA) – who discovered and structured the concept based on topographical and hydrological data (Nobre et al, 2011a) – and the group from CCST – INTE working on the modeling of land, who wrote the computer program to represent the new concept (Rennó et al, 2008). This model consists of a topographical normalization which utilizes the drainage network as a relative reference.

In the use described here, the analysis starts with the acknowledgement that each slope in a hydrographic basin is subject to a gravitational force whose effect is to accelerate the movement of percolation water or that of surface runoff. Thus, the topographical gradients are key ingredients to define the dynamics of water on the surface, the rivers are the relief points positioned at the lower level of the slope, from where the episodic fluxes of surface runoff or the continuous saturated fluxes from the porous medium come from. The land found along waterways tends to have a surface water table. This table starts to become deeper in the rate that the relative unevenness of the surface to the closest draining increases. Thus, the HAND model indirectly describes the land based on the depth of the water table.

Use of HAND model in the mapping of land use aptitudes

One of the hardest tasks for the good planning of agricultural and forestry activities is the mapping of the topographical, physical and chemical characteristics of the soil. For a majority of the farmers such maps are inaccessible due to their cost or due to the lack of assistance which would allow them to apply the spacial knowledge towards production, in a fruitful way. Such difficulty results in the rare usage of land diagnostic maps, which have represented great losses, both for the non-optimized productive activities, as well as for the areas utilized in a non-sustainable way. The HAND model offers, in a direct and quantitative way, topographical data (slope, position on the relief, etc.) and hydrological data (depth of water table, distance from waterway, etc.), which are determining factors for the potential allocation of land use. Indirectly, the HAND model can also offer information on types of soil and environmental or use susceptibility, important factors for the specific allocation of agricultural activities and of areas of protection.

An example of the use of the HAND model in the mapping of use aptitudes can be seen in Figure 5, for the region of Brodowsky near Ribeirão Preto in SP. The satellite image indicates a typical agricultural region with flat interfluves cropped with embedded drainage. The HAND map of the same area (TOPODATA radar database, vertical resolution of 1m and horizontal of 30m) indicates with a relatively high resolution, the land and its potentials and fragilities. The flat areas, with well drained soils (demonstrated in black) are best for more intensive, mechanized, of high income productions. The areas at the bottom of the valleys, close to the waterways (demonstrated in blue) have

Hydromorphic soils (continuously saturated with water – or marshy) therefore are fragile and need to be protected by natural vegetation. The contiguous areas with shallow water table (demonstrated in green) tend to also be relatively fragile land, but which could alternatively be used for legal reserves, could increase the corridors for fauna and be used as additional protection of the riparian areas. In some well defined situations, agriculture could be done in these areas, with special attention to conserving the soil and to the non-contamination of the tables and nearby waterways. The places with high and critical slopes (demonstrated in yellow and red) tend to always be fragile land, highly susceptible to erosion, which undoubtedly need the permanent protection of native vegetation. Areas with moderate and accentuated slopes (demonstrated in pink and magenta) also tend to be relatively fragile but which could alternatively be used for legal reserves, could increase the corridors for fauna and be used as additional protection to soils subject to erosion. In some well defined situations, perennial crops, like fruit trees, can be done in these places, as long as one respects advances practices of soil conservation, such as terracing and no-tillage with short cycled crops.

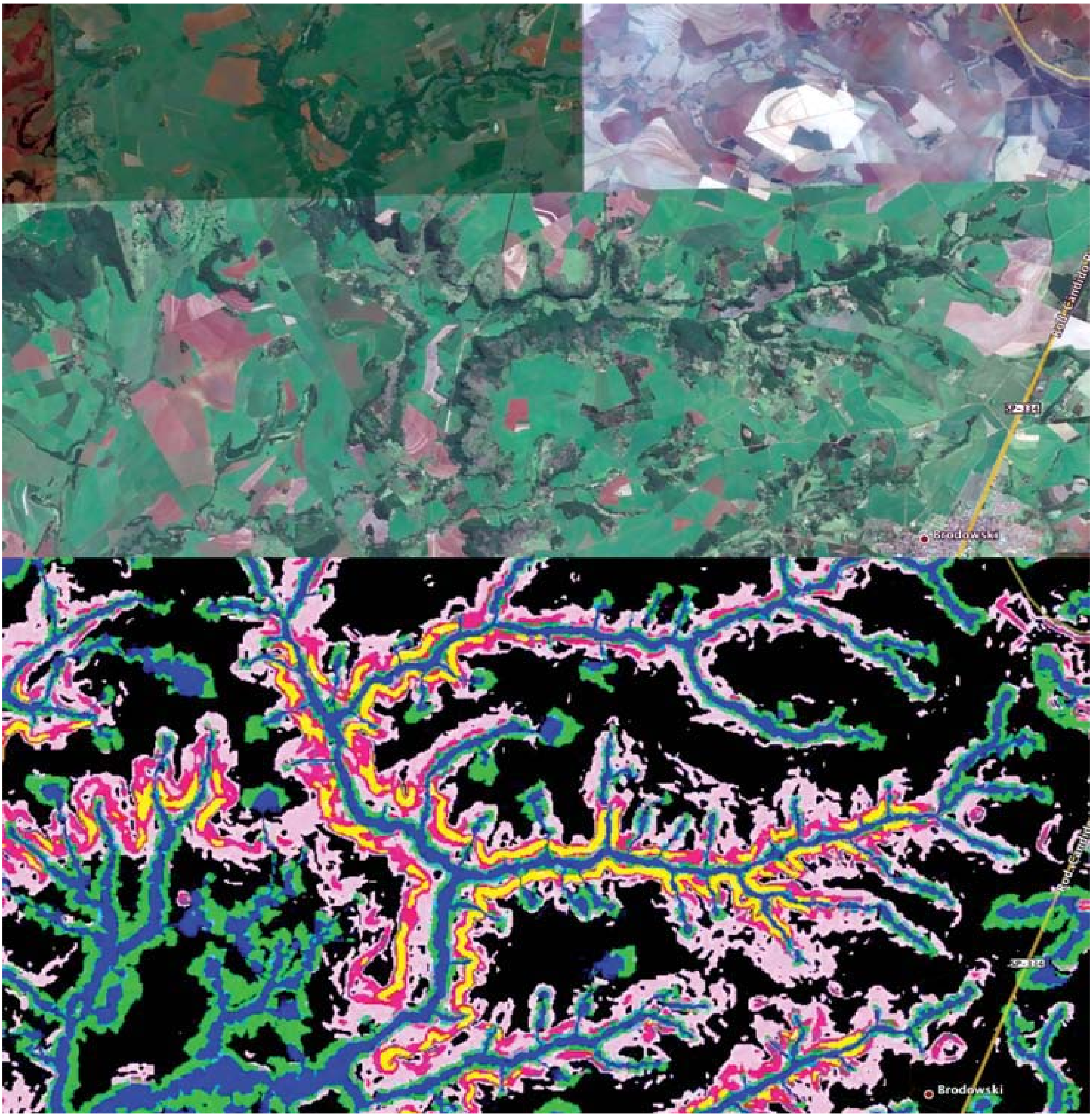

Figure 5. Example of the use of the HAND model for mapping of the suitability of use in the landscape and areas of environmental risk in the Brodowski region, near Ribeirão Preto (SP) Areas in black correspond to plain soils, suitable for mechanization, with better aptitude for productive agricultural activities. Blue and green correspond to humid areas subject to floods; in yellow (high risk) and red (critical risk) are areas with steep slopes with a high limitation of use. In pink and magenta, are the areas with limited potential of use which require attention with regards to erosion.

Use of the HAND model for mapping of areas of risk

Due to the variable morphology of valleys and channels, utilizing only the models of above sea level elevations makes it very difficult to predict the height dynamics of the flood levels. This difficulty is especially intractable when the topographical gradients along the axis of the drainage are steep or when the profiles of the channels and of the surrounding valleys are complex. One method utilized to determine areas subject to floods is the gap in relation to the waterway in its cross section, which works well for relatively flat stretches of waterways (tank type flood). More sophisticated methods to represent leakage flows apply complicated hydrodynamic formulations and parameterizations adjusted to the tridimensional format of the channel and the valley. But because the parameterizations are so hard to be obtained, its application has been restricted to specific experiments. Thus, before the HAND model, there was no method for the generalized mapping of areas with the risks of flood, a growing need in view of the increase of extreme climatic events.

The land HAND model, allows for the consistent hydrological definition of the relative proximity of waterways. Its real capacity of mapping areas subject to floods almond the waterways was tested in the Megacities project, with the mapping of the metropolitan zone of São Paulo (NBRE et al., 2010). In São Paulo, the IPT and other agencies monitor the floods, and in the performed verifications, the HAND mapping was successful.

Figure 6 shows part of the metropolitan zone with the areas of risk highlighted by the HAND model, in this case, Jardim Pantanal, surrounding the Tietê River. In this densely populated region, it becomes possible to illustrate which areas are safe and which require a special attention with regards to planning and from the civil defense. The spacial delineation enables efforts to be focused both on planning and on reactive measures in the susceptible areas.

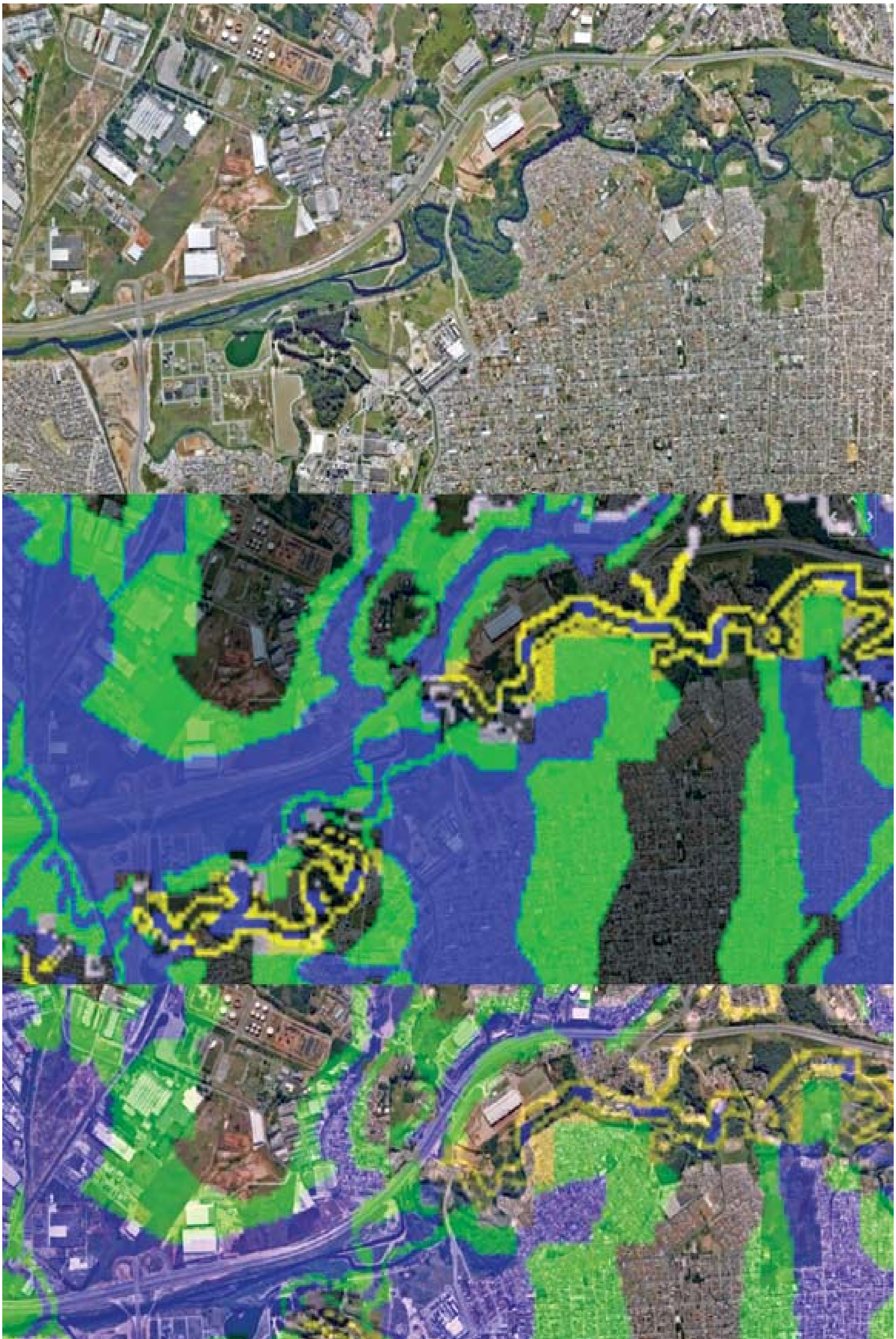

Figure 6. HAND map of areas subject to floods for the central zone of the metropolitan region of São Paulo, superimposed on the satellite image showing susceptible urban areas. A) Satellite image of Jardim Pantanal, in the metropolitan region of São Paulo; b) Hand map of areas subject to floods for the same area; c) superimposition of the susceptibility map with satellite map showing details of susceptible areas. Blue indicates a gap of up to 5 m and green shows gaps of up to 15 m in regards to the closest waterway. Source: Nobre et al. (2010)

With the addition of the slopes to the standard HAND model of relative heights, it becomes possible to identify and map in details the slopes subject to the risk of landslides. In the work done in the Megacities project, Agostinho Ogura (IPT) defined classes of risks for landslides and mass flows using spectral slopes. From the digital elevation model, the algorithm HAND found and mapped these classes of slopes, indicating all the areas subject to environmental risk. (Figure 7).

Figure 7. Use of the HAND Model to map the zones of environmental risks of the metropolitan region of São Paulo, showing in blue the areas subject to floods and flooding and in yellow (high risk) and in red (critical risk) areas subject to landslides and mass flow. In black are the areas relatively safe for human occupation. Source: Nobre et al. (2010).

Although the classes of slopes is a good start for the delineation of geological risks associated to slopes, there are other equally or more important factors in determining the real risk for landslides and mass flows. Geomorphic curvatures, type and depth of regolith, use and cover of soil are the most important, and all are potentially capable of being computationally modeled. The analysis of terrain subject to landslides for the Metropolitan zone of São Paulo, which utilized only the slope in its classes of risks, offered the opportunity for great advances in the alert system, especially in the optimization of efforts, allowing for a concentration on the areas of higher accident potential.

Even while still not having an accurate capacity of predicting landslides, for which more sophisticated models would be needed, the definition of smaller areas by the slope maps allows for a rationalization of urban planning and offers the first step towards being attentive in the efforts of an alert system.

Conclusions and Recommendations

As verified by extensive validations in several regions of Brazil, the HAND model shows great potential to be widely used, in a fast and cheap manner, in the generation of terrain maps useful for planning of territorial organization. Other well established approaches, such as the maps on land cover and use and maps on climate and water balance can be cross analyzed on the computer with the terrain and environmental maps, generating cartographic products even more accurate and specific for the delineation of aptitudes and fragilities of terrains and environments. Topological approaches, mathematically elaborated (Cortizo, 2007) have , in addition, the potential to aggregate better and more sophisticated capacities to the Terrain HAND model, helping to transform the dialogue on the Forest and environmental legislation into a new rebirth for the planning of land use.

Similar to so many other agricultural technologies, these new quantitative diagnostic tools have the potential to contribute towards a considerable increase of rural production without compromising the environmental services generated by the protected ecosystems, and also allow us to efficiently find the best places to recover the natural vegetation.

Due to their nature, the HAND environment maps democratize and universalize the access to accurate information about terrain, allowing farmers to know how to better utilize their lands. If they become legal and regularized, these maps will enable us to end the confusions in understandings associated to the unclear legislation, which generates conflicting interpretations of those who enforce the Law and for those who need to follow them.

With a resolution of 90 meters, the land modeling group of CST_INPE has already concluded the mapping of terrains for the entire South America, thus for the entire national territory. With a finer resolution of 30 meters, more than 300 thousand km2 in the North, Northeast, South and Southeast have already been mapped.

Thus, it is not necessary to wait for years of meticulous and difficult Field work to be done, to aggregate to the Forest Code the ample knowledge about land. The country was able to take advantage, in an extraordinary way, of the innovations produced by the agricultural research to climb the podium of the productive countries. It is essential, therefore, to take advantage of the innovation and of other geospatial technologies to conquer peace in the fields and in the cities and the respect of the markets for its intelligent advances in the territorial planning of Brazil

LIST OF TABLES

LIST OF FIGURES

REFERENCES

ACKERMAN, M. A cidade e o código florestal. São Paulo: Editora Plêiade, 2010. 162 p.

AHRENS, S. Sobre a Reserva Legal: origens históricas e fundamentos técnico-conceituais. In: CONGRESSO INTERNACIONAL DE DIREITO AMBIENTAL, 11., 2007, São Paulo. Meio ambiente e acesso à justiça: flora, reserva legal e APP. [São Paulo]: Instituto O Direito por um Planeta Verde, [2007]. v. 1, p. 691-707.

AHRENS, S. A estrutura do Código Florestal e uma proposta para aprimorar os seus fundamentos. In: CONGRESSO INTERNACIONAL DE DIREITO AMBIENTAL, 14., 2010, São Paulo. Florestas, mudanças climáticas e serviços ecológicos. [São Paulo]: Instituto O Direito por um Planeta Verde, [2010]. v. 1 p. 835-845.

AMARAL, E. Polinização entomófila de Coflea arabica L., raio de ação e coleta de pólen pela Apis mellifera Linnaeus, 1758 (Hymenoptera; Apidae), em cafezal florido. 1972. 82 f. Tese (Livre Docência) - Escola Superior de Agronomia “Luiz de Queiroz”, Universidade de São Paulo, Piracicaba.

ANA. Agência Nacional de Águas. Agricultura irrigada; estudo técnico preliminar. Brasília, DF, 2004. 107 p.

ANDRADE, A. G. de; FREITAS, P.L. de; LANDERS, J.N. Aspectos gerais sobre o manejo e conservação do solo e da água e as mudanças ambientais. In: Prado, R.B.; Turetta, A.P.D.; Andrade, A.G.de. Manejo e conservação do solo e da água no contexto das mudanças ambientais. Rio de Janeiro, Brazil: Embrapa Solos, 486 p. Capitulo 01. pp. 25-40. 2010.

ARONSON, J.; MILTON, S. J.; BLIGNAUT, J. N. Definitions and rationale. In: ARONSON, J.; MILTON, S. J.; BLIGNAUT, J. N. (Ed.). Restoring natural capital: science, business and practice. Washington, DC: Island Press, 2007. p. 3-8.

ARONSON, J.; BLIGNAUT, J.; GROOT, R. S. de; LOWRY II, P. P.; CLEWELL, A.; WOODWORTH, P.; COWLING, R. M.; RENISON, D.; LEVY-TACHER, S.; TONGWAY, D.; MILTON, S.; RANGEL-CH., O.; WIT, M. de; FARLEY, J.; FONTAINE, C.; DEBRINCAT, B.; BIRKINSHAW, C. The road to sustainability must bridge three great divides. Annals of the New York Academy of Sciences. Ecological Economics Reviews, v. 1185, Special issue, p. 225–236, 2010.

AUGUSTO FILHO, O. Carta de risco de escorregamentos quantificada em ambiente de SIG, como subsídio para planos de seguro em áreas urbanas: um ensaio em Caraguatatuba (SP). 198 f. Tese (Doutorado em Geociências) - Instituto de Geociências e Ciências Exatas, Universidade Estadual Paulista, Rio Claro, SP. 2001.

AWADE, M.; METZGER, J.P. Using gap-crossing capacity to evaluate functional connectivity of two Atlantic rainforest birds and their response to fragmentation, Austral Ecology, v.33, p. 863-873, 2008

BALLESTER, M. V. R.; VICTORIA, D. D.; KRUSCHE, A. V.; COBURN, R.; VICTORIA, R. L.; RICHEY, J. E.; LOGSDON, M. G.; MAYORGA, E.; MATRICARDI, E. A remote sensing/GIS-based physical template to understand the biogeochemistry of the Ji-Parana river basin (Western Amazonia). Remote Sensing of Environment, v. 87, p. 429-445, 2003.

BATALHA, R. M. P.; TEIXEIRA FILHO, J.; TERESO, M. J. A. Recuperação da mata ripária como diretriz prioritária no planejamento dos recursos hídricos. In: CONGRESSO BRASILEIRO DE ENGENHARIA AGRÍCOLA, 34., 2005, Canoas, RS. Anais. Canoas, RS: SBEA, 2005. p. 1-4.

BATISTELLA, M. Landscape Change and Land-Use/Land-Cover Dynamics in Rondônia, Brazilian Amazon. 257 f. Tese (Ph.D) - Center for the Study of Institutions, Population and Environmental Change – CIPEC, Indiana University, Indiana. 2001.

BAYER, C. MARTIN-NETO, L.; MIELNICZUKA, J.; PAVINATOC, A.; DIECKOWB, J. Carbon sequestration in two Brazilian Cerrado soils under no-till. Soil & Tillage Research, Amsterdam, v. 86, p. 237-245, 2006. Disponível em: <http://dx.doi.org/ 10.1016/j.still.2005.02.023>. Acesso em: 14 abr. 2011.

BERTOLINI, D.; LOMBARDI NETO, F.; DRUGOWICH, M. I. Programa estadual de microbacias hidrográficas. Campinas: CATI, 1993. 15 p.

BERTONI, J.; LOMBARDI NETO, F. Conservação do solo. São Paulo: Ícone, 1990. 355 p.

BOLFE, E. L.; FERREIRA, M. C.; BATISTELLA, M. Biomassa epígea e estoque de carbono de agroflorestas em Tomé-Açu, PA. Revista Brasileira de Agroecologia, v. 4, p. 2171-2175, 2009.

BOSCH, J.; HEWLETT, J. A review of catchment experiments to determine the effect of vegetation changes on water yield and evapotranspiration. Journal of Hydrology, Amsterdam, v. 55, n. 1/4, p. 3-23, 1982.

BOSCOLO D.; CANDIA-GALLARDO, C.; AWADE M.; METZGER, J. P. Importance of Interhabitat Gaps and Stepping-Stones for Lesser Woodcreepers (Xiphorhynchus fuscus) in the Atlantic Forest , Brazil, 273-276. Biotropica 40 (3). 2008.

BRAGAGNOLO, N; PAN, W. A Experiência de programas de manejo e conservação dos recursos naturais em microbacias hidrográficas. In: MUÑOZ, H. R. (Org.). Interfaces da gestão de recursos hídricos: desafios da lei de águas de 1997. Brasília, DF: Secretaria de Recursos Hídricos, 2000. p. 176-198.

BRASIL. Ministério da Agricultura, Pecuária e Abastecimento. Projeções do Agronegócio Brasileiro: 2009/2010 a 2019/2020. Brasília, DF: MAPA/ACS, 2010. 76 p.

BRASIL. Ministério do Desenvolvimento Indústria e Comércio Exterior. Secretaria de Comércio Exterior. Ali ceWeb. Brasília, DF: MDIC, 2008. Disponível em: <http://aliceweb.mdic.gov.br>. Acesso em: 3 mar. 2011

BRUIJNZEEL, L. A. Hydrological functions of tropical forests: not seeing the soil for the trees. Agriculture, Ecosystems e Environment, v. 104, n. 1, p. 185-228, 2004.

CALDEIRA, M. V. W. Determinação de biomassa e nutrientes em uma Floresta Ombrófila Mista Montana em General Carneiro, Paraná. 2003. 176 f. Tese (Doutorado em Ciências Florestais) - Setor de Ciências Agrárias, Universidade Federal do Paraná, Curitiba.

CARVALHO, L. P. O gênero Gossypium e suas espécies cultivadas e silvestres. In: BELTRÃO, M. E. de M. (Org.). O agronegócio do algodão no Brasil. Brasília, DF: Embrapa Comunicação para a Transferência de Tecnologia, 1999. v. 1, p. 234-248.

CASSATI, L. Alterações no código florestal brasileiro: impactos potenciais sobre a ictiofauna. Biota Neotropica, v. 10, n. 4, 2010. Disponível em: <http://www.biotaneotropica.org.br/v10n4/pt/fullpaper?bn00310042010+pt>. Acesso em: 10 jan. 2011.

CASTRO FILHO, C.; COCHRANE, T. A.; NORTON, L. D., CAVIGLIONE, J. H.; JOHANSSON, L. P. Land degradation assesment: tools and techniques for measuring sediment load. In: INTERNATIONAL CONFERENCE ON LAND DEGRADATION AND MEETING OF THE IUSS SUBCOMMISSION C – SOIL AND WATER CONSERVATION, 3., 2001, Rio de Janeiro. Proceedings... Rio de Janeiro: Embrapa Solos: SBCS: IUSS, 2001. 1 CD ROM.

CHASE, T. N.; PIELKE, R. A.; KITTEL, T. G. F.; NEMANI, R. R.; RUNNING, S. W. Simulated impacts of historical land cover changes on global climate in northern winter. Climate Dynamics, v. 16, p. 93-105, 1999.

CHIARI, W .C.; TOLEDO, V. de A. A. de; COLLA, M. C.; TAKASUSUKI, R.-; OLIVEIRA, A. J. B. de.; SAKAGUTI, E. S.; ATTENCIA, V. M.; COSTA, F. M.; MITSUI, M. H. Pollination of soybean (Glycine max L. Merril) by honeybees (Apis mellifera L.). Brazilian archives biology technology, v. 48, n. 1, p. 31-36, jan. 2005.

COELHO NETTO, A. L.; AVELAR, A. S.; SATO, A.; NEGREIROS, A. B.; VIANNA, L. G.; ARAUJO, I. S.; LA CROIX, D.; LIMA, P. H. M.; SILVA, A. P. A.; SILVA, R. P.; BARBOSA, L. S. January 2011: catastrophic landslides at Nova Friburgo municipality. In. World Landslides Forum , promovido pelo International Consortium of Landslides, 2., 2011, Roma. Proceedings. Roma: NESCO; WMO; FAO,U NISDR; UNU; UNEP; IBRD; UNDP; ICSU; WFEO,;KU & UNISDR, 2011. (Submetido em Congresso a ser realizado em Roma, outubro, 2011).

COELHO NETTO, A. L.; AVELAR, A. S. FERNANDES, M. C.; LACERDA, W. A. Landslide susceptibility in a mountainous geoecosystem, Tijuca Massif, Rio de Janeiro: the role of morphometric subsivision of the terrain. Geomorphology, v. 87, p. 120-131, 2007.

COMMITTEE ON GLOBAL CHANGE, RESEARCH. Global environmental change: research pathways for the next decade. Washington, DC: National Academy, 1999. 1 v. 616 p.

CONAMA. Conselho Nacional do Meio Ambiente (Brasil). Resolução n° 369 de 28 de março de 2006. Dispõe sobre os casos excepcionais, de utilidade pública, interesse social ou baixo impacto ambiental, que possibilitam a intervenção ou supressão de vegetação em Área de Preservação permanente-APP. Diário Oficial [da] União, Brasília, DF, 29 mar. 2006. Disponível em: <http://www.mma.gov.br/port/conama/res/res06/res36906.xml>. Acesso em: 27 jan. 2011.

CONAMA. Conselho Nacional do Meio Ambiente (Brasil). Resolução n° 303 de 20 de março de 2002. Dispõe sobre parâmetros, definições e limites de Áreas de Preservação Permanente. Diário Oficial [da] União, Brasília, DF, 13 maio 2002. Disponível em: <http://www.mma.gov.br/port/conama/res/res02/res30302.html>. Acesso em: 27 jan. 2011.

CONTINI, E.; GASQUES, J. G.; ALVES, E.; BASTOS, E. T. Dinamismo da agricultura brasileira. Revista de Política Agrícola, Brasília, DF, v. 19, edição especial 150 anos do Mapa, p. 42-64, jul. 2010.

CORREL, D. L.; JORDAN, T. E.; WELLER, D. E. Nutrient flux in landscape: effects of coastal land use and terrestrial community mosaic on nutrient transport to coastal waters. Estuaries, v. 15, n. 4, p. 431-442, dec. 1992.

CORTIZO, S. Topo de Morro na Resolução CONAMA № 303. 2007. Publicação avulsa 12 p. http://www. sergio.cortizo.nom.br

CRISTOFIDIS, D. O futuro da irrigação e a gestão das águas. Brasília, DF: Ministério da Integração Nacional, 2008.15 p. (Série Irrigação e água – I).

CRISTOFIDIS, D. Recursos hídricos e irrigação no Brasil. Brasília, DF: CDS-UNB, 1999. 1 v. 19 p.

DE MARIA, J. C. Erosão e terraços em plantio direto. Boletim Informativo da Sociedade Brasileira de Ciência de Solo, Viçosa, MG, v. 24, p. 17-21, 1999.

DeFRIES, R. S.; FOLEY J. A.; ASNER, G. P. Land-use choices: balancing human needs and ecosystem function. Front Ecol Environ, v. 2, n. 5, p. 249–257, 2004.

DEVELEY, P. F. E.; PONGILUPPI, T. Impactos Potenciais na avifauna decorrentes das alterações propostas para o Código Florestal Brasileiro. Biota Neotropica, v. 10, n. 4, 2010. Disponível em: <http://www.biotaneotropica. org.br/v10n5/pt/fullpaper?bn00610042010+pt>. Acesso em: 10 jan. 2011.

DEVELEY, P. F. & STOUFFER, P. C. Effects of roads on movements of understory birds in mixed-species flocks in Central Amazonian Brazil. Conserv. Biol. 15, 1416–1422, 2001.

DUARTE, C. N. A cultura do melão. Brasília, DF: Embrapa -SPI, 2001. 114 p.

DUMANSKI, J.; DESJARDINS, R. L.; LAL, R.; FREITAS, P. L. de; LANDERS, J. N.;GERBER, P.; STEINFEKD, H.; VERCHOT, L.; SCHUMAN, G. E.; DERNER, J. D.; ROSEGRANT, M. Global Potentials for Greenhouse Gas Mitigation in Agriculture. In: STIGTER, K. (Ed.). Applied Agrometeorology. Heidelberg: Springer, 2010a. p. 977-982.

DUMANSKI, J.; DESJARDINS, R.L.; LAL, R.; FREITAS, P.L.de; LANDERS, J.N.;GERBER, P.; STEINFEKD, H.; VERCHOT, L.; SCHUMAN, G.E., DERNER, J.D.; ROSEGRANT, M.. Global Strategies and Economies for Greenhouse Gas Mitigation in Agriculture. In: STIGTER, K. (Ed.). Applied Agrometeorology. Heidelberg: Springer, 2010b. p. 983-988.

EMMET, B. A.; HUDSON, J. A.; COWARD, P. A.; REYNOLDS, B. The impact of a riparian wetland on streamwater quality in a recently afforester upland catchment. Journal of Hydrology, v. 162, p. 337-353, 1994.

FARAH, F. Habitação e encostas. São Paulo: Instituto de Pesquisas Tecnológicas, 2003. 312 p. (Coleção Habitare).

FIGUEIREDO, R. O. Processos hidrológicos e biogeoquímicos em bacias hidrográficas sob usos agrícola e agroflorestal na Amazônia Brasileira. In: PORRO, R. (Ed.). Alternativa agroflorestal na Amazônia em transformação. Brasília, DF: Embrapa Informação Tecnológica, 2009. p. 477-500.

FIGUEIREDO, R. O.; MARKEWITZ, D.; DAVIDSON, E. A.; SCHULER, A. E.; WATRIN, O. dos S.; SILVA, P. de S. Land-use effects on the chemical attributes of low-order streams in the eastern Amazon. Journal of Geophysical Research, v. 115, n. G4, p. G04004, 2010.

FOLEY, J. A; COSTA, M. H.; DELIRE, C.; RAMANKUTTY, N.; SNYDER, P. Green surprise? How terrestrial ecosystems could affect earth’s climate. Front Ecol Environ, v. 1, n. 1, p. 38–44, 2003.

FOLEY, J. A.; DeFRIES, R.; ASNER, G.,P.; BARFORD, C.; BONAN, G.; CARPENTER, S.R.; CHAPIN, F. S.; COE, M. T.; DAILY, G. C.; GIBBS, H. K.; HELKOWSKI, J. H.; HOLLOWAY, T.; HOWARD, E. A.; KUCHARIK, C. J.; MONFREDA, C.; PATZ, J. A.; PRENTICE, I. C. Global Consequences of Land Use. Science, v. 309, 2005.

FONSECA, E. L. da; PONZON, F. J.; FORMAGGIO, A. R. Modelo agrometeorológico-espectral para estimativa da disponibilidade de forragem no bioma “campos sulinos”. Revista Brasileira de Agrometeorologia, v. 15,

n. 3, p. 241-249, 2007.

FORTESCUE, J. A. C. Environmental Geochemistry: a holistic approach. New York: Springler-Verlag, 1980. 347 p. (Ecological Studies, v. 35)

FRANÇA, F. M. C. A importância do agronegócio da irrigação para o desenvolvimento do Nordeste. Fortaleza: Banco do Nordeste, 2001. v. 1, 114 p.

FEBRAPDP. Federação Brasileira de Plantio Direto na Palha. Evolução da área cultivada em plantio direto – 1972/73 – 2005/6. Disponível em: <http://www.febrapdp.org.br/download/ev_plantio_brasil.pdf.> Acesso em: 14 mar. 2011.

FREITAS, A. V. L. Impactos potenciais das mudanças propostas no Código Florestal Brasileiro sobre as borboletas. Biota Neotropica, v. 10, n. 4, 2010. Disponível em: <http://www.biotaneotropica.org.br/v10n5/pt/fullpaper?bn00810042010+pt>. Acesso em: 10 jan. 2011.

FREITAS, B. M.; OLIVEIRA FILHO, J. H. de. Ninhos racionais para mamangava (Xylocopa frontalis) na polinização do maracujá-amarelo (Passflora edulis). Ciência Rural, Santa Maria, v. 33, n. 6, p. 1135-1139, 2003.

FREITAS, B. M.; PAXTON, R. J. A comparation of two pollinations: the introduced honey bee Apis mellifera and an indigeneous bee Centris tarsata on cashew Anacardium occidentale in its native range of NE Brazil. Journal of Applied Ecology, v. 35, p. 109-121, 1998.

FREITAS, P. L. de; MARTIN-NETO, L.; MANZATTO, C. V. Solos: além de tudo, seqüestro de carbono. Agroanalysis, Caderno Especial: Serviços ambientais no negócio agrícola. v. 27, n. 04, abr. p. E15-E16, 2007.

GALETTI, M.; PARDINI, R.; DUARTE, J. M. B.; SILVA, V. M. F.; ROSSI, A. E.; PERES, C. A. Mudanças no código florestal e seu impacto na ecologia e diversidade dos mamíferos no Brasil. Biota Neotropica, v. 10, n. 4, 2010. Disponível em: <http://www.biotaneotropica.org.br/v10n5/pt/fullpaper?bn00710042010+pt>. Acesso em: 10 jan. 2011.

GASQUES, J. G.; BASTOS, E. T.; BACCHI, M. R. P. Produtividade total dos fatores e transformações da agricultura brasileira: análise dos dados dos Censos Agropecuários. In: GASQUES, J. G.; VIEIRA FILHO, E. R.; NAVARRO, Z. (Org.). A agricultura brasileira: desempenho, desafios e perspectivas. Brasília, DF: Ipea, 2010. 298 p.

GALDINO, S.; VIEIRA, L. M. Impactos Ambientais e socioeconômicos na Bacia do Rio Taquari. Corumbá: Embrapa Pantanal, 2005. 356 p.

GERALDINE, D. G. Economia agrícola: contribuição real no real. REU, Anápolis, GO, v. 1, n. 1, jul./dez. 2005.

GILLIAM, J. W. Riparian wetlands and water quality. Journal of Environmental %uality, v. 23, p. 896-900, 1994.

GORSHKOV, V. G.; GORSHKOV, V. V.; MAKARIEVA, A. M. Biotic regulation of the environment: key issue of global change. Berlin: Springer-Praxis Environmental Sciences, 2000.371 p.

GOUVELLO, C; SOARES FILHO, B.S e NASSAR, Estudo de Baixo Carbono para o Brasil - Uso da terra , mudanças do uso da terra e florestas. Banco Internacional para Reconstrução e Desenvolvimento / Banco Mundial. Washington, DC. 2010, 292 p.

GUTRICH, J. J.; HITZHUSEN, F. J. Assessing the substitutability of mitigation wetlands for natural sites: estimating restoration lag costs of wetland mitigation. Ecological Economics, v. 48, n. 4, p. 409-424, 2004.

HECKENBERGER, M. J.; RUSSELL, J. C.; FAUSTO, C.; TONEY, J. R.; SCHMIDT, M. J.; PEREIRA, E.; FRANCHETTO, B.; KUIKURO, A. Pre-columbian urbanism, anthropogenic landscapes, and the future of the Amazon. Science, v. 321, n. 5893, p. 1214-1217, aug. 2008.

HERINGER, I.; JACQUES, A. V. A. Acumulação de forragem e de material morto em pastagem nativa sob distintas alternativas de manejo em relação às queimadas. Revista Brasileira de Zootecnia, v. 31, n. 2, p. 599-604, 2002.

HERNANI, L. C. FREITAS, P. L.; PRUSKI, F. F.; DE. MARIA, I. C.; CASTRO FILHO, C.; LANDERS, J. C. A erosão e seu impacto. In: MANZATTO, C. V.; FREITAS, E. J.; PERES, J. R. R. (Org.). Uso agrícola dos solos brasileiros. Rio de Janeiro: Embrapa Solos, 2002. p. 47-60.

HOUGHTON, R. A.; HACKLER, J. L.; LAWRENCE, K. T. the U.S. carbon budget: contribution from landuse change. Science, v. 285, n. 5427, p. 574-578, jul. 1999.

IBGE. Instituto Brasileiro de Geografia e Estatística. Sidra - Sistema IBGE de Recuperação Automática. Produção Agrícola Municipal. 2008. Disponível em: <http://www.sidra.ibge.gov.br>. Acesso em: 3 mar. 2011.

IBGE. Instituto Brasileiro de Geografia e Estatística.. Censo Agropecuário 2006. Disponível em <http://www. ibge.gov.br>. Acesso em 25 de janeiro de 2011.

IBGE. Instituto Brasileiro de Geografia e Estatística. Censo Agropecuário do Brasil 1995/96. Rio de Janeiro, 1997. 1 v.

INTECOL WETLAND WORKING GROUP. the Cuiabá Declaration on Wetlands. In: INTECOL WETLAND CONFERENCE HELD, 8., 2008, Cuiabá. &e state of wetlands and their role in a world of global climate change. Cuiabá: INTECOL, 2008. 4 p. (Ramsar COP10 doc. 31). Disponível em: <http://www.ramsar.

org/pdf/cop10/cop10_doc31_e.pdf>. Acesso em: 3 mar. 2011

JOLY, C.A., RODRIGUES, R.R., METZGER, J.P., HADDAD, C.F.B., VERDADE, L.M., OLIVEIRA, M.C. & BOLZANI, V.S. 2010. Biodiversity conservation research, training, and policy in São Paulo. Science 328:1358-1359.

JOLY, C.A.; SPIGOLON, J.R.; LIEBERG, S.A.; AIDAR, M.P.M.; METZGER, J.P.; SALIS, S.M.; LOBO, P.C.; SHIMABUKURO, M.T.; MARQUES, M.M. e SALINO, A. Projeto Jacaré-Pepira: o desenvolvimento de um modelo de recomposição de mata ciliar com base na florística regional. In: Rodriguês, R.R. (org.). Matas ciliares: estado atual de conhecimento. Fapesp, EDUSP, Campinas, SP, p. 271-287. 2000.

JONES, J. R.; HOLMES, J. B. Surface-subsurface interactions in stream ecosystems. Trends in Ecology e Evolution, v. 11, n. 6, p. 239-242, 1996.

JUNK, W. J.; PIEDADE, M. T. F.; WITTMANN, F.; SCHÖNGART, J.; PAROLIN, P. (Ed.). Amazonian floodplain forests: ecophysiology biodiversity and sustainable management. Hardcover: Springer Verlag, 2010. 615 p. (Ecological Studies, v. 210)

KELLER, M.; PALACE, M.; ASNER, G. P.; PEREIRA JÚNIOR, R.; SILVA, J. N. M. Coarse woody debris in undisturbed and logged forests in the eastern Brazilian Amazon. Global Change Biology, v. 10, n. 5, p. 784-795, 2004.

KLEIDON, A. Beyond GAIA: thermodynamics of Life and Earth System Functioning. Climatic Change, v. 66, p. 271–319, 2004.

KLEIN, A. M.; WILLIAMS, N. M.; AIZEN, M. A.; GEMMILL-HERREN, B.; LEBUHN, G.; MINCKLEY, R.; PACKER, L.; POTTS, S. G.; ROULSTON, T.; STEFFAN-DEWENTER, I.; VÁZQUEZ, D. P.; WINFREE, R.; ADAMS, L.; CRONE, E. E.; GREENLEAF, S. S.; KEITT, T. H.; KLEIN, A-M.; REGETZ, J.; RICKETTS, T. H. Pollination and other ecosystem services produced by mobile organisms: a conceptual framework for the effects of land-use change. Ecology Letters, v. 10, p. 299-314, 2007.

LAMB, D.; ERSKINE, P. D.; PARROTTA, J.A. Restoration of degraded tropical forest landscapes. Science v. 310, p. 1628–1632, 2005.

LAMBIN, E. F.; TURNER, B. L.; GEIST, H. J.; AGBOLA, S. B.; ANGELSEN, A.; BRUCE, J. W.; COOMES, O. T.; DIRZO, R.; FISCHER, G.; FOLKE, C.; GEORGE, P. S.; HOMEWOOD, K.; IMBERNON, J.; LEEMANS, R.; LI, X.; MORAN, E. F.; MORTIMORE, M.; RAMAKRISHNAN, P. S.; RICHARDS, J. F.; SKANES, H.;

STEFFEN, W.; STONE, G. D.; SVEDIN, U.; VELDKAMP, T. A.; VOGEL, C.; XU, J. the causes of land-use and land-cover change: moving beyond the myths. Global Environmental Change, v. 11, n. 4, p. 261-269, dec. 2001.

LANDERS, J. L.; FREITAS, P. L.de. Preservação da vegetação nativa nos trópicos brasileiros por incentivos econômicos aos sistemas de integração lavoura x pecuária com plantio direto. In: SIMPÓSIO SOBRE ECONOMIA E ECOLOGIA, 2001, Belém. Anais... Belém: [s.ed.], 2001.

LANDERS, J. N.; BARROS, G. S.; ROCHA, M. T.; MANFRINATO, W. A.; WEISS, J. Environmental impacts of zero tillage in Brazil: a first approximation. In: CONGRESS ON CONSERVATION AGRICULTURE, 2., 2001, Madri. Proceedings... Madrid: FAO-Ecaf, 2001. v. 1, p. 317-326.

LANDERS, J. N.; FREITAS, P. L. de; PIMENTEL, M. S. É preciso vender a imagem do plantio direto à sociedade: a valoração dos impactos ambientais fora da fazenda é a chave. In: ENCONTRO NACIONAL DE PLANTIO DIRETO NA PALHA, 8. Águas de Lindóia. Conservando a água e preservando a vida. Resumos. Águas de Lindóia: FEBRAPDP; Secretaria de Agricultura e Abastecimento do Estado de São Paulo. 2002,

LEPSCH, I.F.; BELLINAZZI, J.R.; BERTOLINI, D.; ESPÍNDOLA, C.R. Manual para levantamento utilitário do meio físico e classificação de terras no sistema de capacidade de uso. Campinas: Sociedade Brasileira de Ciência do Solo, 1991. 175p.

LEWIS, S.L.; BRANDO, P.M.; PHILLIPS, O.L.; HEIJDEN, G.M.F.; NEPSTAD, D. the 2010 Amazon Drought, Science 331 (6017) p. 554, 2011.

LIMA, A. J. N.; TEIXEIRA, L. M.; CARNEIRO, V. M. C.; SANTOS, J. dos; HIGUCHI, N. Análise da estrutura e do estoque de fitomassa de uma floresta secundária da região de Manaus AM, dez anos após corte raso seguido de fogo. Acta Amazonica, v. 37, n. 1, p. 49-54, 2007.

LIMA, W.P.; ZAKIA, M.J.B. Hidrologia de matas cilia- res. In: RODRIGUES, R.R.; LEITÃO FILHO, H.F. Matas ciliares: conservação e recuperação. São Paulo: EDUSP/ Fapesp, 2000. cap.3, p.33-44.

LINO, J. S. Evolução do sistema plantio direto e produção de sedimentos no Estado do Rio Grande do Sul. 2010. 119 f.Tese (Mestrado em Ciências). Escola Superior de Agronomia "Luiz de Queiroz", Universidade de São Paulo. Piracicaba, SP.

LUNZ, A. M. P.; FRANKE, I. L. Avaliação de um modelo de sistema agroflorestal com pupunha, açaí, cupuaçú, café e castanha-do-brasil, no Estado do Acre. Rio Branco: EMBRAPA -CPAF, 1997. 3 p. (Embrapa Acre. Pesquisas em andamento, 101)

LUNZ, A. M. P.; FRANKE, I. L. Recomendações técnicas para desenho de sistemas agroflorestais multiestratos no Estado do Acre. Rio Branco: EMBRAPA -CPAF, 1998. 5 p. (Embrapa Acre. Comunicado Técnico, 87)
MAKARIEVA, A. M.; GORSHKOV, V. G.;Biotic pump of atmospheric moisture as driver of the hydrologic cycle

on land. Hydrology and Earth System Sciences, v. 13, p. 1013–1033, 2007.

MALERBO-SOUZA, D. T.; NOGUEIRA-COUTO, R. H.; COUTO, L.; SOUZA, J. C. de. Atrativo para as abelhas Apis mellifera e polinização em café (Coffea arabica L.). Brazilian Journal of Veterinary Research and Animal Science, v. 40, p. 272-278, 2003a.

MALERBO-SOUZA, D. T.; NOGUEIRA-COUTO, R. H.; COUTO, L. A. Polinização em cultura de laranja (Citrus sinensis L. Osbeck, var. Pera-rio). Brazilian Journal of Veterinary Research and Animal Science, v. 40, p. 237-242, 2003b.

MALERBO-SOUZA, D. T.; NOGUEIRA-COUTO, R. H.; COUTO, L. A.; SOUZA, J. C. de. Atrativo para as abelhas Apis mellifera e polinização em café (Coffea arabica L.). Brazilian Journal of Veterinary Research and Animal Science, v. 40, p. 272-278, 2003c.

MALHI, Y.; ROBERTS, J. T.; BETTS, R. A.; KILLEEN, T. J.; LI, W.; NOBRE, C. A. Climate Change, Deforestation, and the Fate of the Amazon. Science, v. 319, p. 169-172, 2008.

MANZATTO, C. V.; ASSAD, E. D.; BACCA, J. F. M.; ZARONI, M. J.; PEREIRA, S. E. M. (Ed.). Zoneamento Agroecológico da Cana-de-Açúcar. Expandir a produção, preservar a vida, garantir o futuro. Rio de Janeiro: Embrapa Solos, 2009, 55 p.: il. - (Documentos / Embrapa Solos, ISSN 1517-2627 ; 110).

MANZATTO, C. V.; FREITAS JUNIOR, E de.; PRES, J. R. R. (Ed.). Uso agrícola do solo brasileiro. Rio de Janeiro: Embrapa Solos, 2002a. v. 1. 174 p.

MANZATTO, C. V.; RAMALHO FILHO, A.; COSTA, T. C. E. C.; SANTOS, M. L. M.; COELHO, M. R.; SILVA, E. F. da; OLIVEIRA, R. P. de. Potencial de uso e uso atual das terras. In: MANZATTO, C. V.; FREITAS, E. J.; PERES, J. R. R. (Org.). Uso agrícola dos solos brasileiros. Rio de Janeiro: Embrapa Solos, 2002b, v. , p. 13- 21.

MARENGO, J. A.; SOARES, W. R.; SAULO, C.; NICOLINI, M. Climatology of the Low-Level Jet East of the Andes as Derived from the NCEP–NCAR Reanalyses: Characteristics and Temporal Variability. Journal of Climate, v. 17, n. 12, p 2261-2280, 2004.

MARINI, M. A.; BARBET-MASSIN, M.; LOPES, L. E.; JIGUET, F. Predicted climate-driven bird distribution changes and forecasted conservation conflicts in a neotropical savanna. Conservation Biology, 23:1558-1567. 2009.

MARQUES, J. F. Custos da erosão do solo em razão dos seus efeitos internos e externos à área de produção agrícola. Revista de Economia e Sociologia Rural, Brasília, DF, v. 36, p. 61-79, 1998.

MARQUES, O. A. V.; NOGUEIRA, C.; MARTINS, M.; SAWAYA, R. J. Impactos potenciais das mudanças propostas no Código Florestal Brasileiro sobre os répteis brasileiros. Biota Neotropica, v. 10, n. 4, 2010. Disponível em: <http://www.biotaneotropica.org.br/v10n5/pt/fullpaper?bn00510042010+pt>. Acesso em: 10 jan. 2011.

MARTENSEN, A. C.; PIMENTEL, R. G.; METZGER, J.P. Relative effects of fragment size and connectivity on bird community in the Atlantic Rain Forest: implications for conservation. Biological Conservation 141, 2184–2192. 2008.

MARTINELLI, L.A., JOLY, C.A., NOBRE, C.A. e SPAROVEK, G. the false dichotomy between preservation of the natural vegetation and food production in Brazil. Biota Neotrop. 10(4). 2010: http://www.biotaneotropica. org.br/v10n4/en/abstract?point-of-view+bn00110042010.

MAY, P. H.; VEIGA, F. C.; CHEVEZ, O. Valoração econômica da biodiversidade: estudos de caso no Brasil. Brasília, DF: MMA, 2000. 198 p.

McCLAIN, M. E.; ELSENBEER, H. Terrestrial inputs to Amazon streams and internal biogeochemical processing. In: MCCLAIN, M. E.; VICTORIA, R. L.; RICHEY, J. (Ed.). Thee biogeochemistry of the Amazon basin. Oxford: Oxford University Press, 2001. p. 185-208.

MENDONÇA, R. C.; FELFILI, J. M.; WALTER, B. M. T.; SILVA JÚNIOR, M. C. da; REZENDE, A. V.; FILGUEIRAS, T. S.; NOGUEIRA, P. E. Flora vascular do Cerrado. In: SANO, S. M.; ALMEIDA, S. P. (Ed.). Cerrado: ambiente e flora. Brasília, DF: Embrapa Cerrados, 1998. p. 289-556.

METZGER, J. P.; LEWINSOHN, T. M.; JOLY, C. A.; CASATTI, L.; RODRIGUES, R. R.; MARTINELLI, L. A. Impactos potenciais das alterações propostas para o Código Florestal Brasileiro na biodiversidade e nos serviços ecossistêmicos. Documento-síntese produzido por Pesquisadores do PROGRAMA BIOTA-FAPESP e pela ABECO (Associação Brasileira de Ciência Ecológica e Conservação), Biota Neotropica, v. 10, n. 4, oct./dec. 2010 Disponível em: <http://www.biotaneotropica.org.br/v10n4/pt/>. Acesso em: 3 mar. 2011

METZGER, J. P. O Código Florestal tem Base Científica. Conservação e Natureza, v. 8, n. 1, p. 92-99, 2010.

MEYER, W. B. e TURNER B.L. Land-use/land-cover change: challenges for geographers. GeoJournal. V. 39, N. 3, 237-240. 1996.

MILLENNIUM ECOSYSTEM ASSESSMENT. Ecosystems and human well-being: biodiversity synthesis. Washington, DC: World Resources Institute, 2005. Disponível em: <http://www.maweb.org/documents/document.354.aspx.pdf>. Acesso em: 15 dez. 2010.

MITTERMEIER, R. A.; GIL, P. R.; HOFFMAN, M.; PILGRIM, J.; BROOKS, T.; MITTERMEIER, C. G.;

LAMOREUX, J.; DA FONSECA, G. A. B. Hotspots revisited: earth's biologically richest and most endangered terrestrial ecoregions. 2. ed. Boston: University of Chicago Press, 2005. 431 p.

MONTAGNINI, F.; NAIR, P. K. R. Carbon sequestration: an underexploited environmental benefit of agroforestry systems. Agroforestry Systems, v. 61, p. 281-295, 2004.

MOORE, R.; WILLIAMS, T.; RODRIGUEZ, E.; HEPINSTALL-CYMMERMAN, J. Quantifying the value of non-timber ecosystem services from Georgia's private forests. Final Report submitted to the Georgia Forestry Foundation, 2011. 44 p. Disponível em: <http://www.warnell.uga.edu/news/wp-content/uploads/2011/02/ Final-Report-1-24-11.pdf>. Acesso em: 15 fev. 2011.

MORAES, J. F. L.; PECHE FILHO, A.; CARVALHO, Y. M. C. Diagnóstico agroambiental para gestão e monitoramento da Bacia do Rio Jundiaí Mirim. Jundiaí: Instituto Agronômico de Campinas (IAC), 2002.

MORETI, A. C. C. C.; SILVA, E. C. A.; ALVES, M. L. T. M. F. Observações sobre a polinização entomófila da cultura da soja (Glycine max Merril). Boletim da Indústria Animal, v. 55, n. 1, p. 91-94, 1998.

MOTA, M. O. S. da; NOGUEIRA-COUTO, R. H. Polinização entomófila em pessegueiro (Prunus persica L.). Brazilian Journal Veterinary Research and Animal Science, São Paulo, v. 39, n. 3, p.124-128, 2002.

NEILL, C.; DEEGAN, L. A.; THOMAS, S. M.; CERRI, C. C. Deforestation for pastures alters nitrogen and phosphorus in small Amazonian streams. Ecological Applications, v. 11, n. 6, p. 1817-1826, 2001.

NEßHÖVER, C.; ARONSON, J.; BLIGNAUT, J. N.; LEHR, D.; VAKROU, A.; WITTMER, H. Investing in ecological infrastructure. In: TEN BRINK, P. (Coord.). &e Economics of Ecosystems and Biodiversity (TEEB): TEEB for National and International Policy Makers. Cambridge: TEEB, 2009. cap. 9, p.1-37.

NOBRE, A. D.; CUARTAS, L. A.; HODNET, M.; RENNÓ, C. D.; RODRIGUES, G. O.; SILVEIRA, A. C.; WATERLOO, M.; SALESKA, S. Height above the nearest drainage, a hydrologically relevant new terrain model. Journal of Hydrology, 2011a. [no prelo]

NOBRE, A. D.; SILVEIRA, A.; RODRIGUES, G.; VALLE, R. S. T.; OBREGÓN, G.; AUGUSTO, C.; CANAVESI, V.; CUARTAS, L. A. Aspectos físicos e geográficos das áreas ripárias no Brasil: análise preliminar da legislação. Ciência para o Código Florestal. São José dos Campos: Centro de Ciência para o Sistema Terrestre - INPE, 2011b. 110 p. Relatório Científico.

NOBRE, C. A. e BORMA, L. S. 'Tipping points' for the Amazon Forest. Current Opinion in Environmental Sustainability, v. 1, p. 28–36, 2009

NOBRE, P.; MALAGUTTI, M.; URBANO, D. F.; ALMEIDA, R. A. F.; GIAROLLA, E. Amazon Deforestation and Climate Change in a Coupled Model Simulation. Journal of Climate, v. 22, p. 5686–5697, 2009.

NOBRE, C.A.; YOUNG, A.F.; SALDIVA, P.; MARENGO, J.A.; NOBRE, A.D.; ALVES, Jr. S.; SILVA, G.C.M.; LOMBARDO, M. Vulnerabilidades das Megacidades Brasileiras às Mudanças Climáticas: Região Metropolitana de São Paulo. Embaixada Reino Unido, Rede Clima e Programa FAPESP em Mudanças Climáticas, 2010. 31p.

OLIVEIRA, R. R.; AVELAR, A. S.; LEÃO, O. M. R.; FREITAS, M. M.; COELHO NETTO, A. L. Degradação da floresta e desabamentos ocorridos em Fevereiro de 1996 no Maciço da Tijuca, RJ. In: CONGRESSO NACIONAL DE BOTÂNICA, 47., 1996, Nova Friburgo. Anais. Nova Friburgo, RJ: Sociedade Botânica do Brasil, 1996. v. 1, p. 353-353.

PARDINI, R.; BUENO, A.; GARDNER, T.; PRADO, P. I.; METZGER, J. P. Beyond the fragmentation threshold hypothesis: regime shi(s in biodiversity across fragmented landscapes. Plos One, v. 5, n. 10, p. 1-10, 2010.

PEDROSA, M. B. Potencial genético para seleção de uma população de algodoeiro de fibra colorida. 2005. 78 f. Tese (Doutorado) - Universidade Federal do Ceará, Fortaleza, CE.

PEREIRA, C. P. Avaliação da biomassa acumulada em áreas de vegetação secundária “capoeira” enriquecida com árvores leguminosas, no nordeste do Estado do Pará. 2001. 36 f. Dissertação (Mestrado em Biologia Vegetal Tropical) - Faculdade de Ciências Agrárias do Pará, Belém.

PINAY, G.; e DÉCAMPS, H. the role of riparian woods in regulating nitrogen fluxes between the alluvial aquifer and surface water: a conceptual model. Regulated Rivers - Research & Management, 2:507-516. 1988.

PÖSCHL, U.; MARTIN, S. T.; SINHA, B.; CHEN, Q.; GUNTHE, S. S.; HUFFMAN, J. A.; BORRMANN, S.; FARMER, D. K.; GARLAND, R. M.; HELAS, G.; JIMENEZ, J. L.; KING, S. M.; MANZI, A.; MIKHAILOV, E.; PAULIQUEVIS, T.; PETTERS, M. D.; PRENNI, A. J.; ROLDIN, P.; ROSE, D.; SCHNEIDER, J.; SU, H.; ZORN, S. R.; ARTAXO, P.; ANDREAE, M. O. Rainforest Aerosols as Biogenic Nuclei of Clouds and Precipitation in the Amazon.Science, v. 329, p. 1513-1516, 2010.

PRADO, T. B. G.; MORAES, J. F. L.; ADAMI, S. F. Evolução do uso das terras e produção de sedimentos na bacia hidrográfica do Rio Jundiaí-Mirim. Acta Scientiarum (UEM), v. 1, p. 1-10, 2006.

Programa ABC. BRASIL. Ministério da Agricultura, Pecuária e Abastecimento. Disponível em: <http://www.agricultura.gov.br/portal/page/portal/Internet-MAPA/pagina-inicial/desenvolvimento-sustentavel/programa-abc>. Acesso em: 25 jan. 2011.

RAMALHO FILHO, A. Aptidão agrícola das terras do Brasil. In: CONGRESSO BRASILEIRO DE CIÊNCIA DO SOLO, 20., 1985, Belém. Programa e resumos... Campinas: Sociedade Brasileira de Ciência do Solo, 1985.

65 p.

RAMALHO FILHO, A.; PEREIRA, L. C. Aptidão agrícola das terras do Brasil – potencial de terras e análise dos principais métodos de avaliação. Rio de Janeiro: Embrapa Solos, 1999. (Documentos, 1).

RATTER, J. A.; BRIDGEWATER, S.; RIBEIRO, J. F. Analysis of the floristic composition of the Brazilian cerrado vegetation III: Comparison of the woody vegetation of 376 areas. Edinburgh Journal of Botany, v. 60, p. 57–109, 2003.

RENNÓ, C. D.; NOBRE, A. D.; CUARTAS, L. A.; SOARES, J. V.; HODNETT, M. G.; TOMASELLA, J.; WATERLOO, M. J. Hand, a new terrain descriptor using SRTM-DEM: mapping terra-firme rainforest environments in Amazonia. Remote Sensing of Environment, v. 112, n. 9, p. 3469-3481, 2008.

RIBEIRO, J. F.; FELFILI, J. M.; DUBOC, E.; ALMEIDA, S. P.; BARROS, C. J. Cerrado em pé: espécies frutíferas para agricultura familiar. IN: SIMPÓSIO BRASILEIRO SOBRE A CULTURA DA MANGABA, 1., 2003, Aracaju. Anais... Aracaju: Embrapa Tabuleiros Costeiros, 2003. 1 CD)ROM.

Ribeiro, K. T. e.; FREITAS, L. Impactos potenciais das alterações no Código Florestal sobre a vegetação de campos rupestres e campos de altitude. Biota Neotropica, v. 10, n. 4, 2010. Disponível em: <http://www.biotaneotropica.org.br/v10n5/pt/fullpaper?bn04310042010+pt>. Acesso em: 10 jan. 2011.

RIBEIRO, M. C.; METZGER, J. P.; MARTENSEN, A. C.; PONZONI, F. J.; HIROTA, M. M. the Brazilian Atlantic Forest: how much is le(, and how is the remaining forest distributed: Implications for conservation. Biological Conservation, v. 142, p. 1141-1153, 2009.

RODRIGUES, R. R.; JOLY, C.A.; BRITO, M.C.W.; PAESE, A.; METZGER, J.O.; CASATTI, L.; NALON, M.A.; MENEZES, N.A.; BOLZANI, V.S. & BONONI, V.L.R. Diretrizes para a conservação e restauração da biodiversidade no estado de São Paulo. Programa BIOTA/FAPESP. Secretaria do Meio Ambiente, 2008. 245 p.

RODRIGUES, R. R.; LEITÃO FILHO, H. F. (Ed.). Matas ciliares: conservação e recuperação. São Paulo: Edusp, 2000. 320 p.

RODRIGUES, R. R.; LIMA, R. A. F.; GANDOLFIA, S.; NAVEA, A. G. On the restoration of high diversity forests: 30 years of experience in the Brazilian Atlantic Forest . Biological Conservation, v. 142, n. 6, p. 1242–1251, 2009.

RUGGIERO, C. Situação da cultura do maracujazeiro no Brasil. Informe Agropecuário, Belo Horizonte, v. 21, n. 206, p. 5-9, 2000.

SALA, O. E.; CHAPIN, F. S.; ARMESTO, J. J.; BERLOW, E.; BLOOMFIELD, J.; DIRZO, R.; HUBER-SAN

WALD, E.; HUENNEKE, L. F.; JACKSON, R. B.; KINZIG, A.; LEEMANS, R.; LODGE, D. M.; MOONEY, H. A.; OESTERHELD, M.; POFF, N. L.; SYKES, M. T.; WALKER, B. H.; WALKER, M.; WALL, D. H. Biodiversity: global biodiversity scenarios for the year 2100. Science, n. 287, p. 1770-1774, 2000.

SAMPAIO, G.; NOBRE, C. A.; COSTA, M. H.; SATYAMURTY, P.; SOARES-FILHO, B. S.; CARDOSO, M. Regional climate change over eastern Amazonia caused by pasture and soybean cropland expansion. Geophysical Research Letters, v. 34, p. L17709, 2007.

SANCHEZ JÚNIOR, L. B.; MALERBO-SOUZA, D. T. Freqüência dos insetos na polinização e produção de algodão. Acta Scientiarum Agronomy, v. 26, n. 4, p. 461-465, 2004.

SANTOS, D. T.; CARVALHO, P. C. de F.; NABINGER, C.; CARASSAI, I. J.; GOMES, L. H. Eficiência bioeconômica da adubação de pastagem natural no sul do Brasil. Ciência Rural, Santa Maria, v. 38, n. 2, abr. 2008.

SANTOS, S. R. M. dos; MIRANDA, I, S.; TOURINHO, M. M. Análise florística e estrutural de sistemas agro-florestais das várzeas do rio Jubá, Cametá, Pará. Acta Amazônica, v. 34, n. 2, p. 251–263, 2004.

SILVA, A. F. Transferências interna e externa de renda do agronegócio brasileiro. 2010. 140 p.Tese (Doutorado em Ciências) - Escola Superior de Agronomia "Luiz de Queiroz", Universidade de São Paulo Piracicaba, SP.

SILVA, R. P. Alometria, estoque e dinâmica da biomassa de florestas primárias e secundárias na região de Manaus (AM). 2007. 152 f. Tese (Doutorado em Ciências Florestais) - Instituto Nacional de Pesquisas da Amazônia, INPA. Manaus

SOCHER, L. G.; RODERJAN, C. V.; GALVÃO, F. Biomassa aérea de uma floresta ombrófila mista aluvial no município de Araucária (PR). Floresta, Curitiba, PR, v. 38, n. 2, abr./jun. 2008.

SOUSA, R. M.; AGUIAR, O. de S.; FREITAS, B. M.; SILVEIRA NETO, A. A.da; PEREIRA, T. F. C. Requerimentos de polinização do Meloeiro no município de Acaraú-CE, Brasil. Revista Caatinga,v. 22, n. 1, p. 238-242, 2009.

SOUZA, R. S.; VIANA, J. G. A. Tendência histórica de preços pagos ao produtor na agricultura de grãos do Rio Grande do Sul, Brasil. Ciência Rural, Santa Maria, v. 37, n. 4, p. 1128-1133, 2007.

SPAROVEK, G; BARRETO, A.; KLUG, I.; PAPP, L.; LINO, J. A revisão do código florestal brasileiro. Novos Estudos, v. 89, n. 1, p. 111-135, 2011.

STADTLER, E. W. C. Estimativas de biomassa lenhosa, estoque e sequestro de carbono acima do solo ao longo do gradiente de inundação em uma floresta de igapó alagada por água preta na Amazônia Central. 2007. 57 f. Tese (Doutorado em Biologia Tropical e Recursos Naturais) - Instituto Nacional de Pesquisas da Amazônia, INPA.

STAUFFER, D. Introduction to percolation theory. London: Taylor & Francis, 1985. 192 p.

TEEB. &e Economics of Ecosystems and Biodiversity. PNUMA, Bonn, 2010. Disponível em: <www.teebweb.net>. Acesso em: 3 mar. 2011

TOLBA, M. K. e EL-KHOLY, O. A. (Ed.) &e world environment 1972-1992: two decades of challenge. London: Chapman & Hall, 1992. v. 1, 884 p.

TOLEDO, L. F.; CARVALHO)E)SILVA, S. P.; SÁNCHEZ, C.; ALMEIDA, M. A. E.; HADDAD, C. B. F. A revisão do Código Florestal Brasileiro: impactos negativos para a conservação dos anfíbios. Biota Neotropica, v. 10, n. 4, 2010. Disponível em: <http://www.biotaneotropica.org.br/v10n4/pt/fullpaper?bn00410042010+pt>. Acesso em: 10 jan. 2011.

TRECENTI, R. Desafios para a implementação do programa Agricultura de Baixo Carbono (ABC). Portal Dia de Campo – Colunas Assinadas. Disponível em: http://www.diadecampo.com.br/zpublisher/materias/Materia.asp?id=22597&secao=Colunas%20Assinadas (acesso em 27/09/2010)

TRISKA, F. J.; DUFF, J. H.; AVANZINO, R. J. Patterns of hydrological exchange and nutrient transformation in the hyporheic zone of a gravel-botton stream examining terrestrial-aquatic linkages. Freshwater Biology, v. 29, p. 259-274, 1993.

TRISKA, F. J.; KENNEDY, V. C.; AVANZINO, R. J.; ZELLWEGER, G. W.; BENCALA, K. E. Retention and Transport of Nutrients in a third-Order Stream in Northwestern California: Hyporheic Processes. Ecology, v. 70, n. 6, p. 1893-1905, 1989.

TSUCHIYA, A.; HIRAOKA, M. Forest biomass and wood consumption in the lower course of the Amazon: a case study of the Urubuera Island. Acta Amazonica, v.29, n. 1, p. 79-95, 1999.

TUNDISI, J. G.; TUNDISI, T. M. Impactos potenciais das alterações do Código Florestal nos recursos hídricos. Biota Neotropica, v. 10, n. 4, 2010. Disponível em: <http://www.biotaneotropica.org.br/v10n5/pt/fullpaper?bn01110042010+pt>. Acesso em: 10 jan. 2011.

VEIGA, F. C.; MAY, P. H. Mercados para serviços ambientais. In: MAY, P. H. (Org.) Economia do meio ambiente; teoria e prática. 2. ed., Rio de Janeiro: Elsevier Campus, 2010.

VERGARA FILHO, O. Estimativa econômica das perdas de solo provocadas pela erosão hídrica no Brasil. Revista Geográfica Instituto Panamericano de Geografia e Historia, n. 120, p. 41-58, 1994.

VOGEL, H,. Quantificação da biomassa em uma floresta estacional decidual em Itaara, RS, Brasil. Ciência Florestal, v. 16, n. 4, p. 419-425, 2006.

WICKEL, B. A. J. Water and nutrient dynamics of a humid tropical watershed in Eastern Amazonia. Bonn: Center of Development Research/ University of Bonn,135 p. 2004. (Ecology and Development Series, 21).

WITH, K. A.; CRIST, T. O. Critical thresholds in species' responses to landscape structure. Ecology, v. 76, p. 2446-2459, 1995.

WITH, K. A.; KING, A. W. Dispersal success on fractal landscapes: a consequence of lacunarity thresholds. Landscape Ecology, v. 14, n. 1, p. 73-82, 1999.

ZOCOLO, G. J. Ocorrência de isoflavonas de soja no ambiente e correlação com atividade estrogênica: estudo de caso da região de Dourados (MS). 2010.185 f. Tese (Doutorado em Química) - Instituto de Química, Universidade Estadual Paulista, Araraquara, SP.

Zucco, C. A.; Oliveira-Santos, L. R,; Fernandez, F. 2011. Protect Brazil's land to avert disasters. Correspondence, Nature, v. 470, 335.

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