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contents

introduction

Renato Casagrande

Renato Casagrande
President of the João Mangabeira Foundation

Brazil can and should take a leading position on three crucial issues to the contemporary international community: the defense of peace, since our diplomacy has always favored dialogue and cooperation instead of confrontation; the right to development, since our great country occupies an intermediate position in terms of economic and technological capacity; and the preservation of the environment, because our territory is home of the greatest biodiversity on the planet.

The concept of sustainability unifies these three agendas. That is the central theme of this fourth issue of *Politika* magazine, a joint publication of the João Mangabeira Foundation and Germany's Humboldt University, with editions in Portuguese, English and Spanish. Seven Brazilian and one German experts were asked to map the subject.

The first two articles deal with the biomes that predominate in most of the Brazilian territory. **Altair Sales Barbosa** offers a broad overview of the historical and bio-geographical development of the Cerrado, which covers Goiás, Tocantins and Mato Grosso do Sul, including the Federal District, the east of Mato Grosso, western Bahia, the north and the center of Minas Gerais, southern Maranhão, and a great part of Piauí, extending to Rondônia. It's called "the cradle of waters" because it contains three giant aquifers and, due to its central position, it feeds our main river basins. Of all the Brazilians systems, it has been the most affected in recent decades, as it is still considered the main area of expansion for the agricultural frontier. It is a challenging process, since the removal of the original vegetation cover and the modification of the composition of the soil greatly reduce the recharge capacity of aquifers, the reserves of which are reaching a critical level. Smaller rivers are the first to disappear, but major waterways are already affected, including the São Francisco River. Altair Sales Barbosa is not optimistic: as long as the exploitation of the Cerrado continues with the strange logic against the ecology of the region, he says "the existence of a rational development program will be null."

Violeta Refkalefsky Loureiro shows how the Brazilian state historically established a colonial relationship with the Amazon, always seen as a region dedicated to export vegetable and mineral commodities and, more recently, energy. Therefore the so-called enclave economies have been created, with little or no multiplier effects on regional scale. Heavily subsidized by the state, business groups have taken possession of nature in the name of a progress that does not reach the local population. Situations of conflict have intensified between those who consider the territory as a part of life and work, and those who see it as a basis for ultra-fast accumulation of wealth. The former are considered "backward", the latter, "modern". It is a drama similar to that of the Cerrado: the Amazon is not considered a region in itself, but rather a deposit of resources available for extraction activities. It is easy to see that such a view is associated with unsustainable practices.

This leads us to water management, subject of the article of **Marina Grossi**, who brings an advanced business view to the debate: "The discussion on the topic of sustainability has already far surpassed the stage of reasonable doubt in relation to possible scientific skepticism. It is necessary to achieve a global agenda currently very well established in the multilateral fora." The article presents no less than fourteen promising technologies for reuse and water savings in the ten sectors of high consumption. If well applied, they can save 4.4 billion m3 per year, if the contributions expected from industry are added, especially from agriculture. There needs to be improvement and rationalization of irrigation techniques, which account for 72% of water consumption in Brazil.

Marina Grossi informs us that the area deforested and occupied by low productivity pastures reaches 150 million hectares, almost three times the agricultural area used effectively throughout the country. Recovering these huge degraded areas, making them productive once more, is essential to reduce the expansionist pressure on agricultural production, preserving our most sensitive regions. The systems that integrate crops, livestock and forests are a step in that direction. **Roberto Waack** also thinks so, and his article addresses the use of land in a low-carbon economy and has the subtitle "Interdependence is the name of the game."

The activities that cause changes in the use of the land are responsible for 24% of emissions of greenhouse gases, preceded only by the electricity and heat production, with 29%. In Brazil, about 2/3 of carbon emissions are associated with land use. However, it is

currently known that the future will be dominated by the low-carbon economies. A new generation of technologies associated with carbon sequestration and storage is born, with enormous potential profitability. Opportunities for Brazil during this transition are immense. Public policies associated with the mobilization of the main actors of the Brazilian countryside, including agribusiness, are crucial. A new technological revolution — precision forestry, biotechnologies, forest regeneration, product traceability, bio-energy, biomaterials etc. — is beginning in this sector. We cannot fall behind.

Alfredo Sirkis presents alternatives to analyze the financing of this transition globally. The numbers are huge: to ensure that the current global warming does not exceed two degrees, about US$ 3 trillion a year are necessary, a much higher amount than the capacity of governments. This shows that the effort must include the whole of society: those who emit greenhouse gases are companies, communities and consumers in general -- in activities that are not always under government control.

The funding of the transition for the low-carbon economy has been very complicated. According to Sirkis, it will require a new "Bretton Woods", a reference to the conference held in 1944, which reorganized the world economy in the second postwar period. Instead of the gold standard, which was abandoned by the United States in 1971, carbon reduction would be considered in unit values, in order to reconcile mitigation actions with economic stimulus. By adopting this standard and acting collectively, governments would provide the necessary guarantees so that large amounts of resources could exchange the current speculative financial channels for financing of productive low-carbon economies. It is undoubtedly an ingenious idea, but it still needs to win political viability.

Another key and difficult issue to allow the necessary transition is a deep adjustment in the ways of producing energy. **Emilio Lèbre La Rovere** presents the results of an extensive recent study, which involved nearly a hundred experts, on the "alternatives for sustainable energy development in Brazil." This article repeats the conclusion of the work on changes in the land use: the opportunities for Brazil are excellent. Contrary to common sense, which combines pollution and income generation with employment and growth. The scenarios that predict higher mitigation of the emission of greenhouse gases are also the most favorable to our economic and social development.

Low-cost measures - such as improved energy efficiency, adoption of renewable energies, expansion of low-carbon farming techniques, changes in transport modes, methane capture in the waste sector, reforestation - can produce great results. With well-founded projections, the study shows that this multidisciplinary team will reduce our emissions of greenhouse gases by half until 2030 (taking 2005 as a reference), if we adopt the path of more radical mitigation. At the same time, it "can bring economic growth, reduce unemployment and increase average family income, with a higher gain for the poorest families."

In order to achieve it, it is necessary to change the current trajectory. **Carlos Eduardo Frickmann Young** shows that, besides presenting low performance, the contemporary Brazilian economy is becoming less "green", since the most resistant sectors to the crisis are energy and natural resource intensive. And he warns: "Specializing in 'brown' activities, whose competitiveness is based on a non-sustainable relationship with the environment, is going against the current."

The new technological paradigm, under development, fully incorporates the environmental concerns. They are new products, new production methods, new marketing structures, new sources of raw materials and inputs. In the developed countries, the pressure of buyers and investors for a better environmental performance is already decisive, increasing synergies between business innovation and preservation policies. If the country does not follow this move, Brazil will be sentenced to become, in the 20th century, a dirty, backward and poor economy.

The last contributor to this number of *Politika* is **Dirk Messner**, director of the German Institute of Development Policy. He explicitly addresses Germany's role in building global sustainability. His article gives many clues for us to imagine the role of Brazil. His country, he says, has underperformed action in relation to its potential. To overcome this situation, it should organize a group of nations to promote ambitious energy changes, establish concrete partnerships with the emerging economies, disseminate knowledge, particularly for developing countries, and actively combat poverty in the almost thirty "failed States". Perhaps Brazil can also increase its international prominence if it better defines its sphere of operations in the foreign policy.

This is our contribution at this time for the necessary debate on the modernization of Brazil and the sustainability of life on Earth.

Based on scientific evidence, the current panorama and the perspectives of specialists, a political attitude to mobilize the country with the mission to elaborate and implement a true national policy for sustsinability of great local, regional and global impact is proposed. The object is to promote real change to adopt an energy matrix that is truly clean and without deforestation. The path is for government and society to establish strategic partnerships in the technical, political and economic arenas for a cultural change in the behavior of leaders, investors and consumers. It is paramount to advance along the lines of a legal framework, planning and actions for a circular economy of innovation and recycling, where green currency defines the sustainability of our future.

Sustainability
in the bio-geographical system of the Cerrado

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In the area covered by what is known as the Cerrado, there are three major aquifers responsible for the formation and supply of large continental rivers. This ancient system has already reached its evolutionary climax. Having been degraded, it will never recover its biodiversity. The main area of expansion of the Brazilian agriculture frontier can be found in this area. The predominance of an economic rationale for the region does not fit with the possibility of a rational development program. The resulting water crisis has put the very survival of the São Francisco River in jeopardy.

The Cerrado covers the entire territory of the states of Goiás, Tocantins and Mato Grosso do Sul, besides the Federal District. It includes the eastern part of Mato Grosso, western Bahia, the northeast and centre of Minas Gerais, the south of Maranhão, a large part of Piauí and extends itself linearly to Rondônia. It even appears separately in certain areas of the Brazilian Northeast and part of São Paulo. It is ecologically related to the savannahs, and some say that the Cerrado is their regionalized configuration. However, if compared to the African savannahs, the evolutionary history of the Cerrado shows significant differences.

In Brazil, this type of landscape receives different denominations according to the region: gerais in Minas Gerais and Bahia, *tabuleiro* in Bahia and in other Northeastern areas, and also *campina*, *costaneira* and *carrasco*, depending on the region. These popular designations do not reflect an ecological totality, referring only to a physiognomic category, sometimes associated with some geo-morphological or purely botanical configuration. None of them is sufficient to describe the totality and the ecological importance of the Cerrado, as they only highlight or emphasize fragmented portions of its composition. When this happens, the character of biodiversity, a striking element of the Cerrado ecology, is not given due importance and cannot even be understood in its fundamental aspects.

The use of the bio-geographical paradigm has been shown to be a key reference for understanding Cerrado as a whole, including the various nuances, open and shaded, as interacting subsystems and critical members of a larger system. The bio-geographic concept has highlighted the importance of Cerrado in the balance of other systems of the continent, besides demonstrating that the main feature of its biocenosis is the interdependence of the components of the various ecosystems (see "Brazilian bio-geographic sys-

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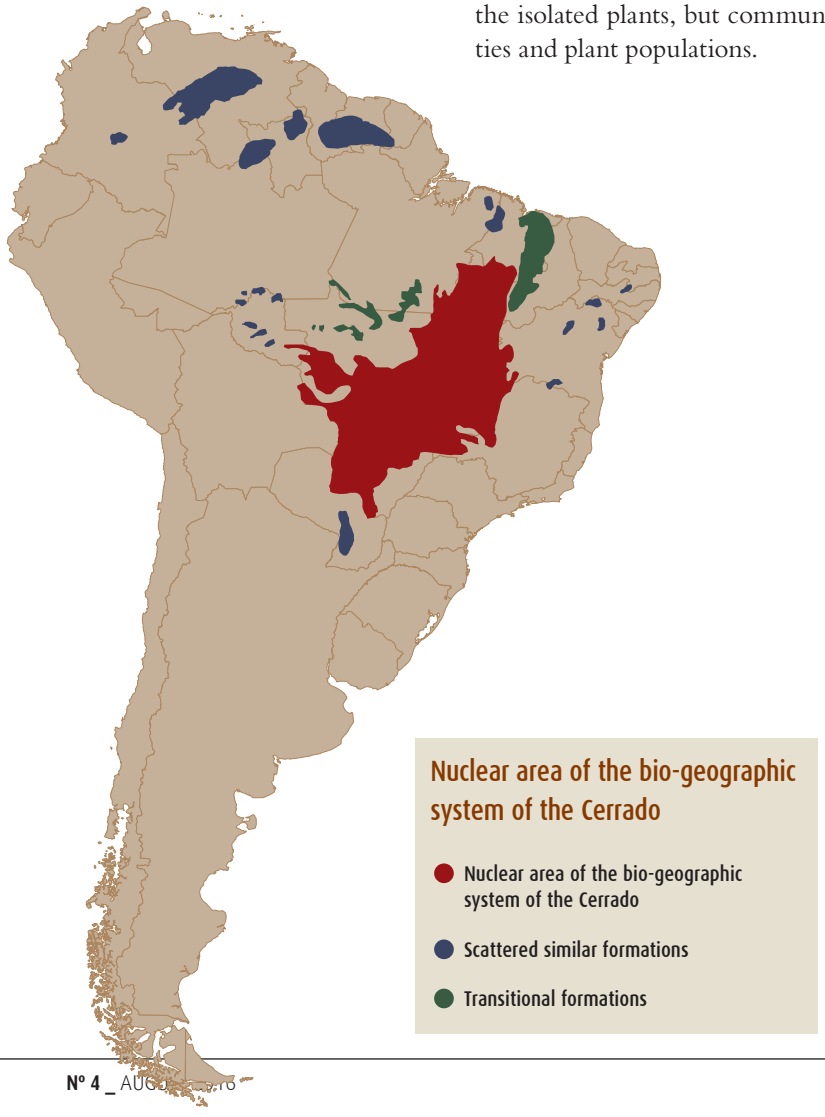
tems"). Therefore, Cerrado is a bio-geographic system composed by several closely interactive and interdependent subsystems. Each subsystem has a work history that is reflected in their level of degradation. These subsystems float from a bright open gradient to shaded gradients.

Subsystem of the forests. It is a forested area not to be confused with either the Amazon rainforest or with the Atlantic forest, since they are sub-humid forests, with a completely different evolutionary history from the mentioned forests. These forests can be found in the Cerrado system due to the presence of soil spots with high natural fertility. They are the so-called lands of cultivation. Precisely for this reason they were the most coveted ones since the beginning of the human occupation. The first large farms and their crops were settled in these areas, which today are also home to the largest cities of the Cerrado. The level of degradation is huge in this area: the preserved part does not reach 2% of its original area, taking into account not the isolated plants, but communities and plant populations.



Subsystem of the fields. At the other end of the gradient are fields which occupy the plateaus. They were intensively occupied for grain production from the 1970s onward. It was such an intense occupation that this landscape disappeared in terms of plant population, even including the conservation units located in areas that were originally fields. These units are very disfigured by inadequate management and the invasion of exotic plants on the periphery.

Subsystem of the *cerradão*. Another subsystem of the Cerrado system is the cerradão, vegetal formation associated with very special soils, such as the southwestern area of Goiás, where there is an association with Bauru sandstone soils. This is a much degraded area, considering the soil characteristics that are prone to erosion. Currently the cerradão occupies only around 3% of the original area.

Subsystem of the *stricto sensu* Cerrado. Since it occupies oligotrophic soils that are arduously cultivated, this subsystem of small and twisted trees – predominate throughout the landscape and from which it got its name – was until recently ignored by agriculture and livestock. However, its high-quality coal aroused the interest of the greedy, who employed chain clearcutting to deforest under very dubious projects that approved by the official environmental agencies as "forest management projects." Coal has been used with increasing frequency in the steel

Brazilian bio-geographic systems

Physiographically, Brazil has seven major environmental matrices, defined more accurately as bio-geographic systems. They involve a set of atmospheric, hydrospheric, lithospheric and biospheric factors, closely interconnected. Any change in one of these factors causes change in the system as a whole. The different facies of a system are presented to us as interacting subsystems.

Amazon bio-geographic system, located in the north and northwestern Brazil. It covers the low plank shape plateaus, large plains, subsectors with forested rounded peaks and forested mountains of the Andes eastern slopes, up to 600 meters high. It is the great matrix of the humid tropics, covered by the Amazon rainforest.

Roraima-Guianese bio-geographic system, located as an enclave in the Amazon bio-geographical system, on the border among Roraima, Venezuela and the former Guianas. It is the tropical wet matrix of the *gran sabana* covered with grassland vegetation called the Rio Branco and Tumucumaque fields.

*Caatinga*s bio-geographic system, located in depressions among highlands of the Brazilian Northeast, with semi-arid climate and intermittent and seasonal drainages. It is the semi-arid tropics matrix, covered by *caatinga* vegetation, which is a thin forest, popularly called *sertões secos* (dry hinterlands).

Atlantic tropical bio-geographical system, located in the Atlantic tropical coast of Brazil, from the shores of the Rio Grande do Norte to the Tropic of Capricorn. At its southern boundary, it extends itself inland to areas of the western São Paulo and northern Paraná. It is the great landscape matrix of the Atlantic Forest, with humid and super humid climates.

Bio-geographic system of South Brazilian Highlands, located in Atlantic subtropical plateau areas, covered by an old mantle of pines. The climate is temperate.

Subtropical mixed grasslands system, situated in the southern half of the state of Rio Grande do Sul and a large part of Uruguay. It is known regionally as *coxilhas* or *pampas*, with fields and subtropical gallery forests.

Bio-geographic system of Cerrado, located in the central highlands of Brazil of predominately sub-humid tropical climates with two seasons, dry and rainy. It is the major environmental matrix of the subhumid tropics, covered by a vegetal landscape that composes a mosaic of physiognomic types, ranging from bright fields to shaded and forested areas.

This physiographic model was modified not for environmental reasons but for geopolitical or specifically politic ones as the Pantanal of Mato Grosso, which is only a subsystem of the Cerrado system, with no characteristics of a specific biome. The Roraima-Guyanese system, despite having a vegetation of grasses, joined the Amazon system. Similarly, the system of the South Brazilian Highlands, which holds an old mantle of pines and is located in the subtropical highlands, is part of the Atlantic tropical system.

For its geographical position and its floristic, faunal and geo-morphological character, among others, the bio-geographic system of Cerrado is the balance point of these different systems, as it is connected with all of them through hydrographic corridors. The central plateaus of Brazil, covered by the Cerrado, constitute the ridge of Brazil and also the continent, since it distributes a significant amount of water that supplies the main continental watersheds.

industry. In addition, the new agricultural production technologies have increased possibilities of the use of these areas. For this reason, the preservation of this ecosystem does not exceed 5% of its original extension.

Subsystems of paths, riparian environments and wetlands. These other subsystems, with different types of facies, do not escape from the common rule of degradation. They are extremely important environments to the ecology of the Cerrado as a whole, since they work like a nursery for fauna, including not only fish, but also mammals, reptiles and birds. Riparian environments have been suffering a major process of erosion caused by disorderly occupations and large agricultural projects that take advantage of the moisture of the wetlands and the easy deployment of mechanical irrigation. The riverbeds – very important environments for the maintenance of surface water – have been undergoing a process of slow death, due to the decrease in the level of the water sources. Despite everything, this is still the best preserved environment throughout the system, reaching the level of 16% of the original areas.

The fauna of Cerrado

The understanding of the environmental aspects of the Cerrado requires an integrated analysis of the elements of the fauna, flora, the geographic space and how they relate to other components. It is believed that the vast Cerrado fauna biodiversity is linked

to the diversity of environments. This correlation provides a glimpse of the environment in its entirety, making it easy to set appropriate environmental policies for the entire system.

The Cerrado system is strategically located among the other Brazilian systems, which facilitates the floristic and faunal exchange. Present at the centre of the country, its core area extends itself from one end to the other of Mato Grosso do Sul to Piauí, in its major axis. To the west, it is bordered by the Amazon rainforest, to the east and northeast by the vegetation of the *Caatinga*, and bordered to the south and southeast by the Atlantic Forest. These connections favoured the creation of important migration corridors, both by land and waterways.

About 935 species of birds inhabit the whole Cerrado system, distributed in different habitats. 298 species of mammals and 268 reptiles were listed. There is no reliable data about fish species.

Fruit maturation and regrowth of grasses, the main food source of a large part of the fauna, do not occur homogeneously in all the areas of the Cerrado. Fruiting occurs during the months of November, December and January, a time that coincides with the peak of the rainy season. Afterwards, the concentration of these resources decreases, following the end of the rainy season. However, except for the months of May and June, critical to the food supply, the other months that correspond to the dry season offer some resources, even in a smaller amount, including flowers, roots, resins and some fruit.

The mammals of the Cerrado can be observed throughout the year, especially those who live in open areas. However, the highest concentration of these species in their dietary niches occurs from September to January. This time coincides with the re-growth of grasses, which during the dry season usually suffers the action of natural or anthropic sources of fire. This also coincides with the

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fruit ripening season. In the same period there is the flight of insects, generating plentiful resources for insectivorous mammals and birds.

Many animals mate during the months corresponding to the dry season. This means they will have cubs in the rainy season. This dynamic of nature reveals the close relationship between the flora and fauna of Cerrado. Unfortunately, the list of animals threatened with total extinction increases every year.

The lack of a serious environmental policy has put the entire natural heritage of this region at risk, due to an intense process of disorderly occupation. The development policy applied in Brazil – mainly in the Cerrado, considered the last great frontier for grain production – has led many species of fauna and flora, which are interdependent, to extinction. Many animals of the mega-fauna (giant fauna) are already extinct, in slow and natural processes imposed by the evolution of nature. Modern animals are being extinguished or close to extinction, in a dynamic provided by human action. Many of these species will not reach their evolutionary climax, since the speed of the degradation process far surpasses the natural phenomena.

Rivers that originate in the Cerrado

The Cerrado, which since the dawn of the Cenozoic period occupies the central part of South America, is also called "cradle of the waters" or "ridge" of the continent, as it distributes the waters that supply the large South American river basins. There are three major aquifers inside its area, which are responsible for the formation and supply of large continental rivers. The best known is the Guarani aquifer, associated with the Botucatu sandstone and other older sandstone formations. It is responsible for the waters that feed the basin of the Paraná River, in addition to supplying some formation rivers that flow to the Amazon basin.

The other two are the Bambuí and Urucuia aquifers. The first one is associated with the geological formations of the Bambuí group, and the second to the Urucuia sandstone formation, which in many places appears superimposed on the Bambuí formation. At certain points the two aquifers meet each other, although there is a huge chronological difference between them. The Bambuí and Urucuia aquifers are responsible for forming and supplying the rivers that are part of the São Francisco basin and sub-basins of the Tocantins and Araguaia, as well as many others located in the area of the Cerrado.

These three major aquifers, stored in artesian water tables, are intercalated in the central part of the plateaus of the South American continent, forming lakes and ponds, known as *águas emendadas*, which flow in all directions, according to the geo-morphological structure that characterizes each space. This is the way the river basins and sub-basins are defined and delimited.

When replacing the original vegetation cover by temporary vegetation, human action prevents rainwater from seeping deep enough to replenish the aquifers.

The water that provides the huge supply to the Amazon River through the right bank springs from the highlands of central South America. The vast majority of the waters of the impressive Paraná Basin springs from the depths of the sandstones of Mesozoic ages, flowing south on the continent. From the top of the Canastra Mountains, joining water coming from the sandstone of the Urucuia formation and water retained in the Bambuí limestone galleries of Proterozoic age, the water of the São Francisco river flows towards the Northeast of Brazil (see "The agony of the São Francisco River").

In addition to these impressive river basins of continental dimensions, there are also waters that sprout in the Cerrado area and generate independent watersheds of great regional importance. Some are so phenomenal that they form unique accidents. This is the case of the Parnaíba Basin, which originates in the Mangabeiras Plateau, supplied with water coming from the Urucuia sandstone, located in the Jalapão Cerrado, in Tocantins state. The Parnaíba River basin is

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much smaller than the others mentioned previously, but is associated with a large transportation of sediments, which are spread over a vast area of the northern coast of Brazil. These sediments, related to variations in tides and trade winds, form dunes, lagoons, the Maranhão and Piauí water tables, extending themselves up to Jericoacoara, in Ceará. When meeting the Atlantic Ocean they form the complex and impressive delta of Parnaíba, which is among the largest in the world.

Another important example refers to the sub-basin of the Gurguéia River, located in the Cerrado of Piauí, responsible for the irrigation of a vast area and the formation of gushing wells, whose water jets have so much pressure that can reach several meters high.

Thus, represented in the form of a complex web, the waters that flow from the Cerrado are responsible for supplying and configuring the major river basins of South America.

These aquifers have been formed over millions of years. However, they have not been recharged properly for some time, in order to sustain the springs. The aquifers recharge occurs through their edges in the flat areas, where rainwater seeps and about 60% of it is absorbed by the root system of the native vegetation, supplying the water table at first, and then slowly storing itself in the deepest water tables.

The intense occupation of plateaus resulted in the removal of the vegetation cover, replaced by temporary vegetation with subsurface roots, thereby inhibiting rainwater from seeping deep enough to replenish the aquifers. Over time, the groundwater level decreases, causing at first the migration of the springs, which leave the higher plains for lower ones, and the decline in the volume of water, until the complete disappearance of the watercourse. This is an irreversible process.

Human occupation

The scenario of the occupation of the central areas of the South American continent started 11,000 years ago (BP). The emer-

gence in the Central Plateau of Brazil of a cultural complex that archaeology calls the "Itaparica tradition" greatly contributed to this event. Around 10,000 years BP, this tradition was already implemented in an area of over 2 million square kilometres. It is quite possible that it covered the area of the central tablelands of Brazil and their extensions. Due to the processes it is associated with, this occupation becomes a reference point of fundamental importance to understand the cultural processes that characterize the dawn of human settlement in the central areas of South America. Around 9000 years BP, or a little later, this culture lost its basic characteristics, represented by the adoption of well-crafted stone artefacts, and started to produce chips with few finishing touches, marking a new trend towards specialization.

Archaeological studies have shown a close relationship between the culture of the Itaparica tradition and the area of the Cerrado. The level of this relationship is evidenced not only by the paleo-ecological management, but also by food remains associated with that culture found in archaeological excavations, and also from the specific spatial distribution of the archaeological sites. Therefore, the Cerrado system is a meeting point among the Amazon region, the Northeast and the South.

The highlands, covered by the Cerrado, are cut by rivers of the three major Brazilian basins (Amazon, Paraná and São Francisco), accompanied by gallery forests of several dimensions. At the meeting of the rivers of the three basins it was formed a greater extent of forests, known as Mato Grosso of Goiás. The areas of forests provide suitable soils for crops, to be cultivated at the beginning of the summer rains. The Cerrado is very rich in hunting animals and a large variety of fruits that can complement agriculture at the beginning of the rains, while rivers provide plenty of fish at the beginning of the dry season.

The contact of the traditional indigenous populations of the Cerrado with white man from the eighteenth century onwards was catastrophic, with enslavement and new diseases.

Long before the potter-horticulturalists, hunters and preceramic collectors had spread throughout the territory, using the resources according to their needs and in accordance with their technology. There is no knowledge of when and how the crops were implemented. Apparently they were not implemented in this area initially, since the different technological traditions studied so far belong to wider horizons, and the oldest dates of

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The Cerrado is one of the oldest environmental matrices of the recent history of the planet. It has already reached its evolutionary climax. Once degraded, it will never be recovered.

settled horticulturists are found outside the region. The Uru tradition is an exception, so far only found in western Goiás, but which certainly spills into Mato Grosso, but still not fully analysed. Crops could have come through the migration of horticultural groups or the acculturation of hunters and collectors previously settled in the region, who could have received them as neighbours. It is possible that both phenomena have occurred.

It is no longer possible to summarize the entire population game in movements of set groups, since the question remains: where did they come from? Of course, as in the other regions of the world, farming systems developed by indigenous people such as the ones from Central Brazil are the end result of a long process of experimentation, collection, cultivation and domestication, development and lending of techniques, and an adjustment of the society. Perhaps the transition from the hot and humid period of altithermal 7000 years BP to a drier and milder period was the time of this change. The fact is that for the central region of Brazil the entire process is still completely unknown. After the ancient hunters are suddenly discovered, established at the time of the pottery-horticulturist groups, at a time when the environment was supposedly the same as the present one.

The different traditions (ceramics) of horticulturists explore different environments and cultures. The Una tradition colonizes hidden valleys, usually not very fertile, with Cerrado predominance, using shelters and natural caves as housing, and as economy system a strong association of crops, predominately corn, with hunting and gathering. It is believed that the population was distributed in small societies, more capable of explore the diverse resources. Regarding their settlement locations, they could reach the nearby river, the small gallery forest, the Cerrado, and often the fields at the top of the plateau. This environment was not disputed by the groups that built their villages in open areas.

The first known villagers are from the Aratu / Sapucaí tradition. Their domain areas are the low foothills of south-central and eastern Goiás mountains, especially the fertile and more forested areas of the former Mato Grosso of Goiás, where they could implement an economy more heavily dependent upon farming, but probably not abandoning the fruits of the Cerrado, hunting and fishing. Their population was

large. No other group managed to infiltrate in their territory. Their populous villages could remain for a long time in the same place, and they could move to a nearby area whenever they wished, since the land was fertile and was under their rule. The cultivation system, based on tubercles and probably on corn, also managed to resist the advances of the cassava groups from the Uru and Tupi-Guarani traditions.

The Uru tradition comes later and dominates the mid-western state of Goiás. Moving forward along the rivers, they occupy the lower ground, probably of little use to the villagers who had settled themselves earlier, but important to them because of transportation needs, and mainly for fishing. Thus it was created a very stable border between the two groups, maybe not always peaceful, where apparently the Aratu tradition was more receptive, accepting selected technological elements, not including cassava and its transformation process, which was only accepted in restricted areas.

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The Tupi-Guarani tradition seems to be the most recent of villager populations. This group considerably dominated the valley of the Parnaíba, from where it moved towards the affluent rivers, camping in shelters previously inhabited by the Uru tradition. It also owned scattered villages in the Alto Araguaia basin, apparently with little autonomy, coexisting sometimes in the same village with horticulturists groups from other traditions. The Tupi-Guarani villages in the Tocantins basin were even more scattered and recent, as if they really were – as one might imagine – people who arrived in the colonial period. Thereby they would have faced not only the other indigenous villagers settled earlier, but also the white colonizers that would have brought the indians.

Perhaps with the exception of the Tupi-Guarani, the representatives of other traditions lived in the territory for centuries with no significant movement, as if the land belonged to them. There were between seventy and one hundred generations of horticulturists without major changes, other than the new adaptations of frontiers, where older populations accepted new technologies.

And so they lived until the day that a very different kind of man burst into the area in large armed groups. These men were not interested in planting, harvesting, hunting or building villages between the Cerrado and the woods, or on the edge of the

pond or the river. They wanted nothing more than to take people, precious stones and gold. Take them far away. These were the first years of the eighteenth century.

It was chaos. Fields were pillaged, villages were destroyed, women were raped, and cultivated land was invaded. People died of unknown diseases. War was the solution dictated by despair; defeat, settlement, demoralization, extinction or escape was the consequence.

Ideas for the history of the generations that followed the indians

Of all the great Brazilian bio-geographic systems, the Cerrado is the one which has undergone more change in recent years. Not only changes in production techniques, but other deeper ones. They are affecting the very life system of people, disrupting their cultural values and often causing a void, lacking something new to fill the space left by the elements that have been or are being decomposed.

The former urban centres, almost all of them originated around mining activities, especially those from the early eighteenth century, find themselves suddenly transformed by regional centres for innovation and agencies of "radical change" with their systems and numerous services, almost all of which are directed to agribusiness and with short-sighted concerns.

The creation of Goiânia and later of Brasília, in parallel with the development of the road system and the agricultural modernization process, has contributed to a certain radicalization in the changes of the previously structured factors, breaking their more traditional features into pieces. Due to the isolation of certain areas, some old models of human-environment interaction persist to the present day, as certain enclaves of western Bahia, south of Piauí and Maranhão, in many spots of the Paraná area and the right bank of the Tocantins river. With the implementation of this new state and the construction of its capital, Palmas, a new "wave" of significant changes has already begun, bringing its predatory consequences.

Until recently, the areas of the Cerrado bio-geographical system were not highly valued or sought after for the implementation of large agro-pastoral activities. The parts more intensely occupied were restricted to subsystems of forests, i.e. forested areas within the system and are always associated with good naturally fertile soils. Therefore these areas were the first ones to suffer the impact of a stronger degradation. On the same level, but to a lesser degree, we can mention the areas that compose the Cerradão subsystem and the gallery forests.

The other areas which compose the major surfaces of the system, such as the subsystem of the Cerrado *stricto sensu*, the fields, the riverbed and wetland environments, due to the characteristics of their soils that did not facilitate an immediate intensive occupation. For this reason they were not wanted for intensive agro-pastoral activities. They were occupied by the extensive breeding, which was supported by a native pasture, the food content of which subject to seasonality. The use of limestone to correct soil acidity, the introduction of the plow and mechanical deforestation systems, and also the easy implementation of irrigation systems transformed these areas – previously unsuitable for agricultural activities – into productive land. In parallel, the replacement of native pastures by foreign species radically modified the pastoral scenario.

This new model of occupation caused visible impacts on the environment, which can be characterized as follows:

- Genetic impoverishment;
- Impoverishment of ecosystems;
- Destruction of natural vegetation;
- Spread of exotic plants;
- Extinction of native fauna;
- Reduction and pollution of water sources;
- Compaction and erosion of the soil;
- Chemical contamination of waters and biota;
- Proliferation of unknown diseases.

Acting together, these factors generate countless others, which, in turn, act as agents to attract population and significantly modify the environment. The energy demand is an example, requiring the formation

of large reservoirs and power plants, creating numerous direct and indirect working fronts, which cause social and natural far-reaching entropies.

Thus, at the beginning of the 21st century the fate of the Cerrado is a big question. It is not possible to know if the next decades will bring its ruin or salvation. Although there are large gaps in our knowledge, we have enough information to prevent an irreversible degradation.

As long as the desire to exploit the Cerrado has foreign roots, the possibility of a rational development program will be zero.

It is also important to note that the Cerrado is one of the oldest environmental matrices of the recent history of the planet. It began in the Cenozoic period. This means that this environment has already reached its evolutionary climax. Once degraded, it will never recover the fullness of its biodiversity. Most of the Cerrado plants have a slow development. Some take centuries to achieve plenitude, which makes it almost impossible to perform a vegetal restoration plan. In addition, these plants are subject to a kind of oligotrophic soil with specific water balance, which is hard to find in equilibrium today in the Cerrado.

The environmental degradation is not measured only by the occurrence of one or another plant. We must consider both plant and animal communities, including pollinating insects, water etc. Today, none of these exists in the Cerrado in a continuous basis. There are only fragments representing a small part of the total area.

Dysfunctional communities cannot find stable jobs in the urban centres and are exposed to increasingly degrading social trajectories.

A new territorial matrix was implanted in the bio-geographical system of Cerrado from 1970 onwards, with roots and predatory consequences. It was a matter of time for the environmental problems to appear and get worse. The current issue of the disappearance of small watercourses, suppliers of the largest ones, is just the tip of an iceberg that tends to become increasingly evident.

Cerrado is included in the Brazilian political planning as a region of expansion of the agricultural frontier, driven by predatory practices, which causes an appalling scene. The total removal of the vegetation cover will decisively affect the recharge of the currently low aquifers, and their reserves will reach a critical level, since rainwater that manages to penetrate the soil will be absorbed immediately due to the arid condition of these soils due to the heat. For the same reasons, the little moisture retained evaporates quickly. At first, there will be attempts to overcome the problems arising from this situation, with the construction of dams, in contour-lines and small reservoirs to retain rainwater. However, the environments resulting from this process have a benthic character, which causes claylization and the subsequent sealing of the bottom of the wells. Associated with the intense heat, it will be futile, swallowed up by evaporation.

There are many cases of illegal occupations (*grilagem*) of land in the bio-geographical system of the Cerrado, causing a phenomenon called deterritorialization, which brings to the current reality the category of the "-less" people (landless, homeless, jobless, undocumented, etc.). This phenomenon accentuates the feeling and the alienation of the population. Banned from their lands by powerful people by the purchase and falsification of land titles, the settlers, who had lived for generations on non-legalized ground, seek shelter in urban centres or at service stations deployed along the road systems, which have experienced sudden growth. In these places, landless people also turn into homeless ones.

In the urban centres, this social category occupies the peripheries, the floodplains, hillslopes, etc. Families build their lives and their space in these places, characterized by social and environmental disorder. They live their lives in this way, until one of the natural cycles causes, for example, a heavy rainfall.

The agony of the São Francisco River

The headwater of the São Francisco River is located in the Canastra Mountains of the Cerrado of Minas Gerais. The river flows for more than 3,000 kilometres to its mouth. Along the way, it increases the water volume mainly with the suppliers of the left bank, which form the sub-basins of the Paracatu, Urucuia, Carinhanha, Corrente and Grande rivers. All these rivers and their smaller suppliers are dying by the hour. Some of them have already disappeared forever.

This is because the two major aquifers that give birth to the São Francisco River and supply it along its route are drying out. In order to understand this situation, it is necessary to travel back in time. At least 45 million years ago the Cerrado acquired its current features, a vegetation that owns a complex root system and, therefore, began to hold the rainwater that fell mainly on the plains of northwestern Minas, western Bahia, Federal District, northeastern Goiás and part of Tocantins. These waters are initially stored in the decomposed rocks that form the water table; then, due to their abundance, they are infiltrated in the cracks of the subsoil rocks and settle in the deep water tables, which form the Bambuí aquifer, from the Proterozoic age, and the Urucuia aquifer, from the Mesozoic age.

When the aquifers retained enough water, it began to shed in the form of springs, especially on the foreheads of the mountains, and in the shape of small lakes in the flatter areas, forming the riverbeds. Over time, the waters, as miraculous tears, began to drain towards east, supplying the gutter of its main conductor, the São Francisco River. Thus they formed landscapes, probably wonderful ones. Ponds and swamps were generated, where the fish population grew, species that were once abundant, not only in the São Francisco River, but in all its tributaries.

The tributaries of the left bank are the main responsible for the perpetuation of the São Francisco River, for its oxygenation and, ultimately, for its headwater and existence. The water stored in this large geographical area is extended from the Canastra Mountain, to the south, to the Mangabeiras Plateau, to the north, and is limited to the west by the Espigão Mestre (Master Spike), separating Goiás and Tocantins on one side, and Minas and Bahia on the other. These rivers are perennial throughout the year. Until about thirty years ago their volume was at le-

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ast five times greater than the current one.

Since 1970 the areas of the plateaus, where are the springs and average courses of these rivers are found, have been undergoing a major transformation, with the removal of the natural vegetation cover for the production of grains and other exotic plants. This has prevented the normal recharge of aquifers, contributing to the disappearance of many small tributaries and the drastic reduction in the volume of the largest courses.

Most of the tributaries of the right bank of the São Francisco River are formed by temporary rivers, which tend to disappear in the dry season, as they do not originate from aquifers. They depend on the water stored in the thin water table, which rests on nonporous rocks that compose the São Francisco craton. As the water table depends on rain water and vegetation, deforestation associated with a period of prolonged drought affects it completely. The most important river on the right bank – the Velhas River – is not temporary, since it comes from the Bambuí aquifer.

The removal of the natural vegetation cover of the Cerrado has influenced the life of the São Francisco itself, since it depends on extremely complex and interdependent ecological factors. Therefore, the disappearance of its hydrographic suppliers is happening at a very fast pace.

Tremendous floods will occasionally occur, caused cyclically by natural phenomena such as El Niño and La Niña, but that does not mean the river will have revived. They are ephemeral phenomena, caused by floods resulting from downpours moving through the old ways of the water.

What happened to the vegetation is also happening with the animals, including the pollinating insects, which are in a severe process of extinction. And the aquatic fauna of the São Francisco, which used to be abundant, with various species of fish that satisfied the hunger of coastal communities and kept dynamic trades, is already severely damaged.

The whole hydrographic system of the basin will be drastically affected when the current project for the transposition of the São Francisco River is completed. The finalization is scheduled for 2017, supplying two large adductor axes and other smaller axes, in line with the overall operation of the sucking pumps installed in Cabrobó and Itaparica. The dynamics of the great river and its entire basin, formed by senile rivers which have already reached a state of equilibrium, will also be dramatically affected.

The consequences of the transposition will be harmful. In short, it will lead to the death most of the tributaries of the São Francisco, including the river itself. With the changed dynamics, the transportation of sandy sediments will increase alarmingly, creating, among other consequences, the silting, since most of its tributaries flow through the areas of the Urucuia formation, the main characteristic of which is loose sandstone.

In the model it has been presented, the transposition will also increase the speed of the rivers in their main channel. This will cause in all the tributaries the phenomenon called "suction of the aquifers", meaning that they will be aspirated in a greater speed to supply the rivers which are now faster since their higher courses, transforming them into intermittent water streams.

When rain falls on the hills, the soil becomes saturated and the water accumulated in the water table can be stored in a non-porous rock of the substrate, forming an aquiclude that bursts with great energy, dragging everything that lies in its path. When the increase in rainfall fills the rivers, they overflow and take back their floodplains, now occupied by shacks. The consequences are destruction, death, diseases and the source of a social situation even more perverse.

In urban centres, the dysfunctional communities cannot find stable jobs to grant them better future prospects. Lost and needy, immersed in a strange environment, they are easy prey to misleading advertising, the stimulator of consumerism. They also become hostages of a music industry that imposes songs that accentuate the situation of depression and alienation. Unable to enjoy the advertised goods, many of them start living in an existence with no rationality. They dive into the neurosis of escapism through hallucinogens or try to obtain goods by means that the organized society classifies as illegal acts. The breakdown of the family, child prostitution and the dispassion for life are some of the consequences dictated by this despair. ■

Complementary reading

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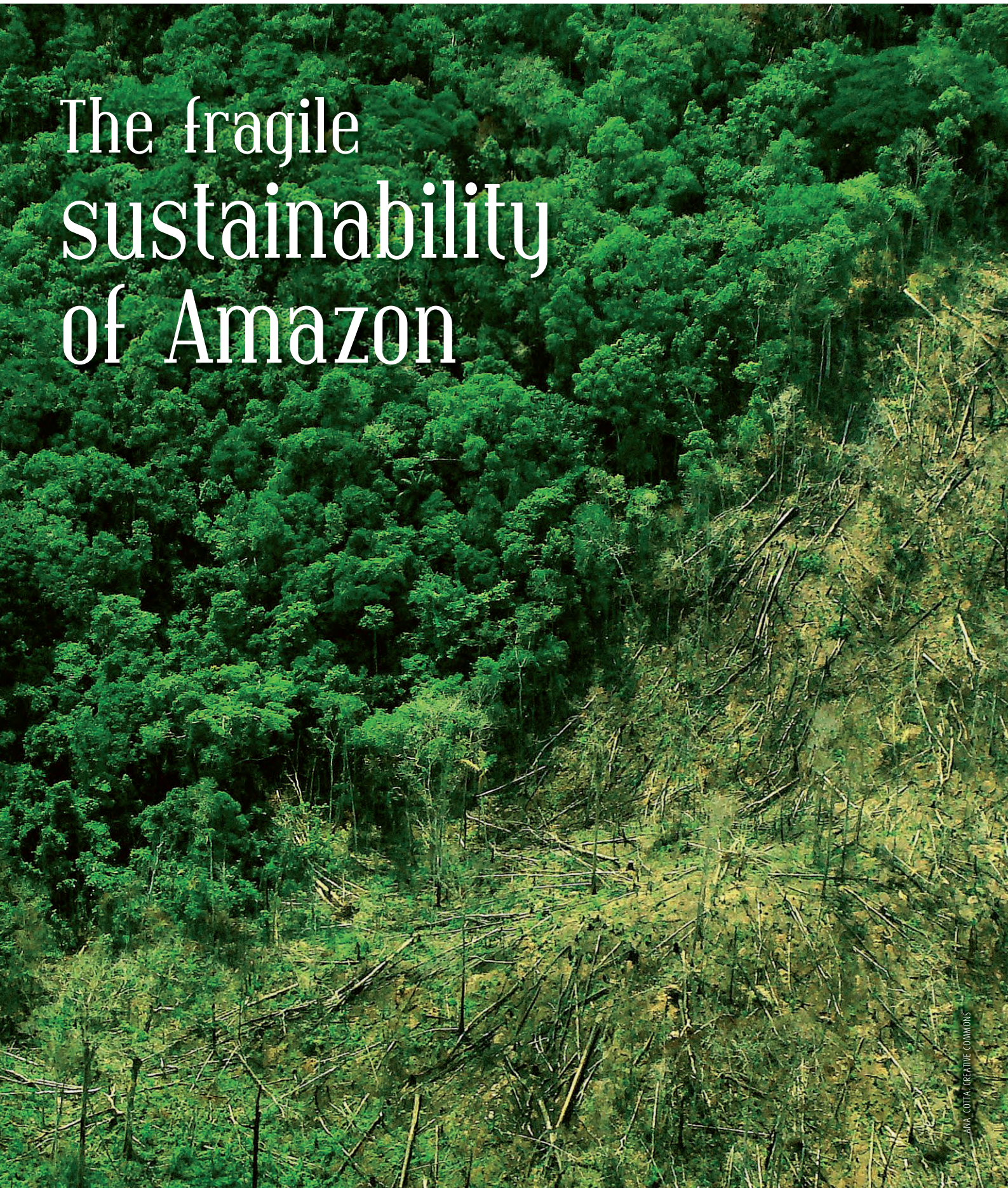
The fragile sustainability of Amazon



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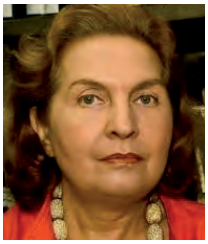

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The relationship between the Brazilian State and the Amazon has been caught up in a web of serious mistakes for decades. Abstract ideas about progress and development at any cost, treatment of local populations as backward and incapable, and thinking that the exuberant local nature is an inexhaustible source of resources are among such mistakes. This has led to the multiplication of enclaves to export raw materials or energy, which only feeds social chaos and environmental destruction. This colonial-type relationship must give way to a regional development project, redesigned and supported by different grounds.

Between 1967 and 1973, the so-called "Brazilian miracle" occurred. During this period, GDP growth rose from 4.2% to 14% per year, and inflation fell back from 25.5% to 15.6% per year, which was an economic success, since in the previous decade it had reached much higher levels (Veloso, Villela and Giambiagi, 2008).

By virtue of these and other thoroughly-disseminated economic data and the new ideology of development, the fact that the regional model reproduced a "dualist" version of Brazil went unnoticed: it created both wealth and poverty, recreating a poor Amazon at one end of the social structure and a rich and flourishing Amazon at the highest social strata and business groups. At that time, influenced by the ideology of progress, the impact of actions developed by the technobureaucracy and the government discourse distorted the nexus of perception and understanding between government and society. The "maximum possible consciousness" (Lucien Goldmann, 1972) that civil society realized from the existing public policies was a utopian promise of development.

The intelligentsia always resented the "backwardness" of the Amazon, compared with the rest of Brazil: the *caboclo* and indigenous origin of most of the population, the life in the woods or in cities surrounded by woods, in a locus distant from modern Brazil. The resentment was such that announcement of progress sounded like a release from prejudice, illnesses and poverty. The local intelligentsia did not assume a critical role unsuccessfully decoding the government's political message. Thus, they did not realize the reproduction of the "dualistic" model that governments of the time (and subsequent years) would implement in the region.

Criticism of the dualistic reason, a classic study by Francisco de Oliveira (1972), would be released at the end of the "miracle" period, referring to Brazil seen as a whole. But the process could be extended to describe the country's relationship with its regions and social strata. That study contradicted the traditional analysis of difficult Brazilian development, which showed the regional or social poverty as a result of the absence of structural conditions (in the structuralist version) or the difficulty in transforming the industry into the key sector of the economy (in the view of Cepal). There was also a version from the theorists of dependence, for whom the underdevelopment depended on multiple conditions: structural difficulties, articulation in markets controlled by large eco-

nomic corporations, technological dependence, transfers from international capitals and their connections with national capitals of the peripheral countries.

None of these theoretical lines analysed in depth the "perpetual motion" represented by the Brazilian public policies that, aiming at development, progress and modernization, engendered policies that favoured social classes and groups who held the capital, thus reproducing the dual situation of society (poor/backward *versus* rich/modern).

Francisco de Oliveira shows that the poor sector is a result of the structure proposed by governments to create a modern and rich sector. It became a classic for demonstrating how the Brazilian public policies subsidize "modern" and rich sectors, and how they take possession of the energy and labour of the poor and "backward" sectors of society. The mechanisms of appropriation of the surplus generated in certain poor, "backward" and "non-entrepreneurial" regions and populations generate the accumulation of capital held by the rich and "modern" social strata and regions of the country. This is not a perverse characteristic of governments and business elites of Brazil, but an intrinsic mechanism of the nature of capitalism. This system is cruel when there is no organized civil society playing an active role in public life, in order to overcome the effects of such selective policies.

This was precisely the mechanism which public policies began to deploy in the Amazon since 1966: entrepreneurs, farmers, miners and loggers received subsidies and other privileges granted by the State, taking possession of a collective asset, the nature of the region. With the mobilization of these resources, they created the "modern" sector, and at the same time perpetuated the "backwardness" and the poverty of the local populations, considered incapable of having an "entrepreneurial spirit".

Between 1966 and 1985 the central government implemented a dynamic and rich industry, a commodity producer. In the early years, the "poor" sector was encouraged to act as workforce for the "modern" sector. Then migrants came hoping for better prospects came on their own. The Amazon became a border of peasantry, with a large migration of landless workers from the Northeast region and small landowners from the South: they were the poor classes redoing the "backward" Amazon. At the same time, the federal government implemented the "modern" sector (power plants, ports, airports, roads, towns etc.), seeing the region as a border for expansion of capital. Businessmen from other regions were attracted by several factors: profitability expectations, incentives from governments, cheap land, legislation friendly to large enterprises, and scarce environmental inspection. The simple exploitation of the rich forest cover made viable the business projects.

There, legally or illegally, they devoted themselves to unsustainable activities: exploitation and export of wood; cattle ranching; mineral exploration; or deployment of basic steelmaking processes. This business layer and its associated services stimulated the "modern" Amazon.

The region continues to attract poor and vulnerable groups, banned from their original regions, maintaining population growth at very high levels.

This model of public developmental policies remains in force in the region with the same format until today. It hinders the environmental and social sustainability, and reproduces poverty, concentrating income in a single pole of society.

This type of policy discriminates the poor and "backward" strata, prevalent in the local society. First of all because public policies incessantly reproduce the dual model, and also because this region attracts poor and vulnerable groups, arriving as migrants, banned from their original regions and stimulated by the ideological discourse of successive governments, who talk about progress, development and opportunities for a better life.

Between 1975 and 1994, years of crisis, the population growth of the states from the North Region (which includes the seven fully Amazonian states: Amapá, Acre, Amazonas, Pará, Roraima, Rondônia and Tocantins) was the

fastest of the country: the local population was multiplied by five, from just 2.5 million in 1960 to almost 16 million in 2010. In states such as Rondônia, the average annual growth reached 16% per year in the 1970s and almost 8% in the next decade, much higher than the average percentages recorded in the country. In the first decade of the XXI century new migratory fronts were still coming to the region, keeping the population growth at very high levels.

Threats to the environmental and social sustainability

The decision of developing the Amazon through the production of commodities brought serious risks to the environmental, economic and social sustainability of the region and the country itself.

a) The impact of livestock and vegetal commodities

The increased populations, settled within the region or in cities, began to put great pressure on natural resources. However, the most serious environmental impact in the region came from the destructive character of the extensive cattle farming, of logging (which precedes the preparation of pastures or is disconnected from it) and of the vegetal commodities. Currently Brazil has about 200 million hectares of pastures, 70 million of them in the Amazon. Most part of these pastures is implemented in areas originally covered by forests, although the region has abundant natural pastures in solid ground and in lowland soils, where livestock farming was practiced in the past. They are around 70 million head of cattle reared on extensive production, with only one animal per hectare (Meirelles Filho, 2014), while in other regions it is possible to accommodate three to six animals per hectare of pasture, when it is fertilized and pasture rotation is applied.

The more intelligent and productive use of prepared pastures and the recovery of pastures abandoned for degradation would avoid further deforestation[1]. However, due to the low price of land and associated reduction of taxes, farmers of the region do not consider the possibility of raising the quantity of animals, which would demand the treatment of pasture. They abandon it as soon as it becomes unproductive. Due to the well-known fragility of the Amazonian ecosystems, it occurs in a few years, especially for the loss of the forest cover that enriched and protected the poor soils, which wear out when exposed to the sun during the Amazon "summer" (period of drought) and have their nutrients removed by the heavy rains of the "winter." It is estimated that around 25% of deforested lands are abandoned and/or degraded (Presidency of the Republic/Civil Household, n.d.).

The myth of the regenerative capacity of the Amazon rainforest fell apart a few years ago, regardless of any study, with the simple observation that the pastures settled in the 1970s and 1980s were already degraded.

In 2013 around 762,979 square kilometres of forest had been deforested – it is equivalent to 18.85% of the original forest[2]. The felling of native trees in the region continues. Imazon (2009), an institute of environmental studies located in Pará, identified 2,226 active logging companies. They extracted 14 million cubic meters of roundwood, which means that about 3.5 million trees were cut. The activity generated 204,000 direct and indirect jobs, with approximate revenue of nearly R$5 billion.

Between 2011 and 2012, at least 78% of the logging in the state of Pará was illegal, with most part of the wood exported to Europe and the United States (Imazon, 2012-2013). The main culprits for deforestation are cattle farming, logging, charcoal production for mining companies and steelmakers and the vegetable commodities – exactly the sectors considered "developed" and "modern" in the region.

According to Inpe/Prodes, between 2001 and 2002, when deforestation was already forbidden, 25,500 square kilometres were deforested. Between 2004 and 2012 deforestation was rather low, around 4,700 square kilometres per year, which shows a considerable effort from the federal government. Even so, it is a significant and unjustifiable number, now mainly caused by the expansion of vegetal commodities (soy, palm, dendê and others). From 2012 on deforestation rebounded: the region lost 5,891 square kilometres in 2013, 5,012 square kilometres in 2014 and 5,831 square kilometres in 2015 (Inpe, 2015).

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The forest emanates dense layers of steam and humidity - without which, entire regions of Brazil would be desert. It is not enough to achieve zero deforestation. Deforested areas must be reforested.

At the time of the Amazon "summer", the forest emanates dense layers of steam and humidity, transferring water to the atmosphere. These moisture-laden air layers move in large volumes to many areas of the continent – through the so-called "flying rivers" – some of them as far away as to the East and the South, causing heavy rains. Without the forest, these other Brazilian regions would be deserts. This link between the Amazon and the rest of Brazil shows that it is not enough to achieve zero deforestation. The deforested areas must be reforested (Nobre, A.D., Salati, E. et alii, 2014:14).

Since the 1990s the production of vegetal commodities had been growing in the Cerrado, in the Midwest, towards the lands of the Amazon biome, initially in areas already deforested, and then moving towards forested areas. In 2006, as a result of pressure from international and national entities and the Brazilian government itself, representatives of large producers, processing industries and soy exporters signed an environmental agreement (called "soy moratorium") and undertook neither to acquire nor to export soy produced in the Amazon. The agreement has been renewed and since then the soy cultivation has not significantly expanded in the Amazon biome. However, it continues to be expanded in the Cerrado biome, which is not encompassed in the agreement and where 63% of Brazilian soybeans are produced (Embrapa, 2013).

This form of destructive exploitation of natural life to which are submitted the Amazon and

Cerrado, and which exposes future generations to the risk of living in poor conditions, is held under support of the federal government, which despises the environmental risk. The major regional investment bank - Banco da Amazônia - directs most of its resources to finance agribusiness monoculture in a mega-biodiverse region, which cannot withstand the homogeneity demanded by the market. The expansion of these commodities benefits a small number of sectors of the Brazilian society.

b) The mineral *commodity* enclaves

The irrationality of the economic model forged by the Brazilian government for the Amazon has a second branch: mineral commodities. In 1979, the Rio do Norte Mining Company (owned by Alcoa and Vale), which currently exports 6 million tons of bauxite per year, performed the first shipment of bauxite for Alcan in Canada, beginning what has been called "modern" steel industry. There began the intensive mining and steel industry cycle, based on production and export of semi-finished products. In 1985 the then President José Sarney visited the company. The Batata Lake, one of the great and beautiful lakes bordering the Amazon River, showed a reddish and almost solid surface due to the tailings (corresponding to 1/3 of the extracted material) deposited on it by the mining company in just six years of operation. The shocking images of an almost Martian landscape were widely disseminated in Brazil and worldwide. To complete the bleak picture, bauxite was heated in furnaces operated with charcoal extracted from the dense forest of the banks of the Amazon and Trombetas rivers, the latter one of the most beautiful rivers in the area, populated by turtles that nest on the local beaches. Currently the mining disposes annually 5 million tons of solid waste in dams, built after the intervention of the federal government in the project. This is the mining and steelmaking model deployed in the Amazon, currently with some not very substantial changes (Pinto, 2015).

In addition to the over-exploitation of mineral resources, which creates huge craters where mosquitoes proliferate and that become hazardous waste basins, there is also another harmful aspect. This type of project works as an enclave and does not internalize benefits in the region. Semi-finished products and materials *in natura* are immediately sent abroad, where they are transformed into finished industrial products, generating jobs, income, taxes and social benefits outside Brazil.

Pará, the largest producer of primary minerals in the Amazon, contributed in 2013 with 36.8% of the trade balance of the mineral sector, accounting for 72% of exports of copper and 29.3% of iron ore, besides aluminium, alumina, bauxite, kaolin, manganese, limestone, gold and other minerals in smaller percentages (Ibram, 2013). In 2015, despite the Brazilian economy already in recession, Pará was the third state in terms of trade surplus, reaching 9.3 billion dollars in exports, mainly of iron, copper and alumina. Only Minas Gerais (13.2 billion dollars) and Mato Grosso (11.7 billion), also major producers of commodities, got better results.

Among the main products of Pará export basket, ranked by income in dollars, are brute iron ore, copper ore, calcined alumina, aluminium, ferronickel, bauxite, kaolin, pig iron, manganese, aluminium hydroxide, tin ore, live cattle, soy, timber, beef, black pepper (Fapespa, 2015: 10). The analysis of this agenda demonstrates the predominance of commodities of the so-called "modern sector" of the Amazon. It is amazing to note the importance of the export of live cattle and timber, products which demand no processing.

c) Energy, the most recent *commodity*

Since the 1980s, the Brazilian government chose the Amazon as a source of resource exploitation, in view of the balance of trade. Two basic activities have been encouraged, the first one requiring the latter: (a) the exploitation of minerals (the region is the largest and most diverse mineral province of the planet) and (b) the production of electricity for the regional mining and steelmaking industries, as well as to supply power for the rest of the country.

Since that decision, the Amazon is no longer a reason in itself to be converted into deployable resource for the country; its watershed and its nature in general left the pages of geography books and the human landscape so as to become but raw material, with

prices quoted in national and international stock exchanges.

The production of electricity in the region was advocated for the first time in 1987, in the 2010 Energy Plan, later re-presented as 2015 Energy Plan, with no significant changes (Ministry of Mines and Energy / Eletrobras). The plan was supported by a basic principle, the preferential option for hydroelectric power, and by an assumption, the need to generate energy in the Amazon to develop the country. For this reason the federal government planned to implement 79 large hydroelectric plants on the mighty Amazonian rivers, in order to generate enough power for mining and steel companies settled or planned in the region and ensure the energy supply to the South-Central region. There were no execution deadlines set, but some plants have already been built and six of them are under construction or being finalized. If all of them are built, they will flood about 10 million hectares, or 2% of the region, in forested areas.

The construction of hydroelectric plants in the Amazon causes problems of different orders. Tucuruí (with 11 million MW, the fourth largest in the world) is a paradigmatic case, but Balbina (AM) and others presented a similar range of problems. From the energy generated by Tucuruí, 1/3 goes to mining companies and regional steelmakers, with subsidized price, 1/3 is distributed specially for the Central-South region, more developed, and 1/3 stays in the area, where consumers are penalized by high prices, established to cover subsidies to mining companies and offset the additional costs to the operation of power plants in the South and Southeast regions, activated in periods of drought in those areas. The system is unfair, absurd and paradoxical. In these periods of higher tariffs, the reservoirs in the region reach their maximum water level, since the dry season in the South and Southeast coincides with the Amazon "winter", the period of greatest rainfall. To complete the range of financial problems, the original cost of the plant construction was multiplied by four, not including the additional works (which were made over the following years) and the floodgates.

As Amazonian rivers flow into the plains, in order to dam enough water to produce the energy amount planned for Tucuruí, it was necessary to form a lake with 2,850 km², which drowned a huge area of biodiverse forest and caused the death of hundreds of thousands of animals. This was not the only environmental impact: with the river damming, numerous aquatic species that lived upstream and downstream of the dam disappeared; since the trees were not previously removed before the filling of the lake, the country lost millions of cubic meters of precious wood, because the flooded area was originally covered by a high, rich and dense forest; the drowning and rotting of the submerged trees caused a plague of hematophagous flies and a strong gas emission. After that, there was a plague of malaria, which seriously affected a great part of the population of Tucuruí and ten neighbouring municipalities (Couto, 2004). Residents of areas around the dam had to abandon their land, since the quantity of mosquitoes and flies made human permanence impossible in the area. This situation lasted for several years (INPA / CVI / UFPa / MPEG et al, 1990).

The idea that traditional populations are backward, primitive, bearers of a poor culture and an obstacle to development must be overcome.

The Tocantins is one of the mightiest rivers in the region, and its damming was a serious economic and social problem, preventing the river navigation in an extensive section. The floodgates were built only 35 years after the dam, and even then, according to experts, they were placed in an inappropriate location that required very expensive work. (G-1, 2016).

In addition to environmental liabilities, the hydroelectric plant caused social discomfort and economic chaos: the population of Tucuruí grew from about 10 thousand inhabitants in 1970 to 111,000 in 1991, according to the Demographic Census. Immigrants went to the region searching for jobs and a better life, but most of them became unemployed after the end of civil works. Many years after the completion of the works there were no educational, health, safety and garbage collection services

to serve this population, which had grown absurdly fast. The federal government only estimated increasing of services for employees who would operate the plant. Only 1,400 of the 10,000 families relocated from the flooded areas had been settled in urban areas, according to Eletronorte itself. The remaining ones settled in shacks on the outskirts of the city and fifteen years later still claimed their rights, which the company and the government either denied or tried to negotiate to the detriment of the relocated families.

Before and after the dam construction, minority rights were violated, especially those of the Indians affected. In the face of numerous complaints and ignored by the authorities, the Brazilian Anthropological Association (ABA) sent anthropologists to raise the problems and subsidize support and protection actions to the various affected indigenous groups: the Guajajara and the Gavião Parkatejê had their lands crossed by the Carajás railroad and a federal road, facilitating the invasion of squatters (the Carajás Program was being implemented at the same time, and the plant would be of fundamental importance for it); the Awa-Gurupi and the Guajá, who were unsociable at the time, had their lands affected in the same way; the Krikati had their area occupied by 104 farmers who brought legal actions requiring the ownership of the indigenous land they had occupied! The Gavião-Pykobjé complained that a part of their area had been occupied by farmers and small squatters. The land of the Assurini was crossed by a road and later invaded.

The situation of the Parakanã, in Tocantins, was even more serious. The impact on them had already begun in the early 1970s, when the Trans-Amazon highway crossed their land. Some parts had been invaded by Northeastern settlers who were looking for land in the Amazon, forcing the indians to move for the first time. Later, part of the forested areas of the Parakanã was covered by the flood-

BRUNO HUBERMAN. CREATIVE COMMONS

FOTO: EMÍLIA SILBERSTEIN. CREATIVE COMMONS

PAYGOMUYATPU MUNDURUKU. CREATIVE COMMONS

ing of the lake, for which the volume prediction had been erroneous. They were transferred to a much smaller area, poor in fishing and hunting, which caused a conflict with the Araweté, who used to seek food in the same area. The impact required a new removal of the Parakanã. However, the area where they were taken to was even smaller than the first one, and had been partially occupied by farmers and squatters. The plants under construction or nearing completion entail very similar problems to those of Tucuruí and Balbina.

When the first steel mills began to settle, there was an increase in the problems of the 23 indigenous groups distributed in the grounds of a large area covering parts of the states of Pará, Maranhão and northern Goiás. All of them had conflicts with managers of the settled or planned projects. They were hampered by the steel mills, by the invasion of their forested areas for extraction and production of vegetal charcoal of native forest, which impoverished the fauna and flora; by the iron mine (Companhia Vale do Rio Doce), by roads, villages and new settlements that emerged in the immediate vicinity, by the invasion of their land by farmers and settlers.

There are large mineral reserves in the Amazon[3], but a considerable part of them is located on indigenous land or in conservation areas. If the exploitation of these resources remains as it has been done, disrespecting the environment and giving little or no attention to the people of the affected areas, the current model of intensive exploitation of minerals may expand and aggravate social conflicts in the region, which are already quite numerous. They oppose people who consider the land as an element of life and work on the one hand, and groups who understand it as a resource for exploitation and accumulation on the other.

The conflict has been a permanent feature in the Amazon life, not just around the conquest of the land and its assets, but also because of the idea, present in the Brazilian society, that traditional populations are backward, primitive, and culturally poor. They would be an obstacle to development and would benefit by integrating into urban and "civilized" society, handing their land over to so-called modern, "rational" and cost-effective activities.

From this point of view, indigenous lands[4] were but a temporary situation that would disappear as the indians (and the *quilombolas*) are assimilated by the national society, diluting themselves only to erase the "backwardness" and "primitivism" that make them different and drive them away from the civilized standards of modern society.

Reproduction of poverty

The concentration of income due to the preferential option for the economic model based on regional enclaves – poorly connected with the domestic market and the life of local human groups – has a double face:

the profits are absorbed by the federal government and major economic groups, owners of the mining and steel activities which are harmful to the rest of the population. The few benefits that this kind of enclave internalizes are concentrated in a few municipalities, considering that the royalties they receive do not bring considerable benefits and are not spread to municipalities around them. In Pará, for example, although several municipalities have mining and steel activities, only Parauapebas concentrates more than 53% of total exports of the state and presented the highest surplus in the Brazilian trade balance in 2013 (Fapespa, 2015:7).

Pará is the state which received the largest investments in mining, steel and a wide range of commodities in Brazil. Moreover, it has the fourth most powerful hydroelectric plant in the world (Tucuruí). Even so, only Belém presents an IDMH level (Human Development Index of Municipalities) above the national average level (UNDP, 2013), which is low. No wonder, therefore, that the Atlas of Human Development (UNDP / IPEA / FJP, 2013th) pointed that from the 56 municipalities with the lowest living standards, 43 are located in the Amazon. The city with the worst standard of living among the 5,565 Brazilian analysed municipalities is located precisely in Pará (g1.globo.com, 2013), the Amazon state with the largest number of mining and steel companies.

This was already a very serious situation in 1991, when the Atlas (UNDP / IPEA / FJP, 2013b) showed that the Amazonian states were included in the group with the lowest income range in the country. In the case of Pará, for example, when the percentage of the population living in extreme poverty (26.28%) was added to the one of people who lived in poverty (53.85%), the result showed that 80.28% of the population was poor or very poor. In 2000 the situation had somewhat improved: the poor and very poor were 69.81%. In 2010 almost half the population (48.23%) was poor or very poor. The other Amazonian states were in a similar situation. In Maranhão the percentages of poverty and extreme poverty were even higher, while the national average was 29% (IBGE / PNAD / 2009/2011)[5]. In 2010, "Pará already has a high level of absolute poor, 29.77%; and when relative poverty is measured, this level rises over: 45.45% of individuals living in the state are now considered poor [...], taking the fourth position among the relatively poorer states" (Bagolin, Lopes and Vitce, 2016).

In 2012 (IBGE, 2013) the monthly percentage distribution of household income *per capita* in the states of the North Region (the fully Amazonian states) presented a painful scenario: in 29% of families people received up to 1/2 minimum wage (MW); in 30% of households people received between 1/2 and 1 MW; in 22% of families people received between 1 and 2 MW; in only 14% of households people could earn more than 2 MW. The others were included in the categories with no income or others. IBGE data (2015) about the monthly household nominal income *per capita* of the population showed that the Amazonian states had the lowest income of the Federation. In the case of Maranhão, for example, the monthly income *per capita* was equivalent to 1/4 of the income in the Federal District; Pará's reached less than 1/3. Therefore, in the analysed years, with the use of multiple sources and different methods, almost half of the Pará population had a monthly *per capita* income under the minimum wage.

The Brazilian government encourages the search for increasing profits, but ignores the fundamental rights of the local populations and mortally wounds the most bio-diverse region in the planet.

In the metropolitan area of Belém, according to the 2010 Census, 52% of people living in "substandard clusters" – i.e., slums – the highest percentage among all the Brazilian metropolitan regions. In that year, 1.1 million residents lived in these conditions, in a total population of 2 million.

The extremely low educational indicators of the Amazonian states show that the current development model does not lead society to achieve the right to a decent life. Most of the current

generation of children and young people cannot afford good quality education in private institutions. Between 2007 and 2013, Pará – the state that owns the largest network of schools and the largest number of college degree courses – oscillates between the worst and the second worst performance among Brazilian high schools, as measured by the Basic Education Development Index (IDEB), with average levels of 2.8 and 2.9, respectively. The same occurred in elementary school (fourth and fifth grades) between 2005-2013 (Opesociais 2005-2013). Thus, one of the states with the highest government surplus – thanks to the export of electricity and mineral and vegetable commodities – has the worst national and regional performance in the field of basic education. The model of development based on enclaves and commodities, besides not providing conditions for a decent life nowadays, brings the perspective of an equally difficult future for children and young people. The big economic enterprises do not always result in social benefits. The other Amazonian states, with lower investments in commodities, have slightly better indicators than Pará. Even so, they were also among the lowest Brazilian indicators, alongside some of the northeastern states (on average, this region presents better performance if related to the northern region in many social indicators).

Historical facts, indicators and data confirm the two-faced position of the Brazilian government towards the region, reproducing an economic elite that takes possession of the energy of the lower classes and the nature, and violates the fundamental rights of minorities, while enjoys the economic accumulation, using the tutelage situation it holds in the region. This is only possible because it is in line with the regional governments.[6]

By imposing the current model of development on the region, the federal government failed in keeping the constitutional promise of eliminating – or at least of striving to reduce – the regional inequalities, a compulsory duty (see "The Colony of Brazil").

Final comments

Different characteristics of the country make it difficult to structure a more desirable and sustainable way of life. Among them are the internal, centralizing policies for income; the idea that the Amazon nature is self-healing and indestructible, given its extension and exuberance; the poor management of public policies, due to the scientific-technical unpreparedness of the staff of state and local governments and the derision manifested by technobureaucracy about the claims from the underprivileged social groups in the region; the lack of commitment of the elite with proposals for income distribution; progress and development at any cost, an ideology that has impregnated the national and regional technobureaucracy.

Despite generating few jobs, since the supply chains of enclaves have not been completed to produce final goods; displacing natural and traditional populations; consuming huge amounts of energy (including coal production originated from the native forest burning); exhausting nature and putting it in danger – despite all of this – this production model based on raw materials and semi-manufactured products has been supported by continuous public policies, which, with a few exceptions, reproduce the secular agro-export model. For all the ills it carries, in my view it is a policy of "degenerative development." The more it advances and deepens, the more damage it causes. The economic model established in the Amazon not only destroys the richest ecosystem in the world, putting the region and the country at risk of severe and painful environmental changes, but also reproduces the poverty of the local population and jeopardizes the future of new generations.

It is not possible to speak of development while the official organizations report positive results resulting from a perverse economic model. Governments have done so since the 1960s, mobilizing national emotion, manipulating the myths of progress and development and promising the future improvement of living conditions among regional populations, while the present stubbornly refutes such promises.

There is no "modernization" when there is not a correspond-

ing participation from the society in the benefits generated by economic growth. The current model remains a strong trait of irrationality. It causes considerable social and environmental damage, much of which is irreversible. When, instead, the model restores perverse and archaic forms of exploiting human labour, thereby increasing inequalities and impoverishes the region's most valuable assets: its biodiversity and multiculturalism.

The Brazilian government is entangled in this complex situation and behaves in an oscillating and dubious way: while aiming to increase profits from the export of commodities and energy, the fundamental human rights of local and traditional populations are ignored, mortally wounding the most biodiverse region in the world and taking with it the vitality that could emancipate the local society. ■

The colony of Brazil

A colonial relationship is historically created and has several implications. The case of the Amazon in relation to Brazil is not different. During the colonial period, Portugal had two colonies in Latin America, Brazil and Maranhão and Grão Pará, each one reporting directly to the Metropolis, since there was no communication by land among them, and the sandbanks of the Maranhão seashore made coastal navigation difficult and dangerous. For this reason the Portuguese government decided to run the colonies individually. In both of them, indians and *mestizos* (ethnic groups who represented the majority of the Amazon population, including Belém, capital of Grão Pará) spoke indigenous languages derived from different branches. At the time of the Independence of Brazil, the colony (at that time already called Grão Pará) did not join the event and remained loyal to the Portuguese Crown. Only in the following year, after great resistance, Grão Pará and Maranhão became part of Brazil. Communications were scarce and difficult. The first land connection only happened in 1961, with the construction of the Belém-Brasília road.

The distances, the predominance indigenous and *caboclo* peoples, the lifestyle on the river, poor academic and intellectual education for the population – in short, the "backwardness" in relation to the rest of Brazil – rendered the region as the negative and neglected pole of the "modern-backward" dichotomy. For other Brazilians, the Amazon stood outside the civilizational borders of the place where the "modern" Brazil was defined. When the integration of the region to the rest of the country began to be effective – through the roads, the media, the movement of goods and people – a relationship of dependency with respect to the "modern" Brazil was established. The Amazon had become the place of inferiority: primitive, uncultured, distant, unknown.

A crucial element in the structuring of this modern neo-colonial relationship in which the region finds itself involved relates to a cultural issue. In addition to the region having been seen within national imagination as distant, primitive and backwards for more than two centuries, another cultural aspect was added in a more recent time. In the late 1960s, the plans for economic development started to be outlined. Teams of technicians and planners came from the South and Southeast. Settled in federal agencies based in Belém and Manaus, they designed plans without the knowledge of the regional population. The intellectual, political and economic elites were only informed about them through seminars, conferences and a few publications coming from Brasilia or Rio de Janeiro, destined for the agencies that would be in charge of implementing the defined policies. It was there that the regional fate for the medium- and long-terms was registered. The Amazon did not appear as a region, but as a resource, subject to exploitation to exhaustion. There was not a balanced and equitable relationship between the federal government and the states of the region.

Economic dependence came through the import of manufactured goods, the trading of raw materials and semi-finished goods from the region and other economic activities made possible by the construction of roads in the 1960s, 1970s and 1980s.

The scientific, cultural and technological dependence is another form of this relationship between the region and "modern" Brazil. Through the plans, programs and federal projects drawn up by extra-regional teams, and the control of resources to make them feasible, the neo-colonial condition of the region has been consolidated. Through these public policy instruments and financial resources controlled by the federal government, the "modern" Brazil dominates the Amazon culturally, scientifically and technologically. When the creation of the first post-graduation courses in planning, humanities, health, etc – together with the emergence of the most consistent studies on the region that began in the 1980s – the outside cultural and political domination had already settled and the fate of the region was set by the federal government. The cultural, scientific, ideological and, above all, political dependence enabled such policies to deepen the economic subordination of the region of various types of commodities and energy at the time. The regional intelligentsia began to criticize the model implanted, but with no chance of modifying it substantially.

This fate, set in plans and projects, was imposed. There were no local resources to carry out projects of local interest, but there were resources available from the federal government that would defined how they would be applied, according to pre-defined targets. Thus, a centre-to-periphery domination was implemented and perpetuated.

Notes

1 The felling of native trees continues and, as before, illegally: at least 78% of the logging in the state of Pará between 2011 and 2012 was done illegally and most part of the wood was exported to Europe and the United States. Source: Imazon, Belém / Transparency in Forest Management (2011-2012) andwww.imazon.org.br/publications/forest-management-transparency/forest-management-transparencyreport-state-of-para-2012-to-2013. Accessed on 05.31.2015.

2 INPE / PRODES started the satellite control with the current methodology in 1988; before that, the deforested areas were estimated by the same program. Available in: http://www.obt.inpe.br/prodes/index.php accessed on 06.02.2016.

3 The Amazon has six major mineral provinces: Carajás, Pará (iron, copper, gold, manganese, tin, nickel, bauxite and diamonds), Rio Trombetas, Pará (bauxite, copper, limestone, lead, etc.), Amapá (iron, manganese , bauxite, cassiterite, columbite, gold and kaolin), North Roraima (gold and diamonds, tin, uranium, tantalite), Rondônia (diamond, non-ferrous minerals etc.) and Tapajós-Pará (gold and other noble minerals), and large reserves of niobium and potassium in the Amazon and reserves of various minerals scattered throughout the Amazon territory. The largest reserves are located in Pará, where are the largest investments in international mining companies.

4 They correspond to 12.54% of the Brazilian territory and 20% of the Amazon, since 405 indigenous lands (69%) are in the Amazon. Their extent in the region corresponds to 98.6% of total existing in the country, while the remaining 1.4% are distributed throughout the national territory (Funai, 2005).

5 The data on poverty and extreme poverty often vary according to the institution responsible.The World Bank, for example, considers as poor people living with $ 1.90 / day. The numbers are very similar in the various sources and highlight the degree of poverty of the population living in the richest natural region in the world.

6 The Free Zone of Manaus, in the state of Amazonas, as an industrial hub, might seem an exception before the other states in the region, but it is not. In addition to its production to be mostly from multinational companies that supply their subsidiaries in the rest of Brazil, the local ownership of the income generated in it is minimal. In 2013 the Manaus Free Zone (ZFM) employed 129,663 workers; despite being an industrial center, yet there is a high turnover of employees. And although the tax incentives granted by governments to companies based in Manaus has reached R$ 17 billion in 2012, the wages paid by them amounted to only $ 4.5 billion, while the income of the companies reached the sum of R$ 70 billion (http://www.suframa.gov.br/download/ indicators / indicators-performance-pim-February-2012-03042012.pdf; accessed on 14/05/2015).

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Water

management is the challenge

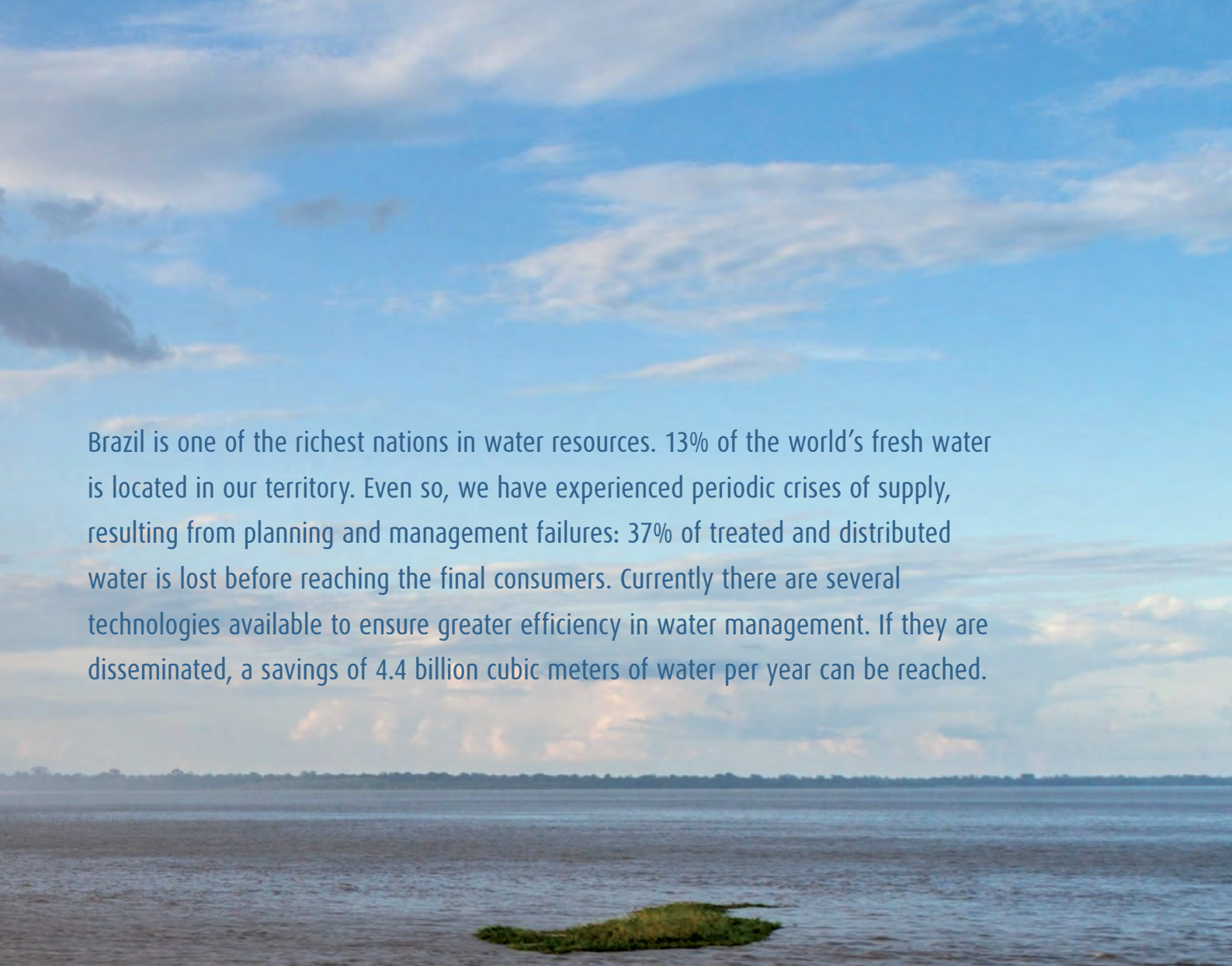
Marina Grossi
President of the Business Council for Sustainable Development (CEBDS)

The Business Council for Sustainable Development (*CEBDS*) is an institution of civil society focused on the development of mechanisms for promoting the various aspects of corporate sustainability. We consider corporate sustainability to be all the productive practices that organize companies in relation to the three pillars that support the production activities of goods and services. These pillars are based on the economic, social and environmental plans. It is only possible to understand any of them by their interaction among each other.

Our main mission is to promote access to processes and technologies that drive companies to deploy good practices and awareness of the impact their activities cause in the lives and communities in which they operate, as well as in the countries where they are located, through debates, discussions and continuous information, so they can evaluate their own role in the world order.

We live in an integrated and interdependent world. The production processes are organized in global supply chains, suppliers and consumers. We articulate ourselves in a worldwide network of information and communication in which we interact with public opinion that is also of global dimensions.

By the very nature of our work, we have no party ties, nor any previously determined view



Brazil is one of the richest nations in water resources. 13% of the world's fresh water is located in our territory. Even so, we have experienced periodic crises of supply, resulting from planning and management failures: 37% of treated and distributed water is lost before reaching the final consumers. Currently there are several technologies available to ensure greater efficiency in water management. If they are disseminated, a savings of 4.4 billion cubic meters of water per year can be reached.

in relation to any ideology. We are aligned with the global sustainable development agenda. At this point, we believe that the discussion on the topic of sustainability has already far surpassed the stage of reasonable doubt as to any scientific scepticism. Now it is necessary to execute a global agenda already very well established in the multilateral forums.

The Climate Agreement of Paris marks a new phase in terms of setting parameters and responsibilities for countries, companies and all citizens and organizations in any way involved with the sustainable future of the planet and of our way of life. Several tools are at our disposal to achieve this agenda. Among the most important are, undoubtedly, the Objectives of Sustainable Development (OSD).

OSD is an instrument created under the sphere of the United Nations to guide and organize the efforts of the signatory countries to implement a new standard of development that is fairer, more inclusive and more aware of the limits of the planet.

Its scope is organized in the form of 17 goals and 169 targets, all of them interconnected and integrated, applicable to all countries, respecting the differences, although sometimes abysmal, of levels of development. It is a spirit that evokes a whole vision of sustainable production and consumption, with the adoption of technology to save resources, to eradicate poverty and inequalities by combating, in short, the perception that it makes no sense to insist on a development and consumption model that perpetuates inequality, puts the environment at risk and disregards the finite resources that belong to the common heritage of mankind.

By emphasizing issues related to overcoming poverty and to the access to a standard of comfort and well-being still very far from the reality of so many countries or populations, the systemic view of OSD reaffirms that sustainability is necessarily anchored on the three dimensions we mentioned: economic, social and environmental.

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Figure 1

Any action that excludes any of these dimensions cannot be sustainable. Populations condemned to misery and deprivation become, for example, a pressure factor on natural resources, while extreme inequality reaffirms the option of a minority group for a consumption pattern that is incompatible with the possibilities of the planet. Development at all costs – based on production processes that do not incorporate clean technologies – end up putting at risk the survival of our way of life.

The business sector plays a decisive role in the effort to reach, on a global level, a large number of the goals of OSD by 2030, which is the established deadline (Figure 1).

Besides the proposed public policies, it is up to the private sector to understand that the vision related to the responsibilities arising from the performance of each segment of the economy constitutes today an imperative factor for the survival of the business itself. The recent environmental disaster involving the Samarco mining company reminds us sadly of that truth. In the face of the disaster, not only is the survival of the Doce River discussed, but also the company's.

The main topic of this article, water management, brings us back to the sad reality expressed by the high degree of inequality that prevails in our country. Access to clean and good quality water, a right and a goal set in the OSD-6, reminds ourselves of the precarious situation of sanitation, of the pollution of important water resources due to the lack of treatment of wastewater and the precariousness of housing in large cities.

The need to rationalise the use of water in a country which holds about 13% of all available fresh water on the planet may seem paradoxical. After all, the European continent, which has only 7% of this total and is home to almost three times the population of Brazil, is rarely sees headlines due to some supply-related crisis. It seems to be a paradox, but it is not.

In fact, these huge numbers simply remind us that we have not managed smartly this asset endowed by our tropical clime. Even owning abundant natural resources, we find ourselves condemned to periodic crises result-

ing from planning and management failures.

Water, in fact, is such a crucial element to our survival that almost all human actions are somehow related to aspects of its use. The relative abundance of this resource in our country led us to an illusory notion that we need not worry too much, as it will be at our disposal and in the desired amount forever.

The awareness that we are the guardians of a scarce environmental asset to 47% of the population should, instead, make us reflect about our global responsibility. After all, the hydric risk was pointed out during the last meeting of the World Economic Forum in Davos as the main threat to the survival of our production systems.

We Brazilians generate most of our energy from clean sources, mainly from the hydroelectric ones. We are the second leading exporter of agricultural commodities and still irrigate less than 12% of our potential arable land. We shelter in our territory two of the largest river basins in the world, with huge potential for transportation, fish farming and many other commercial uses.

However, this luxury does not prevent us from having indexes as bad as the ones of other developing countries when it comes to sanitation, wastewater treatment, preservation of water sources and watersheds, mitigation of losses and renewable technologies.

Adequate pricing of water use is surely among the measures capable of making us aware, as a society, of the responsibilities arising from our disabilities. It is necessary to economically scale the meaning of the waste, so that we can encourage the implementation of technology to save this valuable resource. Just to cite one example, 37% of the treated and distributed water is lost in different ways before reaching the final consumers (Instituto Trata Brazil, 2015).

The shortages resulting from the water deficit in the Southeast region was a warning signal. Companies which had not considered the impact of the restriction scenario on the use of water in their strategic planning realized they needed to be prepared for such situations, with reusage technologies, rainwater collection, classification of the various types of water and their allocation to a suitable purpose. Just like machines, systems and products requiring less water resources minimize company dependence by ensuring the continuity of their processes, avoiding clashes of interests in the access to a collective asset and repositioning according to impact on social life.

Climate variability – due to the phenomenon of "heat islands" that geographically move the incidence of rainfall in large urban centres or due to the increasing occurrence of extreme weather events – is an irrefutable fact that sharpens the perception of the risks associated to the use of water. No one should ignore this reality.

Henceforth, any discussion about water management should take into account the new context created by the high degree of scientific assurance and political convergence in which we live after the Climate Agreement of Paris.

We have a global responsibility as the guardians of a scarce environmental asset. Water-related risk is the main threat to the survival of the production systems of today's world.

The final text, which resulted from an unprecedented consensus among the participating countries, will be the basis for building a more sustainable world in the coming decades. Putting it into practice will require great capacity for action and clear goals of our society.

The target is to curb global warming at a level below 2°C. If we can ensure that it does not exceed 1.5°C, we will be more capable of predicting events the increase in atmospheric temperature will cause. The dimension of the necessary changes to achieve this goal will be huge, and it is an important sign in terms of actions to be undertaken from now onwards.

The current agreement clarifies the ambitions of all the 196 signatory countries with deadlines and concrete goals. Moreover, and more significantly, none of the countries among the major

emitters failed to recognize their responsibility in a process that, due to its characteristics, must be multilateral.

However, it is necessary to remember that agreements of this magnitude are not set under last minute arrangements. It was a long journey to establish the Paris Agreement, an extensive negotiation in the process of building the Intended Nationally Determined Contributions (INDCs). Although several scientists believe that the sum of these voluntary national intentions may not be enough to reach the ambitions set out in the agreement, the periodic reviews every five years will update and re-evaluate these commitments.

Strictly speaking, even if the parties are not obliged to comply with all the points that make up the final text, the size of this treaty, its regular reviews and the strong signal emitted to all agents involved in the process, it is clear that the issue has reached another level.

The management of water resources is one of the issues that may be impacted by the unpredictable scenario resulting from changes in the weather regimes. It is envisaged the possibility of significant changes in the cycles of rain and drought, extreme temperature levels and exacerbation of natural phenomena such as El Niño and La Niña.

The management of water resources in Brazil

Water is the most abundant natural resource on Earth. With an estimated volume of 1.36 billion cubic kilometers (km³), it covers 2/3 of the surface in the form of oceans, polar ice caps, rivers and lakes. Brazil is one of the richest nations in water resources, accounting for 13% of global freshwater reserves (ANA, 2013).

However, it is necessary to understand that the estimates on a "stock" of water on the planet can take us to the false impression that there is a fixed and finite quantity available for our use. In fact, the water cycle is a dynamic and changing system. It is extremely complex, influenced by countless factors, by the climate, the movement of clouds, solar radiation and, increasingly, by the human management of the process.

Although impressive by volume, the distribution of water availability on the planet, and especially in our country, is extremely uneven. As shown in Figure 2, the northern region, where the Amazon forest is located and where only 5% of the Brazilian population lives, concentrates 81% of the available freshwater. Meanwhile, in the Southeast region, accounting for nearly half of Brazil's GDP and where 45% of the population lives, the supply of water is only 6% of the country's total quantity (ANA, 2012). In an expansion scenario of urban development and sectors that intensively use water, this mismatch between supply and demand requires greater initiatives for efficiency in order to reduce the problems related to a still ineffective water management.

CEBDS, in partnership with GIZ, recently launched a publication called *Eficiência no uso da água* (Efficiency in water use), which deals with the issue of water and the opportunities that can be generated for both companies and financial institutions in efficiently managing water resources. This study analyses fourteen promising technologies for reuse, availability and economy of water in the ten sectors of high consumption. Figure 3 lists the technologies and the potential use in each sector.

The study estimates that the investment gap of these technologies is something around R$ 48.8 billion, with R$ 25 billion from financial institutions (CEBDS and GIZ, 2016).

These technologies aim to achieve greater efficiency in water management. The potential annual savings can reach 4.4 billion cubic meters, with approximately 52.27% of savings from industry and 47.73% from agriculture. Figure 4 summarizes the potential for water savings with the use of technologies presented in the study.

Human supply

We can classify water collection by the objective of its usage. There are consumptive uses – that is, related to the various types of consumption, human, animal, industrial and for irrigation purposes – and non-consumptive uses, especially hydroelectric power generation.

This classification aims to explain the water cycle from the point of view of its use. Regarding the use for human consumption – our primary concern – there is a historical failure in adequately addressing the population's needs.

Figure 2

Demography and water resources

Region	Demographic density (inhab./km²)	Concentration of hydric resources in the country
North	4,12	68,5%
Northeast	34,15	3,3%
Midwest	8,75	15,7%
Southeast	86,92	6%
South	48,58	6,5%

Source: IBGE / National Water Agency (2010)

Urbanisation brings great challenges for proper planning of the use of the available water.

Figure 3

Potential technology usage per sector

	Techonology	Livestock	Soy and sugarcane agriculture	Food processing	Automotive industry	Petrochemical industry	Steel and metallurgy	Mining	Beverages	Paper and cellulose
1	Hydrometer for consumption segmentation			●	●	●	●	●	●	●
2	Drip irrigation		●							
3	Dust dispenser							●		
4	Sewage for aquaculture	●								
5	Evaporative concentration of vinasse			●						
6	Water loss detector			●	●	●	●	●	●	●
7	Cooling towers without chemicals			●	●	●	●	●		●
8	Rainwater harvesting			●	●	●	●	●	●	●
9	Ozone processing			●					●	
10	Artificial wetlands	●	●	●	●	●	●	●	●	●
11	Ultra-filtration	●	●	●	●	●	●	●	●	●
12	Reverse osmosis			●	●	●	●	●	●	●
13	Thermal distillation			●	●	●	●	●	●	●
14	Reforestation	●	●	●	●	●	●	●	●	●

Source: CEBDS e GIZ, 2016.

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Many cities, like São Paulo, coexist with deteriorated urban rivers, inappropriate for usage. This scenario reflects the degradation of resources made available by surface and underground water, contaminated with loads of untreated sewage and rainwater that carries pollution to rivers, which are used as deposits of urban garbage.

Of course, the great urban concentration – a global trend that gained dramatic dimensions in countries, such as Brazil, which have not yet completed the demographic transition – brings with it the biggest challenges for proper planning of water usage.

The deficiency of the works related to the supply of the population, treatment of household wastewater and sewage show a pattern of development that hardly take into account the environmental and population welfare. It also shows the chronic inability of governments at various levels to meet the needs of the huge influx of people concentrated in large urban centres, as a result of

Figure 4

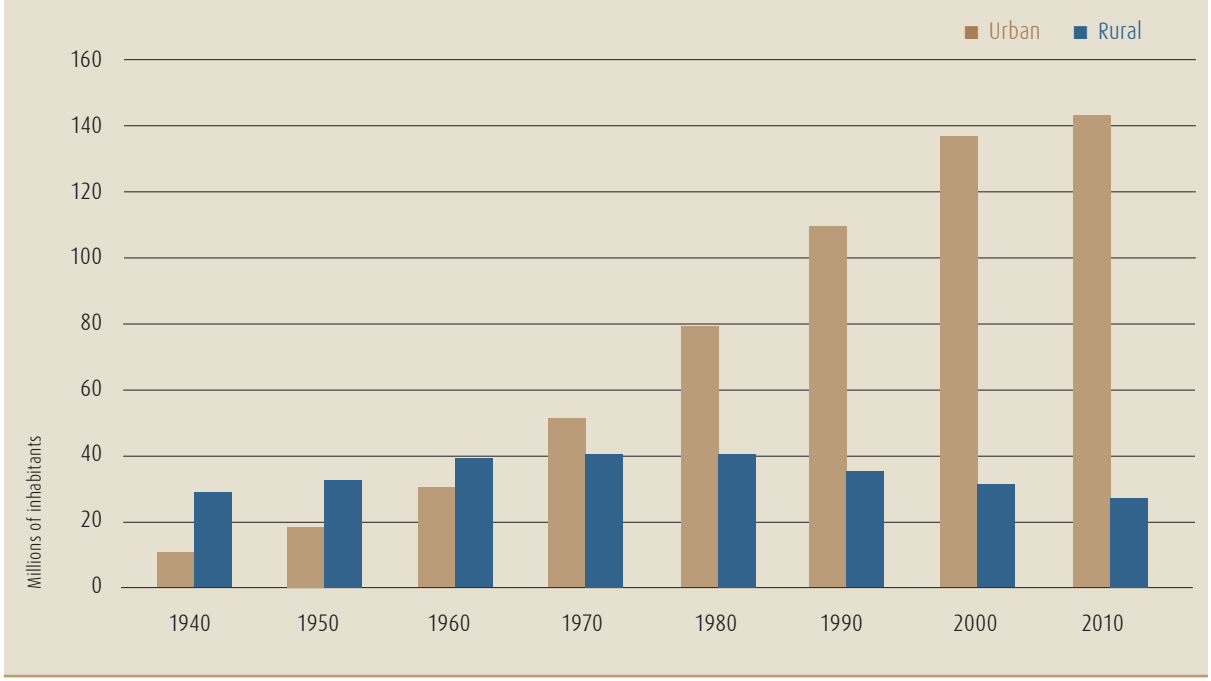
Potential water savings

	m^3/s	m^3/year	% Savings with Technologies
Total removal of water in Brazil in 2010 / Industry	403	12.720.837.688	19%
Total consumption of water in Brazil in 2010 / Industry	197	6.233.722.105	39%
Total removal of water in Brazil in 2010 / Agriculture	1281	40.393.831.680	3%
Total consumption of water in Brazil in 2010 / Agriculture	836	26.361.573.120	5%

Source: ANA (2010) Made by SITAWI

Figure 5

The current situation of water resources in Brazil –Urban and rural populations in Brazil (1940-2010)



Source: IBGE

the rural exodus and the transition to a society which currently has more than 80% of its population living in urban areas.

The outskirts of large cities lack major works that could ensure a civilizing standard compatible with the expectations of those seeking access to the comforts available in the oldest and central regions. What can be seen in these areas are usually open sewers, unlit and unpaved streets or waterways transformed into smelly cesspools.

It is true that this situation tends to stabilize under the demographic point of view, once it is established the transition from rural to urban areas, a move that is already close to be consolidated in our country (Figure 5).

This trend also becomes less dramatic when we observe that there is a certain exhaustion of the population absorption capacity for large urban centres. Population movements towards the medium-sized centres have been more significant than the traditional move towards the very large cities.

What is the size of the environmental damage that will be left as a legacy by an accelerated and poorly planned urbanization with no sense of priority? Some natural resources affected by this movement may have already been irretrievably lost by the time we are able to carry out the actions necessary to address the demands of the agents of this process.

Brazil has to live with a large asymmetry in the geographical distribution of the population and, consequently, with the increasing pressure on resources unequally located. About 80% of our population are concentrated in the coastal basins and the Paraná River basin.

There is a large population concentration in a few cities, and consequently in a few regions. When we think of our huge urban population we should keep in mind that any shortage of supply – as seen in the last great drought that affected the Southeast region – is caused less from the poor water supply than the lack of adequate sanitation, treatment and storage.

The consumption of water for human supply is not among the largest uses. In fact, consumption is unevenly distributed between rural and urban populations, between rich and poor people, between the centre and periphery: the more urban and richer the consumer, the higher the consumption.

This situation leads us to predict that, even with the stabilization of population growth, even with the fall of the rate of expansion of the big cities, the demand for water for domestic use will continue to grow significantly, since the level of the lack of sanitation and supply works is very high.

Dealing properly with this situation requires an adequate sanitation policy in the large cities, with waterworks that ensure higher levels of storage, correct treatment of effluents and a remuneration policy for environmental services that ensures adequate supplies from sources located as close as possible to the consumer centres.

There are many worldwide examples of solutions that, preserving springs and sources, avoid the high cost of the treatment plants, which need to work with heavily polluted water. Many regions, such as the giant New York, found out that paying for environmental services may cost far less to the community than the costly construction of treatment plants. The city and much of its metropolitan area are supplied by excellent quality water, conserved by farmers whose properties are many kilometers away. These farmers are true "pastors" of the water that sprouts or circulates in their properties. They are paid for this conservation service, keeping waterways free from animals, sewage or any other form of pollution. They preserve riparian forests and practice all necessary care actions to maintain the quality of waterways, creating a new profitable activity and helping the community to economize.

An interesting Brazilian example is Brasília, which, according to Caesb, has the best raw water in the country, with protected and clean water resources. It allows people from the region to drink water straight from the tap (Laboissière, 2011).

Agricultural irrigation

Like all intensive and innovative production processes, in various aspects the irrigated agriculture is an opportunity to optimize resources and increase productivity. Currently, irrigation accounts for 72% of total water consumption in Brazil (ANA, 2014).

Within the same area that had previously been able to produce only one harvest, research led by institutions such as Embrapa was able to produce two harvests – the summer crop and the so-called *safrinha* during the dry season. By using irrigation, it has now been possible to add yet another harvest, making a total three in a single annual cycle.

The irrigation technologies used in Brazil vary, depending on the culture and the region. In general, about 42% of the irrigated area uses the method of flooding, which is the controlled flooding of the cultivated area. This type or irrigation is present especially in the Southern region, in large rice fields implanted in wetlands and floodplains, characteristic of the pampa biome. Almost all Brazilian harvest of rice, about 11 million tons, is produced this way.

Currently, the most disseminated technology is the centre pivot. This equipment is being used in an area of 1.17 million hectares (ANA and Embrapa, 2013). It is formed by a structure of pipes combined under a mobile chassis powered by motors or self-propelled, which spin and spray water over the plantation. This technique, which increases productivity and has been expanded, is the second worst irrigation system in terms of efficiency. According to Nicolas Arnaud, from *Aprece*, "each centre pivot generates a 50% loss of water from the valve before falling on the ground, evaporation being one of the worst losses". Therefore, the waste of water in the use of the centre pivot system is extremely high (Junior, 2013).

The Midwest region has the greatest potential for expansion, for its huge Cerrado areas with well-defined wet and dry seasons, large watercourses and fertile soil.

The study developed by CEBDS in partnership with GIZ presents the drip irrigation technology, which supplies water directly to the roots where the plant needs it. This slow drip system prevents evaporation, reduces power consumption and increases the productivity of the plantation. The use of this technology can save 824,000 cubic meters of water a year (CEBDS and GIZ, 2016).

Figure 6 shows the feasibility analysis and the market potential of this technology, developed in the study cited above.

Soy and corn, whose recent harvests reached, respectively, 100 million and 80 million tons, are the main crops using the centre pivots. However, they can be used in various types of crops, irrigated pastures and crops of vegetables

such as tomatoes, peas and many others, on an industrial scale.

The spray irrigation occupies about 22% of the total area and is also adequate to various kinds of crops. It can be used on various biomes and proves to be particularly flexible with regard to the topography of the land. The mesh format is the most used, due to the savings in the material. Normally water pipes are laid at a depth of 30 centimetres, to which are connected sprinklers that throw water on the ground like a drizzle. The supply is done by a pump that collects water from a pond and transports it through a pipeline connected to the mesh irrigation system.

Brazil has a great potential to expand its irrigated area, especially in the Midwestern region. However, what will determine the pace of expansion is the domestic and foreign demand for the production of food and raw materials. The Food and Agriculture Organization (FAO) estimates that by 2050 the world population will reach about 9 billion people, and then it will start a stabilization process. About 40% of the increasing of the global demand for food – whether driven by population growth or motivated by the im-

Figure 6

Drip irrigation system for soybeans

Feasibility analysis		Market potential	
1 | General parameters			
A | CAPEX (R$)	R$4.000.000	**E |** Applicable company size	P/M/G
B | Annual OPEX (R$)	R$684.000	**F |** Applicable sectors	Agricultura
C | Annual reduction in water consumptiom (m^3)	824.000	**G |** Companies that own the technology (%)	0%
2 | Other gains and costs of technology		**H |** Quantity of equipment	542
Productivity gains in relation to production through centre pivot		**i |** Water savings generated by technology (m^3)	447.066.675
		2 | Specific parameters for technology	
		J | Soy area irrigated with centre pivot (1.000 hectares)	542
D | Cost of water balance (R$/$m^3$)	R$ 0,94	**K |** Investment gap	R$2.168.000.000

3 | References and premisses

A | CAPEX for implementation in 1.000 hectare. Based on data provided by Amaggi

B | Includes savings in energy and maintenance costs for 1.000 hectare. Based on data provided by Amaggi.

C | Water savings related to irrigation with centre pivot in crop of 1.000 hectare, based on 4 ton/ha productivity, with water savings of 206 m^3/ha.

D | Water balance cost to allow drip irrigation compared with centre pivot.

E | Technology applicable to all sizes of companies/producers.

F | Technology destined to soy agriculture.

G | It was assumed that the use of this irrigation model is close to zero.

H | Each irrigation equipment corresponds to 1.00 hectare; thus, the potential market corresponds to (J)

i | Calculated on the area of soy cultivation irrigated with centre pivot (K), multiplied by Capex (A).

J | The soy production in 2015 was 95 million ton (Conab, 2016). Since 12% of the production is irrigated, and that from this value 19% uses centre pivot, production in this model corresponds to 2.167.596 ton. The annual soy production per hectare is 4 ton. Thus, the soy area irrigated with centre pivot is of 542 thousand hectare.

K | Calculated on the quantity of equipment potentially commercialized (H), multiplied by Capex (A).

Source: CEBDS e GIZ, 2016

provement of the nutrition pattern of populations currently deprived from the access to high quality food – will be provided by Brazilian agriculture.

Estimates of the National Water Agency (ANA) show that Brazil irrigates currently about 6 million hectares, located in regions of São Paulo, Rio Grande do Sul, Minas Gerais, Bahia and Goiás. Together these states account for about 68% of the irrigated area.

Irrigated agriculture increases productivity; reduces the pressure for new areas of deforestation; offers an agricultural production with higher quality, productivity and aggregated value; reduces the risk of crop loss by drought; and enhances the generation of stable jobs and income for the rural population. However, in order to enjoy these advantages, it is necessary to the manage surface and groundwater properly, in order to ensure their continual natural cycle and prevent human intervention from causing significant changes in a process that is still not yet fully understood.

The situation of the huge aquifers – the Guarani, the Gurgueia (PI), the Pantanal and others – has not yet been fully mapped, nor has their cycle been perfectly understood. Before they are released for human consumption, it is necessary to know their potential and the operation of their cycle.

Brazilian agriculture is able to meet the demand for the improved nutritional required by populations from countries such as China and India without cutting a single tree. Embrapa has estimated that we grow today about 60 million hectares of soybeans, corn, cotton, rice, coffee, sugar cane and other products. Only the additional area that has already cleared and occupied by low productivity pastures, reaches 150 million hectares. It is almost three times greater than the agricultural area currently in use.

Conservation efforts should be focused on the adoption of appropriate technologies to incorporate these huge degraded areas to the

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modern agricultural production system, thus cooling the pressure for the expansion of new areas, especially forests. Crop-livestock or crop-livestock-forest integration systems are an extraordinary move in that direction.

The rational and controlled use of irrigation is another element that, incorporated to the system, relieves the agricultural expansion pressures for new areas still covered by native vegetation of the Cerrado, forests or fragile and sensitive ecosystems such as the Pantanal, in addition to areas of slopes and floodplains.

As in any process of human intervention in a natural system, there must be control and moderation, as well as knowledge of the geological conditions, soil and reservoirs. There are, for example, reports of salinization and desertification in semi-arid areas, resulting from the misuse of water coming from wells with high salinity.

Hydroelectric power plants

Water is one of the few energy sources of production which does not contribute to global warming. It is a renewable resource: its cycle, through the effects of solar energy and the force of gravity, turns liquid into steam, which, in turn, is condensed into clouds, which return to the surface in the form of rain. The participation of water in the world energy matrix, however, is not significant. In the electric power matrix, it is decreasing.

This apparent paradox can be explained by some characteristics related to the availability of this resource. Almost all of the planet's water is in the oceans, and the force of the tides is not yet used on a commercial scale to produce electricity.

From the remaining fresh water, only water flowing in the topographical situation of steep slopes and/or with a great volume may be used for hydroelectric plants. When these characteristics that are necessary to produce mechanical energy that drives the turbines of the power plants are not present, the use is very costly or impossible.

The reduction in the participation of the hydraulic matrix in the total generation of electricity has to do with the depletion of the

There will be extreme weather events, with new extended periods of drought and flooding. Management systems must be improved.

reserves that are utilized in the use of hydropower. Hydroelectric power supply has increased in only two places in the world: Asia, particularly China, and Latin America, thanks to the peculiar Brazilian situation. Our country, despite the increasing diversification, still generates about 63% of its total energy from hydraulic sources, which are clean and non-polluting. Developed countries have already explored almost all of their potential. Other sources of energy, such as natural gas, nuclear, wind and solar power plants, account for almost all the expansion of the matrix, decreasing the relative position of hydropower.

In Brazil, the use of the hydraulic potential reaches about 30% of the estimated potential. The great concern refers to the unexplored possibilities, which are located almost exclusively in the basins of the Northern region. The characteristics of this region make projects complex, due to the distance from consumer centres and the predominantly flat topography, as well as the impact on the communities affected.

The main variables used in a hydroelectric power plant classification are: height of the waterfall, flow, capacity (or installed capacity), type of turbine, location, dam and reservoir types. These are interdependent factors. Thus, the height of the waterfall and the flow, which depends on the construction site, will determine installed capacity; this, in turn, determines the types of turbine and dam reservoir to be chosen.

There are two types of reservoirs: pumped-storage and run-of-river. The first, usually located in the headwaters of rivers, in high waterfalls sites, allow the accumulation of huge quantity of water and works as stocks to be used in dry periods. Moreover, since they are located upstream the other hydroelectric plants, they regulate the water flow, allowing the integrated operation of the group of plants. The run-of-river units generate energy through the river water, i.e. through the flow itself, with minimal or no accumulation in lakes and reservoirs.

The prevailing trend in recent projects – such as Jirau, Belo Monte and Santo Antônio – was the use of the run-of-river technology to minimize the environmental impacts caused by large dams. The debate on the scientific and environmental community about the pros and cons of this option is intense.

The size of the plant also determines the dimensions of the transmission network that will be needed to bring energy to the consumption centre. The larger the plant, the farther away it tends to be the major centres. For this reason it is necessary to build large transmission lines with high and extra high voltages. The greater the distance travelled, the lower the efficiency and greater the losses.

In short, we are a privileged nation in terms of matrix, enjoying a unique situation in the world. Our option for the predominance of hydropower, however, should not make us lose sight of the need to diversify. Our heavy dependence on water resources also means a large exposure to risks associated with the variability of climatic cycles, of rain regimes and interference in the river flows.

The impacts generated by large hydroelectric plants are not small – nor is its cost construction. We have a great potential to explore alternative renewable sources, such as wind and photovoltaic options. According to the Brazilian Association of Industrial Development, Brazil has an average of eight hours of direct sunlight per day throughout the year, while in Germany the average is one hour. However, we have an almost derisory installed capacity of solar generation, while 10% of Germans already use photovoltaic energy sources.

The same is true in relation to wind energy. We have some of the most favourable winds of the world, especially in the Northeast region. In most part of the national territory we can find winds with speed of more

than 2km per second, enough to move a micro turbine, for example, which would already make exploitation.

In recent years, wind power has seen a major expansion in its participation in the energy matrix. Biomass has also won an important expression, associated with the sugar-ethanol and pulpwood industries.

The water crisis

The years 2014 and 2015 will be remembered by the serious crisis in water distribution in the state of São Paulo, with rationing measures and system outages. The gradual emptying of the Cantareira reservoir, the main source of water for the metropolitan area, as a result of reductions in average rainfall in the last four years, forced the use of the "dead volume", i.e., pumping water from a level below the feed pipe in order to maintain the distribution.

The water crisis affected not only households, but also economic activities, which make extensive use of the resource in their processes. Although some companies do not rely exclusively on the public supply system and have their own alternative resources to collect water, a large number of industries depend on the public service to perform their activities.

Everyone recognizes that the adoption of water efficiency initiatives is a complementary need, since alternative sources may also suffer if the availability of the resource in its processes keeps increasingly uncertain.

It is a new scenario, in which everyone was warned about the need of incorporating water saving processes. All indicators predict an increase in extreme weather events, with new extended periods of drought and the possibility of flooding. The management of this scenario will require more attention and planning.

After the water crisis in the Southeastern region in the years 2014 and 2015, the topic was widely discussed by the Thematic Chamber of Water of CEBDS. It is believed that there should be a change in the consumption patterns and that water security should be treated as priority, thereby requiring a commitment from businesses, governments and civil society.

From the point of view of businesses, new technologies must be introduced to mitigate the most of the uncertainties that will result from abrupt climate changes. It is also important to discontinue the culture of waste, which still predominates in our society.

Finally, CEBDS sees the crisis beyond the mere lack of water. This is also an energy, food and credit risk crisis. Therefore, it is necessary to take increasingly frequent collaborative actions for an entire landscape vision of the management of this resource. ■

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Low carbon emissions in land usage

interdependence is the name of the game

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It is possible to produce and preserve, leaving behind the false dilemma of producing *or* preserving. Other countries will hardly be able to compete with Brazil in this field. The sign that the planet will move towards a low carbon economy has been given. If properly conducted, Brazil will have a unique competitive position, extremely favourable in the production of commodities related to land usage, achieving the valorisation and preservation of its immense natural capital at the same time.

November 2014. The country underwent the disenchantment of a strange, confrontational, little constructive electoral process, incapable of indicating the development options presented. Fragmentation.

At the same time in Copenhagen, the Intergovernmental Panel on Climate Change (IPCC) presented the elements for another synthesis report, published in early 2015, from its fortieth session. The report concluded that the planet warms due to carbon emissions and there is a strong correlation between natural and anthropogenic reasons. It presented scenarios of evolutionary trends, risks, uncertainties, impacts, alternatives for adaptation, mitigation, sustainable development, vulnerability of regions and ecosystems, living with extreme events, metrics, modelling, carbon removal from the atmosphere, responsibilities and subnational, national, bilateral and multinational policies, innovation, investments, trade-offs and synergies. It also addressed the effects on the atmosphere, cryosphere, oceans, soil, freshwater, forests, countryside and cities. The so-called political biogeochemistry prepared the ground for the COP-21, the Climate Conference to be held in Paris in December 2015.

December 18, 2014. A group of people representing organizations from the Third Sector, companies, associations and above all, themselves, meets in a hotel in São Paulo. The *Coalizão Brasil Clima, Florestas e Agricultura* (The Brasil Climate, Florestas and Agricultura Coalition) was born.

(A few) numbers

About 50 billion tons of CO_2 equivalent (CO_2e) are emitted on the planet. According to the IPCC, two economic sectors are mostly responsible for the emissions of these greenhouse gases

(GHGs): the production of electricity and heating (29%) and the change in the land usage (24%). This latter group, defined by the acronym AFOLU includes agriculture, forestry and other factors that affect the use of land.

The following emitters, in descending order, are industry (21%), transport (14%) and other sectors such as construction industry and infrastructure. A closer look reveals a very serious scenario of emissions from the production and distribution of food in general. This result arises when the emissions from industrialization of food and fibre, as well as the logistics associated to it, are added to the AFOLU group's emissions.

According to the Greenhouse Gas Emission Estimate System (GGEES), about 2/3 of carbon emissions in Brazil (1.5 billion ton of CO_2e) were associated with farming changes in the use of land in 2014. The country is one of the world champions of emission reductions: in 2004, Brazil emitted nearly double the total of 2014. Brasil is globally acclaimed by the significant reduction in deforestation, which at its peak in 2004 emitted 2 billion ton of CO_2, a very significant amount. However, despite the undeniable success of the monitoring and control of deforestation, Brazil still holds a much less commendable title: world champion of forests destruction. This activity still represents 1/3 of the national emissions.

Interdependence

> "I belong to a lost generation and am comfortable only in the company of others who are lost and lonely."
> **Umberto Eco**

The world is increasingly complex, turbulent and socially, economically and environmentally globalized. The effects of human actions are spread throughout the planet in real time. "The way we work in Sweden influences the rainfall pattern for a small pro-

TIAGO FIOREZE / WIKIMEDIA COMMONS

The Paris Agreement of December 2015 opens a new path for the technologies to strengthen the low-carbon economies.

ducer in southern Africa; and the way a fisherman behaves in the mangroves in Thailand affects the climatic pattern in England", said Johan Rockstrom of Stockholm University.

Land usage has a unique role in the world of greenhouse gas emissions. The mitigating potential of land usage results from two alternatives: the reduction of emissions resulting from land management and the production of agricultural and forestry commodities, together with the alternatives for carbon removal arising from the vegetal metabolism.

The land usage supplies most of the food to the human population, provides fibre for various uses and energy through different alternatives. It involves a great part of the world's population. At the same time, it provides multiple ecosystem services, in addition to the aforementioned effect on the atmospheric quality, on the preservation of water sources and biodiversity.

The unique role of land usage is exposed almost literally to an unusual pitched battle: on the one hand, land occupation to produce food and other commodities that are historically related to greenhouse gas emissions; on the other, providing the environmental service of removing such gases. Not surprisingly, the main multistakeholder governance initiatives on the planet were incubated in this confrontation and flourished in it.

Certification systems such as the Forest Stewardship Council (FSC) and roundtables for soy and palm flourished in this environment. In Brazil, the extensive discussion of the Forest Code comes from the same matrix. Agents operating in agribusiness, forests, nature conservation and especially in the social use of land have coexisted for a long time with common themes - all in a way with their own independent agendas. Decades of solitary living in isolated bars.

But suddenly the fragmentation, the disenchantment and the hangover of the Forest Code are associated to the perspective of a new institutional order, resulting from the evidence of climate change, bowing to relevant political and socio-economic signals. They are the following:

- knowing with precision how the land will be used is a very clear trend on the planet;

- the society follows up this usage with increasingly sophisticated instruments, such as satellites and geo-monitoring systems;

- transparency is here to stay; the society, organized or not, plays an increasingly important role in the granting of operation licenses;

- the use of natural resources, especially land and water, will be greatly optimized;

- It is inexorable to integrate the use of these resources, coming out from the gate of the properties towards a more integrated approach of the environment;

- what is wasted or underused should be restored in some way; the purpose of these restorations can be quite diverse;

- the production of goods and services will generate fewer externalities;

- the society will find ways to remunerate positive externalities, promoting less impactful production methods.

Transparency, rationality and more efficient use of natural resources, restoration of natural capital, recognition and compensation for environmental services, social and economic punishment for the production of negative externalities are some of the main boundary elements of land use. The concept of extended landscape management is consolidated gradually. It is evident that in this field, interdependency is the name of the game. The lonely people start going to the same bar.

Paris (COP-21) did not give the signal. Paris read the signal given by the growing critical mass of the lonely individuals. Maybe not so lonely for being in the same bar, aware that it was established a new way of dealing with land use, stimulated by the universe of climate changes, but not limited to it.

The economic rationality of the externalities management

> "What is a cynic? A cynic is a man who knows the price of everything and the value of nothing."
> **Oscar Wilde**

While the various dimensions of sustainability and low-carbon economy move forward, some definitions are consolidated. One of them is the idea of externality, particularly relevant in the agribusiness and for its relation with conservation. The concept is very simple: externalities are "indirect, negative or positive effects of the production of goods or services, transferred to individuals and or entities not involved in the production process; environmental pollution is an example of negative externality ". This is a quote from the document Environmental Markets: a New Asset Class, published by CFA Institute, which joins investment professionals and is considered one of the most renowned entities of the financial universe. This clear position indicates that the subject is no longer limited to the world of non-governmental organizations (NGOs) working with the environment or social issues. Few segments incorporated the theme of externalities as deeply as agribusiness, especially in Brazil. Deforestation is the prime example, and its relation to the issue of water reinforces its practical relevance.

There are exciting nuances in the definition of the term. Ricardo Abramovay at the Department of Economics of the University of São Paulo deals with a central issue: the monetization of externalities, i.e., "everyone that produces any negative or positive impact on someone yet does not belong to pricing system." Carlos Eduardo Frickmann Young from the Economics Institute of the Federal University of Rio de Janeiro follows the same line: "It means that, instead of being paid by everyone, the tribute must be paid by the person responsible for it." In other words, identifying, qualifying, quantifying and if possible monetizing externalities become a challenge for the business world.

There have been many attempts for quantification and valuation: "The value of everything that nature provides free of charge to humans is estimated at US$ 124.8 trillion per year, which corresponds to approximately twice the global GDP," writes Robert Costanza, professor at the Australian National University. The CFA Institute shows that 40% of deaths worldwide result from environmental factors, including the side effects of the environmental degradation and the spread of diseases. It also mentions pollution, which causes the loss of five years of life per person in northern China. The Principle of Responsible Investment estimates that the annual cost of environmental damage caused by human activity reaches US$ 6.6 trillion, or 11% of the world GDP, and that 1/3 of this cost is under the responsibility of the 3000 largest companies in the world.

In the book Big World, Small Planet, Johan Rockstrom presents alarming statistics, complementary to the increase of CO_2 concentration on the planet. They include the exponential increase of impacts of the so-called "great acceleration of human activity" from the mid-twentieth century. They doubled or nearly tripled the atmospheric concentrations of nitrogen dioxide (NO_2) and methane (CH_4), with acidifying of oceans, forest losses and degradation of the biosphere. Numerous analyses show that it has exceeded the pressure limit on the natural capital of the planet.

Several organizations are dedicated to seeking such estimates, albeit with very different and often divergent numbers. This means that the current stage is less the demand for precision and more the construction of methodologies. Moreover, they point out responsibilities that affect the reputation of sectors and the economic value of companies. The reputation of food producers in Brazil suffers commercially significant damage due to the association of these companies with deforestation.

The debate on who should pay the bill of externalities is directly associated with greenhouse gas emissions, damage to water resources, biodiversity loss, soil degradation and varied social impacts. On the other hand, there have been advances in some discussions on compensation for environmental services, arising, among other elements, from the forest conservation. The effective implementation of the Brazilian Forest Code seems to depend on the balance between these two branches of externalities, negative and posi-

tive. Knowing in depth the social and environmental effects of legal reserves and permanent preservation areas, establishing metrics, is one of the important challenges the use of the land in Brazil will have to face.

Society has put a price on the externalities, albeit with great imperfection. This discussion has provided the debate on actual costs and prices. After all, how can the cost of the eventual damage caused by the production of a product be embedded in its price? The subject is complex and controversial. May we assume that all externalities are monetized? Biologist and activist Jutta Kill from the World Rainforest Movement published the book *The Economic Valuation of Nature*, questioning the monetization of externalities as an alternative to having its value considered by the society: "Calculating the economic value is not the same of putting a price label on nature."

One of the main leaders of this debate, the Indian economist Pavan Sukhdev, defiantly argues that the economic invisibility of nature must end. "We use nature because it has value, but we lost nature because it is priceless. Currently, no one pays for ecosystem services. At the same time, there is a lack of incentives for the ones who do things correctly ... It is necessary to create a market." In contrast, Geoffrey Heal argues that "if our concern is to preserve the ecosystem services, valuation is largely irrelevant... Valuation is neither necessary nor sufficient for conservation. We preserve much of what we do not value, and do not preserve what we value."

This debate is related to the payment for environmental services, which in some cases legitimize the economic exploitation of natural resources or the emission of pollutants. Carbon credit trading models go in that direction, with transferable permits of the right of polluting, i.e. establishing a price for this right. Alternatives such as carbon taxation are widely discussed and, in relevant cases, implemented in countries around the world. There is a fierce dispute over the possibility of creating a market for externalities, which is an acceptable option.

The future points to a composition in which externalities should be indicated in a transparent manner, verified and certified by independent mechanisms, with multistakeholder governance, broadly affecting the value of organizations (not only in economic terms), defining measures with metrics far more accurate than the current ones, with structured markets for some categories. Certainly not all of them will be monetized or priced, but they will have their value recognized.

Innovation and dynamic capabilities

> "We know accurately only when we know little, with knowledge doubt increases."
> **Goethe**

The management of externalities is one of the main drivers of innovation in the world today. One of the great scholars of the role of innovation in business management, David Teece, from the Institute for Business Innovation of the University of California (Berkeley), has been addressing the concept of dynamic capabilities for a few years. Its application in the agro-forestry sector is more modern than ever. He undergoes significant technological breakthroughs in several borders: forest-based, use of soil, intensification of the production, industrialization and logistics of food, fibre and energy.

According to Teece, the winners at the global level will be companies with rapid and dynamic response to the innovative environment, demonstrating managerial capabilities to incorporate new skills and deal with the new challenges, both internal and external, that are presented. In other words, innovation does not happen only in the field of new technologies or products, but requires new skills in management models. The concept of dynamic capabilities emphasizes two aspects: first, the ability to quickly understand and incorporate changes in the external environment; second, the need to adapt, integrate and reconfigure organizational elements, resources, skills and functional routines.

Having ended the long process from the countries reacting to the threat of climate change – the climax of which was the Agreement of Paris – a new journey began. We entered the phase of the technology curve, necessary for the consolidation of the low carbon economy. According to the theory of the technological life cycles ("S curve" of innovation), the technologies that

will replace the prevalent ones in each period are hidden within them. At first, they are even less efficient, more expensive, and less attractive to consumers, demanding changes of habits and regulations. They need to start the exponential growth phase to ultimately surpass the traditional way of how the goods are produced. Therefore, they often demand events like the COP 21 - a turning point, a *tipping point*.

During the Paris Conference, Christiana Figueres, former executive secretary of the United Nations Framework Convention on Climate Change (UNFCCC), mentioned a few times that "the signal is above the noise." Read: COP-21 confirmed the signal that the future will be of a low carbon economy. The noises are the questions of Goethe's quote. The sentence reflects the fact that the scope and the depth regions of an area of knowledge grow for those who are deeply interested in them. The open questions increase instead of decreasing. The B*rasil, Clima Florestas e Agricultura* Coalition movement experiences this situation daily.

Technology changes occur when a certain critical mass is reached. Discussing the role of various actors in the field of low-carbon economy consolidation, Al Gore uses a humorous and clarifying joke: "The president of the United States arrives at a dinner event and asks for butter. The waiter refuses to bring it. The president asks him: "Do you know who you're talking to? I am the president of the United States" and the waiter says: "I take care of butter".

The one who takes care of the delicacy to be spread on the bread in each moment are entrepreneurs and the civil society. Governments have a critical role in consolidating the political and regulatory environment, but the menu of opportunities is stimulating. It is not known very well the way the economic system will work in an environment where the carbon economy will be predominant.

In this game, the private sector has a decisive role not only facing the moral dilemma of externalities, but also leading the opportunities that the new scenario can offer. It is a challenging environment, unlike the way the economy traditionally evolves. Thus, it is not yet clear how it will evolve. The social and environmental inclusion is inexorable. "We created a very powerful dream. Now we need to create reality" said Figueres, quoting Golda Meir.

The dialogue between nations is not trivial, but everything changes when the community of institutional investors enter the field. The realization that their fiduciary responsibilities are related to climate changes is evident and requires new ways of dealing with investment profiles. From this realization it is possible to see that the opportunities of Brazilian agribusiness are immense and require adjustments in the way the land is used. It is no longer enough to observe what happens within the farms. It is necessary to seek greater integration with the surroundings. The concept of landscape management is a promising way. New professional skills are necessary, expanding the already innovative management of externalities to a wider, interdependent and complex territorial vision.

Tom Steyer, one of the important names in the world of capital management, points out that the game goes through three "Cs". The first one is clarity, particularly in relation to the commitments of the countries, aligning the private agenda to the Intended Nationally Determined Contributions (INDC) and to the linking commitment to transparency and the measurements of emissions of greenhouse gases. The second one is cooperation, or interdependence, since nothing will occur in isolation. The links are becoming evident and among them there are opportunities for new institutional and business arrangements. Finally, confidence, crucial to expectations and long-term decisions, but highly dependent on the momentum imposed by the Paris agenda. Clarity is the basis for the construction of cooperation, which generates confidence.

The role of financial agents navigates the world of the impact of climate agenda in the valuation of assets. Valuations will change dramatically with the inclusion of externalities and future risks associated with climate change. But not only risks. Diving in the opportunities of the new frontiers and innovations offered by this agenda will be crucial to define the leaders who will occupy the space of the low-carbon economy. In other words, one of the great risks is precisely the loss of opportunity. Advances in pricing and carbon taxation are seen on this

horizon. Business associated with emissions, such as those related to fossil fuels, are confronted with the ones that promote carbon sequestration and storage, such as forest-based ones. The unique feature of the land use segment and its relation to emissions stands out. Innovations related to the reduction of emissions arising from land management, relationships with conservation and restoration of soils and forests, as well as advances in the production of agricultural and forestry commodities, possibly combined, are aligned for the removal of carbon resulting from the preserved and driven plant metabolism.

One of the richest discussions concerns macro-alternatives to deal with the reduction of emissions. There is a line which claims that the solutions will come from the development of technologies focused on sequestration and low emission of carbon in the atmosphere. They are called in a grotesque way "artificial trees", a bet of the developed countries. On the other side there is the forceful defence of forests as the most efficient way of removing and maintaining carbon stocks. Brazil has significant comparative advantages in the land use and production of food, fibre and energy. The mobilization of the key forest stakeholders and agribusiness – including livestock and it relationship with civil society – is crucial so that we can take advantage of the new technological wave.

In Brazil, it is based on extensive valorisation of natural capital. The country dominates most of the necessary technological foundations. Among the demands, refinement efforts, such as the predominance of forestry of native species (for the agenda of restoration), and consolidation of opportunities to combine forest and agriculture. The adjustment of public policies is essential, as demonstrated by the successful case of ethanol. On the list of practical challenges are instruments for monitoring, control and traceability to stop deforestation and the illegal timber trade.

This does not mean that Brazil will act just only at the front of the changes in land usage. National emissions have been growing in the areas of energy and transportation (fuel), but both of them may also have partial solutions from the proper management of natural capital. The low carbon logistics is an example.

This game of consolidating the new technological curves depends on many actors. The leadership in the development and use of new technological alternatives seems to be in the private sector, but it will require hard-hitting public policies and elements such as changing consumer habits and the education of society.

Comparative advantages

This set of forces points to the comparative advantages of Brazil in the use of land and the production of commodities. Brazil is a forestry nation. More than 50% of its territory is covered by natural forests in the Amazon, Cerrado and Atlantic Forest. It is one of the most biodiverse countries and one of the largest holders of water capital on the planet. It has a large territory, reasonably fertile soil, good distribution of rainfall and sunlight. In short, it has immense natural capital. In addition, it developed forestry technologies that led it to stand out in the field of planted forests to produce fibre and, more recently, bio-energy.

The country followed an efficient path in the development of one of the most thriving agribusiness in the world, leading grain, bio-energy and animal protein production rankings. It has a good intellectual capital in the agro-forestry sector. Due to a history of complex territorial occupation and conversion of native forests for the production of commodities, the country has made significant progress in relation to deforestation management and control measures, with the latest technologies in the aerospace monitoring of its territory. Therefore, it has two strong competitive components: the natural capital itself and the intellectual capital to deal with it.

Another important feature in the Brazilian environmental field is the strong presence of civil society. With striking action, it reached important victories in the field of conservation and recognition of original communities and old possessions. This is a strong social capital. Far from settling with victories, it keeps on being a fighter, not standing the unacceptable reality of the way we deal with our natural capital.

The land occupation and its economic use have been considerably discussed. In the recent decades, civil society has had strong

confrontations with agribusiness. Thus was born the Forest Code, one of the most advanced regulations aimed to organize the use of natural resources of the planet. This legislation, among other things, defines the role of permanent conservation areas, productive- and alternative-use forests. Elements such as geo-referencing allow the implementation of a new form of land management. Thus, social capital is strengthened through institutional capital. It was created a strong sense of interdependence, along with the perception that open dialogue can bring new elements.

Innovation in forests

There are many studies, reports and mentions about restoration and reforestation. In Brazil, the most intensely discussed goal is the restoration of 12 million hectares, an integral part of the Intended Nationally Determined Contributions (INDC). Overseas, two important and complementary initiatives are highlighted: the Bonn Challenge and the New York Declaration on Forest. The first one intends to restore, by 2020, 150 million hectares of deforested areas. The second one, in addition to the total indicated in the Bonn Challenge, aims to add another 200 million hectares by 2030. The three aforementioned propositions are aligned with the Paris Agreement. All of them are considered very ambitious.

In recent survey by The New Climate Economy, a branch of the change of land use (AFOLU) appears to have great potential for reducing greenhouse gas emissions by 2030. The document estimates that reforestation can promote an annual reduction of emissions of nearly 1.2 to 2.9 gigatons of CO_2e. The amount represents between 3% and 5% of the total cuts that are required to keep global warming below 2°C, using the pre-industrial period as a reference.

One of the great debates about the so-called forest restoration agenda was limited around the cost to reforest one hectare. Ideological confrontations tried to defend different models with more environmental or more economic nuances. An initial estimate provided by the Escolhas Institute at the request of the *Brasil Clima, Florestas e Agricultura* Coalition pointed out the need for investment of approximately R$ 30 billion to R$ 50 billion for reforestation of 12 million hectares by 2030 (following the Brazilian INDC).

This statement was based on the distribution of the activity in five different models of forest recovery: (a) conduction and enrichment, (b) densification and enrichment (c) direct planting of seedlings and seeds, (d) consorted planting of native and exotic species and (e) agro-forestry systems. Thus, the agenda of the forest recovery is very wide, and there is no strict separation among the different models. Cases of combination and gradual transition among them may occur.

This scenario requires a consistent effort in research and development. Brazil has one of the world's best technological arsenals in forestry, certified by the competitiveness of the planting of species such as pine and eucalyptus. Therefore, the challenge is not to perform a technological breakthrough, but to intersperse broad knowledge on forestry. Examples include topics such as achieving a good genetic base of native species, acquisition and processing of seeds, production of seedlings, classical genetic breeding, forestry treatment, sanitary control, establishment of growth curves, consortia and monitoring of planting.

The integration among the forestry world and other sectors, such as energy and agribusiness, must be expanded to strengthen "landscape management", which includes restoration and environmental services.

Demand forecasts for forestry products grow rapidly. The main driver of this phenomenon is the consolidation of the bio-economy, with the expansion of market (energy, biomaterials, and chemical industry). The most traditional companies of the sector lead the process, aware of the demands of end consumers and reputational

A new and comprehensive spatial and territorial vision, with its complex social, environmental and political components, must be increasingly present in the repertoire of the contemporary industrial managers.

elements of members of the value chain. The quote by Stora Enso, one of the oldest and most innovative companies of the sector, is emblematic: "Everything that is made from fossil fuels today can be made from a tree tomorrow"

The offer in the estimated dimensions can only be achieved with the intensification of plantations, greater efficiency and the adoption of sustainable management systems worldwide. These trends are confirmed by the reduction of deforestation rates and the consequent decrease in the supply of wood derived from forest conversions.

In the forestry area, innovations in forestry precision are consolidated, with the inclusion of monitoring (from satellite image processing to the use of drones), geo-referencing and data management as routines. Biotechnology moves forward, with impacts on productivity, resistance to pests and adaptation to environmental conditions, such as water stress and soils with nutritional deficiencies. It is estimated that by 2050 the genetic breeding can double the average forest growth rate in the world.

The application of biotechnology is a good example of how the concept of dynamic capabilities can be applied. The border is not just in the technological innovation; it requires the incorporation of skills in conducting the debate on genetically modified trees. Dialogue initiatives have been growing, but some of the agents involved (not only NGOs but also companies related to the final consumer) are still hesitant as to technological inevitability, although recognizing its extent and value. The debate goes beyond the issue of environmental safety, including ideological elements such as the distribution of social benefits resulting from the new technology.

Also in the forestry field, knowledge applied to forest regeneration and recovery of soils and degraded areas form a strong demand, with extensive discussion about forestry models of native species and attention to the various restoration models. In forestry, the concept of multiple usages is established as a good practice paradigm. Countries with high incomes, most in the northern hemisphere, largely dominate these techniques, but their application in Brazil is still very restricted.

In general, it has been expanded the multiple and full use of trees and forest and industrial by-products, such as lignin from the pulp and paper industry, and sawmill waste from the solid wood sector. In the industrial processing front we can highlight the advances in bio-energy, the direct use of wood as a thermal or thermoelectric component or in the direct production of second-generation fuels. The biomaterials market grows, with strong emphasis on bio-plastics, textiles, bio-compounds, panels and automotive materials, with special focus on low weight products, with a positive impact on emissions of greenhouse gases from the transportation sector. The application of forest products in the production of chemicals such as sugars, phenols, acids, abrasives, adhesives and others keeps on growing, with pilot scale and industrial production in North America and Nordic countries.

Innovations in the forest industry include advances in the tracking of products, which especially critical for products from tropical zones, following the trend of origin monitoring, beyond the legality demanded by regulators of the main buyer countries. This is another good example of how dynamic capabilities can go beyond the internal environment of the companies, often limited to what happens in their forests and industries.

The increasing complexity of business transactions and the acceptance of products require innovative marketing skills, relationship, brand management and reputation. The dynamism in the

world of externalities management and social licensing for operations explains the growth of voluntary certification, notably Forest Stewardship Council (FSC), and initiatives such as The Forest Dialog and New Generations Plantations. Active participation in these forums requires complementary skills to the traditional ones, representing what Teece considers dynamic external challenges.

Therefore, there is the consensus that consumption will be decisive in innovation, especially with the increasing awareness of the positive role of forests and products derived from them on climate changes and on the resulting demand for alternatives to fossil fuels. The development of innovations in the forestry field is directly linked to the concept of responsible consumption.

In the relationship with the society and consumers, the role of forests in the context of climate changes requires what seems to be the main innovation management models: expansion of the integration of the forest world with other sectors, such as energy and agribusiness, within the context of "landscape management" (landscape models), which includes restoration and environmental services.

There is no space in the concept of dynamic capabilities for the myopic focus on the internal environment of corporations and their properties. There is no way of ignoring that the trend of the forest sector is to be protagonist of the main demands of the expanded use of soil occupied by its trees and industries. The spatial and territorial vision, with its complex social, environmental and political components, must be a part of the repertoire of the industry managers.

Low carbon agriculture

The evolution of Brazilian agriculture was driven by the territorial expansion and the technological development, generating increasing productivity and resulting in extensive inclusion and leadership in international markets. Brazil has become a reference in the production of food, fibre and bio-energy. In addition to the public-private technology, this trajectory was based on an apparatus of agricultural policies (minimum prices, agricultural credit and rural extension) that promoted the improvement of the technology itself and the conditions to expand production and productivity in Brazil.

The agricultural credit for investment was a determining factor for the adoption of mechanization, adaptation to different ecosystems, greater efficiency in the use of feedstock, minimum tillage, pest control and precision agriculture. With increasing pressure on sustainability, the objectives of agricultural policies are changing, becoming more transversal, and expanding its scope to food safety, environmental protection and agricultural zoning.

Currently, the Brazilian agricultural sector is funded by three main sources: the public system (Bank of Brazil, Caixa Econômica Federal, state and regional banks), private banks, feedstock and traders companies, as well as resources of the producers themselves. Thus, the evolution of agriculture for the incorporation of low carbon practices depends on a triad represented by public policies, credit and national and international market pressures.

The Brazilian Intended Nationally Determined Contribution (INDC) refers to the recovery of 30 million hectares of degraded pastures, half of it directly related to the Low Carbon Agriculture Plan (ABC) and the implementation of integrated agricultural-forestry production systems. Agribusiness accounts for about 1/4 of the national gross domestic product and nearly half of exports. National emissions targets mention it explicitly, indicating how determinants are the low carbon economy and the use of land for national development. It is a key sector for the country to achieve its global goal of reduction of greenhouse gases.

The main themes and trends of the sector have been the intensification of production, rationalization of land use and refusal of conquering new territories, notably forestry. The degradation of pasture areas heavily contributes to the national emissions, along with the conversion of forests and Cerrado areas. They are associated with the decomposition of organic materials and the inefficiency of the land use for weight gain of the animals. Recovering and maintaining the pasture productivity contributes to increase the stocking rate of pastures and the mitigation of the emission of greenhouse gases.

The low-carbon agriculture depends on production technologies focused on the integrated production systems (livestock-forest), the increasing of pasture support capacity and the search for a neutral emission balance. However, the debate on the low-carbon agriculture is extensive. It is not limited to a single model or to a model specifically dedicated to a production method. It is also relevant the volume of emissions resulting from the use of fertilizers, especially the nitrogenous ones.

Organizations such as the Centre for Sustainability Studies of the Getúlio Vargas Foundation, the Climate Policy Initiative, Imaflora and Rabobank have been devoted to point out ways of adopting practices with reduced incidence of negative externalities in agribusiness. There is a strong correlation between productivity and sustainability programs, including costs and differentiated access to markets. Unlike the forestry sector, the access to credit is crucial in this segment. Instruments such as the Green Protocol, ABC Program, guidelines from Febraban, Princípios do Equador and Banking Environment Initiative can be strong fostering instruments.

One of the main innovative borders is the development of agroforestry systems, or consortium of agricultural crops with tree species. They are used to combine forest restoration with recovery of soils and production of food, wood and energy. A wide range of technologies minimizes the risk of degradation, optimizes productivity with minimal use of agrochemicals and controls externalities by focusing on further harmonization of ecological functions, enabling the establishment of a better interrelationship among soil, fauna, flora and climate.

Paths to be followed

In a synthetic form, perhaps the most powerful concept linked to land usage is landscape management, which covers housing, production and conservation in an integrated and coordinated way. This concept is based on some critical pillars:

- transparency in the use of land and traceability of products derived from it;
- recognition of the value (not just economic) of the natural capital;
- rationality and efficiency in the use of natural resources;

►restoration of degraded and underused natural capital;

►recognition of the production of positive externalities and payment for environmental services;

►social and economic punishment for the production of negative externalities;

►social integration, connecting the country to the cities;

►integration of logistics and responsible consumption of goods resulting from the use of the land;

►attention to innovation in products, services and management models related to low-carbon emissions;

►Medium and long term integrated planning.

The articulation of the productive sector linked to land use, with civil society gradually learning to deal with the complexity of the multistakeholder governance. The answer to the challenge of complexity is actions to promote confidence and joint innovative progress through cooperation. Initiatives such as the *Brasil Clima, Florestas e Agricultura* Coalition and its more than 130 members indicate that the consolidation of the low carbon economy, associated to the use of land, requires some elements:

► effective and transparent implementation of the Forest Code, using the Rural Environmental Registry (CAR) as the central pillar, enabling the society to create its own tools to monitor the quality of mapping and propose integrated landscape management systems;

► establishment of plans for land regularization in territorial planning, addressing conflicts arising from the overlap of ownership and land use rights;

► increasing participation of low-carbon agriculture in the scenario of food production in Brazil, using as the central pillar the credit policy, the innovation and the wide dissemination of sustainable practices, such as the production intensification, the recovery of degraded areas and pastures, the crop-livestock-forest integration, the dissemination of agro-forestry systems, the direct planting and other similar initiatives;

► effective forest restoration, integrated to the production of food, energy and fibre, with striking provision of environmental services related to climate, water regime, biodiversity and soil quality. Here, the technological development of forestry of native tree species is vital;

► vigorous resumption of the national agenda of bio-energy, with integration to the ethanol products like biodiesel and fuels from forests;

► consolidation of the rain forest economy, historically relegated to informality, illegality and impunity, through the encouragement of sustainable forest management in tropical forests and efficient mechanisms for tracking timber and non-timber forest products.

► commitment to fully eliminate deforestation and forest degradation in the supply chains of food, fibre or energy;

► incorporation of public information practice of inventories of emissions of greenhouse gases, as well as plans to mitigate their emissions;

► effective financial compensation for environmental services, recognizing the carbon value and of transaction mechanisms associated to it;

► inclusion and leadership of Brazil in the international cooperation related to the land use and the low carbon economy; adoption of incentive and priority recognition to low-carbon practices in the international trade of commodities.

The interdependence of sectors involved in land usage may replace the *or* for the *and*: it is possible to produce and preserve, leaving behind the false paradigm of producing or preserving. Other countries will hardly compete with Brazil in this field. The signal that the planet will move towards a low carbon economy is given. If properly conducted, Brazil may reach a unique and extremely favourable competitive position in the production of commodities from land usage, achieving at the same time the valorisation and the preservation of its huge natural capital. ■

A Bretton Woods of low carbon

in the era of financialisation

Alfredo Sirkis
Executive director of *Centro Brasil no Clima*, journalist and writer.

Tackling climate changes cannot be the exclusive responsibility of governments, almost all of which are indebted and running high deficits. A portion of the $220 trillion circulating in the international financial system must be drawn to the productive investments required for building low-carbon economies. It is already possible to establish economically-valid unit value for carbon reduction. This can generate a new monetary standard that reconciles environmental protection with strengthening of the global economy.

Recently, the conservative Time magazine chose as its cover story a striking critique of what it defined as the financialisation of contemporary capitalism. In other words, this means an economy where the financial capital fails to adequately supply the productive sector and circulates primarily in a world apart, one of the multiple forms of speculation. This situation contributes to the stagnation of the world economy, with mediocre growth and the constant risk of recession, despite low interest rates and inflation (Brazil is an extreme case: recession with inflation and high interest rates). Globally, financialisation contributes, among other factors, to the structural unemployment, poor growth, income concentration, indebtedness and public deficit, which have incited austerity measures that tend to generate vicious circles.

At the same time, climate change has become a major challenge for humanity in this century. Its consequences are already clearly visible: larger and more frequent floods and inundations; accelerated melting of glaciers at the poles and in mountain ranges; rising and acidification of oceans – which have come with the alarming scientific predictions of heat waves, droughts, forest fires, huge losses in agriculture and food production, repeated damage to urban health, transport and communications infrastructure, as well as new risks of new pests and diseases, migrations, tension and conflicts. The civil war in Syria was preceded by five years of drought, a collapse in agriculture and mass migration to urban peripheries.

As a consequence of the increasingly intense and frequent climate change, there are mounting losses for the world economy, with entire segments increasingly exposed, such as the insurance and reinsurance sectors. It is clear that the process of climate change will lead to growing economic losses, which have already been partially quantified and greatly exceed the investments necessary to tackle the problem, keeping global warming of the planet below two degrees over the century.

There is therefore a double historical necessity: restore growth and productivity in the global economy and finance the transition to low carbon economies. Both are deeply linked. The solution depends on the capacity to mobilize at least part of the "locked" capital in the global financial sector, bringing it to the productive sector and, within it, to investments in low-carbon economies and, in the future, carbon-neutral.

Countries no longer have the resources available to them in the past. Most of the world's money is not in their hands, even if they charge taxes or take ownership of oil export earnings. They still have much power, but it is decreasing. Any realistic analysis of public financial resources and internal political circumstances of the governments of the United States, the European Union, Japan and most other developed countries will reveal that they would have extreme difficulty in financing this process.

In fact, it will be difficult for them to be able to faithfully comply even with the commitment has already pledged – an annual contributing of US$100 billion for the Green Climate Fund for mitigation and adaptation actions as of 2020. Some kind of accommodation in this disbursement will inevitably be negotiated, which increases after 2025. It is said that a large part of it can come from an AAA Fund, capable of capturing resources on the financial market. Governments of developed countries would offer guarantees for the fund. However, this debate still has not happen in the Standing Committee on Finance of the United Nations Framework Convention on Climate Change (UNFCCC), where there seems to be a dialogue among the deaf: explicit accusations on the one hand, implicit denials and delays on the other. Even if the US$ 100 billion were materialized, the problem would not be solved. It is estimated that the annual demand for mitigation actions consistent with the 2oC trajectory is approximately US$ 3 trillion per year (US$ 1 trillion only for the energy transition).

It is an illusion to imagine that governments will be able to promote mitigation and adaptation through public investment, as occurred during the Marshall Plan after the war. This investment continues to be strategic both to finance the transition to low-carbon/neutral-carbon economies and to accelerate the pace of the world economy. The question is: How can this be done? What kind of public investment? What would it be directed to? This investment can play a catalytic role in scientific and technological research, which is essential to the desired transition, which, among other things, in-

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volves abandoning fossil fuels. In addition, it can offer guarantees to new financial mechanisms created to leverage the transition to low carbon/neutral carbon economies. Along with a civilizing pressure of world public opinion and civil societies mobilized against the financialisation of the global economy, governments need to create new mechanisms to encourage and guarantee investments that require large initial outlays and have a slower return. Today, these types of finance are typical of development banks, including the multilateral ones, such as the BIRD, BID and in the future the development bank of the BRICS and the Asian bank. That's not enough.

The global economic and financial system has flows and their dynamics that historically go in the opposite direction to what would be necessary: the so-called "markets" still bet heavily on fossil fuels. The auspicious information is that a process of "disinvestment" is in motion that already strongly affects coal. Sovereign wealth funds, such as Norway's, pension funds, major universities and even families with large fortunes are beginning to withdraw their investments in coal and, in some cases, oil. The recent drop in oil prices is a two-edged sword: it inhibits large investments that increase future emissions, but, to some extent, hinders clean energies, especially in the transportation sector, making the electric car less competitive, for instance.

Some rightly say that the Stone Age did not end for lack of stones, but because our ancestors learned to make tools and weapons with metals. So must the era of fossil fuels to be replaced by the clean energies. However, a push from politics and the new signs in the economic game will be necessary.

Economics is intended to be an exact science, but it results from circumstances and human historical needs. Today, a central issue is climate change, with its announced catastrophe and its tendency to exacerbate many other problems. A new economic and financial order is needed so that we can tackle the great challenge of the era in which we live. Its cornerstone is the recognition of the social, environmental, economic and financial value of decarbonisation.

New realities in the economy often have as their starting point international political and diplomatic arrangements that relate to some pressing historical necessity. This was the case of the contemporary economic system, structured in 1944, at the end of World War II with the Bretton Woods agreement that created the World Bank and the International Monetary Fund. The gold standard was also instituted, serving as the financial backing for the dollar in relation to most other national currencies. This gold standard was different from the one previous to World War I, because it was much more comprehensive. In 1971, in the Richard Nixon administration, facing the risk of a significant decline in reserves, abandoned gold as collateral. The dollar remained the currency-standard, but dissociated from gold. This was good for the United States, but not necessarily for the rest of the world.

We need a new economic order capable of promoting the transition from carbon-intensive to low-carbon economies, in order to prevent the climate changes underway from becoming catastrophic.

John Maynard Keynes had proposed in Breton Woods a new international currency, the "Bancor", but the proposal was not accepted by the United States. Although the gold standard/dollar mode and many of the suggestions on foreign exchange and international trade have not survived, the Bretton Woods conference structured relations of the world economy for the post-war. It was completed a few years later by the Marshall Plan, a huge package of outright American public investments, to rebuild war-torn Europe with remarkable success.

Gradually, the idea has been suggested that the era of the climate change and the global eco-

nomic stagnation should be a kind of "Bretton Woods of low carbon", i.e., a new economic order to promote the transition from financialisation to a new cycle of the productive economy: from the carbon-intensive era to a low-carbon/carbon-neutral one in order to prevent climate change from becoming catastrophic – and which comes with the extra perks of combating local air pollution, job creation, reduced health spending, technological development etc.

What can we do to make the issue of climate change no longer just a matter of governments, but also a matter of economics? Negotiations at the UNFCCC assume that governments may impose rules that require a cut of gas emissions large enough to stabilize climate. However, for this to be possible, low-carbon productive investments must be lured from the world economy, at least a portion of this huge mass of money circulating today through financial markets – which is outside the control of governments.

The current effort is insufficient

After the Climate Change Conference held in Paris in December 2015 (COP-21) Conference, the glass may be fuller, but it is still half empty. How empty or full is the object of a debate that will not end anytime soon. There was a breakthrough with regard to the outline of an instrumental action plan that, if objectified and accelerated, will be able to help the next conferences on climate. The political, diplomatic and cultural context for a civilizing turnabout is being created that can produce something exponential, especially in the economic field.

Therein lies the hope of our species, which is has been paving the way to extinction, like the dinosaurs, which can still avoid this tragic fate. The climate negotiations in the UNFCCC join 196 governments with equal sta-

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Global warming is very serious. However, to face it and keep it under control, it is not necessary that 196 countries cut their emissions significantly: a much smaller group of nations can take this decision.

tus, from the United States to Maldives, from China to Tuvalu. This is attractive from the point of view of the high ideals that inspired the creation of the UN, but does not reflect the power (of destruction and change) that each country has on the climate. In fact, to achieve the "2 degrees and 450 parts per million" paradigm, it would not be necessary that 196 countries cut their emissions significantly: it would be enough that a much more restricted group did so.

In 2011, the ten largest emitters, in descending order, were China, the United States, the European Union, India, Russia, Indonesia, Brazil, Japan, Canada and Mexico. This becomes important when we think of "closing the account", surpassing what was voluntarily committed by all the countries during the COP-21 process. Considering all of the goals presented in 2015 and assuming that it will be fulfilled by 2030, we will have exceeded the global emission required to put the planet on a two-degree trajectory by 15 gigatons (billion tons of equivalent CO_2).

China, United States and the European Union are responsible for more than half of the emissions. But if we look to the future, decades ahead, we realize that other countries may have a much greater weight than the current in GHG emissions. The most obvious case is that of India itself, which now exceeds China in GDP growth and is installing more coal plants (although, in parallel, it also expands the supply of solar energy). Other Asian, African and the Middle East countries will play a bigger role in the future. Thus it is necessary to identify trends and act proactively, especially in relation to coal. Each new coal plant emits for thirty years at least.

Here appears another problem: in the final analysis, governments are responsible for the emissions that occur in their territories, but their ability to drastically and efficiently impose reductions to third parties (companies, energy providers, drivers, farmers, consumers) depends on a series of political, governance (government run quality) and governability (ability of a government to enforce public policies) factors. We talk a lot of emissions of countries, but in fact, they are not emissions of nation-states, except in cases of state enterprises. The emitters are companies, human conglomerates and consumers in general,

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and the control of governments on these processes is relative. Even where the economy is still largely state-controlled, as in China, the central government no longer controls everything. In the provincial and local levels there is a strong obstruction to a drastic reduction in the use of coal, for example.

In the democracies, the process of "command and control" over the economy and its externalities is complex. Therefore, as we shall see, one cannot imagine that governments will solve the problem by themselves. Many companies emit more greenhouse gases than several countries together. They need to be directly engaged and charged, participating in the various business forums on decarbonisation and associating themselves to the negotiating process. This has been one of the limitations of the process led by the UN.

This process has two features that are unlikely to be changed: (a) the responsibility of emissions is given in the place of emission and not where the products are consumed and (b) the so-called parties of the negotiating process are just national governments. Thus, China – where Japan's, Europe's and the United States' industries were "relocated" and from where products are exported to consumers from these markets – is solely responsible for its emissions. Even if investors and consumers are across the sea, the onus is only assigned to the country where emissions occur. On the other hand, national governments negotiate decisions that must be later implemented by private companies or regional and local governments that fail in following the process.

To put the planet on a path under the two-degree objective, it will be necessary to diversify ways and multiply consultations beyond the UNFCCC. We have already seen that in 2030, in an optimistic hypothesis, 15 gigatons will be needed - equivalent to one and a half China of emissions - to achieve a trajectory compatible with two degrees.

The Intergovernmental Panel on Climate Change (IPCC) still conducts studies to estimate the possibility of achieving something close to 1.5 degrees, but this seems to be an impossible goal without geo-engineering solutions.

To make possible the path "of less than two degrees" it will be necessary to reach carbon-neutral societies sometime between 2055 and 2070. In order to approach the 1.5 degree mentioned in the Paris Agreement it will be necessary to obtain greater decarbonisation of the economy. In addition to the geopolitical, cultural and political difficulties, inherent in many countries, there is a fundamental question in common: the transition to low-carbon economies requires relatively high levels of investment, of approximately US$ 3 trillion per year, which makes the US$ 100 billion of north-south transfer mentioned derisory, although it is in the discussion and debates in the UNFCCC.

Not surprisingly, the Achilles' heel of the COP-21 and the UNFCCC is the issue of financing the transition to the low-carbon economy and the adaptation. The Standing Committee on Finance is the epicentre of this paralysis. Since the beginning of the process, the idea that developed countries should finance the mitigation and adaptation processes in the developing countries has predominated. It comes from the notion of "historical responsibilities" in the greenhouse gas accumulation in the atmosphere, which creates an obligation by the "polluter-payer" principle. Although this notion has never been officially recognized by the developed countries and has given rise to significant caveats, an obligation in the UNFCCC was set up since the Convention that developed countries should contribute in a larger scale to tackle global problems, notably those related to climate change, although this has never been clearly analysed.

Leaving mitigation exclusively in the hands of developed countries, as understood in the paradigm of the Kyoto Protocol, means giving up any chance of achieving a two-degree trajectory, since the developing world emissions are today higher than the developed one's: China is responsible for 1/4 of global emissions and India has become the third largest emitter (if we consider the countries of the European Union separately) or the fourth (if we consider the European Union as a country).

The greater involvement of developed countries in financing mitigation and adaptation actions has been accepted and consecrated when the Green Climate Fund

was established. They are expected to contribute from public, private, multilateral and bilateral sources with US$ 100 billion annually from 2020 onwards. Just before COP-21, only US$ 10 billion had been effectively allocated, although there were mentions to US$ 60 billion which had been "promised".

Currently, most observers think that the US$ 100 billion will be collected in 2020, but only a small part will be directly available to the Green Climate Fund. Most of it will probably come in the form of guarantees to leverage private funding. A good start would be to redirect spending directly or indirectly, subsidizing fossil fuels. In a 2013 study, the IMF calculated the cost of subsidies at US$ 480 billion, and the overhead costs, including externalities costs, at US$ 1.9 trillion. The elimination of these subsidies would release resources that could be invested directly in clean energies and energy efficiency, improving the competitiveness of other sources instead of fossil fuels, now subsidized. In some countries, however, the end of these subsidies is a very delicate political process, which will require compensatory measures for population groups affected by possible inflationary effects on basic products. Anyway, the best time to tackle the issue of subsidies for fossil fuels is the current one, when oil prices are low.

The elimination of these subsidies is just a transition component. It will be necessary to do something even more ambitious: what is conventionally called "new international financial order" or metaphorically a "Bretton Woods of low carbon". Today, the central problem of humanity is climate change, with its promised disaster and its tendency to aggravate all the other problems. A new economic and financial order is necessary in order to face the problems of the era in which we live. Its cornerstone is the recognition of "the social, environmental, economic and financial value of decarbonisation".

New economic mechanisms for decarbonisation

In addition to direct public contribution and the elimination of subsidies to fossil fuels, there are roughly three families of possible economic mechanisms: the carbon credit markets, the real pricing and the so-called positive pricing.

1) The carbon credit markets were created following the Kyoto Protocol of 1997, they consist of enabling an agent to fulfil their goals by "buying" the reduction of emissions from another. It is a mechanism that after all is quite limited and subject to misuse, to double counting, to speculative operations and frauds in certain situations.

COP-21 created an alternative to this "market" after a competent negotiation, the two main agents of which were Brazil and the European Union. Found in Article 6 of the Paris Agreement, this is a "voluntary cooperation" involving "the use of mitigation results transferred internationally to nationally determined contributions."

We face the challenge of updating the "carbon markets" to the context inaugurated by COP-21, in which all countries have their Intended Nationally Determined Contributions (INDC), with a vehement decision of halting the "double counting" and sanitizing these markets from their previous sins. Can this mechanism operate in this new context? At first glance, the interest in it would be lower than it seemed in the early days of the carbon credit market, which financed many important projects of mitigation in several countries, including China and, to a lesser extent, Brazil. It was hard to avoid double counting, when developing countries did not have any internationally registered target for mitigation and there were many gaps in secondary markets of such credits. One cannot say that the carbon credit market has been useless, becoming a speculative deception. Despite distortions and stumbles, it played a positive role.

Even reviewed and supposedly worthy of interest, which is not correct, the carbon credit markets are structurally limited in their scope. They are essentially a mechanism to streamline the fulfilment of established goals. In a situation where all countries already have their voluntary emissions targets, it tends to be even more limited. The "carbon markets" are not able to trigger and guarantee the exponential process required to make the


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global transition to low-carbon economies, producing a dramatic decarbonisation in the second half of the century. For this purpose, trillions of dollars per year must be invested. To mobilize resources on such a scale, it is necessary to price carbon in the two aforementioned modes, the "real pricing" (essentially a tax reform, country by country) and the "positive pricing" (the carbon reduction, for which the COP-21 produced an effective action in the 108 paragraph of the Paris Agreement).

2) Real pricing for carbon taxation would be the backbone for a more robust and global mitigation action, since it allows the incorporation of usually ignored externalities: inputs, processes, products, services and technology, according to the carbon intensity - including the cost of damage caused by their contribution to the climate change and local pollution. Thus, fossil fuels would receive a reality shock. There are frequent complaints that clean energies such as the solar and wind ones are still too expensive (although their cost has fallen spectacularly), so that coal and oil are the most recommendable from an economic point of view. However, the numerous subsidies, direct and indirect, given by governments to fossil fuels are not included in this amount.

Externalities resulting from burning of these fuels are also not included. What does that mean? An externality is a direct or indirect negative consequence, but with a clear cause-effect relationship. Let's imagine a coal plant near a city like Beijing or a steel mill in Santa Cruz, in Rio de Janeiro. As local effect polluting agents, they cause a large amount of respiratory diseases. This requires a strong increase in the expenses of the health systems. In cities like Beijing or New Delhi, these emissions are horrible. According to the World Health Organization, there are annual 7 million premature deaths from exposure to air pollution. In addition, greenhouse gases reinforce the climate changes, floods and droughts, the economic cost of which is also not perceived. Of course, the consequences of global pollution of greenhouse gases are more dif-

fuse than the toxic fog that smothers New Delhi: we must consider the increasing of floods, droughts, losses in agriculture, heat waves, damage to infrastructure etc.

These and other externalities are not included in the calculation of the price of coal or gasoline. It is time to do it, and taxation is the way. This precise calculation is not trivial, but the reality is clear: fossil fuels imply global and local externalities that need to be incorporated into prices. The best way to do this is taxing carbon, incorporating to its price the damage it causes to society in medical costs, environmental damage and others.

Some claim that coal is good for India because it is cheap, plentiful and easy to obtain. Do these people consider the costs to air pollution in the cities, spending with health and accidents in the mines, in addition to the global climatic effect? Local air pollution causes public health costs of up to 43 billion euro in the European Union – even with all its technological capacity. It is possible to imagine the situation in China and India, where coal causes almost apocalyptic consequences. Once externalities are incorporated, things that were cheap become expensive.

The carbon taxation also enables the clean and renewable energy sources to compete equally. So far, however, it has not significantly evolved. Participants of the Kyoto Conference in 1997 chose the path of "carbon credit markets" instead of the carbon taxation. Australia adopted it in the following election, but the Conservatives abolished it when they retook government. Voters did not like the price increase in the electricity rates.

This real pricing makes the intensive carbon more costly, helping to improve the competitiveness among clean energies and technologies. It raises an additional amount to be invested in the low-carbon economy and helps to establish a more socially fair tax system. This should be done without increasing in the tax burden, replacing taxes on labour and the investment by taxation according to the carbon intensity.

This is a battle to be fought in each country, since the tax systems and subsidies are nation-

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al. At the global level, a positive sign from the UNFCCC to all the countries is a possibility. There is not the necessary consensus yet. In the Paris Agreement there was only an oblique reference to carbon pricing, in a section which deals with non-governmental contributions. It appears in the fifth part, which deals with "non-party partners," at the end of paragraph 136: "[the decision] also recognizes the important role of providing incentives for emission reduction activities, including instruments such as domestic policies and carbon pricing". This real pricing, however, is already being practiced by many national and sub-national governments, besides companies, including major energy companies, such as Shell.

The expectation is that the carbon price allocation advances in countries at national, regional and local levels, and on businesses. An increasing number of companies are already setting up a shadow price in its operations, related to the emission intensity at different stages of production of their product or service.

Tax reforms, taxing carbon instead of other taxes and eliminating fossil fuel subsidies, will help to create a more favourable economic environment for the transition. They will occur gradually, country by country, reaching the companies. They will hardly result from a global agreement, although UNFCCC can gradually create a more favourable environment for national, sub-national and corporate advances.

3) Positive pricing. The carbon taxation is the "truncheon", while the positive pricing is the "carrot". We assign in it a price not directly related to carbon, but to its reduction or removal (by the so-called "mitigation activities"). It is a process still under construction, whose first step was taken at COP-21 with the recognition of the "social and economic value" of mitigation actions. The genesis of this positive pricing of carbon reduction is in paragraph 108 of the Paris Agreement, which "recognizes the social, economic and environmental value of voluntary mitigation actions and co-benefits for adaptation, health and sustainable development." Like so many others, this formulation and its location in the text were the result of commitments with different types of objectors. It was a bit of a baroque negotiation, but it preserved the basic device, i.e. the recognition that the carbon reduction (mitigation actions) means value. Those that reduce greenhouse gas emissions will generate an intrinsic economic value. A form of pricing different from carbon pricing was thereby established. They are not opposed, since each one has its own usefulness.

Future mechanisms to apply this recognition and boost low-carbon investments, "mobilizing the trillions," will only tangentially pass by UNFCCC. The essence of this construction will probably happen through a "climate club", to be composed by interested governments, central banks, development banks, multilateral agencies and possibly sub-national governments. At some point, it will require a G-20 push. It depends on the UNFCCC system to certify emission reductions, which should relate to the successor mechanism of carbon credits. Its currency will be the "emission reduction/removal certificates", guaranteed by governments and operated by a system of accredited institutions.

With the G20 support, national and sub-national governments, central banks, development banks and multilateral agencies can constitute a "climate club" to boost investments.

Which driving mechanisms of investment may come from "positive pricing"? Initially we can think of two of them. The first one would consist of carbon reduction certificates - guaranteed by a number of governments, central banks, development banks and multilateral agencies - with which decarbonisation certified projects could pay part of their debt. Companies, governments and civil so-

ciety organizations could partially reimburse funding for these projects. Such certificates would be absorbed by an international fund, guaranteed by governments or by a pool of institutions that would accept converting them into currency for the project financing bank. These certificates could generate a private secondary market, the green bond type. Instead of being tied to specific projects, they would keep the dynamics of the increasing demand for reduction/removal of carbon, to the extent that the Intended Nationally Determined Contributions of the countries were reviewed in an increasingly ambitious way, according to the Paris Agreement.

The second one would be a specific mechanism to compensate the "early actions" of mitigation, completed ahead of schedule and/or the "additional" actions, the ones beyond the target set in the Intended Nationally Determined Contributions of the intermediate country. They would be remunerated with a "climate currency", which would be exclusively used to acquire products, services and technology, leading to a subsequent reduction of emissions and generating a virtuous cycle.

A Bretton Woods of the low carbon

Before even putting into practice any of the aforementioned mechanisms, another one already in full operation would need to be redirected. This is the "quantitative easing", by which central banks – previously the American "Fed", currently the European Central Bank – inject liquidity into the economy by buying a wide range of government securities, companies and financial markets. This indiscriminate purchase, including dubious titles – the so-called "junk bonds" – provides resources that could go to the production system, but are often put back by banks in the speculative wheel. The great solution would be directing a substantial part of this quantitative easing explicitly to the transition to low-carbon economies, by acquiring or offering guarantees to emission reduction/removal certificates and bonds (or climate currency) linked to the remuneration of these "anticipated" or "additional" mitigation actions.

It is necessary to establish a "friendly" backdrop in the international financial system for the transition towards the low carbon economy. We have already seen that the global demand for this transition is currently estimated at US$ 3 trillion per year. In the energy sector alone, it is $ 1 trillion. This money will not come from governments, almost all of them heavily indebted and with a negative balance. It would not come from the Green Climate Fund of the United Nations either, which so far has only saved US$ 10 billion, with the promise of another US$ 60 million. No one believes that it will reach the goal and there are doubts about it being able to spend these savings effectively. Meanwhile, there are around US$ 220 trillion circulating through the various circuits of the financial system in various applications. How is it possible to attract a portion of it for low carbon productive investments?

It is possible to reconcile the fight against the climate challenge with the productive recovery of the global economy in order to recover from the current stagnation towards a new production cycle.

Although no longer able to directly finance these US$ 3 trillion annually, the governments would probably be able to collectively provide the necessary guarantees so that these resources could finally leave the large speculative financial circuits and finance a productive low carbon economy, tending to carbon-neutrality.

This, in large part, will probably be articulated outside the UNFCCC, under the G-20 (the group of countries with the twenty largest economies) and the multilateral financial system. Tackling climate change cannot be just an exercise among gov-

ernments. The civil society and the citizens must actively participate. And the actions to reduce emissions need to work not only from the climatic point of view, but also from an economic point of view. This takes on a new meaning if we consider the unit value of carbon reduction, as approved in paragraph 108 of the Paris Agreement.

There is an initial scepticism about financial products and devices to be created from this value recognition. Would it be just a Bitcoin business, simply a virtual currency of the internet and social networks?

We don't think so. We're talking about a real value. The Stern Report, from a working group of leading economists commanded by British Lord Nicholas Stern, calculated in a very detailed way the total damage that climate change caused by the "greenhouse effect" will inflict on the global economy. It calculates between 5% and 20% of GDP, depending on the calculation of various indirect costs.

Let us consider the 5% scenario. If global GDP in 2014, which was US$ 77.6 trillion, were our basis of calculation, we would have a loss of US$ 3.8 trillion per year. Obviously, this cost estimate would have to be projected in time (2050? 2010?) and fixed by the governments based on a calculation from experts. Although it cannot be done with precision, this "official number" has been sought several times.

From the moment a number is set that measures the damage inflicted on the global economy in a given period, it is possible (and even relatively easy) to establish the value of each ton of carbon that is no longer emitted. If we recognize this as a "unit of value", we can even imagine that the carbon reduction would be a new "gold standard". The gold standard had several "lives" in different ways: in the strongly liberal economy of the late nineteenth century, in the years after World War I, between 1944 (Bretton Woods Conference) and 1971, when the United States abandoned it, the dollar itself taking its place in a way, with growing problems and conflicts. The adoption of the gold standard reflected an old monetary practice, but it is in fact a human convention, something established in a negotiating table. It could have been some other metal - silver was considered at some point - or a commodity.

"Value" is something humanly arranged in a given historical context and reflects a human need. Therefore, when it is agreed that the carbon reduction represents a unit of value because it has social, economic and environmental value, as the Paris Agreement has done, a new wind is now blowing in the world economy. If we imagine that the possible consequence is attracting large resources for productive low carbon economy, with investments that can reduce emissions of greenhouse gases, we realize that this may be an important element to "close the account" of 15 gigatons left over in 2030 – even if all current targets are met.

Here's an idea that needs to be considered: carbon reduced or removed is the new gold! Currently, there is nothing capable of producing a new international financial order, as was the Bretton Woods Conference. The UNFCCC, the International Trade Organization (ITO), the OECD and the Bretton Woods institutions – the World Bank and the International Monetary Fund – or the control circuit of the Basel agreements, act separately, each one in their particular area. Perhaps the G-20 is the body capable of promoting the wide, necessary consultation. If in the future humanity is able to face the challenge of keeping the temperature rise below two degrees (or come close to 1.5), surely the aforementioned mechanisms will play an important role in the coming decades. They will establish the points of intersection between the answers that humanity must give before the emergence of climate changes and the need for global macroeconomic recovery, reversing the process of speculative financialisation with a new development cycle: one of the low-carbon or carbon-neutral economies. There is a consistent convergence between what needs to be done to face the climate challenge and what can facilitate a productive recovery of the global economy to get it from the current speculative stagnation towards a new production cycle. ■

Alternatives for

sustainable energy development in Brazil

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Increased energy efficiency, dissemination of renewable energy, low carbon agricultural techniques, changes in the modes of transport, improvements in the waste management and reforestation would allow a significant reduction in the emission of greenhouse gases in Brazil. They are low-cost measures, consistent with economic growth, creation of jobs and increased family income.

Energy, environment and development

Energy, in its various forms, is present in all human activities, both as an essential service to the quality of life and as a production factor that boosts economic development. Therefore, we should look upon the production and use of energy with a systemic approach that transcends the energy sector itself. It is necessary to consider the energy component, as well as the environmental one, in the different sectoral policies.

The relationship between energy and the environment is also very large, both by the use of natural resources and by the impacts in the long chain that produces, transports, distributes and stores energy before its final use. The primary energy sources can be found in nature: oil, natural gas, coal, wood, sugar cane, waterfalls, and uranium. Some of these sources, such as wood, can be used directly by the final consumer, but in most cases it is necessary to utilize processing centres, such as refineries, gasification plants, coking plants, coal plants, distilleries, hydroelectric plants or thermal power plants. Thanks to these facilities, energy is delivered to the consumer in the form of gasoline, diesel, fuel oil, naphtha, kerosene, gas, coke, charcoal, alcohol, electricity and other secondary forms. Boilers, engines, stoves, ovens, turbines and other equipment convert them into goods and services, such as heat, motor power and lighting.

Along this chain, inevitable losses reduce the amount of useful energy to only a fraction of the total primary energy captured in nature. In Brazil, for example, the Energy Research Company

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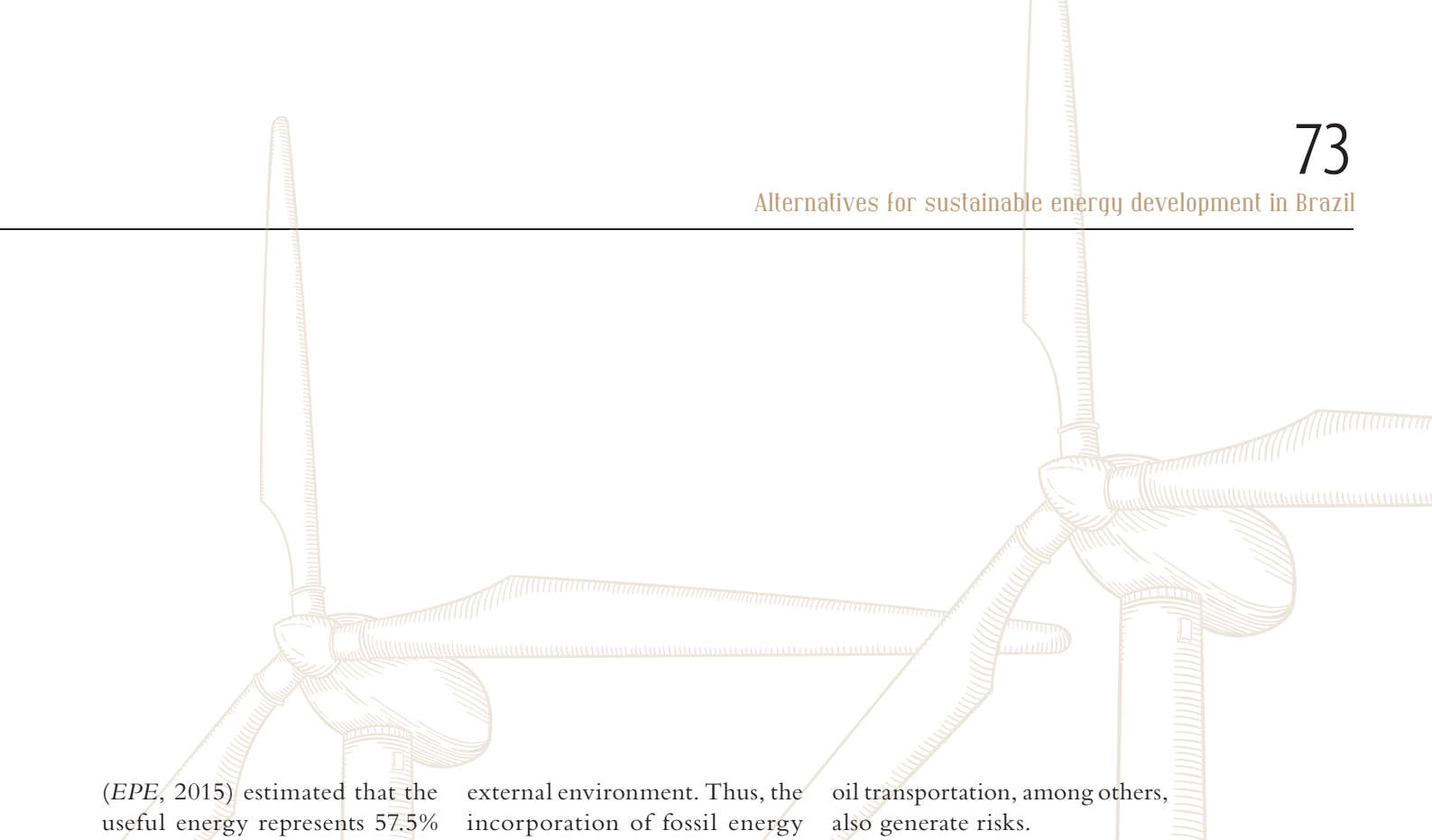

(*EPE*, 2015) estimated that the useful energy represents 57.5% of the gross domestic primary energy supply (production plus imports, minus exports and stock variations).

This great loss has two main sources. First, a great amount of energy is wasted in Brazil and many other countries due to inefficiencies in the planning processes and the operation of equipment. This is explained primarily by (a) the low energy prices, particularly oil (dominant energy source in the world), the orientation of the technological progress over the 25 years after World War II, during which time much of the current global productive apparatus was installed; and (b) the low incidence of energy costs in the budget of companies and households (less than 5% in most cases). On the other hand, a minimum level of losses along the chain of energy transformations is inevitable, due to the very laws of physics, in particular the second principle of thermodynamics.

The loss takes the form of degraded energy released into the external environment. Thus, the incorporation of fossil energy (oil, coal, gas) to the production of goods and services will necessarily be emitted as waste (material / energy), causing a series of environmental impacts (Odum, 1988). In addition, the use of energy sources causes environmental impacts associated with the opportunity cost (economic, social and ecological) of the use of natural resources. Such impacts can be quite significant even in the case of renewable sources (such as hydroelectricity, planted biomass, solar and wind power), due to the large areas required to produce large-scale energy (construction of large dams, forests and energy crops, surface occupied by solar panels and wind turbines).

Energy technologies also increase the risk of accidents, disasters and use for improper purposes with great potential to harm the environment – nuclear power is the most significant. However, on another scale and with different characteristics, hydroelectric dams, biotechnology, coal mines, wells, refineries and oil transportation, among others, also generate risks.

Today, technological risks and environmental impacts associated with energy use threaten the very survival of mankind and life on Earth. While energy is essential to satisfy human need, man is the only animal whose needs change significantly over generations. Mankind's energy consumption evolved moderately until the Industrial Revolution, an event that increased the number of man's "mechanical slaves", requiring an increasing jump in energy use (Puiseux, 1977). With the change from wood to coal in the nineteenth century and the widespread use of oil and electricity after 1930, the basis of the modern industrial civilization was moved to the consumption of fossil fuels that nature had taken millions of years to produce. The world energy consumption increased seven times between 1900 and 1965. The unprecedented acceleration of energy consumption after World War II led, finally, to the use of nuclear energy to generate electricity.

Dangerous limits have been surpassed: for the first time in history, human activities can destroy fragile ecological balances essential to reproduce life, whether by the level of aggression on the environment (caused by waste that disturb biogeochemical cycles) or the incidence of serious accidents. With the exception of the "hole" in the ozone layer, the water crisis and threats to biodiversity, the main environmental risks on a planetary scale are closely associated to the growth in energy consumption, as follows:

a) the greenhouse effect increasing, since global warming by the emission of gases that are accumulated in the atmosphere, particularly carbon dioxide (CO_2) released by the burning of fossil fuels and deforestation, is already causing dangerous climate changes;

b) urban air pollution, especially in large cities, by the industry and the transportation vehicles;

c) acid rain and its impacts on soils, water resources, vegetation and buildings;

d) the risk of accidents in nuclear reactors, the problems created by the care of their waste and its deactivation after its lifetime, in addition to the contamination hazards associated with the use of nuclear energy.

The burning of fossil fuels, primarily responsible for the first three cited environmental risks, and the use of nuclear energy can threaten the biosphere, surpassing the borders of the countries that benefit from these sources. Three consequences are particularly important:

a) the preservation of the environment is very complex, since it requires a global awareness of a coordinated action at international level;

b) energy planning must increasingly incorporate an environmental dimension that will condition the decisions on the production and use of energy;

c) In the short and medium terms, it is essential to stop the growth of energy consumption in industrialized countries. They are home to 29% of the world's population, but use 84% of the energy supplied globally. This will require a comprehensive conservation policy which promotes a more efficient use of energy. Developing countries, in turn, should not mimic the Northern consumer societies, which always benefit the local elites, with the "waste pollution" and its inevitable counterpart, the "poverty pollution" from the majority of the population. This implies seeking a less intensive development style on energy and, in the long run, not destructive of the vital balances of the planet. At the same time, this process must eradicate the typical evils of economic, social, technological, political and cultural underdevelopment, the main factors of deterioration in the quality of life in these countries (La Rovere, 1985).

This general context contains the relationship among energy, environment and development in Brazil, characterized by some special features:

a) strong preponderance of hydroelectric generation in the electricity supply, with most of the remaining hydropower potential located in the Amazon, a region of particularly fragile ecosystems and high biodiversity;

b) existence of an important segment of the steel industry, particularly pig iron and ferroalloy production, based on the use of charcoal (as reducer and fuel), partly resulting from deforestation;

c) importance of sugar cane alcohol as an automotive fuel, thanks to the *Proálcool* programme, a pioneering program in the production and use of renewable biomass on a large scale;

d) low use of coal for historical reasons, since domestic coal is poor in quality, with high levels of ash and sulphur.

Thanks to these characteristics, the Brazilian energy system occupies a privileged position in the world: in 2015, renewable sources ensured 41.2% of gross domestic energy supply in Brazil, against 14.3% in the world average and 9.4% in member countries of the OECD (MME, 2016). However, the production and use of energy from renewable sources does not automatically guarantee sustainability, which depends on the energy system configuration and the definition of its beneficiaries.

Energy in Brazil: recent developments and current situation

The national energy balance provides an overview of energy use in the country. From the calorific values of each source, tons of oil equivalent are calculated, which provides an aggregated treatment to the different forms of energy consumed. Figure 1 shows the evolution in each decade, from 1940 to 2010, and in recent years by 2015, of the gross domestic supply of energy in the country (production plus imports minus exports of primary energy).

The classification into renewable and non-renewable energy is only estimated, since the lack of accurate data requires the use of estimates of firewood and charcoal. Both are considered as renewable sources, but a portion of them come from illegal logging.

In Brazil, the use of energy begins to show high growth rates after World War II, driven by the population growth, rapid urbanization, the industrialization process and the construction of the road transportation infrastructure, demanding has high energy consumption. In 1940, for a population of about 41 million, from which 69% lived in rural areas, Brazil's primary energy consumption was only 23.8 million tons of oil equivalent (Mtoe). The total primary energy consumption in Brazil shows a strong growth over the 1970s and less intense growth in the next decade. At the end of the century, 81% of a population that had already reached 175 million people lived in the cities of a country with a per capita GDP of US $8,454 (in dollars of 2014). The average energy consumption per inhabitant almost doubled, from 0.6 to 1.1 ton of oil equivalent per inhabitant per year. In the 21st century the expansion continued until 2014, but was interrupted by the recession of 2015 and 2016.

Energy supply has also changed radically over the period, according to changes in the demand. In 1940 and in a predominantly rural society, wood supplied more than 80% of primary energy used in the country, against a contribution of only 6% of oil and coal and 1.5% from hydroelectricity. Today, two large centralized national systems, an initiative of the State, are predominant: the hydroelectric and oil systems. They supply the different forms of energy that an industrialized, urban and on-road country demands: electricity for industry, households, trade and urban services; diesel for trucks and buses; fuel oil for industry; gasoline and alcohol for private cars; naphtha for the petrochemical industry; liquefied petroleum gas for food preparation; coal coke and charcoal for the steel industry.

If we consider the non-renewable sources, oil loses participation in the supply structure of the 21st century, falling from 45.6% to 37.3% of the total between 2000 and 2015. This loss was offset by the growth of natural gas, from 5.4% to 13.7% in the same period. The participation of hydroelectricity in energy supply also drops, from 16% in 2000 to 11% in 2015, due to the difficulties of using the remaining hydroelectric potential that is located primarily in the Amazon, where there are environmental restrictions for constructing plants with large reservoirs. However, the consumption of sugarcane products (ethanol and pulp), after being almost stagnated in the 1990s, starts to grow strongly in the first decade of this century, from 11% in 2000 to 17% in 2015. In the same period, wood and charcoal continued to lose participation due to the urbanization process, falling from 12% to 8%, while the bleach and biofuels rose from 1.8% to 4.7%.

After the oil crisis in 1973, a new international distribution of labour emerged. Today, rich countries are service economies.

After a very rapid growth between 1970 and 2000, consumption of electricity started to grow in this century at the same pace as GDP, following the total energy consumption. Both the domestic energy supply (OIE), seen as a whole, and the electricity supply (OIEE) were stabilized as a proportion of GDP (Figure 2).

After the oil crisis in 1973, a new international division of labor emerged, speeding up the fall of industry in the OECD countries, which today are economies based on services. Brazil became a major exporter of intensive industrial products in the 1980s (steel

and ferroalloys, aluminium, paper and cellulose). The industry reached 38% of the final energy consumption in 2007 (MME, 2016). In 2015, with the substantial reduction of these exports, the industrial sector accounted for 32.5% of the final energy consumption, and was almost reached by transportation, which was increased from 20% to 32% between 1973 and 2015 (Figure 3).

According to data from the Ministry of Mines and Energy (MME, 2016), Brazil had 13 billion barrels of proven oil reserves in 2015, allowing for a production of 2.5 million barrels per day (Mbpd), of which 93.5% is offshore. Due to the lower consumption, the country was a net exporter of oil by-products in 2015. The oil sector has a nominal refining capacity of 2.4 million barrels per day. However, the technical constraints of the refinery capacity require a significant importation of naphtha, LPG and diesel, and a lower amount of gasoline, with large exports of fuel oil.

The country also had natural gas reserves of 429 billion cubic meters. Such reserves enabled the production of 96 million cubic meters per day in 2015, corresponding to 57.5% of total consumption. The remaining consumption is covered by the liquefied natural gas re-gasification (LNG) and imports from Bolivia (Gasbol). In 2013, the sector was able to process 95.4 million cubic meters per day.

The Brazilian power generation park is hydrothermal, characterized by the strong presence of hydroelectric plants with large reservoirs of multiannual regularization or without reservoirs (run of the river), located in different river basins, away from consumer centres. The system is interconnected by long transmission lines. The hydropower source is complemented by thermal power plants (conventional and nuclear), wind farms, cogeneration from biomass (mainly sugar cane pulp), plus a distributed solar generation base, which is incipient but expected to grow significantly. In 2015, Brazil could have generated approximately 141 GW, with 91.65 GW in hydroelectric plants, 41.4 GW in power plants (14.1 GW from gas, 13.2 GW from biomass, 8.7 GW from oil derivatives, 3.4 GW from coal and 2 GW from nuclear power) and 7.6 GW from wind power. Moreover, the contracted importation of hydroelectricity reached 5.85 GW. It is estimated that the remaining hydropower potential is about 95 GW, located mainly in the Amazon region. In 2015, the generation of renewable sources provided 75.5% of the total electricity supply (64% from hydropower, 8% from biomass, 3.5% from wind power and 0.01% from solar power), while fossil fuels generated 22.1% and nuclear power 2.4% (MME, 2016).

About 99% of the 68 million of the permanent households in the country had access to electricity at the end of 2015, against 500,000 still disconnected from the network (from 2011 to 2015, the average quantity of new connections was 1.5 million households per year). However, the residential price of electricity increased by an average 52.6% in 2015, reversing the reduction observed since 2012.

In 2015, the Brazilian production of sugarcane alcohol reached 30 billion litres (6% increase over 2014), providing 16 million tons of oil equivalent (Mtoe) of the domestic energy supply (5.3% of total) which were added to 35 Mtoe (11.3%) from sugarcane pulp. Biodiesel production reached 4 billion litres in 2015 (15% higher than in 2014), allowing a mixture of 7% in diesel and providing 1.1% of the domestic energy supply. The installed capacity in the 53 biodiesel plants reached 7.4 billion litres / year by 2015, and 41 of them (91% of the installed capacity) hold the seal of social fuel.

Scenarios for the development of Brazil by 2030

The scenarios analysed below were developed under the project *Implicações Econômicas e Sociais de Cenários de Mitigação de Gases de Efeito Estufa no Brasil* (IES-Brasil - Economic and Social Implications of Scenarios for Mitigation of Greenhouse Gases in Brazil) to 2030 (La Rovere et al., 2016). The present study was requested by Izabella M. Teixeira, former Minister of the Environment, the Brazilian Forum on Climate Change (*FBMC*), as support for the Indented Nationally Determined Contributions (INDC) of Brazil in the context of the Paris Agreement, decided at the 21st Conference of the Parties (COP-21) of the Climate Convention (UNFCCC) in December 2015.

Figure 1 | Recent developments in the gross domestic energy supply in Brazil and its current situation - from 1940 to 2015, Mtoe and%

Energy sources	Unit	1940	1950	1960	1970	1980	1990	2000	2010	2013	2014	2015
Oil and by-products	Mtep	1,5	4,3	12,7	25,3	55,4	57,7	86,7	101,7	116,5	120,3	111,6
	%	6,4	12,9	25,7	37,7	48,3	40,7	45,6	37,8	39,3	39,4	37,3
Natural gas	Mtep	-	-	-	0,2	1,1	4,3	10,3	27,5	37,8	41,4	41,0
	%	-	-	-	0,3	1,0	3,1	5,4	10,2	12,8	13,5	13,7
Mineral coal and coke	Mtep	1,5	1,6	1,4	2,4	5,9	9,6	13,0	14,5	16,5	17,6	17,7
	%	6,4	4,8	2,9	3,6	5,1	6,8	6,8	5,4	5,6	5,7	5,9
Nuclear energy	Mtep	-	-	-	-	-	0,6	1,8	3,9	4,1	4,0	3,9
	%	-	-	-	-	-	0,4	1,0	1,4	1,4	1,3	1,3
Others non renewable	Mtep	-	-	-	0,1	0,1	0,4	1,0	1,1	1,6	1,8	1,8
	%	-	-	-	0,0	0,0	0,0	0,5	0,5	0,5	0,6	0,6
Subtotal Energy Non renewable	**Mtep**	**3,0**	**5,9**	**14,1**	**27,9**	**62,5**	**72,7**	**112,8**	**148,6**	**176,5**	**185,1**	**176,0**
	%	**12,8**	**28,6**	**28,6**	**41,7**	**54,5**	**51,2**	**59,3**	**55,3**	**59,6**	**60,6**	**58,8**
Energy hydroelectric	Mtep	0,4	1,6	1,6	3,4	11,1	20,1	30,0	37,7	37,1	35,0	33,9
	%	1,5	3,2	3,2	5,1	9,6	14,1	15,8	14,0	12,5	11,5	11,3
Wood and Charcoal	Mtep	19,8	31,4	31,4	31,9	31,1	28,5	23,1	26,0	24,6	24,7	24,5
	%	83,3	63,9	63,9	47,6	27,1	20,1	12,1	9,7	8,3	8,1	8,2
By-products from sugar cane	Mtep	0,6	0,9	2,1	3,6	9,1	19,0	20,8	47,1	47,6	48,1	50,6
	%	2,4	2,7	4,3	5,4	8,0	13,4	10,9	17,5	16,1	15,7	16,9
Other renewable	Mtep	-	-	-	0,2	0,9	1,7	3,5	9,4	10,6	12,6	14,2
	%	-	-	-	0,2	0,8	1,2	1,8	3,5	3,6	4,1	4,7
Subtotal renewable energy	**Mtep**	**20,8**	**27,4**	**35,1**	**39,0**	**52,2**	**69,3**	**77,3**	**120,2**	**119,8**	**120,5**	**123,3**
	%	**87,2**	**82,3**	**71,4**	**58,3**	**45,5**	**48,8**	**40,7**	**44,7**	**40,4**	**39,4**	**41,2**
Total	**Mtep**	**23,8**	**33,3**	**49,2**	**66,9**	**114,7**	**142,0**	**190,0**	**268,8**	**296,3**	**305,6**	**299,2**

Sources: EPE, 2015 (data from 1940 to 2014); MME, 2016 (preliminary data for 2015); Mtoe = million ton of oil equivalent.

Figure 2 | Population, GDP and energy consumption in Brazil, 1970-2014

Indicators	Unit	1970	1980	1990	2000	2010	2014
Domestic Energy Supply (DES)	Mtep	66,9	114,7	141,9	190,1	268,8	305,6
Domestic Supply of Electricity (DSE)[1]	billion kWh	45,7	139,2	249,4	393,2	550,4	624,3
Population	million inhab	95,7	122,2	148,1	174,7	196,4	203,6
GDP[2]	billion US$ 2014	380,7	948,0	1.132,5	1.475,2	2.152,5	2.346,6
GDP/capita	US$ 2014/inhab	3.983	7.768	7.656	8.454	10.973	11.539
DES/capita	tep/inhab	0,699	0,939	0,958	1,088	1,369	1,501
DES/GDP	tep/10^3 US$ 2014	0,154	0,116	0,123	0,128	0,127	0,130
DSE/capita	kWh/inhab	478	1,139	1.684	2.251	2.802	3.066
DSE/GDP	kWh/10^3 US$ 2014	120	147	220	266	255	266

Source: EPE, "National Energy Balance ", 2015.
1. It includes imports and self-production;
2. GDP informed by IBGE converted to dollars at the average exchange rate of 2014 (Central Bank: US$ 1.00 = R$ 2,3529)

Figure 3 | Matrix of final energy consumption by sector (% and toe)

Setor	Brazil	Brazil	OECD	OECD	Other[1]	Other[1]	World	World
	1973	2015	1973	2015	1973	2015	1973	2015
Industry	29,8	32,5	31,2	20,0	33,1	33,0	30,6	26,8
Transportation	25,0	32,2	22,6	30,0	10,8	17,0	21,5	25,2
Energetic sector	3,3	10,7	8,5	8,4	5,8	8,3	7,2	8,1
Other sectors	38,7	18,8	30,6	32,8	46,6	33,9	35,0	31,9
Non-energetic use	3,1	5,8	7,2	8,8	3,8	7,9	5,7	7,9
Total (%)	100	100	100	100	100	100	100	100
Total (Mtep)	76	261	3.072	3.962	1.691	5.694	5.027	10.273
% of world[2]	1,5	2,5	61,2	38,6	33,6	55,4		

Source: MME, 2016.
1. Exclusive Brazil and OECD countries;
2. Bunker, included only in the world, completes 100%.

The Scenario Development Committee (*CEC*) of IES-Brasil was composed by a multidisciplinary group of nearly a hundred experts from academia, government, labor movements, private sector and civil society, invited by the Brazilian Forum on Climate Change (*FBMC*), bringing together the majority of the Brazilian experts who monitor the issue at national and international levels. During the five meetings of the CEC in 2014 and 2015, sectorial groups defined and established the chances of introducing additional measures to reduce emissions of greenhouse gases (GHGs) in the country by 2030. These measures were grouped into three scenarios:

1) The Government Scenario Plan (*GSP*) is not a baseline scenario, since it already includes all the government efforts to mitigate emissions of greenhouse gases. It is based on the macroeconomic scenario of the National Energy Plan (NEP) 2050, of the long-term energy plan of the Ministry of Mines and Energy (MME)/ Energy Research Company (EPE). It adopts additional assumptions established by the CEC on the extension to 2030 of sectoral plans for mitigation and adaptation of the National Policy on Climate Change (*PNMC*) and on variables not specified in the government plans (for example, about the future income distribution policy).

2) The Additional Mitigation Scenario 1 (MA1) involves a significant effort to remove obstacles and allows for a reduction of emissions higher than the previous scenario.

3) The Additional Mitigation Scenario 2 (MA2) is the most ambitious effort to achieve a reduction of the emissions even greater than the in the MA1.

Furthermore, the Research and Modelling Committee (*CPM*), bringing together researchers from various institutions under the coordination of the Climate Centre / Coppe / UFRJ, processed the information and input data, operating mathematical simulation models (a macroeconomic module and several modules related to different areas) for economic, social and gas emission-related results for each scenario. There are international and macroeconomic assumptions common to all scenarios, but there are also differences among them.

Figure 4 presents the results obtained by IES-Brasil for the Bra-

zilian macroeconomic scenario in 2030. If the additional mitigation measures are implemented through microeconomic instruments and appropriate control and command mechanisms, GDP tends to grow more than in the GSP. The scenario with the greater growth rates is the one that takes the most ambitious mitigation measures, the MA2. In this case, GDP is about 2.5% higher than in the GSP. Even in the MA1 scenario, GDP is still slightly higher (0.77%) than in the GSP. In these cases, the GDP growing is higher due to the embracement of more cost-effective mitigation actions, that produce a positive macro-economic effect as, for example, the expansion of ethanol, which has a low cost per avoided ton, and generates a large quantity of jobs.

Social implications

The additional mitigation scenarios tend to generate more jobs than the base scenario (GSP), as shown in Figure 5. In the MA1 and MA2 scenarios, the number is higher due to the higher level of economic activity. The MA1 scenario generates 355,000 jobs more than GSP. The most ambitious scenario (MA2) generates 1.152 million additional jobs. The sector that created the largest number of jobs was the energy sector, due to the increase in the participation of renewable energies in the matrix, especially the production of biomass and bio-fuels, which are more intensive in manpower.

In Figure 6, which shows the evolution of the average annual household income, it is found that the average annual household income may increase in the additional mitigation scenarios, with greater gains in the MA2 scenario. In all the scenarios, the biggest gain is the one of class 1, the poorest households. The salary is more relevant in the composition of its income than in the wealthier classes, who own other sources of income, not affected by the mitigation policies. The smaller gain in the additional mitigation scenarios is of the richest families. I.e., the additional mitigation policies tend to contribute to a slight improvement in the income distribution in the country. However, this improvement is too small to be captured by the Gini index, which would be 0,42 in 2030 in all scenarios.

Figure 4 | Results for the Brazilian macroeconomic scenario in 2030

	Base year 2005	GSP	MA1	MA2
Population hypothesis (million)	185	223	223	223
GDP (trillion R$ 2,005)	2,14	5,55	5,59	5,68
Average annual GDP growth until 2030	-	3,88%	3,91%	3,98%
GDP variation in relation to GSP in 2030	-	-	0,77%	2,46%
GDP per capita (R$ 2005)	11.570	24.868	25.060	25.480
Unemployment rate (%)	9,90%	4,35%	4,08%	3,50%
Increase of the general level of real prices compared to 2005 (%)	-	16,1%	22,5%	28,4%
Trade balance (% GDP)	3,70%	0,72%	0,44%	0,23%
Total investment (billion US$ 2005)	332	1.152	1.100	1.039
Investment rate (% GDP)	15,5%	20,8%	19,7%	18,3%
Investments in additional mitigation in the period (R$ billion 2005)	-	-	99	372
Variation of GHG emission level in relation to GSP in 2030	-	-	-21,7%	-38,5%

Source: La Rovere et al., 2016.

Figure 5 | Jobs by economic sector (thousands)

(In thousand jobs)	Base year 2005	GSP	MA1	MA2
Agriculture and cattle farming	19.000	14.547	14.468	14.505
Industry	9.783	20.458	20.125	19.728
Energetic sector	2.755	6.380	7.080	7.484
Transportes e serviços	59.674	85.912	85.978	86.732
Transportation and services	91.212	127.297	127.652	128.449

Source: La Rovere et al., 2016.

Pollution and development are disassociated from each other. By adopting bolder policies to mitigate the emission of greenhouse gases, Brazil will be able to improve growth and income.

Figure 6 | **Average family income (R$2005)**

	Base year 2005	CPG	MA1	MA2
Class 1 (16% poorest)	1.169	3.689	3.956	4.300
Comparison with GSP in 2030	-	-	7,2%	16,5%
Class 2 (60% following)	4.421	12.306	13.173	14.248
Comparison with GSP in 2030	-	-	7,0%	15,8%
Class 3 (24% richest)	26.360	53.882	57.556	61.832
Comparison with GSP in 2030	-	-	6,8%	14,8%

Source: La Rovere et al., 2016.

Figure 7 | **Household purchasing power (base 2005 = 1)**

	Base year (2005=1)	CPG	MA1	MA2
Income Class 1	1	3.16	3.38	3.68
Purchasing power	1	2,60	2,68	2,87
Income Class 2	1	2.78	2.98	3.22
Purchasing power	1	2,22	2,27	2,38
Income Class 3	1	2.04	2.18	2.35
Purchasing power	1	1,62	1,64	1,66

Source: La Rovere et al., 2016.

Figure 7 shows that the selected additional mitigation measures may have a positive impact on people's purchasing power, despite the increase in the price level. In the additional mitigation scenarios, a part of the family income gains against GSP is absorbed by a larger increase in the price level. We calculated the price increase of the consumer basket of goods and services for each family income class, allowing the verification of the net growth of the purchasing power of each one of them.

When comparing the additional mitigation scenarios with GSP, it seems that the purchasing power: (a) significantly increases for Class 1, the poorest class, in all the scenarios; (B) also increases for Class 2, the intermediate one; (C) marginally increases to class 3, the most wealthy one.

Alternatives to a more sustainable energy development in Brazil

Regarding the implemented generation capacity, as shown in Figure 8, GSP provides a moderate increase in coal power plants and a significant expansion of natural gas power plants. The additional mitigation scenarios only kept coal thermoelectric plants that are already being built, significantly reducing the installation of natural gas thermoelectric plants, mainly in MA2. In these scenarios, the hydroelectricity, the sugarcane pulp, the wind power and the solar power increase their expansion, re-

Figure 8 | Mitigation measures in the energy supply and demand

Mitigation measures on the energy supply side	GSP level in 2030	MA1 level in 2030	MA2 level in 2030
Reduction of the expansion of thermo-electric plants powered by fossil fuels	Mineral Coal: InstCap = 4,705 MW Natural gas: InstCap = 24,330 MW	Mineral Coal: CapInst = 3,705 MW Natural Gas: InstCap = 19.300 MW	Mineral Coal: InstCap = 3,705 MW Natural gas: InstCap = 14,134 MW
Expansion of generation from sugarcane pulp	Installed capacity: 17.170 MW	Installed capacity: 27.170 MW	Installed capacity: 27.170 MW
Expansion of wind generation	Installed capacity: 24.325 MW	Installed capacity: 31.325 MW	Installed capacity: 29.325 MW
Expansion of concentrated solar PV generation PV in distributed generation	Installed capacity: 6.500 MW 10.000 MW	Installed capacity: 6.500 MW 10.000 MW	Installed capacity: 8.500 MW 10.000 MW
Expansion of hydroelectric generation	Installed capacity 134.086 MW	Installed capacity: 134.086 MW	Installed capacity: 144.086 MW
Expansion in the use of ethanol	57 billion litres	67 billion litres	74 billion litres
Expansion in the use of biodiesel	7% mixture to diesel (6.5 billion litres)	10% biodiesel mixed with diesel from 2020 (7.6 billion litres)	Biodiesel mixture would be increased to 15% from 2020 (8.4 billion litres)
Mitigation measures on the energy demand side	**GSP level in 2030**	**MA1 level in 2030**	**MA2 level in 2030**
Increase of the energy efficiency in the residential sector	Energy consumption: 33,7 Mtep	Greater efficiency in the burners of stoves powered by LPG	Greater penetration of solar and LED heaters replacing LED fluorescent lamps
Increase of the energy efficiency in the service sector	Energy consumption: 24,0 Mtep	Substitution of tubular fluorescent lamps of 40W by W 32 lamps	Same as MA1
Increase of thermal efficiency on the cement industry	Reduction of the overall indicator from 0.077 to 0.064 tep / t of cement by 2050	Reduction of thermal energy for calcination from 3.8 to 3.56 GJ / t clinker by 2030	Reduction of thermal energy for calcination from 3.8 to 3.35 GJ / t clinker by 2030
Increase ofco-processing in the industry of cement	7% of the sector's energy demand	10.5% of the sector's energy demand	14% of the sector's energy demand
Increase of energy efficiency in the steel industry	Reduction from 0.48 for 0,414tep / t crude steel	Additional reduction of 2%, from 0.414 to 0.406 tep / t crude steel	Same as MA1
Replacement of mineral coal for charcoal in the steel industry			1.8 Ha of eucalyptus for charcoal production
Improvements in refineries	Processed oil: 2.68 Mbbl / day	Keeps GSP	Energy efficiency gains of 3% on all existing refineries by 2025
Traffic optimization in large cities		Reduction of the number of urban trips at 3.45% in relation to GSP from management measures of urban demand	Same as MA1
Energy efficiency in light vehicles		Goal of the European Union (improvement of efficiency from 1.82 MJ / km to 1.22 MJ / km) with a lag of five years: entry in 2026 and full scope in 2030	Goal of the European Union (improvement of efficiency from 1.82 MJ / km to 1.22 MJ / km): entrance in 2021 and full scope in 2025
Energy efficiency in heavy vehicles		12% efficiency gain for new buses and trucks, starting in 2017 and reaching full capacity in 2030	Same as MA1

Source: La Rovere et al., 2016.

The combination of greater energy efficiency with the expanded use of renewable energies allows a significant reduction in the emission of greenhouse gases.

versing the trend of reducing the participation of renewable energies in GSP.

The supply of crude oil reflects an extraordinary expansion of crude oil extraction in the country, which will grow 167% between 2010 and 2030, reaching the significant milestone of 5.5 million barrels per day (Mbbl/day), thanks mainly to the exploitation of large reserves in the pre-salt. The study assumes the National Congress fulfils its desire to make the country a major exporter of crude oil to finance public investments in education and health, reaching 3.16 Mbbl / day in 2030, a higher level than in Iraq in 2013 (fifth world's largest exporter). This was the reason why most of the extracted volume (57% in 2030, GSP) will be destined for exportation.

Regarding the extraction of oil and natural gas, the production remained the same in all the three scenarios, but export levels varied. The MA2 scenario accepted some measures to increase the energy efficiency of the existing refineries, which reduced 3% of the oil demand for the production of by-products.

Power generation

The total electricity generation, which includes the network, self-producers and the distributed generation, grows at a lower rate than GDP, thanks to the efficiency gains in the sector, with reduction of losses in the generation, transmission, distribution and end use of electricity. These gains are greater in the additional mitigation scenarios: in 2030, the total electricity generation by the GDP value unit falls 5% in the GSP, 6% in MA1 and MA2 9%, compared to 2010.

In GSP, the participation of renewable sources in the total electricity generation is decreased, since the expansion of the use of by-products of cane and other renewable sources for electricity generation does not compensate for the decline in the participation of hydroelectricity. There is a significant increase, though lower than the total generation. In the MA1 scenario, renewable sources reach in 2030 the same level of participation of total generation in 2010, thanks mainly to wind generation and sugar cane by-products. In MA2 they surpass the 2010 level, thanks to the increase of the hydroelectric generation.

There is a 28% increase in the average cost of electricity between 2010 and 2030 in GSP, mainly caused by the higher cost of the hydroelectric plants to be built. In relation to GSP, the additional mitigation slightly increases the price of electricity – about 4% in MA1 and 8% in MA2 – due to the increase of renewable sources with higher cost.

The Brazilian Intended Nationally Determined Contributions (INDC) for COP-21 include the following mitigation measures in the energy sector by 2030:

a) participation of 23% or more of renewable sources in the electricity generation, not including the contribution of hydroelectricity, including the increase in the wind, solar and biomass generations. This purpose is included in the range between GSP (21%) and MA1 (25%) and MA2 (24%) scenarios;

b) gains of 10% in efficiency in the electricity sector. The INDC did not specify the concept of "efficiency gains". However, for illustrative purposes, the variation in the power generation coefficient per unit of GDP can be seen in Figure 9, which in 2030 falls 5% in GSP, 6% in MA1 and 9% in MA2, compared to 2010.

During her speech at the UN General Meeting on September 27, 2015, President Dilma Rousseff presented the Brazilian position for the COP-21, mentioning another objective which is not contained in the INDC: the participation of at least 66% of hydroelectricity in the electricity generation. In all the scenarios, this level is only reached in 2030, having as a reference the power generation connected to the national interconnected system. In relation to the total electricity generation, which includes the self-producers and distributed generation, this level would not be reached in any of the scenarios for 2030.

Gross domestic energy supply (DES)

GSP predicts a substantial increase (120%) in the domestic energy supply between 2010 and 2030, due to the high growth of final consumption (the supply expansion only considers the traditional technologies already available). The MA1, thanks to an effort to increase energy efficiency, predicts lower growth – 94% compared to 2010 – with reductions in both the supply of electricity and of fuel. MA2 predicts a growth of 99% in the domestic energy supply, due to the increase in the supply of renewable biomass fuels (Figure 10).

There is a notable increase in the participation of renewable sources in the domestic energy supply in the additional mitigation scenarios and a drop in GSP compared to 2010. This participation, which was 49% in 1990, fell to 41% in 2000 and rose once again, reaching 45% in 2010. In this decade there has been another fall at a faster pace, reaching 39% in 2014 and 41% in 2015. The participation of renewables in GSP remains at the level of 39% 2030. In the MA1, renewables raise once more their relative participation, reaching 46% in 2030, slightly above the 2010 level. In the MA2 they reach 49%, returning to the same level as 1990.

In comparison, INDC includes the following mitigation measures in the energy sector by 2030:

a) reach the level of 45% of renewable sources in the domestic energy supply, within the range of GSP (39%) and MA1 (46%) and MA2 (49%) scenarios;

Figure 9 | Power generation

Electricity generation by source (average MW)	2010	2030 - GSP	2030 - MA1	2030 - MA2
Nuclear	1.692	3.225	3.225	3.225
Natural gas	3.445	8.272	7.016	4.806
Mineral coal	706	3.268	906	906
Fuel oil	0	2.448	-	81
Other non-renewable	275	618	618	618
Hydroelectric plants	49.485	73.797	73.753	75.621
Small Hydroelectric Centre (PCH)	2.069	6.274	6.274	6.274
Sugarcane by-products (pulp + straw)	3.710	9.959	10.868	10.868
Wind power	514	9.601	12.638	11.273
Solar power	0	1.300	1.300	1.700
SUBTOTAL ELECTRIC NETWORK	61.896	118.762	116.598	115.372
Self-generation and distributed generation				
Natural gas	2.890	5.862	5.576	5.695
Fuel oil	317	642	630	624
Diesel	456	925	908	898
Sugarcane by-products (self-production)	2.520	4.170	4.187	4.187
Bleach	818	1.570	1.548	1.538
Solar photovoltaic power (distributed generation)	0	1.752	1.752	1.752
SUBTOTAL SELF-PRODUCED DISTRIBUTED GENERATION	7.001	14.921	14.782	14.694
ELECTRICAL GENERATION TOTAL	68.897	133.683	131.380	130.066
% of electricity generation from renewable sources	86%	81%	85%	87%
% of Hydroelectric plants + *PCH*	75%	60%	61%	63%
% sugarcane by-products + other renewable	11%	21%	25%	24%
ELECTRICAL GENERATION TOTAL / GDP	25,3	24	23,7	23
% de 2010	100	95	94	91
"Electrical efficiency" gain over 2010	-	5%	6%	9%

Source: La Rovere et al., 2016.

Figure 10 | Gross domestic energy supply (DES) - Mtoe

Sources	2010	2030 - GSP	2030 - MA1	2030 - MA2
Oil and oil by-products	101,7	233,6	173,2	173,8
Natural gas	27,5	98,9	81,7	73,0
Mineral coal and coke	13,7	22,1	20,4	18,3
Nuclear e other non-renewable	4,6	7,7	7,7	7,7
Hydroelectric plants and *PCH*	34,7	55,6	56,8	60,5
Sugarcane by-products	47,1	103,5	109,4	113,1
Primary sources of biodiesel	1,9	5,2	6,0	4,2
Other biomasses	24,1	25,5	34,7	56,6
Other renewable	13,6	38,5	31,0	26,5
TOTAL	268,8	590,6	520,8	533,6
% Renewable sources	45%	39%	46%	49%
% Renewable sources without hydroelectricity	32%	30%	35%	38%
% Sugarcane by-products	18%	18%	21%	21%
% Sugarcane + biodiesel	18%	18%	22%	22%

Source: La Rovere et al., 2016.

b) expand the use of renewable sources, excluding hydroelectric, from 28% to 33% of the domestic energy supply, below the level reached in MA1 (35%) and MA2 (38%), while GSP is located within this range (30%);

c) increase the participation of sustainable bioenergy to 18% of the energy matrix, including the expansion of the ethanol, advanced bio-fuels (second generation) and the blend of biodiesel to diesel oil production. Considering the sum of sugar and biodiesel by-products, this level of 18%, the same of 2010, is reached in GPC and surpassed in the MA1 and MA2, where it reaches 22%.

In her speech at the UN on September 27, 2015, President Dilma Rousseff mentioned the goal (which is not in included in the INDC) of reaching 16% for the participation of the sugarcane by-products in the domestic energy supply by 2030. This level would be surpassed in all the scenarios, since the participation of sugarcane by-products remains at the same level of 2010 (18%) in the GSP, reaching 21% in the MA1 and MA2 scenarios.

The long-term starts today. We must take immediate actions to demonstrate that public policies will support more sustainable energy development.

Emissions avoided by the energy mitigation measures

Figure 11 brings the emissions of greenhouse gases avoided between 2010 and 2030 by the mitigation measures, separated by sectors. The reduction of emissions potential of the renewable supply (505,0 MtCO2 in MA1 and 727,4 in MtCO2 in MA2) and of energy efficiency (445,9 MtCO2 in MA1 and 812,2 MtCO2 in MA2) is noteworthy.

Thus, by adding energy efficiency to renewable energies, an accumulated total reduction of 1,540 Mt CO_2 in the MA2 scenario can be achieved over the 2010-2030 period, more than 2/3 of the full potential mitigation of agriculture, forests and land use (AFOLU), which is 1995.5 MtCO2e MA2 in the same scenario. In the MA1 scenario, the energy efficiency subtotal plus the renewable energies reaches the first position in the emissions reduction potential, being able to mitigate up to 951.0 MtCO2 against 657.4 of AFOLU-

Final comments

The recent study of scenarios produced by the IES-Brasil concludes that there is a huge potential to reduce the national greenhouse gas emissions through a wide range of mitigation measures, including energy efficiency, renewable energies, low-carbon agricultural and cattle farming techniques, changes in the transportation modes, methane capture in the waste sector (landfills and sewage treatment plants) and reforestation with native species with rapid growth.

Most of these measures are low cost, such as those in the agricultural sector, focused on the energy efficiency and some renewable energy sources, such as hydroelectricity and the sugar cane ethanol. The adoption of these measures may result in greenhouse gas emission mitigation significantly higher than that of the government's efforts in progress. If other measures are added – such as the restoration of the Atlantic Forest, the large-scale production of charcoal from planted forests and a substantive increase in the rail freight transportation (intercity) and of passengers (urban) – it would be possible to achieve a level of total emissions of 1 GtCO2e by 2030 in Brazil, 25% lower than in 1990 and 49% lower than in 2005, in a more ambitious mitigation than the one of the Intended Nationally Determined Contributions.

In addition to other environmental benefits, this path of deeper mitigation can bring about economic growth, reduce unemployment and increase average family income, with a bigger gain going to the poorest families, contributing to a slight improvement in income distribution. There are several economic, financial, legal, regulatory and institutional barriers to enabling a scenario of high mitigation, but there are also many tools to overcome them. These include command and control measures, microeconomic instruments and innovative mechanisms to finance the initial outlay of the mitigation measures.

The last Brazilian economic growth cycle has run out. After adjustment policies to be implemented in 2016-2017, a new growth cycle will have to rely on another basis. There is a broad consensus among Brazilian econ-

Figure 11 | Avoided emissions from 2010 to 2030, grouped by major groups

Mitigation Measures / Sectors	CMA1	CMA2
AFOLU	657,4	1.995,5
Agriculture and cattle farming	260,3	259,2
Planted forests	29,6	427,3
Agroforestry systems	367,5	367,5
Restoration of the Atlantic Forest		941,6
ENERGY EFFICIENCY	445,9	812,2
Residential, trade and services (including solar heating)	16,8	19,9
Industry (steel and cement) and refineries	38,7	382,7
Transportation (Traffic optimization)	42,2	42,2
Light vehicles	115,1	134,2
Heavy vehicles	233,2	233,2
TRANSPORTATION MODES	84,5	506,9
Urban transportation on wheels (BRT, bike paths and electric buses)	84,5	125,4
Urban rail transportation (subway and tramway)		234,4
Freight transportation (rail and waterways)		147,2
RENEWABLE ENERGIES	505,0	727,4
Ethanol (transportation)	301,3	278,7
Biodiesel (transportation)	103,3	206,5
Eletricity generation (Wind, Biomass, hydroelectric, solar)	100,4	242,2
WASTE	597,0	608,5
TOTAL	2.290	4.650

Fonte: La Rovere et al., 2016.

Figure 12 | **Comparsion between brazilian INDC and the scenarios of the IES-BRASIL study**

	2010	2030 INDC-Brazil	2030 MA1
REDUCTION OF TOTAL GHG EMISSIONS (Compared to 2005)	40%	43%	35%
DOMESTIC SUPPLY OF ENERGY (Mtoe)	268,8		520,8
% Renewable energies	45%	45%	46%
% Renewable energies without hydroelectricity	32%	33%	35%
% Sugarcane by-products + biodiesel products	18%	18%	22%
% Sugarcane by-products	17,5%	16%	21%
% Hydroelectricity of the National Interconnected System (*SIN*)	83%	66%	69%
ELECTRICAL GENERATION TOTAL (average GW)	68.9		131,4
% Renewable electricity generation	86%	81%	85%
% Hydroelectricity	75%	66%	61%
% Sugarcane by-products + Other renewable	11%	23%	25%
ELECTRICITY GENERATION TOTAL / GDP (average MW/R$ billion 2005)	25,3		23,7
% 2010	100		94
Improvement of "productivity of electricity" (compared to 2010) (and "efficiency gains in the energy sector," in INDC)	-	10%	6%

Source: La Rovere et al. (2016); MMA (2016); EPE (2016).

omists that a new development strategy should prioritize investments in infrastructure. Thus, given the huge potential of renewable energy resources in the country, a positive synergy can emerge between the investment in the low-carbon infrastructure and the beginning of a new virtuous cycle of development.

Figure 12 shows the sectoral priorities of the mitigation technologies in the energy system of the country. The Brazilian Intended Nationally Determined Contribution (INDC) is located in the gap between the Government Scenario Plan (GSP) and the two additional mitigation scenarios of IES-Brasil (MA1 and MA2). In the view of nearly one hundred experts involved in the project, and considering the possibility of a high rate of economic growth by 2030, it is feasible to meet the goals of the Brazilian INDC. Furthermore, if it is implemented through appropriate public policies, INDC can contribute to the sustainable economic growth and the improvement of the social development, while reducing emissions of the country's greenhouse gases. It would be interesting to increase efforts to remove barriers against renewable energies (hydroelectricity and by-products of sugar cane, but also biodiesel and other sources of biomass, and wind and solar power) and improve energy efficiency. Such efforts can help us to achieve INDC and hold its regular review (every five years, as determined by the Paris Agreement), towards a greater ambition, capable of leading us to the MA2 scenario in the study of IES-Brazil.

Challenges and feasibility requirements

It is essential to identify the requirements to make a transition from current policies towards a more sustainable energy development in Brazil.

The biggest challenge is to avoid the temptation of canalizing the huge amounts of oil from the pre-salt to expand its use in the country, reducing the price of oil by-products for consumers, in order to hold down the rate of inflation. The recent past shows how this option is problematic

and inefficient. The official government decision, confirmed by the National Congress, points in the opposite direction: the stated objective is to export as much oil as possible, to finance the expansion of government investment in education and health. It is essential to comply with this decision, avoiding a misuse of the recent oil discoveries, which would sabotage the efforts to increase efficiency in the energy use and the production of energy from renewable sources.

For the country, the main technological challenges in this sector are: (a) design and build a new generation of sustainable power plants in the Amazon and (b) enable the generation of renewable energy from other sources during the dry season, when hydropower is less available. The expansion of the distributed generation in small scale from intermittent sources, such as wind and solar energy, increases the difficulty in complementing hydroelectricity, demanding the installation of smart grids and the contribution of other renewable sources, such as biomass, as well as reversible power plants.

Many more sustainable energy alternatives require structural changes and require higher initial expenditures. Barriers to their implementation are related to the fossil fuel subsidies, the financing difficulties and the opposition of vested interests, particularly in two areas: electricity generation and transportation (intercity freight and urban mobility). The high initial investments and the long maturation periods involved in the sustainable use of the hydroelectric potential and the construction of an efficient transportation infrastructure will require sophisticated financial engineering and the improvement of the institutional arrangements in order to facilitate public-private partnerships under appropriate conditions. Given the current low level of the domestic savings rate, it will be important to attract external finance on favorable terms, taking advantage of the potential of renewable energy resources in the country, in the context of international mobilization for the transition to a low carbon economy.

But the long-term begins today. There are several recommended immediate actions to point public policies in a direction of more sustainable energy development. First of all, it is essential to eliminate subsidies on prices of the oil by-products, such as diesel and gasoline, and restore the financial health of the electricity sector. Further ahead, the regulatory framework must be improved to remove barriers and encourage the widespread use of smart grids and the power distributed generation from the solar photovoltaic energy. The same applies to energy efficient technologies in all sectors: it is necessary to get the National Energy Efficiency Plan (MME, 2010) and the National Plan of Logistics and Transportation off the drawing board in order to facilitate investments in waterways and railways, in urban rail transportation and BRTs.■

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The Green Economy in Brazil

disappointments and possibilities

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Some still believe that serious environmental damage is an inevitable and even necessary side-effect of economic growth. The concept of green economy challenges this idea. Activities associated with preservation may have greater impact on the levels of employment and income, since they are more intensive in labour force and more demanding in terms of technological innovation. The primary activities linked to pollutants tend to be more capital intensive and depend on a spurious competitiveness, based on the availability of cheap raw materials and energy.

Brazil's current crisis results not only from cyclical and political factors. It has structural roots. It reflects the contradictions of a pattern of increasing specialization in predatory activities, intensive on natural resources and with low capacity for social inclusion. The chronic deindustrialization Brazil has been experiencing since the late 80s is combined with an increasing dependence on primary activities – agriculture-cattle farming and mining – which has shaped the Brazilian economy as an export platform with great social exclusion since its beginning.

Nevertheless, Brazil hosted in 2012 the United Nations Conference on Sustainable Development (Rio+20), in order to enshrine the concept of green economy as a guide for solutions for sustainability, especially for the institutions which "act locally", including governments, businesses and civil society organizations. According to the definition of

the United Nations Environment Program (UNEP), this is the economy in which the increase of productive activity results in the improvement of human well-being and social equity, while significantly reducing the environmental and ecological risks. This requires the economy to be efficient in the use of natural resources, in the generation of jobs and social inclusiveness, so that public and private investments can generate growth in income and employment, through the reduction of polluting emissions, greater energy efficiency and conservation of the biodiversity and ecosystem services.

The purpose of this article is to discuss whether there is room for the principles of the green economy to be deployed in contemporary Brazil. The next section shows that Brazil is increasingly far from a green growth strategy. The following sections propose axes of transformation that would be needed in the current public policies to build a pattern of alternative development, stimulated by the adoption of sustainable and socially inclusive practices. This includes sectoral policies, with examples for biofuels and wind energy, macroeconomic policies and funding policies.

Reprimarisation: the wrong way to sustainability

In recent decades, the Brazilian economy was characterized by Reprimarisation of its production agenda, i.e., a structural change in the composition of gross domestic product (GDP) and exports, with an increasing specialization in intensive products, natural resources and energy, and activities with high pollution potential. The dependence on the intensive economic activities in the predatory use of environmental resources was increased, including deforestation, the excessive use of fossil fuels and other natural assets. This is the opposite way to that proposed by the green economy. An economic model based on the "hunt" for natural resources reinforces social exclusion, since the economic benefits tend to focus on a relatively small group (these activities require little work) and the worst consequences of environmental degradation affect precisely the poorest populations.

The Quarterly National Accounts, prepared by IBGE, show a huge asymmetry in the evolution of GDP, when analysed for its sectoral composition. Seen as a whole, Brazil's GDP grew 68% between 1995 and 2015. However, some activities have performed well above the average, with emphasis on agriculture (102% growth) and extractive mining industry (125% growth). The construction industry grew around the average (63%), but with a strong decline in 2014 and 2015.

The manufacturing industry, the largest employer in the sec-

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ondary sector, had a mediocre performance: it grew 18% in the period, far below the average GDP. The theme of deindustrialisation has been widely covered by the literature (for a review of the literature on the subject, see *A desindustrialização do Brasil* [The Deindustrialization of Brazil] in *Conjuntura Brasil* n.2 Bulletin from João Mangabeira Foundation, October 2015).

Spending on public administration grew only 55% in the period, well below the variation in the total GDP. Contrary to what has been disclosed, the current crisis is not due to an uncontrolled expansion of public spending, but from the type of targeting of these resources. As we shall see, redirecting the development to a green economy will require an increasing involvement from the State: the fundamental point is to change the method of the State intervention, not simply remove the State from the planning and regulation process of the economy. The transition to more sustainable and inclusive practices will not happen spontaneously through the free forces of the market.

More evidence of reprimarisation is the increase in the participation of raw agricultural and mineral materials in the total export basket. In 2000, agricultural-cattle farming products accounted for 6.0% of Brazilian exports, and mineral products 7.4%. For 2013, those numbers rose to 15.3% and 19.5%, respectively. There was a sharp setback in the Brazilian participation on the international market, which became increasingly dependent on the cyclical fluctuation in the commodity prices and the long-term trend of deterioration of the trading terms (as had been originally predicted by Prebisch).

The productive specialisation occurs not only in raw materials, but also in products whose production processes present a high pollution potential (Gramkow, 2011). In the processing industry, the activities with the best performance in recent years are those which emit more pollutants per unit of value produced. In such cases, the competitiveness is based on the cheap access to raw materials and energy, or in the disregard of the negative environmental externalities.

The return to a primary export model, propelled by high environmental impact activities, undermines social inclusion; due to its inability to generate high-productivity jobs, wages have little expansion, as well as formal jobs.

The farming industry continuously declines in the number of people it employs: despite the great expansion of production, the reduction of jobs is continuous. IBGE data show that the agriculture and livestock sector was responsible for 24.6% of total jobs in the 1995-1999 period, falling to 21.4% in 2000-2004 and only 16.1% in 2005-2009 (Young, 2015). In absolute terms, this meant a net loss of 833,000 jobs between 2000 and 2009 for the sector as a whole (farming, forestry, plant extraction, livestock and fishing), although production has grown 39% in the same period.

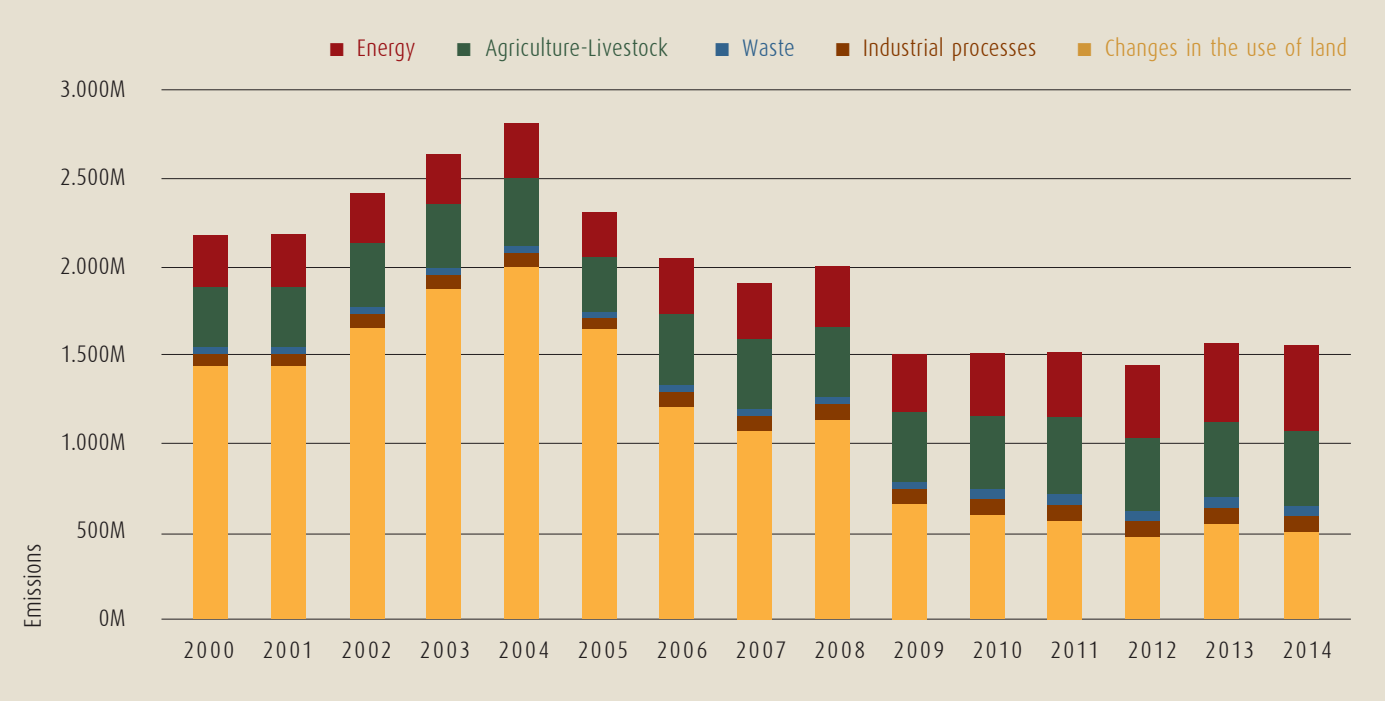
The extractive mining industry, which is the most prominent in terms of product and exports expansion, has a minor role in the job creation, accounting for less than 1% of total jobs (Young 2015).

Not surprisingly, recent studies have shown that the alleged redistribution of income in Brazil since 2003 is an optical illusion (see *Concentração de Renda* [Income Concentration]), *Conjuntura Brasil Bulletin* n. 4, from João Mangabeira Foundation, June 2016). During the analysis through more accurate statistics on the functional distribution of income, it is possible to see that an eventual variation was small and restricted, very far from being a permanent trend. This is due to the current (low) standard growth based on the primary exports, which traditionally concentrates income.

Even the most positive factor of the environmental policy – the massive reduction of deforestation in the Amazon in the 2005-2010 period – was negatively affected in its successful performance. There was a relative stabilization in the levels of deforestation in the Amazon in the current decade, but in other biomes, especially in the Cerrado, the massive conversion of natural habitats to areas of pasture or cultivation persists.

In addition to the threat to conserving biodiversity in the most biodiverse country in the world, the persistence of deforestation increases the concentration of greenhouse gases, the most important factor responsible for global climate changes. Figure 1 shows that total emissions of greenhouse gases (GHGs) in Brazil present a

Figure 1 **Total emissions of greenhouse gases in Brazil, SEEG / Climate Observatory, 2000-2014 (in million t CO2 GWP)**



Source: Greenhouse Gas Emissions Estimation System (SEEG), available at http://plataforma.seeg.eco.br/total_emission.

slight uptrend in the current decade, mainly due to the increased emissions from the energy industries and agriculture and livestock.

In addition to global climate change and the loss biodiversity, there are serious social-environmental problems associated with the same pattern of specialization in high impact activities on natural resources. Recent changes in the Brazilian law reduced the minimum legal requirements for forest conservation on private properties in order to maximize the available area for cultivation and pastures. Currently, the political pressure is focused on the reduction of areas dedicated to conservation units and indigenous lands. This process of change in land usage is often violent, so that deforestation is statistically correlated with the increase in homicides (Sant'anna & Young, 2010) and the spread of epidemics, such as malaria (Olson et al., 2009).

It also draws attention the high contamination by pesticides in the areas of agricultural production, as well as the increasing incidence of associated diseases (cancer, for example), especially among the most vulnerable rural workers (Abrasco, 2012). This proves that these substances have not been used according to the safety instructions. As a result, Brazil presents alarming statistics related to the human health.

There are also consequences for consumers: according to a study conducted by the National Health Surveillance Agency, 36% of 1,628 samples of alimentary vegetable products were considered unsatisfactory due to the content of unauthorized pesticides or pesticide levels above the tolerable upper limit (ANVISA, 2013). It was found the presence of pesticides above the maximum residue limit levels (MRL) in 2.3% of the samples and unauthorized pesticides were identified (NA) in 32% of the samples. Worse than that: in 1.9% of the samples were found simultaneously residues above the maximum tolerable limit and the presence of unauthorized pesticides. In other words, pesticides are present in the typical Brazilian food in limits well above the tolerable and containing substances that the government itself condemns.

Brazil is one of the largest users of pesticides in the world. This results in the risk of high incidence

of associated diseases such as cancer, especially in the rural workers who are more exposed (Silva et al. 2005). Field studies have shown alarming statistics for human health. For example, in Lucas do Rio Verde (MT), in the soybean belt, between 2007 and 2010 samples were taken in urban and rural schools to evaluate some environmental components related to the risks of pesticides (Moreira et al., 2010, quoted in Carneiro et al., 2012). The results showed contamination with residues of various pesticides in 83% of the twelve wells of drinking water in schools, in 56% of the rainwater samples (schoolyards) and 25% of air samples (schoolyards) monitored during two years. Another study in the same municipality showed that all the 62 samples of breast milk of nursing mothers showed residues of at least one type of pesticide. The results indicate an average exposure of the population of 136 litres of pesticide per inhabitant in the agricultural harvest of 2010 (Palma, 2011; Pignati and Machado, 2007; quoted in Carneiro et al 2012).

The use of genetically modified organisms (GMOs) is continuously expanded, a very distant issue from the concern of regulatory agencies and consumers themselves (Castro, 2012). There is an ongoing bill in the National Congress for legislation, suggesting the removal of the mandatory identification from foods containing genetically modified products, thereby reducing the fragile public control over the dissemination of these organisms in the country.

Most of the population (84%) live in the urban areas. However, the inadequate infrastructure and lack of urban services, combined with the concentrating trend of the activities in the central areas of cities, allow problems such as traffic jams, pollution, inadequate housing and increased risk of accidents to bring rising costs to society, even if not all of these losses are directly monetized. Estimates of economic costs resulting from the loss of time in commuting caused by traffic jams (Haddad & Vieira, 2015; Vianna & Young, 2015) show that there is a strong regressive feature in the urban immobility, since the most affected social groups are the poorest people (Pero & Stefanelli, 2015). The inadequacy of the urban infrastructure to deal with natural disasters also means greater exposure to damage caused by increasingly frequent flooding, sudden floods and land movements, a result of climate changes. Young et al. (2015th) show that the frequency of these disasters has increased consistently over time throughout the country and estimate that they bring significant costs, around 1% of GDP, considering only the resulting material losses.

However, the severity of these issues seems not to attract attention neither from leaders in Brazil nor even from the general population. The national security policy to the environment was designed supported by instruments that require active participation of the State in controlling the actions of companies and individuals. Despite the increased social demand for environmental management measures, due to the significant increase in pressures on natural resources and the public awareness on the issue, the public budget for environmental management has grown at a much slower pace than total public expenditure. A study on the behaviour of the discretionary spending on environmental management in the three spheres of government (Young et al., 2015b) shows that the problem is more serious in the federal administration, where spending remained nearly stagnated between 2011 and 2013.

Sub-national administrations are increasingly important in the environmental management, at least in volume of resources. State governments are the sphere with greater expenditure on the subject. However, there is an enormous heterogeneity among subnational governments, indicating very strong disparities in the ability to deal with environmental problems. The current fiscal crisis in the states and municipalities is expected to accentuate this heterogeneity, with negative consequences for the people affected by negative environmental externalities.

In other words, Brazil faces a wide range of environmental problems, combining typical issues of developing countries, such as deforestation and the lack of basic sanitation, and difficulties more often found in developing nations, associated to the loss of quality of life due to industrial pollution and the high degree of

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"Green" activities tend to be more intensive in manpower and manufactured goods. Furthermore, they demand greater innovation. The future economies will be focused on them.

urbanization. The following sections discuss the opportunities to reverse this process, analysing possibilities to reorient growth through the green economy, with emphasis on public policies needed to induce this transformation.

Growth led by sustainable activities

More conservative groups often claim that the increase in the environmental damage is a necessary price for Brazil to ensure the increase of the economic activity. The implicit assumption in this thinking is that the economic activity and the environmental preservation would be necessarily opposed. Therefore, decision makers would have to choose between the increase of employment and income or the disruption of the economic growth to preserve the natural resources.

The concept of green economy challenges this view, under the argument that the activities associated with environmental protection can bring positive effects on employment and income levels in the short and long terms. It is a simple explanation: the "green" activities tend to be more intensive in manpower and manufactured goods with greater innovation content (Schumpeter, 1984). There is a statistically significant and positive relationship between the industrial companies that adopt innovations and those that are proactive in the adoption of voluntary environmental management measures (Queiroz & Podcameni, 2014). In contrast, the primary activities linked to potentially more pollutant products tend to be intensive in capital, with low manpower demand, and their competitiveness is mainly based on the low cost of raw materials and energy (Gramkow, 2011).

Some examples highlight this conclusion in the microeconomic sphere. In the energy sector, it draws attention the Brazilian potential for generation from alternative sources. Brazil has great experience and has built a biofuel production model on a large scale. Natural factors contribute to it: land availability, favourable climate, plenty of water and exposure to sunlight, aspects that favour the rapid growth of biomass. Thus, bio-fuels can be considered mutually beneficial solutions (win-win), for its potential to reduce emissions of greenhouse gases, increase the economic activity and, directly or indirectly, reduce the social problems (Coutinho & Bomtempo, 2011).

Sugarcane is the main raw material for the ethanol production in the tropics, including almost all the Brazilian production. An additional energy advantage of sugarcane is the use of the pulp to generate heat and electricity through the cogeneration process: the contribution of the sugarcane pulp and other biomass sources (including wood) was almost 7% of the total electricity supply in Brazil in 2012 (EPE 2013). Likewise, organic fertilizers may also be obtained from waste of the ethanol production process. The range of raw materials for the biodiesel production is still higher, but most of the current supply in Brazil comes from the soybean cultivation, with a small portion coming from other oilseeds.

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However, it is questionable whether the current production of bio-fuels in Brazil should be considered "green". The main problem refers to the effects of the expansion of the cultivated area, especially where the increase in deforestation pressure occurs. Other important aspects are the competition with the growing area destined to other food products (reduction of the production and increase in the price of food), the technological challenges of the new "generations" of bio-fuels (Brazil has invested very little in research on second and third-generation fuels) and the volatility of fossil fuel prices.

Another area that may present an expressive expansion in Brazil is the electricity generation from wind or photovoltaic exploitations. This can ensure the expansion of the supply of clean energy, while avoiding the problems of the hydropower model historically adopted in Brazil. In addition, these alternatives solve environmental and social problems, most notably the displacement of communities due to the construction of large hydroelectric reservoirs; and economic problems, such as expensive transmission over long distances to the consumer centres. Recent years have registered a rapid expansion in the production of the wind power in Brazil (and in the world).

This is associated with the accelerated cost reduction, the "smart grids" of distribution and specific incentive programs, with emphasis on the adoption of differentiated tariffs ("feed-in" systems), in which prices are higher for alternative renewable energies. An additional advantage in Brazil is the understanding of wind and hydroelectric sources as complementary parts of an integrated system. When the wind power stations are operating, they allow water savings (flow reduction) in the reservoirs, acting as a back-up for periods of less wind (Pereira, 2012).

In Brazil, despite the delay in relation to developed countries and China, the installed capacity has grown from less than 30 MW in 2005 to over 1,000 MW at the end of 2011 and exceeding expectations, 7,000 MW in 2014 (Pereira 2012). The total potential for wind power generation in Brazil is officially estimated at 144 GW, or 270 TWh / year (about half the nation's current electricity consumption), considering fifty-meter high rotors. However, if hundred meters high rotors are considered, the potential for power generation can exceed 300 GW, more than the hydropower potential (Pereira 2012).

The low capacity of job creation is usually presented as a negative aspect of these alternative energy sources. However, this is not a particular problem, since it affects the energy sector as a whole. Hydroelectricity and other sources are also characterized by the high capital intensity and low labour demand (Oliveira, 2012). The main possibilities of creating jobs are not in the power generation sites, but in the production of equipment. This is another challenge for the sector in Brazil: the portion of imported components remains relatively high, and most of the national contribution is composed by low-tech activities, mainly in construction: instead of establishing prices or other incentives to expand production, the emphasis should focus on a national innovation system that encourages the development of a national technology and high-skilled jobs in the country (Podcameni, 2012).

That is, the transition to a green economy creates opportunities to redefine the direction of the Brazilian development. Combined with advances in education, housing and citizenship, the investment required for this transformation can increase the economic activity in the short term. Moreover, it can bring more authentic competitiveness in the productive sectors, through innovation and professional qualification. This requires the redirection of the economic efforts, which are currently focused on the export model of raw materials or goods, with competitiveness based on the unsustainable use of natural resources and low impact on social inclusion.

This desirable transition to a green economy will not take place without structural reforms in the role of the Brazilian State and the regulatory framework, which includes internalizing externalities through the application of the *polluter pays principle*; reorienting purchasing policies, with the adoption of sustainability criteria and emphasis on social and environmental certification; and reorienting the principles of the macroeconomic policy, emphasizing the quality (not quantity) of growth and including the principles of green taxation and sustainable finance. Only this reorientation of priorities and policies of pro-production activities will allow Brazil to walk towards an economy in which the growth of the added value occurs through the increase of efficiency and innovation, with social inclusion and conservation of the environmental quality.

Internalizing externalities in sectoral policies

The fundamental principle of environmental regulation in a green economy is the "internalization of externalities", with the adoption of economic instruments for environmental management. Popularly known as "*polluter pays principle*", the negative and positive environmental externalities must be incorporated to the pricing of products. This requires economic calculation of externalities, making these variables relevant to decision-making, both in the allocation of public resources and private credit.

Resistance, however, is still very large. In times of economic crisis, the claim that this pricing reduces the competitiveness of exports, impacting economic growth and employment is common. In fact, it is related to the reduction of the diffuse "social Brazil cost", but finding resistance from producers and consumers of the affected markets: social gain is larger but diffuse, while the private costs for this transition are lower, but private. Thus, the political balance sways against the collective interest.

Despite the consolidation of public agencies focused on the subject at all federal levels, environmental quality indicators in Brazil are still far below satisfactory. This is due to the lack of investment in infrastructure and urban services (sanitation, public transportation, garbage collection, and public housing), the persistence of large concentrated areas of poverty and consumption patterns that aggravate environmental conditions. The rapid growth of the private car fleet, making traffic in urban centres increasingly chaotic, is the most striking example.

Environmental aspects are still poorly integrated into the formulation of public policies. The problem is intensified by the lack of information about the extent and relevance of the problems arising from the environmental degradation. However, if the erratic dynamics of the economic growth, the rapid urbanization and the State crisis can be identified as part of the question, the adopted management model also proved inadequate to deal with various problems. The environmental managers themselves acknowledge the need to seek more efficient controlling methods.

There is a growing consensus on the need of ensuring greater flexibility for the economic agents, as well as to seek new sources of funding that are directly related to the causes of environmental problems.

There is already in Brazil a series of experiments that considers the "internalization of externalities" and the payment for ecosystem services, incorporating economic instruments based on the *polluter pays principle*, in which the use of natural resources shall be charged even if they are in compliance with legal standards. These proposals give greater flexibility to the economic agents, in order to minimize the social costs of adjustment to the environmental goals.

Older industries, in which the cost of rehabilitation is higher, can benefit from the negotiation with other more efficient agents in the environmental control. Moreover, unlike in a single standard, there would be the possibility of imposing a higher "price" in the emissions which result in higher levels of pollution, adopting lower "prices" where the problem is not relevant (the concentration of pollutants resulting from emissions may vary considerably depending on the circumstances of the affected location). Payment systems for environmental services (PES) emerged as an important mechanism arisen from the greater awareness from the society about the deterioration of the environmental services, such as climate, water and flood regulations, support services (pollination, for example), provision of food and recreational services. PES systems represent a voluntary transaction in which a well-defined environmental service, or land usage that can guarantee the provision of this service, is acquired by at least one buyer, of at least one provider, under the condition that it ensures the provision of the service (Wunder, 2006). Some examples of policy instruments that adopt PES principles in Brazil are: charging for the use of water, with allocation of funds to owners who conserve forests ("water producers"), the transfers of ICMS (Tax on the Circulation of Goods and Services) resources to municipalities that present positive performance according to environmental criteria ("green ICMS") and the transfer of resources to communities that contribute to the conservation of forests and biodiversity, such as the *Bolsa Floresta* program of the Sustainable Amazon Foundation.

Internationally, the most expected progress in the area of economic instruments for environmental management was established around the carbon credit markets. However, the collapse of the carbon markets after the financial crisis of the late 2000s and the inability of raising funds to areas where Brazil has greater potential for reduction or sequestration of emissions (control of deforestation and reforestation of degraded areas policies) within the Kyoto Protocol prevented large-scale actions from being taken.

After the Paris Agreements, signed in 2015, there are positive expectations for developed countries to invest in conservation projects (REDD: reducing emissions from deforestation or forest degradation), especially those associated with biodiversity conservation (REDD+). However, there is still great uncertainty about the release of enough resources to combat deforestation effectively and preserve habitats. If these resources are released, programs may be implemented in the entire Brazilian territory, especially in the more remote areas, where the opportunity cost of land is lower.

The area of public purchase policies focused on more sustainable goods and services is still under-exploited. The intention is to encourage contracts and public procurement tenders that favour sustainability criteria, including guides for sustainable procurement tenders. However, public procurement in Brazil is still dominated by rules of preference for lower-priced products. It is common to hear criticisms on Law 8666/93, which regulates the process of public procurement in the federal administration, for imposing restrictions on the differentiation of products with higher quality, but with higher price.

On the other hand, the private sector resists in adopting such measures, especially in the sectors that consume more natural resources, such as mining and agriculture-livestock industry, and in the most intensive or more polluting industrial activities in energy. This results in a view that the economic growth and environmental preservation are essentially antagonistic, which still prevails among decision makers. The massive political lobbying, also supported by the leading business associations, in order to reduce environmental safeguards both in the Forest Code and in the licensing procedures of productive enterprises reflect the persistence of this view. As an analogy to the "cake theory" that synthesized the debate on growing and income distribution in Brazil, it can be said that the guiding principle has been "we need to dirty the cake to make it grow; we may clean it later."

It is crucial to show that the current trend of the Brazilian participation in the international trade, as an expert in "unde-

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Consumers have been increasingly demanding in relation to the environmental impacts of products and services. The growing interest in environmental certification is not a temporary fad.

sirable" activities, is in conflicts with the well-being of communities affected by pollution, costs to society as a whole, and increasing risks for the very economic sectors involved.

The problems arising from the specialization in minerals, agricultural and industrial commodities with low added value go beyond the environmental dimension. From the social point of view, a double exclusion is implemented. The first one comes from the unequal distribution of the result from the "enclaves" of high profitability at the expense of environmental degradation: the richest people get most of the income and wealth generated, and still have a higher and more intensive pattern of consumption in emissions. The most obvious example is the agricultural frontier: the economic agents located at the "top" of the agribusiness chain get rich, but at the same time it is created a serious social imbalance, from the movement of traditional communities and family farmers banned by the agricultural expansion, which causes an increase in violence in these areas, to the expansion of infectious diseases and the increase in the concentration of pollutants caused by burning. There are similar problems in the mining enclaves and exporting industrial centres.

The second exclusion is the environmental one, since the excluded sections suffer the most with the effects of the loss of the environmental quality: in the countryside, traditional communities are deprived from the natural resource base essential to their livelihood, and in the cities periphery people are forced to live in environments degraded by air pollution, poor sanitation and other basic necessities for the lack of infrastructure investments.

The increasing specialization in a "brown" economy also causes specifically economic losses. The expansive growth cycle in commodity prices hid an old discussion on the long-term trends of the behaviour of the terms of trade: commodities had an upward trend during the last two decades, but there are no guarantees that they will keep on growing in the long run when compared to the technology intensive products. This problem can also occur with the industrial commodities, usually very homogeneous intermediate goods that have already achieved high technological maturity, which makes its competitiveness to be based essentially in lower production costs.

Another aspect is the change in the consumers' behaviour (and therefore the existence of companies sensitive to such demands, especially in developed countries), which are increasingly demanding with regard to the environmental impacts of goods and services. The growing interest in the environmental certification shows that this is not a temporary fad, but a strong trend that is extended to an increasing range of products and sectors, including the domestic market, almost a requirement in some export destinations.

The new element in this story is that the demand for environmental certification is no longer restricted to final consumers. Businesses and governments are incorporating sustainability criteria in their procurement policies. Large corporations are being pressed to present socio-environmental responsibility results not only in their own activities, but also throughout their supply chain. Public procurement policies are increasingly mentioned as a tool to incorporate and disseminate "green" technologies and products, which certainly will affect the dynamics of suppliers.

Thus, the proposal for a green economy wants to move forward, from the areas which have direct relation with environmental issues (wood products, fishing products, etc.) to increasingly focus on the productive chains. Being an expert in "brown" activities, the competitiveness of which is based on a non-sustainable relationship with the environment, is swimming against the tide.

The green economy also arises from the need for a new competitive paradigm. Businesses have a key role in the transition to this new model, with innovation understood in its broadest sense: new products, new production methods, new markets, new sources of raw materials and other inputs, and new market structures. Empirical studies show that the environmental concern increases in companies which are open to adopt or generate innovations and in those which have interests and/or responsibilities in developed countries, where there is greater pressure from buyers and investors for better performance from the companies (Queiroz & Podcameni, 2014). I.e., the innovative company is also more likely to become "green", creating an important synergy between the innovation policy and the environmental protection policy.

The "sustainable competitiveness" does not depend on the sector, but on the capacity of absorbing and generating new technologies. Until the 1980s it was believed that the industry was naturally "more advanced" than producers from the primary commodities sectors (minerals, agricultural-cattle farming products, etc.). Today, however, the competitive edge is given by the innovative capacity of the company, regardless of the area in which it operates. The development of organic products, for example, can be very complex and the product differentiation can be a valuable asset. It should be expected, for example, that an important part of the higher-income consumer markets offer resistance against the genetically modified products. The same applies to the mineral industry: the same product can meet different market segments according to the characteristics of the manufacturing processes. In developed countries, such differentiation can be decisive for a supplier to enter in markets where prices are higher. The trend of demanding environmental certification for imported commodities, especially from developing countries, will occur regardless of what is decided in the rounds of international trade regulation, since this movement is not started by governments, but by the consumers themselves.

Economic policy reform

Macroeconomic policies can help or hinder the environmental management, because investment decisions are very sensitive to monetary policy. The rise in interest rates, for example, shortens the time horizon of decisions: quick return investments are focused, instead of the long-term ones. Since the cost of capital opportunity is higher in countries with financial difficulties, a bias has been created in favour of decisions that result in gains in the shortest possible time, since long-term costs and benefits become less important in projects with very high discount rates. This is the antithesis of the sustainable development.

By increasing the cost of money, the recent rise in interest rates in Brazil creates a major obstacle to extend the relevant time in the investment analysis. In a world of high interest rates, businesses whose cash flow predicts concentrated income in the future are abandoned in favour of projects with lower net income, but focused on the short-term return.

This phenomenon, called "immediacy," supports the explanation of the reason for the abandonment of some business options with strong possibility of income over time. A reduction in the interest rates would make projects of sustainable use of nat-

Macroeconomic policies influence environmental management. The rise in interest rates shortens the time horizon of decisions, favouring a quick return on investments that undermines sustainable development.

ural resources more attractive, such as the managed cutting of native wood (through forestry concessions), the management of fishery resources and non-conventional energy sources (wind, photovoltaic, etc.). As mentioned before, to achieve this "sustainable competitiveness" it is essential to generate and absorb new technologies. Fostering innovation policies are also environmental policies: the one who achieves the best solutions to deal with the environmental demands imposed by regulation, or voluntarily desired by buyers, will have new opportunities for competitive gain.

Another aspect relates to the fiscal crises resulting from financial crises, which usually lead to the reduction of resources for social and environmental costs. Spending on costs and investments necessary to the "greening" of the economy often suffer drastic cuts. In this sense, the green economy must guide the public spending efforts to re-heat economy with sustainable conditions. The restrictions and financial instability are a considerable barrier to the achievement of this goal.

There has been in Brazil a clear disproportion between the increase in the budget for the infrastructure sector and the relative stagnation of spending in the environmental control and preservation. As a result, large enterprises are expanded in the country, increasing the demand for funds invested in the environmental control, but causing the stagnation of resources for controlling the environmental impacts of these projects. It is very worrying that the spending on the expansion of the transportation infrastructure has grown four times with no significant change in the spending on the environmental control (Young et al., 2015b).

The overcoming of the fiscal crisis and the public debt - "twin" problems connected to the current macroeconomic model - are as important as the creation of specific programs focused on the environment. Implement economic instruments to achieve the environmental management can help to minimize the problem. However, it does not eliminate the need of increasing the allocation of stable resources to expand environmental projects in all the spheres of the public administration.

To provide sustainability to the environmental policies it is essential to seek alternative forms of financing. As we shall see, the Brazilian experience indicates the use of "classic" economic instruments (taxation, tradable certificates) combined with unique and specific solutions ("green" ICMS, resources from royalties and other forms of financial compensation, such as sector funds for science and technology). The greater involvement of the private sector in the environmental management is another necessary condition to meet the established goals.

Another little exploited aspect in Brazil concerns the reduction of the tax burden to re-heat the economy. However, it is necessary to build tax instruments to charge externalities, which is an unpopular measure, especially in crisis times. The solution to the impasse is the replacement of conventional taxes by new collection schemes that consider the "ecological footprint" of the resource when setting rates. However, the tax authorities are quite conservative. They believe that such a move would be risky, since economic agents may have an opportunistic behaviour in order to maximize the reduction of the conventional taxes and minimize the collection of new taxes.

Sustainable finance

The requirement of sustainability criteria in financing operations became increasingly frequent in order to avoid losses on transactions that may be blocked in the future for reasons of environmental policy or damaging corporate image even if legal. Internationally, the most important initiative in this regard is the Equator Principles (http://www.equator-principles.com), The requirement of sustainability criteria in financing operations became increasingly frequent in order to avoid losses

on transactions that may be blocked in the future for reasons of environmental policy, damaging the corporate image even if legal. Internationally, the most important initiative in this regard is the Equator Principles, which establish minimum criteria for granting of credit, ensuring that the funded projects are developed in a socially and environmentally responsible manner (Rechtman & Young, 2010). The Equator Principles establish a code of conduct, of voluntary membership, so that financial institutions assume their share of responsibility for the environmental impacts and damages caused by operations financed by them.

In practice, this means developing more selective credit assessment criteria, which take into account the externalities associated with the projects to be funded, especially in the granting of large enterprises financing. If the borrower fails to comply with one of the social and environmental clauses, the lender will work with it to find solutions for this clause to be fulfilled.

In Brazil, public financial institutions have a predominant role, since most of the financing of gross capital formation is concentrated in the public funding agencies. Since it directly controls most of the financing for the productive investment, the government may impose improvements in the project approval system, including the strengthening of the induction policies, by providing greater benefits and more agility in raising funds for sustainable projects.

To encourage the financing of sustainable development, the federal government launched in 1995 the Green Protocol. Federal financial institutions - the National Economic and Social Development Bank of Brazil (BNDES), *Banco do Brasil* (BB), *Caixa Econômica Federal* (Caixa), *Banco do Nordeste do Brasil* (BNB), *Banco da Amazônia* (BASA) and the Funding Agency for Studies and Projects (Finep) - signed the document, committing to take into account environmental variables in the analysis of the credit concession.

The goal was to incorporate environmental principles at all operational levels of these institutions, if possible exceeding the minimum legal requirements. In addition to requiring compliance with environmental legislation, the provision of credit should take into account environmental criteria beyond the legal procedures for licensing and operation, creating specific lines of credit with more favourable terms to projects that resulted in environmental benefits.

These principles were applied in a very unevenly manner by the institutions involved. There was not a great effectiveness in the implementation of the Green Protocol as an integrated program, since the implementation task was under the responsibility of each institution, individually.

It is necessary to go beyond the requirements established by the legislation. In order to do so, additional measures are needed, such as customer information, setting of parameters, establishment of baselines, qualification and hiring of specialized personnel. Behind this idea is the notion that more rigorous environmental requirements raise the production costs without adding value to the final product. This is a static perception, since it ignores the efficiency gains with the rationalization of inputs or the opening of new markets, which will demand products with higher environmental quality.

Conclusion

The transition to a green economy creates a unique opportunity to redefine the direction of Brazilian development. Combined with advances in education, housing and citizenship, in general, the investment required for this transformation can simultaneously ensure the increase of the economic activity in the short term (for example, in the need of reorganizing the large Brazilian cities) and the expansion of the production capacity in sectors of authentic competitiveness, intensive in innovation and professional qualification.

This will require the reordering of the growth efforts, which are now focused on the export model of raw materials or commodities whose competitiveness is largely based on spurious factors, with unsustainable use of natural resources and without significant effects to social inclusion.

The virtuous cycle of the green economy will not be materialized spontaneously. The public and private sectors should build a synergetic relationship, in order to allow the regulatory framework to

encourage a proactive behaviour from the companies, which need to act more forcefully in the new paradigm construction. It is also necessary to ensure stable sources of financing under conditions that prevent the immediacy, the myopic perception that favours short-term results, fuelling much bigger future problems. Therefore, in addition to the explicit environmental policies, the fiscal and financial policies also have a crucial effect on the establishment of obstacles or incentives to achieve the goals of sustainability.

In other words, the transition to the desired green economy will require structural reforms. It is a governmental role to change the regulatory framework to allow these changes. It includes:

► the internalization of externalities, through the implementation of the *polluter pays principle*;

► the re-orientation of procurement policies, by adopting sustainability criteria, particularly for certification;

► the reorientation of the principles of macroeconomics, emphasizing quality rather than quantity of growth, including "green" principles in taxation and credit concession.

That is the only way of moving towards an economy that will add value when increasing efficiency and innovation, instead of offering low cost agricultural and industrial products financed by misguided public policies. ■

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Shaping Global Sustainability

in the Umbrella of "Comprehensive Globalisation"—Germany's Role

The current confrontation of irreconcilable concepts of global order poses a serious threat to international cooperation in crucial areas of global governance. German foreign policy faces many challenges in an international system characterised by "comprehensive globalisation". This global constellation however also implies the great opportunity to establish new patterns of cooperation via transformative alliances with emerging actors of international politics. In this way, Germany could play a substantial transformative role in the global agenda for sustainability.

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The New Reality of the International System: "Comprehensive Globalisation"

Since the end of the Cold War, the following four mutually reinforcing waves of global transformation have created a new reality for the international system: a) the networked global economy: accelerating economic globalisation, which creates manifold opportunities along with global vulnerabilities and risks;[1] b) diffuse architectures of power: tectonic shifts of power towards emerging economies, above all China, India, and Brazil, which are challenging the dominance of the West and bringing forth polycentric constellations and blockades of power;[2] c) the Anthropocene Era, the geological era of human dominance: the insight that human beings have become the driving force in the planetary ecosystem and that over the course of this century a transformation of the earth system is likely, with unforeseeable consequences for a human population that will soon total nine billion, if the global economy continues to pursue its established path of greenhouse gas-driven and resource-based growth;[3] d) digitisation—new communication infrastructures for global society: for the first time in human history, digital communications technologies have made possible a real-time exchange of information, knowledge and news that spans the globe, opening up new, virtual cross-border spaces and possibilities of cooperation, while at the same time creating previously unknown forms of data control and surveillance.[4]

These four waves of global transformation are translating and condensing into many different patterns of societal globalisation and worldwide social interdependencies affecting an increasing number of people. Ebola is spreading from West Africa around the globe through air travel, while fear of the disease is being proliferated rapidly on digital networks. Islamic Jihadism is financed by illegal oil exports, radicalises individuals via digital networks and uses social media to recruit followers around the world; so that what was initially a local conflict in Syria and Iraq is becoming a global security threat. The protests by students in Hong Kong in 2014 would almost certainly never have come about if the city had not been successfully integrated into the global economy, leading to the emergence of a broad-based, well educated and young middle class. Our increasing knowledge of the limitations of our planetary ecosystem means that we as Europeans cannot afford to be unconcerned with the consumption patterns and lifestyles being adopted by the emerging middle classes on the other side of the planet. Consolidation and acceleration of global networking between societies is far from over and is creating a new reality and a new quality within the international system, a process of "comprehensive globalisation" for which no political system has yet been "found or founded" which could ensure security, prosperity and democracy for as many of the world's citizens as possible.[5]

The dynamics of the 19th century engendered the industrial revolution, the modern nation-state, the gradual spread of the ideas of the enlightenment and the dominance of Western societies.[6] The first half of the 20th century was marked by two world wars with Europe at their centre and anarchy in the international system of nation-states,[7] while the second half was characterised by the attempt to establish an international security architecture around the United Nations, and the triumph of market economies, which made tremendous gains in prosperity possible for some one billion people.[8] The 21st century is taking shape under the influence of an emerging global society characterised by global interconnections; an unprecedented density of worldwide cultural, economic and political exchange; a global market economy from which non-West-

ern societies are also beginning to profit,[9] but which also threatens to surpass the limits of our planetary ecosystem; further global systemic risks, and—at least in the early 21st century—a diffuse world political order without a clear centre, suspended between juridification (for example, the establishment of the ICC), informal networks of coordination (such as the G7/G8, G20 and BRICs), regression into sometimes apparently anachronistic power politics (as in the current Ukraine crisis), and totalitarian, globallyconnected movements ruled by violence such as the "Islamic State". We are living in an interim period between the era dominated by the nation-state, in which the lives of most people in the West essentially depended on dynamics within their own countries as long as "external peace" was ensured, and the era of a highly interconnected global society in which the lives of very many, if not most, people are significantly shaped by cross-border dynamics that take a course which individual nation-states can only influence to a limited extent on their own. At the same time, we are living in a transitional period that will determine whether or not humanity learns to assume responsibility for the stability of the planet and thereby to lay the foundations for the existence of many generations to come.[10] Without a new quality of global cooperation, our societies will meander towards situations in which cross-border dynamics unleash increasing instability, volatility and crises of the legitimacy of "politics", the ability of which to shape the outcomes of these challenges is limited.

The "old foreign policy" of the 19th and 20th centuries was closely intertwined with security policy in order to protect the internal and external sovereignty of states. The "new foreign policy" must be interwoven with almost every other field of politics that is involved in the global networks of interdependence. "Global domestic policy" and "global governance" are terms that seek to illustrate this new reality: reflections on them can be found as far back as the 1980 Brandt Report and the 1995 report of the Commission on Global Governance. In these early phases of the discussion of global governance however, the second, third and fourth waves of global transformation were not yet discernible.[11] These concepts are not popular, as quick, simple progress can hardly be expected. At the same time, no blueprints have been drawn up for how the transformation of global cooperation would need to look in order to live up to the new realities. Instead, current literature on global governance is pervaded by a deep-seated scepticism towards cooperation.[12] The "No one's world"[13] is described as a warning sign. However, the future of German and European foreign policy must still be discussed, in light of the phenomenon of "comprehensive globalisation" and towards the search for new patterns of international cooperation. The only alternative would be to carry on as if there were no global interdependencies; a pattern of action which was applied by the international community prior to the current global financial market crisis. However, denial, escapism and a refusal to face up to reality would not appear to be viable strategies for the future.

Expectations of Germany as a Global Agenda Setting Power

Germany is thriving economically right now. Its international partners expect it to make larger contributions to managing international crises and shaping global processes. This opens up room to manoeuvre, but it also implies a high level of demand placed on German policy. Germany's situation is a bit like China's. Only two decades ago, Germany was (like China) still a minor political figure on the foreign and global policy stage. Today the two countries must take a position on nearly all foreign and global policy issues. These external expectations are not easily met. Doing so requires worldwide networks, agenda-setting capabilities, prioritisation, financial and human resources, military capacities, international and global expertise in nearly every ministry, and internationally well-positioned and networked research on global issues. All of these capacities can only be developed incrementally. The placement of rapidly rising external expectations on those responsible for foreign and global

policy in a country that used to play more in the second league can easily lead to a kitchen-sink approach: help shape things a bit everywhere, be a bit present everywhere, try not to disappoint anyone. This kind of ad hoc-ism is, however, the opposite of strategic action.

While the comparison with China is not without warrant, there are significant differences. Unlike China, Germany needs a strong EU and Eurozone as a framework and support for the use of the aforementioned instruments of a global agenda setting power.[14] If Germany is to become an influential global political actor, it cannot go it alone, but rather must work within the context of the EU; the EU as a network of nations might become a central pole of the newly emerging global order.[15]

The reflections of three external observers of German foreign relations outline the challenges that Germany faces. Andrew Cooper, one of the leading researchers in the field of global governance dynamics, recently remarked: "Germany is, after the US and China, the country with the greatest potential influence in world politics thanks to its economic progress, its highly regarded model of society, and its pioneering role in climate-change and energy policy." Commenting on the foreign policy significance of the German transition to green energy, Jennifer Morgan, Director of the Climate and Energy Programme at the World Resources Institute in Washington DC, said: "If the US government had introduced such an epochal shift to sustainable energy, it would have sent hundreds of energy ambassadors out into the world to tout this policy in order to gain allies and shape the direction of global energy transformation as it did after the announcement of the Apollo Programme and during the Marshall Plan; nothing comparable, however, is being seen in Germany". A member of an OECD expert commission that evaluated German development policy in 2010 summed up his impressions as follows: "All of this does not feel like one of the most important bilateral donors, like a global player. Germany is punching below its weight".[16]

After the Agenda-setting Speeches on Foreign and Security Policy: Germany as a Driver for a Global Transformation

Against this backdrop, the agenda-setting speech by Federal President Gauck at the 2014 Munich Security Conference and similar statements by Foreign Minister Steinmeier, Defence Minister von der Leyen and Development Minister Müller were important wake-up calls about Germany's increased responsibility in foreign policy and world politics.[17] These public statements have initially focused on security policy issues. A quick glance at world political events of the past few months shows that these fields remain pivotal and, unfortunately, do not appear to lose

Germany has a thriving economy and has made progress in sustainability. However, its overall performance is still below the country's potential.

importance. The authoritarian ruler of the Syrian regime can still feel relatively safe from military intervention after failed attempts by some Western states to induce regime change in other authoritarian states in order to enforce democratic structures from the outside. In Libya, a dictator was toppled with assistance from outside, but support for reconstruction remains limited and the state is in danger of failing. The "Islamic State" represents a globally networked terrorist organisation that is occupying whole regions of Syria and Iraq and has advanced as far as the borders of Turkey, a NATO member. Mali, the Central African Republic, South Sudan and Afghanistan are representing the roughly 30 countries[18] that can be described as failed states, and from which regional or global security risks potentially emanate. Beyond this, the Ukraine crisis demonstrates that even in Europe, territorial conflicts that

were long believed to have been overcome have not in fact been relegated to the past. Security thus is and remains a pivotal field of foreign policy. Tectonic power shifts and the attendant rivalries between "old" and emerging powers, have created new security problems and are making these problems even more difficult to handle.

But problems of global interdependence extend beyond the field of security policy, as the outlines of the four waves of global transformation show. Global sustainability policy is another vital field that must be tackled through international cooperation. The catch phrases are familiar: in the dawning Anthropocene Era, human beings are becoming a force altering the Earth system, with irreversible and virtually unforeseeable consequences for human civilisation;[19] scientists have described runaway climate change and other planetary tipping points at great length.[20] Humanity is becoming the de facto architect of the Earth system, but has so far refused to face up to this role, which is arguably the greatest formative task of the 21st century. Many observers consider these challenges to be environmental policy issues ("soft politics", peripheral realms of international policy) that one might approach with greater or lesser degrees of engagement and enthusiasm. But what is actually at stake here is a profound transformation of the global economy and the organisation of prosperity, security, and democracy in a nine-billion-people civilisation within the boundaries of the Earth system.[21] Our planet is the greatest global common good, one that needs to be stabilised and preserved for many future generations to come. The issue of sustainability in the 21st century will be as pivotal for the future viability of the global market economy as the embedding of capitalist dynamics in democratic social welfare systems was in Western industrial societies after the Industrial Revolution.[22]

It is time for an agenda-setting speech on Germany's role in global sustainability policy, and "climate Chancellor" Merkel would be the ideal person to deliver it. The Federal President, the Foreign Minister, and the Development, Environment, and Education and Research Ministers could play important roles here, too. They must make plain that a global transformation to sustainability needs to take place within a narrow window of time, and that this task cannot be postponed even in the face of multifarious resurgent security problems. A German strategy for *sustainable global development* could comprise four components:

An effective international energy policy should bring together countries to form a transformative club that advances ambitious energy transformations towards renewables while also accelerating the climate-change negotiation process. The "Renewables Club" founded by former Environment Minister Altmaier could be the starting point for such an initiative. Significant joint investments in research, education, and outreach; regulatory learning processes; and potentially, trade policies would be oriented towards creating shared advantages. Clubs could develop transformative potential through a range of characteristics. *Speed*: Mancur Olson argued as long ago as 1965 that small groups reach agreements more quickly, as there is a higher degree of social pressure between their members than between members of large groups, such as in the context of the UNFCCC process.[23] *Level of ambition*: Smaller groups can be more ambitious in their objectives and generate more visible shared benefits for all stakeholders than large groups, which are often based around the lowest common denominator.[24] *Implementation mechanisms*: By using positive incentives (club benefits) and sanctions (such as the threat of membership suspension), clubs are better placed to avoid free-riding by members and therefore to implement their goals more effectively than large alliances.[25] Ambitious clubs can use these mechanisms to encourage other actors to follow their lead, as they show what is possible. In this way, a transformative green energy club could bring about political tipping points in the UN climate process. At national level and as a group, the club members would pursue significantly more ambitious objectives than those currently achievable in climate-change negotiations, while also representing a more ambitious position as a club within the climatechange negotiation process. Last but not least, the

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We need to establish more partnerships. In the emerging economies, especially in Asia, where the largest middle class in the world will be formed in the next decades - which is a great change.

club approach can be scaled up by admitting new members, with the club's initially exclusive logic becoming progressively inclusive in the medium term.[26] The creation of a transformative green energy club would therefore accelerate processes of transition to low carbon global economy and would at the same time incrementally improve the conditions for a successful multilateral climate regime.[27]

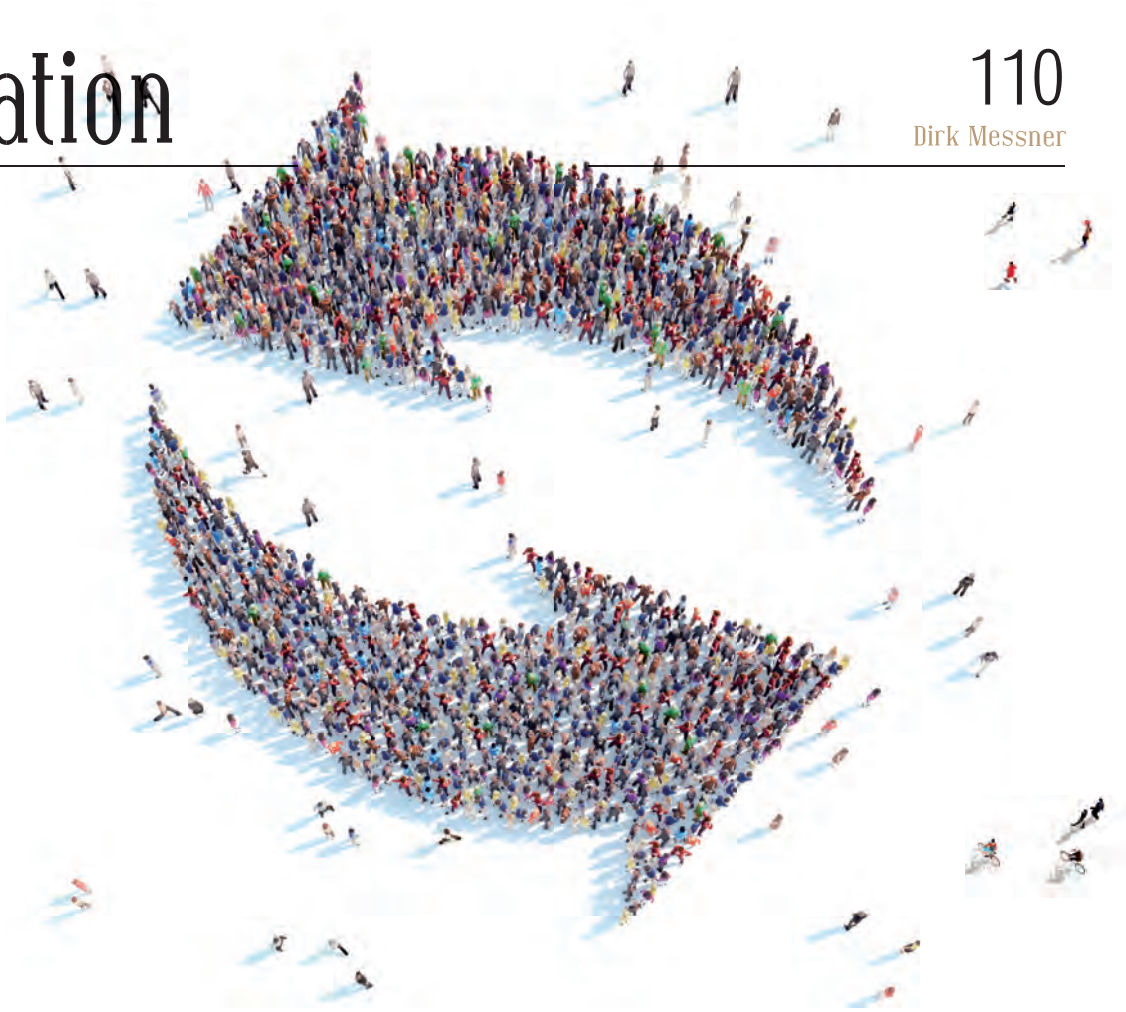
2 The largest *global middle classes* in the world economy will take shape in the next two decades in the emerging economies, most notably in Asia.[28] This trend is tied with the most extensive *urbanisation* trend in the history of humanity.[29] Today 50% of the world's population lives in cities; by 2050, 80% will. Both of these trends must be decoupled from climatedamaging greenhouse gas emissions, resource exploitation, and excessive strain on ecosystems in order to prevent turbulences within the planet's ecosystems in the second half of this century. Germany is highly regarded—particularly in the emerging economies—as an economically and technologically strong sustainability pioneer. Concrete reciprocal partnerships with a select group of emerging economies (or regions in these countries) should be initiated in order to strengthen transformations to sustainability. Energy and mobility systems, green urban infrastructures, resource-efficient and low carbon innovations, and a strategy for transformation to sustainability would be at the centre of these partnerships. Their starting points would be joint research and training efforts, ambitious standards (e.g. in energy efficiency of buildings and in electric vehicles), the interlinking of emissions trading systems (which would require a reform of the European system), joint initiatives for sustainability in international organisations (such as the World Bank), and negotiation processes (such as climate-change negotiations).[30] The stated goal would be to build up transformative alliances with companies, societies and states together with emerging economies in order to strengthen the shift to a low carbon and resource-

efficient world economy. Such a strategy would create markets for "green" innovation processes and would thus also be in the interest of German and European economic competitive advantages. In order to establish such transformative alliances, Germany and Europe would have to do their homework on sustainability.[31] This would imply, first of all, systematically linking investment and growth strategies with concepts of climate neutrality, resource conservation and recycling. Secondly, Germany would need to push hard for a reform of the European Emissions Trading System. Thirdly, the country would need to work to ensure that economic factors are systematically linked with sustainability requirements in negotiations on a Transatlantic Trade and Investment Partnership (TTIP).

3 In the 21st century, *knowledge* will stand alongside (international) law and the intelligent use of soft power and money (to finance cross-border initiatives) as one of the most vital resources of international cooperation. "The main fuel to speed the world's progress is our stock of knowledge".[32] However, it is important how this stock of knowledge is built up. If global cooperation is to be boosted, then it will be necessary to expand cross-border knowledge partnerships, particularly those with developing countries and emerging economies. International science policy and knowledge collaboration in a broader sense generate commonly accepted knowledge on global issues of the future, thereby providing legitimacy for joint action.[33] The World Bank has placed knowledge collaboration at the heart of its forward-looking strategy.[34] Germany could go one step further in this field than the World Bank, which is successfully establishing an increasing number of internationally connected knowledge platforms dealing with global development issues.[35] If global commons (such as the oceans, the climate system and resilient financial markets) are to be protected and global interdependencies managed effectively, then there is an urgent need to develop problem-solving approaches on a consistent basis from the perspective of global system logics and risks and of global common goods. However, even in the field of (applied) research into global development issues, the dominant perspectives have so far been those that are rooted in individual nation-state (ultimately, particular) outlooks. "Comprehensive globalization" necessitates that these "nationally focused" lines of research into global development matters be complemented by "world knowledge" that is thought through consistently from the perspective of the increasingly significant global systems.[36] In this field, too, Germany is highly regarded and has tremendous potential to become a major global node in the fields of knowledge that engage with worldwide sustainability issues.[37] In this context, the concept of knowledge cooperation must be re-imagined in conjunction with the roll-out of digital communications technology. Until recently, dense and high-speed communications networks, access to bodies of knowledge and libraries, and knowledge dialogue, all of them on an international scale, were the privileges of the Western middle classes and global elites. But the situation is changing rapidly. In 2000, just 700 million people, 70% of whom lived in OECD countries, had a mobile phone, giving many of them mobile access to the internet and global communications networks. By 2012, there were six billion mobile phone connections, with 75% of them in non-OECD countries. This is increasingly opening up completely new opportunities for collaboration as part of international knowledge cooperation, whether through joint research in virtual labs and networks, access to shared knowledge bases, and data with no need to construct expensive libraries in developing countries, or access to virtual learning events delivered by the best regional and global researchers as a public good. There is enormous scope here for social innovation in developing new forms of international knowledge cooperation: This shift is due to continued simultaneous performance improvements and cost declines in both mobile phone devices and networks, and it has an important consequence: it will bring billions of people into the community of potential knowledge creators, problem solvers, and innovators.[38]

4 *Development policy* needs to move from being an aid industry to a driving force for building international alliances to shape global development dynamics in future. This would allow it to make major contributions to a German strategy for *sustainable global development* (Faust and Messner 2012; WBGU 2014a). On the one hand, this is a matter of continuing to combat poverty, especially in the roughly 30 countries that are known for being "failing states". In this area, stabilisation of states and societies must be linked together with efforts to combat poverty (in cooperation between the Federal Ministry for Economic Cooperation and Development, Federal Foreign Office and Federal Ministry of Defence). On the other hand, approaches should be taken which support transformations to sustainability and inclusive development in three groups of countries. Firstly, in the resource-rich countries of Africa and Latin America, these initiatives should prevent the familiar "resource curse" dynamic in times of high raw materials prices and mobilise growing foreign exchange revenues for sustainable development. Secondly, in the rapidly growing emerging economies, strategic partnerships can (as suggested above) create pro-poor sustainability pilot programmes (in this area, initiatives of the Federal Ministry for Economic Cooperation and Development would need to be sensibly combined with those of other ministries). Thirdly, the Federal Ministry for Economic Cooperation and Development has a comparative advantage over other ministries in cooperation with the large group of "in-between" societies that count among neither the poorest and most fragile states nor the ascending newly emerging powers—Vietnam, Peru, Caucasus countries, Morocco, and Kenya are examples of these "in-between" countries. In this group in particular, important trajectories will be set in the energy and infrastructure sectors over the coming decades, with significant and path-dependent consequences for natural resources, greenhouse gas emissions, and ecosystems, both locally and globally. When it comes to cooperation with emerging-economy societies and "in-between" countries, it is not only about selecting the "correct" areas for cooperation, but also about how that cooperation is conducted. One of the key challenges is to develop an increasing number of cooperation models that are based on reciprocal partnership and that fuel change processes on both sides—in partner countries and in Germany. Conventional models of development cooperation that are geared towards shaping policies in developing countries and emerging economies, but that exclude or fail to consider cooperation in the other direction to change policies in Germany and Europe are losing legitimacy. "Meddling" in the internal affairs of partner countries is only likely to work in future if both partners are permitted to do so. To give a specific example, this would mean that cooperation between Germany and India as part of an energy partnership or an initiative for strengthening sectoral recycling industries should increasingly involve collaboration between networks of actors from the two countries who initiate or support reform processes in India and in Germany on an equal basis. Cooperating with increasingly self-confident countries would mark a shift away from established North-South, donor-recipient, and developed-underdeveloped patterns of collaboration associated with the old model of development cooperation. Development policy is therefore about quality of cooperation, about generating strategic impetus for transformations towards sustainability, and about jettisoning paternalistic patterns of cooperation,[39] but it is as well about quantity and real investment. If Germany wants to realign its role in the world and boost its international reputation, it should move up from its mid-table position among countries that invest in development cooperation (measured in terms of Official Development Assistance (ODA) provided in relation to their GNP, these "mid-table" countries include Australia, Austria, France and Belgium) to join the leading group of countries, which includes Norway, Sweden, Denmark, and the UK.[40]

Many of the elements that have been outlined in this paper already exist, but the effort to root them in international politics must be greatly increased— by, let's



The creation of a global culture of cooperation is a significant challenge of the 21st century, so that we can face the systemic risks of the contemporary world together.

say, a factor of 2–5 by 2025. "Factor 2–5" demands a broad range of efforts: "scale matters", that is, the scale of investments in different areas must be increased; bundling the instruments and activities of different ministries and other players into effective packages is important; the priorities in this pooling must be clear in order to have an impact; international agenda-setting efforts must be stepped up; Germany's presence and active shaping role in international organisations and networks needs to be expanded; cooperation between the political and academic realms should be developed further. A corresponding strategy must not only apply to the use of German instruments, but also be introduced correspondingly into EU foreign, development, energy and climate policy.[41]

Transformative Pragmatism that Brings about a Leap Forward in the Quality of International Cooperation

A boost to the quality of international cooperation will not occur through a "big bang" (e.g. through swift and comprehensive reform of the United Nations or through a perfect climate regime as the outcome of the 2015 climate-change negotiations in Paris), as the new reality in international politics described at the beginning of this paper makes such an event inconceivable in the next few years.[42] An incremental "a little bit more everywhere, everything a bit better" approach, however, is not a viable alternative. What is needed, rather, is for Germany to take an ambitious approach to strengthening its international role, an approach that ties pragmatism together with a demand for transformative action. Many of the elements needed to increase Germany's capacity to exert a formative influence are already present in some fields of foreign relations, and now they can be strengthened through pooling of individual initiatives, clear prioritisation, global agenda-setting and astute network-building, as well as through additional investment. The "new foreign relations" must be sustained by many ministries as well as exponentiated through interaction among them and with

society and academia.[43] Within this framework the Federal Foreign Office is gaining, alongside the "traditional tasks" of diplomacy and of foreign and security policy, a vital role as a "network manager", making it possible to bring together various contributions of different ministries and action in joint corridors of action. In so doing, the Federal Foreign Office is thereby dependent on other strong and capable ministries contributing their own respective competencies. Increasing its impact by a factor of 2–5 would be an aspiration for Germany as a relevant global player on the way to 2025.

This path has both continuities and new challenges. Germany's role as a global agenda-setting power working in close coordination with its European partners to advance European foreign policy shows continuity. With the new European Commission, whose programme includes establishing stronger links between outward-looking EU policies, beginning its work in autumn 2014, the next steps can be taken.[44] An orientation towards multilateral solutions and towards strengthening international law is another form of continuity, which is often severely put to the test in the context of power shifts and rivalries, flexible and polycentric architectures of power, and the weakness and resistance to reform of many international organisations, but which nonetheless must not be given up as a point of orientation. There is also specific room for improvement in this context, with the 2015 climate-change negotiation process in Paris providing an opportunity for Europe to work with its partners to establish at least some ambitious elements of a global climate agreement.[45] The Ebola crisis has revealed a clear and urgent need for the WHO to be reformed, strengthened, and placed on a solid financial footing. At the same time, the World Bank is undergoing a dynamic process of reform that could be more visibly supported by Germany and Europe.

A greater emphasis should be placed on building up alliances of trailblazers and clubs of the like-minded that can move projects forward more quickly and ambitiously than is possible within comprehensive multilateral processes which always have to take into account laggards and foot-draggers (see the aforementioned example of an ambitious club of countries shifting to green energy). Today's EU, Eurozone and WTO also started out as smaller clubs, gained the shared advantages of a club, increased their attractiveness, and thereby created impetus for broader multilateralism. Ambitious clubs could move the politics of global sustainability across various tipping points towards a sustainable global economy and Germany could play an important role in this area.

The creation of a global culture of cooperation is a formidable challenge in the 21st century if we do have a chance of giving shape to the increasingly dense network of global interdependencies, keep global systemic risks in check and stabilise the situation of our global common goods (above all the planetary ecosystem, but also the international financial markets) and use them on a basis of generally accepted criteria of fairness. We appear to be further away from achieving this kind of civilisation now than we were just a few years ago. The incompatibility and conflict between the four aforementioned concepts of global order currently in existence (fair global governance and improved multilateralism; neo-imperialistic power play; narrow nation-state perspectives on international cooperation; and Islamic Jihadism) actually run the risk of producing an ice age in international cooperation at precisely the moment when "comprehensive globalization" calls for "comprehensive cooperation" in order to reign in global risks. "Policy disasters"[46] are conceivable if these roadblocks are not removed. At the same time, the current consolidation and acceleration of globalisation dynamics carries the seeds of an emerging cooperation culture. The Ebola crisis, the movement of refugees towards Europe as they flee failed states in North Africa, and the "Islamic State" on the borders of a NATO member country all demonstrate what has been analysed in global governance literature since the mid-1990s: the reality that there is no longer such thing as a stand-alone nation that is immune to the risks of global interdependencies. The fact that the many different opportunities afforded by globali-

sation can only be exploited in the long-term on the basis of global cooperation, common regulations, international law, and the cross-border reconciliation of interests is now far more tangible to people than when it was originally debated in initially abstract terms during the global governance debate of the mid-1990s.

Moreover, the clash between the four models of global order could give rise to new and surprising cooperation alliances. The "Islamic State" is serving to remind Europa, the United States, China, Russia, Brazil, India, and many, presumably almost all, other actors of the vital importance of a comprehensive global security architecture paving the way for prosperity and peace in the societies of individual nations and in the emerging global society. Achieving such an architecture under the conditions of comprehensive globalisation will require suitable initiatives, including but not limited to the G20. At the same time, it is likely that many emerging economies such as Brazil and India, and probably also the political actors within China, will view Putin's neo-imperialistic strategies in the Ukraine with scepticism, as this approach is creating zones of instability and giving rise to the violation of international rules and norms that could undermine the benefits of economic globalisation that depends on rule based trade and the relative certainty of expectations. Therefore, it is conceivable that current global interdependency crises will create new incentives for global cooperation.

In his work for the "High-Level Panel of Eminent Persons on the Post-2015 Development Agenda", former Federal President Horst Köhler has often pointed to the major challenge of creating a culture of global cooperation.[47] Power shifts, polycentric power structures, and the erosion of North-South and donor-recipient structures—the elements, that is, of the transition to a post- Western world order—demand great efforts to develop a viable and peaceful global architecture of cooperation. Various long-term dynamics are involved: opposing interests must be negotiated and shared interests generated. Dialogue must be conducted about divergent and shared norms and values as well as mechanisms of cooperation that accept cultural diversity without undermining fundamental human rights. Shared production of knowledge can help to work out common perspectives on international problems and shared approaches to solving them. The most important mechanisms of developing and stabilising collaborative relationships are familiar to us from cooperation research: reciprocity, trust, dense networks of communication, positive reputations, fairness, instruments to support rule-abiding behaviour and to sanction free-rider strategies, a sense of common identity, and shared narratives.[48] The chances of reigning in power plays within collaborative relations and the likelihood of implementing strategies of shared problem-solving against narrowly defined national interests increase in spaces and constellations of players in which these basic mechanisms of cooperation are especially pronounced (e.g. in the EU, despite all the current turmoil). None of this is easy. Setbacks are inevitable, and all the basic mechanisms of cooperation require time and patience. Looking at the foundations for cooperation, it becomes clear within the G20, for example, that it is not only a case of relatively emerging "new powers" and relatively declining "old powers" jostling for power, but that there is also an acute shortage of the aforementioned basic cooperation mechanisms at present. Overcoming this problem would make it possible, or at least easier, to keep selfish power plays in check and to develop an ability to act collectively. Since all the basic mechanisms of cooperation are man-made, the question is: what initiatives would be suitable within the G20 for

Four inter-related waves of transformation have led to broad globalisation, creating a new reality in the international system.

encouraging investment in the basic conditions of cooperation and for building up "cooperation capital"?[49]

It is clear that a global culture of cooperation equal to the cross-border challenges of the 21st century will not emerge of its own accord from the dynamics of global transformation. Rather, the work of helping to advance this kind of a new global culture of cooperation is one of the gentle tasks of the "new German foreign policy".

Conclusions

1 The debate surrounding Germany's new role in international policy-making is taking place in a specific phase of development in the international system and within the dynamics of global transformation: "Global interdependence is greater than ever before". Four waves of global transformation have brought about "comprehensive globalisation", thereby creating a new reality for the international system.

2 Germany currently has great potential for shaping international policy and, aside from the United States and China, is perhaps one of the countries from which the greatest things are expected. The agenda-setting foreign policy speeches by Federal President Gauck and Foreign Minister Steinmeier addressed in 2014 this weight of expectation, rightly highlighting the challenges it poses for the nation's policy-making.

3 Germany could play a transformative role in global sustainability policy. Four starting points (energy-related foreign policy, transformative alliances with emerging economies and powers, new patterns of international research cooperation, and sustainability partnerships with "in-between" countries such as Vietnam, Peru, Morocco and Kenya) are outlined for significantly increasing Germany's international impact in this field ("factor of 2–5 by 2025").

4 A transformative development in international cooperation relationships raises some fundamental questions for the German government. How can the international capabilities of all the ministries be mobilised and networked? Can collaboration within alliances of trailblazers (e.g. on sustainability policy) reinvigorate the multilateralism that is currently blocked in many areas? How can a culture of global cooperation be fostered successfully? And how can this be achieved at a point in history when incompatible or barely compatible concepts of global order are colliding with one another, be they a) visions of a fair and inclusive global governance architecture based on shared sovereignty, the development of global common perspectives and the reconciliation of interests, b) a neo-imperialistic approach à la Putin based on classic power play, c) the world views of many emerging powers (such as Brazil, China and India) that draw still heavily on classic concepts of national sovereignty and selfinterested foreign policy or d) Jihadism, which seeks the destruction of others and is developing into an internationally connected political power. ■

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36. In Germany, for example, the German Institute for International and Security Affairs, the Kiel Institute for the World Economy and the German Development Institute (DIE) are working in different dimensions of global development. Given that the addressees of the policy advice based on the research carried out by

these institutes are, generally speaking, firstly the German Government, then the European Union, it is not surprising that the solutions proposed show a "German" or "European" bias. Against this backdrop, the Global Governance School at DIE, where researchers and research institutions from Europe and emerging economies work together on common solutions to global problems,is a social innovation. However, practical experience at the Global Governance School also shows how difficult it is, even for researchers, to put national perspectives to one side, that is, to break away from patterns of conventional international cooperation and (at least in theory) to adopt a global system perspective in which we are all global citizens: "Imagine that we had to solve the problems of climate change and financial market volatility not from the point of view of Germany, Europe, Brazil, China, India, South Africa, or Mexico, but rather from the perspective of an emerging global society. What conclusions would we draw then"?

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JOÃO MANGABEIRA FOUNDATION EXHIBITS AT THE 32ND BRASÍLIA BOOK FAIR

Between 16 and 24 July, the stand released books and periodicals produced by FJM with distribution of copies and special events. The space also exhibited their audiovisual productions and multimedia galleries about the centenary of the great leader of the party Miguel Arraes, with emphasis on their publications and translated works. Events and publications are virtually available on TV João Mangabeira and Socialist Memory Center, accessible through the website www.fjmangabeira.org.br.

Renato Casagrande, President of FJM, and Carlos Siqueira, President of PSB, present and distribute to participants copies of *Uma Agenda para o Brasil* (An Agenda for Brazil) and *Estado Presente* (State Present).

Prof. Adriano Sandri, Coordinator at Miguel Arraes School, presents the pedagogical and social objectives of the institution during chat with the public of the fair.

Senator João Capiberibe promotes his autobiographical novel *Florestas do Meu Exílio* (Forests of My Exile) and the publication *Mandato Sustentável* (Sustainable Mandate) accompanied by his wife, Congresswoman Janete Capiberibe.

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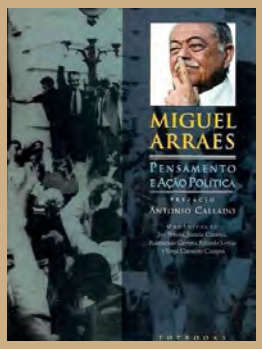

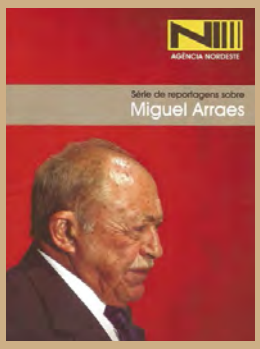

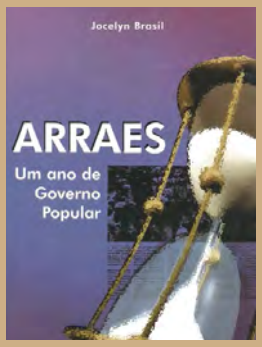

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