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Point of view

Brazil on the spot: Rio+20, sustainability and a role for science

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ABSTRACT – (Brazil on the spot: Rio+20, sustainability and a role for science). Rio +20, or the United Nations Conference for Sustainable Development, will take place at the end of this month of June 2012. In this paper, our central argument is that Brazil, as the host of Rio+20, has a historic opportunity to make the conference a success and take a decisive step in becoming a world leader in the shift from the traditional development paradigm to a new, sustainable development paradigm. To do that, Brazil will have to resolve a paradox: on the one hand the country has modern legislation and world class science, and on the other hand very poor social and environmental decision-making in recent times. In this column, we examine the green economy as a trajectory that leads to sustainable development and describe some pilot experiences at the sub-national level in Brazil. We discuss how science, and particularly plant sciences, will be essential to the transition to sustainable development. Finally, we propose immediate actions that we call upon the Brazilian government to commit to and to announce during this pivotal Rio+20 moment, which should serve as a milestone for all nations in building a sustainable future.

Key words - green economy, Rio+20, sustainable development, United Nations Conventions

INTRODUCTION

Rio+20, or United Nations Convention on Sustainable Development, will begin on June 13th, 2012, in the shadow of a bleak environmental and development record. Species extinction rates, greenhouse gas emissions, and unsustainable land use change are greater than ever and continue to increase. An estimated 800 million people are hungry, while the planet wastes 1/3 of the food it produces. All these statistics cast doubt on the effectiveness of the global governance system created 20 years ago at the UN Rio Summit of 1992. Copenhagen, Nagoya, Cancun, Changwon, and Durban are cities that recently hosted conferences of parties of the three major conventions born in Rio 92 – biodiversity (UNCBD), climate (UNFCCC) and desertification (UNCCD). They all recognized humanity's failure to achieve sustainability goals and set new targets for years to come. Can we expect Rio+20 to achieve more than an expression of collective remorse about past failures and a compilation of another wish-list without the will or means to achieve it?

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We have very recently argued that the success of Rio+20, as is always the case with UN Conventions, is largely dependent on the host country and, therefore that Brazil will have a major role to play (Scarano et al. 2012). We submit that Rio+20 is the right opportunity for Brazil to move from the negotiation table to practical action and to lead – by example – a shift in the global development paradigm towards a greener path. Brazil has a powerful combination of characteristics that justify our optimism: it is home to the greatest natural capital stock on the planet; its economy has grown significantly while most of the world has been experiencing a severe economic crisis; and it has been a true leader in the negotiations of all three conventions during the past twenty years. However, Brazil has considerable work to do, as evidenced by some poor decision-making regarding socio-environmental issues in recent years.

In this paper, we examine 1) Brazil's reticence to embrace its role as a global leader on sustainable development demonstrated by ongoing policy contradictions; 2) how sustainable development might take place; 3) how science will back up this process; and finally 4) some progressive actions Brazil should launch at Rio+20 to lead by example.

A HESITANT GIANT

The contrasting policies and apparent contradictions listed in table 1 demonstrate that Brazil currently hesitates

as whether to develop in traditional ways (i.e., at the expense of natural capital) or to do so in a sustainable fashion. Interestingly, Rio+20 will deal precisely with the conundrum of how to increase human well-being while maintaining or enlarging natural assets – the essential ecological infrastructure that allows humanity to thrive. One way to do so is by increasing efficiency of production systems utilizing natural capital as opposed to expanding the production frontier. Energy and agricultural production are two examples of the efficiency vs. frontier expansion debate.

Hydroelectric power plants account for over 80% of Brazil's electricity generation (Lucena et al. 2009). While the Brazilian government could have opted to consolidate energy production in rivers that have been already modified by dams, or to increase the efficiency of energy grids and transmission, their choice in the past few years has instead been to build new hydropower facilities in undisturbed Amazon rivers, such as the Madeira (Santo Antonio and Jirau in 2009) and the Xingu (Belo Monte in 2011). These dams were forcefully pushed by the federal government with disregard for both the rights of indigenous peoples and for legal environmental requirements (e.g. Fearnside 2010). Proposed expansion of the hydropower network to the Tapajós river risks important human and environmental impacts (Scarano et al. 2012 and table 1).

Similarly, Brazil does not need to transform even more natural habitat to farmland in order to excel in agricultural production. The country has some 60 million hectares of unproductive land with fertile soils that are currently underexploited by extensive cattle-raising

Table 1. Brazil's paradox: contrasting policies and actions regarding social, economic and environmental sustainability (adapted from Scarano et al. 2012 and references therein).

FACTOR	POSITIVE	NEGATIVE
NATURAL ASSETS	Brazil is the most diverse of all megadiversity countries (i.e., the 17 countries that respond for 70% of the species diversity of the planet), harbors 12% of the freshwater of the world, produces more food than consumes, and is the largest carbon sink.	Brazil was the world leader in deforestation of tropical forests, cutting down ca. 19.500 km^2 a year between 1996 and 2005,which represented historically from 2-5% of global CO_2 emission (Nepstad et al. 2009). It is one of the 8 countries that contribute to 50% of the world's water footprint largely due to agriculture (Hoekstra & Chapagain 2007).
PROTECTED AREAS	Between 2003 and 2008: secured with reserves > 70% of the land protected in the planet during the same period. Thus, around 50% of the Brazilian Amazon is now inside protected areas and indigenous territories, substantially reducing deforestation rates.	January and May 2012: federal government reduces size and change boundaries of 8 protected areas in the Tapajós region, central Amazon, to allow creation of more hydrodams. President Dilma Rousseff's first year in office was the first in over 15 years when federal government did not create any new protected area and reduced the area cover of some of them.
SOCIO-ECONOMICS	Survived the global economic crisis to become world's sixth largest economy.	Human development index (HDI) in Brazil is only 84^{th} in the global rank due to social inequity and poverty.
AGRICULTURE	Brazil is a world leader in no-tillage systems (> 10 million hectares), i.e. a low-impact farming practice that safeguards the required organic matter content and protects the soil from exposure (Romeiro 2011). In 2010, the country launched an innovative policy for low carbon agriculture.	Changes in the Forest Code, despite vetoes from President Dilma Rousseff last May 2012, will make requirements for conservation of natural cover within rural properties less strict. Thus, nearly 50 million hectares of natural ecosystems can be lost in years to come and significantly enhance Brazil's already high CO_2 emission due to deforestation.
SEA OIL	The last UNCBD conference, in Nagoya (2010), set targets for marine protection: 10% by 2020. Brazil defended and negotiated in favor of this position, despite having only 1.5% of its marine economic exclusive zone protected, and having an estimated 80% of marine fisheries overexploited.	There are estimates that indicate that nearly 9% of priority areas for marine conservation have already been conceded to oil companies in Brazil.

practices that average one head of cattle per hectare or less. This is almost the same amount of land dedicated to highly productive, modern agribusiness (nearly 62 million hectares). With adequate land reform to intensify cattle-raising in smaller areas and to allow expansion of agriculture over unproductive areas, Brazil could arguably double its food, fiber, fuel and commodity production without cutting down a single tree. Furthermore, Santana et al. (2011) estimated that by 2030, under current agricultural practices, export-driven growth of Brazilian soy, beef, sugar cane and cotton would require an additional 13.5 million hectares of land beyond 2006 levels. By improving agricultural practices and increasing resource use efficiency, the same increase in production could be achieved with a mere 1.3 million additional hectares; and more importantly, with appropriate incentives and governance, either increment in land use could be fulfilled in the recovery of degraded lands.

However, a number of cases have begun to emerge at sub-national level that provide a reason for hope. We call them pilot tests of green development (table 2). All these initiatives have a long way to go before we can say they have established green economies; however, they and many other cases emerging at the local level throughout the country, are an important start. They all have in common the fact that local societies are supported by partnerships between sub-national governments, academia, NGOs and even major private sector leaders that now foresee risks to their own businesses and bottom lines posed by poor environmental or social management (Lustosa 2011). Later we discuss how Rio+20 could provide a boost to strengthen and replicate these green development efforts, and how science could support them. But first we examine what is it we are calling sustainable development, the main focus of the Rio+20 summit.

Table 2. Potential pilot experiences in green development at sub-national level in Brazil (adapted from Scarano et al. 2012 and references therein).

SUB-NATIONAL UNIT	DEMONSTRATION
State of Acre, Amazon Biome	A community-run, sustainable forest management system launched in 2000 resulted, on average, in a two- to threefold increase in farmers' incomes by 2001, and a 12-fold increase in the value of rural property by 2012, compared with nonparticipating farms.
State of Amazonas, Amazon Biome	> 50% of the state is within protected areas and indigenous territories, while capital city, Manaus, has the 4th GDP among Brazilian capitals.
State of Amapá, Amazon Biome	72% of territory is covered by protected areas and indigenous reserves, and a few years after this conservation network was established, the state showed some of the highest annual rates of growth in human development index among Brazilian states.
Municipality of Luís Eduardo Magalhães (State of Bahia), Cerrado Biome	Used to hold some of the highest rates of deforestation in the country due to expansion of soybean agribusiness. In late 2011, the municipality launched a campaign and promoted incentives to have all properties in its territory abiding to APP (permanent protected area) 100% legal, as predicted by the old Forest Code, despite all movement to change it in congress.
State of Espírito Santo, Atlantic Forest Biome	Launched a project to restore 200,000 ha in the next 13 years so as to expand its current 11% natural cover to 16%. This is expected to take place on the land of unproductive properties, so as to create corridors between remnants of native vegetation, foster new agricultural models, create job and business opportunities for poor rural workers and protect water sources in a state where oil, mining and forestry fastly expand.

WHAT IS SUSTAINABLE DEVELOPMENT?

Green economy, green development, sustainable development, healthy and sustainable economies … the world seems to have as many concepts and terminologies for this new development paradigm as there are United Nations conventions and governing bodies. Furthermore, each of these concepts has countless definitions that may either render them

synonyms or give them entirely different meanings (Sawyer 2011). We follow UNEP's framework, which sees green economy as a trajectory or a process that drives a given society towards a state of sustainable development with a secure natural capital base. Green economy, therefore, is one that results in "improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities". In its simplest expression, a green economy can be thought of as one which is low carbon, resource efficient and socially inclusive. In Rio+20, resolution 64/236 of the UN General Assembly states that the term to be used in the Convention is "green economy in the context of sustainable development and the eradication of poverty." Along these lines, sustainable development would give equal weight to its three pillars: economic, social and environmental (UNEP 2011).

A country's income and economic well-being depend on its wealth, where wealth is defined in the broadest sense to include natural, produced, human and social capital (Serageldin & Grootaert 1998). Natural capital includes all renewable (but not inexhaustible) resources (e.g., all products derived from ecosystems and their services) as well as non-renewable stocks of exhaustible useful substances generally found underground (e.g., oil, gas, minerals, etc.). Produced capital includes all physical assets or durable goods (e.g., man-made infrastructure) as well as finance (liquid assets). Human capital is the stock of competences, knowledge and personality attributes that individuals acquire through research, education and practice embodied in the ability to perform labor so as to produce economic value. Social capital includes institutions and social relations that determine, depending on the context, how efficiently the first three types of capital can be combined (e.g., governance).

The four capitals compose the productive base of an economy. However, non-renewable natural capital (nature and its services) underpins all other capitals. Its contribution to an economy is best understood through an analysis of its services. Ecosystem services are defined as the direct and indirect contributions of ecosystems to human well being (MEA 2005). There are four major categories of ecosystem services (table 3). Supporting and regulating services influence one another. They are mostly intermediate ecosystem services, those that are not directly consumed by people but underpin the production and/or flow of other services. Regulating services have insurance values, as they reduce the risk of loss of ecosystem service flows in the face of disturbances in the environment. People directly consume provisioning and cultural services. When combined with elements of produced and human capitals, these services generate products that have market values. There are buyers and sellers, and the product's value can be estimated from this interaction. As a consequence, provisioning and cultural services are an important part of the flows of goods and services that compose national and global economies.

Table 3. Categories of ecosystem services (see also MEA 2005).

TYPE OF SERVICE	DEFINITION
Habitat or supporting	Associated with the maintenance of species and all ecological processes that compose the basis for all other ecosystem services
Regulating	Services that ecosystems provide by regulating ecological processes that are critical for human survival such as air quality, flood and disease control, pollination and biological control
Provisioning	Provide the material outputs from ecosystems such as water and food
Cultural	Include the non-material benefits (e.g., aesthetic, spiritual and psychological) people obtain from contact with nature

To move from the traditional economy towards a greener economy that leads to sustainable development, societies have to be prepared to follow a different path. We envision six major transformations that include natural capital, production, consumption, markets, financing and institutions (table 4).

AN EMERGING SCIENCE AND A ROLE FOR BOTANY

As with any other major change the planet has gone through in its history, green economy and sustainable development have to be backed by science. This new paradigm requires a new science, now known as sustainability science, which is an interdisciplinary

Table 4. Shifting from traditional development to green development. The six transformation steps.

COMPONENTS	DEFINITION	DESCRIPTION
Sustainable Natural Capital	Maintain or enlarge critical natural capital	Critical natural capital is the portion of a region's natural capital that is irreplaceable for the functioning of the ecosystems, and hence for the provisioning of its services. Without critical natural capital societies are not resilient against global changes and cannot sustain socio-economic development. Its conservation requires careful design and implementation of strategies that seek to maintain or restore ecosystems.
Sustainable Production	Produce more while consuming less	Production systems become more efficient and the impact of the man-made infrastructure that is needed to realize their market values is minimized, mitigated or compensated. Production systems and infra-structure should be well planned following the best benchmarks available and constrained by the protected area network that is required to protect the region's critical natural capital.
Sustainable Consumption	Progressive reduction until elimination of the consumption of products that do not follow best sustainability standards	The power of the consumers should be adequately driven to promote transformational changes on how the markets operate. Legislations supporting only the purchase of sustainable products by governmental organizations can promote the incentives that sustainable products need to become competitive in the market.
Sustainable Markets	Markets for ecosystem services are created or expanded and incentives are adopted to correct eventual market failures	The values of the ecosystem services needed to a specific product are often not incorporated in the prices, as they are perceived as free of charge. Initiatives such as payment for ecosystem services as well as green taxes are the first steps towards the recognition of the monetary values for nature's services.
Sustainable Financing	Financial resources coming from individuals, corporations and government are directed mostly to sustainable economic activities	Developed countries should make sure that Overseas Development Aid is used to maintain critical natural capital and support the emergence of sustainable economic activities rather than to support the traditional development models. Private sector should incorporate social and environmental safeguards in their investments. Global standards built together by different stakeholders will constrain investment flows to "brown" activities.
Sustainable Institutions	Green economies require a positive societal relationship with nature's values and effective governance of ecosystem services	Societies need to develop new and innovative social agreements that define how ecosystem services will be valued and managed. To be effective, these agreements should define how the values of ecosystem services will be incorporated in national accounts, who will own or have the rights to use ecosystem services, and the process and tools that will be used to make decisions on the management of ecosystem services.

science produced by interdisciplinary scientists. It combines environmental and social sciences and disciplines, from economics, business and sociology through to meteorology, biology, forestry and agricultural science (Bethencourt & Kaur 2011). Irigaray (2011) argues that by permeating distinct and separate areas, the concept of sustainability "exerts an integrative and revolutionary function, implicating a rupture of secularly consolidated patterns, beliefs and techniques linked to a context of changing patterns in the relations between man and the natural world". The revolutionary nature of sustainability science is also related to the fact that it is a bottom-up science. It moves from case to theory, rather than the opposite. Therefore, it is not surprising that the geographic footprint of such science is very much unlike that of natural sciences that have been historically concentrated in a few countries of the northern hemisphere. Brazil, China, South Africa and other developing nations produce a significant portion of the papers and citations in sustainability science (Kajikawa et al. 2007) in a pattern unlike that of any of the individual disciplines that it integrates. Currently, there is no accepted global theory of sustainability science. Moreover, due to the high degree of complexity that emerges as social, economic and environmental variables are analyzed together under a common

framework, theories and models vary immensely from one place to another. New metrics and indicators are needed and are emerging on a regular basis (Matthews & Boltz 2012).

Where does Botany fit in? It does so at both the disciplinary level and by providing grounds for interdisciplinary research. Traditional disciplines will continue to be necessary: we need good names for plant species, we need to understand structure and function of organisms, of communities, and of ecosystems. Brazil excels at disciplinary science and has an outstanding tradition in science and education in plant sciences, strictu sensu (Scarano 2007, 2008). However, we need to do a lot more in terms of lending our botanical knowledge to science that cross-fertilizes with social and economic disciplines. In Brazil, we need to exercise interdisciplinary dialogue, particularly in terms of providing the necessary environment for scientists of the future, when much more will be demanded from them in terms of moving from disciplinary specialists to transdisciplinary generalists with a specialized sense.

TOWARDS A GREENER DEVELOPMENT WITH THE SUPPORT OF INTERDISCIPLINARY SCIENCE

In recent years Brazil has led UN conventions through its power of diplomacy and discourse (e.g., Mittermeier et al. 2010). At Rio+20 Brazil has the unique opportunity to move from the negotiation table to real action to become the first green superpower in the world. The basic elements are in place: political and economic stability, growing institutional capacity, a strong private sector, world-class academia and abundant natural capital (see also Gaetani et al. 2011). Brazil will be well-positioned to insist upon accountability for environmental costs in international trade. In parallel, since the host country has the moral obligation to make the convention successful, our hope is that Brazilian government will build on existing examples and announce its commitment to funding and fiscal mechanisms for local green development. For instance, the Norwegian government has committed 1 billion dollars to the Amazon Fund created in 2008 at BNDES (Brazilian Development Bank). This fund aims to promote initiatives that halt deforestation in the Amazon and foster sustainable development. We call upon the Brazilian government to launch a Green Development Fund at Rio+20, one at least three times as large as the Amazon Fund that will resource initiatives throughout the country and build the basis for a sustainable Brazilian future for an infinitesimal fraction of the annual national income. We suggest that 20% of the fund should be committed to help neighboring countries in the continent and also African countries to follow on the same track. Environmental compensation funds from energy, presalt oil and mining activities should capitalize and sustain this annual funding. Developed nations might feel compelled to follow the example and bring in additional resources to the fund. The private sector could also contribute. Such funds could also move incentives to the emergence of a more interdisciplinary science. Obviously not all science should be solely dedicated to solving social/economic/environmental issues, but we need a lot more of it in Brazil, so as to provide the adequate atmosphere to allow for the appearance of a new scientist/professional who is capable of dealing with a larger number of variables by transiting between different fields of knowledge.

The challenges confronting our global environment and the needs of the world's human populations have never been greater; the future, quite literally, is at stake. Every person on Earth deserves a healthy environment and the fundamental benefits that nature provides. But our planet is experiencing an unprecedented drawdown of these resources, and it is only by protecting nature and its biodiversity that we can ensure a better life for everyone, everywhere. To address this ongoing crisis we must develop green economies, which enhance social capital and equity, and improve human well being. This economic path requires the integrity, resilience and productivity of natural ecosystems and their biodiversity. If societies recognize the importance of the values of nature to social development and mainstream those values in decision-making, then natural ecosystems will be protected more effectively than ever. Transforming economic development path from the traditional model to a greener one requires innovative policies, effective learning institutions, and seed resources to cover the transition costs. The feasibility of this process has been partly demonstrated scientifically, even for Brazil (Young 2011). Latin America and the Caribbean is the last region on the planet where natural capital is still in place and local capacity has grown fast in the recent years (Tavares 2011). There, Brazil is an economic and environmental powerhouse and can lead the region and emerge as a global leader in green economy design and implementation. Our hope is that this opportunity is seized with concrete and meaningful actions at Rio+20 that are commensurate with the magnitude

of the challenge we face in sustaining a robust and productive planet and economy for current and future generations.

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REFERENCES

Bettencourt LMA, Kaur J. 2011. Evolution and structure of sustainability science. Proceedings of the National Academy of Sciences 108:19540-19545.

Fearnside P. 2011. A Usina Hidrelétrica de Belo Monte em pauta. Política Ambiental 7:1-19.

Gaetani F, Kuhn E, Rosenberg R. 2011. Brazil and the green economy: a panorama. Política Ambiental 8:76-85.

Hoekstra AY, Chapagain AK. 2007. Water footprints of nations: Water use by people as a function of their consumption pattern. Water Resource Management 21:35-48.

Irigaray CTJH. 2011. The transition to a green economy in Brazilian law: perspectives and challenges. Política Ambiental 8:151-164.

Kajikawa Y. 2008. Research core and framework of sustainability science. Sustainability Science 3:215-239.

Lucena AFP, Szklo AS, Schaeffer R, Souza RR, Borba BSMC, Costa IVL, Pereira Jr AO, Cunha SHF. 2009. The vulnerability of renewable energy to climate change in Brazil. Energy Policy 37:879-889.

Lustosa MCJ. 2011. Innovation and technology for a green economy: key issues. Política Ambiental 8:108-119.

Matthews JH, Boltz F. 2012. The shifting boundaries of sustainability science: are we doomed yet? Public Library of Science Biology 10:e1001344. [doi:10.1371/journal.pbio.1001344]

MEA – Millennium Ecosystem Assessment. 2005. Ecosystems and human well-being: synthesis. Island Press, Washington, DC,

Mittermeier R, Baião PC, Barrera L, Buppert T, Mccullough J, Langrand O, Larsen FW, Scarano FR. 2010. O protagonismo do Brasil no histórico acordo global de proteção à biodiversidade. Natureza & Conservação 8:197-200.

Nepstad D, Soares Filho BS, Merry F, Lima A, Moutinho P, Carter J, Bowman M, Cattaneo A, Rodrigues H, Schwartzman S, McGrath DG, Stickler CM, Lubowski R, Piris-Cabezas P, Rivero S, Alencar A, Almeida O, Stella O. 2009. The end of deforestation in the Brazilian Amazon. Science 326:1350-1351.

Romeiro A. 2011. Agriculture for a green economy. Política Ambiental 8:120-126.

Santana CAM, Torres DAP, Guiducci CN, Alves MAS, Garagorry FL, Silva e Souza G, Assad ED, Pellegrino GQ, Barioni LG, Souza MO, Chaib Filho H, Marra R, Mota MM. 2011. Regional case study: R5, Productive capacity of Brazilian agriculture: a long-term perspective. *In* Foresight project on global food and farming futures (The Government Office for Science, ed.). Foresight – Government Office for Science, London. (http://www.bis.gov.uk/Foresight).

Sawyer D. 2011. Green economy and/or sustainable development? Política Ambiental 8:36-42.

Scarano FR. 2007. Perspectives on biodiversity science in Brazil. Scientia Agricola 64:439-447.

Scarano FR. 2008. A expansão e as perspectivas da pós-graduação em Ecologia no Brasil. Revista Brasileira de Pós-Graduação 5:89-102.

Scarano FR, Guimarães AL, Silva JMC. 2012. Lead by example. Nature 486:25-26.

Serageldin I, Grootaert C. 1998. Defining social capital: an integrating view. *In* Evaluation and development: the institutional dimension (R Picciotto, E Wiesner, eds.). The World Bank, New Brunswick, p.203-217.

Tavares M. 2011. Green economy in Latin America: the origins of debate in ECLAC work. Política Ambiental 8:57-68.

UNEP – United Nations Environment Programme. 2011. Towards a green economy: pathways to sustainable development and poverty eradication. (htpp://[www.unep.org/greeneconomy (accessed 2012 May 25)

Young CEF. 2011. Growth potential of the green economy in Brazil. Política Ambiental 8:86-95.