

## COMMENT

**Interdisciplinary research as a strategy for environmental science and management in Brazilian Amazonia: potential and limitations**THEMATIC ISSUE  
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Interdisciplinary research has wide applicability to the environment and its management, and few areas can rival Brazilian Amazonia in terms of interdisciplinary challenges. Interdisciplinary research refers to studies that not only include more than one of the traditional academic disciplines but also draw conclusions that emerge from including information and methods from the different disciplines together (see reviews by Bammer 2005; Tress *et al.* 2005a). Brazil's Ministry of Science and Technology currently makes interdisciplinary research an explicit priority, and to this end directs financing to large networks of researchers working in different institutions and fields. An impressive number of programmes support and carry out interdisciplinary research in the region, with varying success. This comment suggests shifts in funding priorities needed to maximize further advances.

With a forest the size of Western Europe, in addition to a variety of savannahs and other habitats, Brazilian Amazonia has a range of vegetation types, biological interactions and geochemical processes with global significance for both biodiversity and climate. The combination of rapidly advancing deforestation and a large area of forest that is still standing gives particular urgency to understanding the biological and social processes in this region, and to applying this understanding to public policy. Deforestation and degradation through activities such as logging are the major processes from which biological, climatic and other consequences ensue. These land-use transformations cannot be predicted or controlled unless they are understood, thereby requiring knowledge of social processes. Interdisciplinary research has an important role in this, but it also has limits.

Because both the causes of and the solutions to environmental problems usually involve human action, the disciplines included in interdisciplinary research often bridge the divide between social and natural sciences (see reviews by: Wright 1987; Ewel 2001; Kinzig 2001; Tress *et al.* 2001, 2005b). This divide is part of what C. P. Snow (1959) famously denominated as the 'two cultures', and the differences are clearly greater than would be the case between more closely related fields. Insights from both sides of this divide are needed both to understand environmental problems themselves and to induce the social changes needed to solve them (Gundersen & Holling 2002). Even within the field of ecology itself, it is the interaction between different approaches that is most needed to advance the field (Holling 1998).

Supporting the Amazonian population should be the first priority for science and technology in the Amazon. This priority needs to be explicit because of the tradition that Sioli (1980) termed 'endocolonialism', or the treatment of Amazonia as a colony whose resources are to be exploited for the benefit of distant centres of power, such as Rio de Janeiro and São Paulo, much in the way that European powers exploited their colonies throughout the tropics in past centuries. Predominant land uses in Amazonia, such as extensive cattle pasture, are notoriously unsustainable (Fearnside 2005). Redirecting development to sustainable alternatives will require a wide range of kinds of scientific research, which necessarily require different approaches according to the nature of each issue. This diversity of research approaches suggests the need for diversified research support.

In 2001, Brazil's Ministry of Science and Technology undertook an extensive effort to rethink its priorities for research support. The result was a book known as the *Livro Verde*, or 'Green Book' (da Silva & de Melo 2001). This has been followed by a *Livro Branco* (White Book) and a *Livro Amarelo* (Yellow Book) (da Silva *et al.* 2002; de Carvalho Filho 2005). These will soon be joined by a *Livro Azul* (Blue Book). However, the science presented in these books focuses on the use of high-tech equipment by large teams of scientists, often shown in the accompanying photographs wearing their trademark white coats.

The approach embodied in the series of 'colour' books has produced surprising results in various emblematic projects all over the world, such as in genome sequencing and in the Manhattan and Apollo projects. Nevertheless, a number of problems in the Amazon are quite different from those that are the focus of the colour books. An equipment-intensive approach is not suitable for studies that require researchers to live with *caboclos* (traditional Amazonian inhabitants) in rough conditions deep in the forest, or to observe different species in their natural habitats.

In the case of the Amazon, the diversity of problems and the incipient research in many areas indicate a need to stimulate the generation of new ideas. The choice of problems to be studied is always the most important step in science, even more important than technology. After ideas are created and initially evaluated, large networks may be established (both of institutions and of individual researchers). A good system to support science and technology in the Amazon should not only stop excluding small projects, but should also set aside a reasonable part of the budget for them. Small projects are

**Table 1** Examples of projects and programmes promoting interdisciplinary research in Brazilian Amazonia. <sup>1</sup>Abbreviations: CNPq = National Council for Scientific and Technological Development (Brazil); DI = Darwin Initiative (UK); EU = European Union; G7 = Germany, United Kingdom, USA, France, Japan, Italy and Canada (in order of contribution to the PPG7; only the first five contributed; the programme's 'Directed Research Projects' were funded by the USA); GBMF = Gordon and Betty Moore Foundation (private); IRD = Institute of Research for Development (France); MCT = Ministry of Science and Technology (Brazil); NASA = National Aeronautics and Space Administration (USA); SI = Smithsonian Institution (USA); UEA = University of East Anglia (UK). <sup>2</sup>LBA was 'nationalized' in 2007, meaning it now has only Brazilian funding.

<i>Years</i>	<i>Abbreviation</i>	<i>Project or programme name</i>	<i>Major funder<sup>1</sup></i>	<i>Website</i>
1978–	AGROECO	Human Carrying Capacity, Environmental Impacts of Deforestation and Sustainability of Development	CNPq	<a href="http://agroeco.inpa.gov.br/">http://agroeco.inpa.gov.br/</a>
1979–	BDFFP	Biological Dynamics of Forest Fragments Project	SI	<a href="http://pdbff.inpa.gov.br/">http://pdbff.inpa.gov.br/</a>
1993–2008	PPG7	G7 Pilot Programme to Conserve the Brazilian Rain Forest	G7	<a href="http://www.mma.gov.br/ppg7/">http://www.mma.gov.br/ppg7/</a> <a href="http://www.redegoverno.gov.br/defaultCab.asp?idservinfo=5480&amp;url=http://www.mct.gov.br/index.php/content/view/43656.html">http://www.redegoverno.gov.br/defaultCab.asp?idservinfo=5480&amp;url=http://www.mct.gov.br/index.php/content/view/43656.html</a>
1996–	TFR	Tropical Forest Research	DI, UEA	<a href="http://www.tropicalforestresearch.org/Default.aspx">http://www.tropicalforestresearch.org/Default.aspx</a>
1997–2002	PRONEX	Programme of Support to Nuclei of Excellence	MCT	<a href="http://www.mct.gov.br/">http://www.mct.gov.br/</a>
1998–	LBA	Large-Scale Biosphere-Atmosphere Experiment in Amazonia	NASA, EU, MCT <sup>2</sup>	<a href="http://lba.inpa.gov.br/lba">http://lba.inpa.gov.br/lba</a>
2002–	GEOMA	Thematic Network for Research in Environmental Modelling in Amazonia	MCT	<a href="http://www.geoma.lncc.br/">http://www.geoma.lncc.br/</a>
2002–2008	Institutos do Milênio	Institutes of the Millennium	CNPq	<a href="http://www.cnpq.br/">http://www.cnpq.br/</a>
2003–2007	Amazon Scenarios	Amazon Scenarios	GBMF	<a href="http://www.whrc.org/southamerica/amaz_scen.htm">http://www.whrc.org/southamerica/amaz_scen.htm</a>
2004 –	PPBio	Programme for Research in Biodiversity	MCT	<a href="http://www.ppbio.inpa.gov.br/">http://www.ppbio.inpa.gov.br/</a> <a href="http://www.museu-goeldi.br/biodiversidade/index.asp">www.museu-goeldi.br/biodiversidade/index.asp</a> <a href="http://www.mct.gov.br/index.php/content/view/7913.html">http://www.mct.gov.br/index.php/content/view/7913.html</a>
2007 –	AMAZ	Biodiversity and Ecosystem Services of Amazonian Landscapes: Socio-Economic Determinants and Scenario Simulations	IRD	<a href="http://www.brasil.ird.fr/spip.php?page=article_programmes_regionaux&amp;id_article=3822&amp;id_rubrique=422&amp;id_secteur=82">http://www.brasil.ird.fr/spip.php?page=article_programmes_regionaux&amp;id_article=3822&amp;id_rubrique=422&amp;id_secteur=82</a>
2009 –	Projeto Cenários	Scenarios Project for Amazonia [Integrated Programme of Science, Technology and Innovation for the Conservation and Sustainable Development of the Amazon Region]	MCT	<a href="http://www.mct.gov.br/index.php/content/view/68113.html">http://www.mct.gov.br/index.php/content/view/68113.html</a>
2009–	INCT	National Institutes of Science and Technology	CNPq	<a href="http://www.cnpq.br/programas/inct/_apresentacao/index.html">http://www.cnpq.br/programas/inct/_apresentacao/index.html</a>

essential both for the process of innovation and to allow the prolonged individual contact needed to achieve an in-depth understanding of social processes at the level of individual actors.

Many calls for proposals from funding agencies such as Brazil's National Council for Scientific and Technological Development (CNPq) demand that proposed projects demonstrate interdisciplinarity. This is usually done by including participants from different academic disciplines.

In theory, a project that brings together all the institutions, specialties and researchers in the Amazon would obtain the highest score in any competition, even though, in practice, such a project would produce almost nothing. Putting people from different disciplines together in the same project does not guarantee that the resulting research will be interdisciplinary. Interdisciplinary research is done by interdisciplinary individuals, not by groups of specialists from different disciplines if they lack the abilities and

attitudes needed to bridge the differences between different fields.

Projects and programmes in Brazilian Amazonia that are intended to promote interdisciplinary research already exist (Table 1); the list here is not intended to be exhaustive. These initiatives have had varied results, but collectively represent an impressive amount and scope of research. Programmes such as the Institutes of the Millennium, the Directed Research Projects (PPDs) of the Pilot Program to Conserve the Brazilian Rain Forest (PPG7), and the National Institutes of Science and Technology (INCT) all established large 'networks' with the explicit purpose of promoting interdisciplinary research. I have participated in all three of these, including responsibility for proposing and leading networks (*redes*) in the last two.

The Biological Dynamics of Forest Fragments Project (BDFFP) has produced 547 publications, plus 143 masters and PhD theses, while the Large-Scale Biosphere-Atmosphere Experiment in Amazonia (LBA) has produced over 1400 publications, plus 549 masters and PhD theses. LBA has involved over 2000 scientists from 281 institutions in 158 projects (see websites in Table 1). There are many examples of interdisciplinary research among these. Both BDFFP and LBA have included studies of social processes leading to deforestation. In 2001, a paper produced by researchers at the National Institute for Research in the Amazon (INPA) involved in both projects (including myself) simulated the impact on deforestation that would be caused by the Brazilian government's plans for infrastructure projects in Amazonia (Laurance *et al.* 2001). This so enraged the Minister of Science and Technology that both BDFFP and LBA were, for several years, effectively prohibited from studying social issues (see Fearnside 2009). This was an unfortunate blow to the most critical nexus for interdisciplinary research. Interdisciplinary research is often designed to tackle tough, real-world problems but such work is not necessarily always well received. Fortunately, the climate for such research in Brazilian Amazonia has improved markedly in more recent years.

It is virtually platitudinous that intellectual work has become progressively more specialized. A 'renaissance man' who is interested in everything, such as Leonardo da Vinci, is seen as an impossibility today because the accumulation of knowledge over the intervening centuries supposedly implies that greater effort is needed to reach the forefront of any given field. The '19th century naturalists', such as Darwin, Wallace and Bates, are seen as anachronisms. Imagine Darwin trying to apply for a research grant today: a geologist by training setting out to observe forms of life from barnacles to humans in order to infer a mechanism for biological evolution (for example Loehl 1990).

However, the essence of scientific creativity and discovery remains the same today as it was centuries ago. New ideas, including major leaps in understanding (paradigm shifts), are generated by individuals who interpret information from different sources and fields, usually including both information gathered first hand and that gathered by others. The ideas come first and massive investments in data collection

come later. Interdisciplinary research is essential for the first step in this process, and this is precisely the step that receives the least support. Mounting large groups of researchers to collect data in the second phase should not be confused with the creative aspect of interdisciplinary research, which is concentrated in the first phase.

## Conclusions

Interdisciplinary research is intimately linked to environmental conservation and management because these problems, by nature, span various fields, often including the divide between natural and social sciences. Governmental efforts in Brazil to fund interdisciplinary research have had varied results. Focus on large-scale networks and high technology overshadows the creative process. Individuals vary greatly in their receptivity to engaging in interdisciplinary research and in the skills, attitudes and sensibilities needed to make it work. The environmental challenges in Brazilian Amazonia require interdisciplinary research in many ways.

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