

## Approaches and Responses to Climate Change: Challenges for the Pantanal and the Upper Paraguay River Basin

*Antonio Augusto Rosotto Ioris<sup>1</sup>*

**ABSTRACT:** Anthropogenic climate change is expected to have serious socioecological consequences around the globe, in particular for wetland areas. That is the case of the Pantanal, a large tropical wetland located in the Upper Paraguay River Basin (UPRB), in the centre of South America, where a range of responses are being devised to cope with the negative impacts of climate change. After a review of the most common approaches discussed in the literature, the results of an empirical study conducted in Brazil, Bolivia and Paraguay are presented. The research attested that most responses have so far evolved around the principles of systematic adaptation (e.g. technology amelioration) and climate scepticism (e.g. postponement of responses) and, more recently, under the influence of marketisation measures (e.g. carbon trading). However, there is also growing enthusiasm, particularly in Bolivia, for the inclusion of initiatives associated with the architecture of entitlements (e.g. improved access to resources) and climate justice (e.g. compensation for the negative impacts of conventional development). Two important factors that seem to undermine the efficacy of the responses to climate change in the region: the hegemonic influence of the agribusiness sector and the relatively low importance of the UPRB for national and trilateral environmental policy-making.

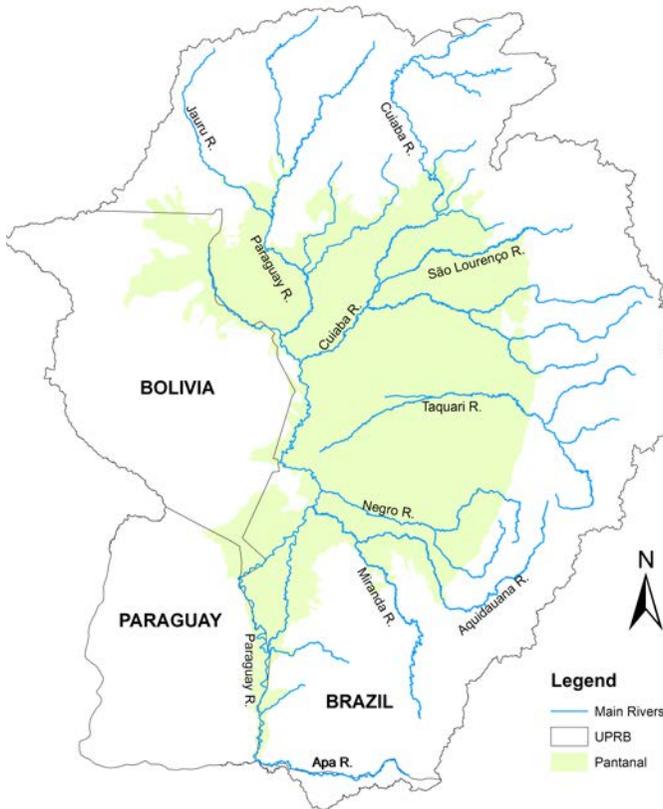
---

1 Antonio A.R. Ioris is a human geography lecturer at the University of Edinburgh. He can be reached at a.ioris@ed.ac.uk. This research was supported by the Brazilian Research Council (CNPq) through the Sinergia Project coordinated by the Pantanal Research Centre (CPP); Ioris was directly responsible for its sub-project 3.1 'Politico-Institutional Vulnerabilities to Climate Change'. The author wishes to thank Dr. Carlos Padovani (Embrapa-Pantanal) for allowing the reproduction of the river basin image (Figure 1), three anonymous referees for their helpful comments on a previous version of this paper, Ms. Isabel Kirsten for her dedicated assistance during the research project, Prof. Pierre Girard (CPP and UFMT, Cuiabá) for the opportunity to take part in the Sinergia Project and, in particular, the many stakeholders in Brazil, Bolivia and Paraguay who kindly agreed to take part in the interviews.

Anthropogenic climate change represents one of the most challenging, complex and contested problems faced by the international community today. The contemporary concerns about human made climate change also offer a unique entry point into the preparedness of public and private responses to global environmental problems. For instance, the multilateral negotiations on the United Nations Framework Convention on Climate Change (UNFCCC) reflect the failures of technical assessments, the intricacy of international relations and the shortcomings of conventional environmental management. Particularly the embeddedness of the carbon economy in contemporary society means that the climate change controversy is at once a problem of environment, economy and human rights (Haines & Reichman, 2008).

The global interlinkages of the climate mean that no region in the planet is likely to be spared of the consequences of anthropogenic global warming, even areas that are located relatively distant from the main economic and industrial centres, such as the South American Pantanal. The Pantanal is a large floodplain wetland in the centre of the Upper Paraguay River Basin (UPRB), which has a total area of around 360,000 km<sup>2</sup> (see Figure 1). The Pantanal spreads for about 140,000 km<sup>2</sup> is shared between Brazil (80 percent of the Pantanal area), Bolivia (19 percent) and Paraguay (1 percent). The rainy season in the region begins between September and December, increases between January and March, and then promotes a flood wave movement from the north through the south Pantanal that inundates as much as 70 percent of the floodplain until July (Hamilton *et al.*, 2002). Significant portions of the Pantanal floodplain are submerged from four to eight months each year by water depths from a few centimetres to more than two meters (PCBAP, 1997). The Pantanal functions as a large reservoir that stores water from the surrounding plateaus during the rainy season and then delivers it slowly to the lower sections of the Paraguay River. As a result, any significant change in the rainfall pattern is likely to have major impacts on the local ecology and socioeconomic relations.

**Figure 1 - The Upper Paraguay River Basin (UPRB) and the location of the Pantanal wetland**



At the 8th INTECOL (International Wetlands Conference), which was held in the Pantanal region in July 2008 – more exactly, in the city of Cuiabá – it became clear that, although wetlands (including marshes, peat bogs, swamps, river deltas, mangroves, tundra, lagoons and river floodplains) only cover a relatively small percentage of the planet's surface, they actually contain a large proportion of the world's carbon stored in terrestrial soil reservoirs (Kayranli *et al.*, 2010). That means a major contribution regarding the balance of greenhouse gases (GHGs) in the atmosphere and underscores the importance of wetland conser-

vation. Beyond carbon storage, wetlands provide a range of environmental services, including water filtration and storage, erosion control, buffer against flooding, nutrient recycling, biodiversity maintenance, and nursery for fisheries. In the same event, the Pantanal has been recognised as one of the most important tropical wetlands in the world and it had been officially designated a Biosphere Reserve by UNESCO in 2000. The local ecosystems comprise a complex biodiversity mosaic with influences from the Amazon, Cerrado and Chaco biomes (PCBAP, 1997). Nonetheless, the Pantanal is also one of the most threatened socio-ecological systems in the planet, especially due to pollution, loss of biodiversity, high sedimentation, modification of natural cycles, large-scale projects, the lack of conservation units and the impacts of anthropogenic climate change (Swarts, 2000). The tension between available resources and economic growth has resulted in recurrent calls for ecological protection and the conservation of ecological systems (Ioris, 2004), but there are major disagreements about the most adequate environmental management and regional development policies (Neves, 2009).

The majority of the economic pressures and development conflicts have occurred in the Brazilian section of the Pantanal region, where the ecosystems have been impacted by uncontrolled urban and agro-industrial expansion in the surrounding plateaus, as well as to the intensification of agriculture production, tourism and recreation activities, and the use of agrochemicals within the floodplain itself (Alho *et al.*, 1988). Native vegetation has been increasingly removed to make space for artificial pastures, which occurred together with other problems such as illegal hunting, unsustainable tourism and the use of fire as an (unlawful) land management technique. Due to the introduction of exotic pastures, the Pantanal floodplain has lost already 17 percent of its original vegetation (Harris *et al.*, 2005) and between 2002 and 2008 the rate of deforestation (713 km<sup>2</sup>/year) was proportionally higher than in the Amazon region (statistics from Deter/INPE, published by Brasil, 2010). In addition, around 115 new hydropower schemes are under construction or being planned in the Brazilian side of the UPRB, though the local and the cumulative impacts of such structures are still not properly understood. However, there are some preliminary evidences of serious disruption caused by the operation of hydropower dams (Zeilhofer & Moura, 2009). All those pressures lead Junk & Cunha (2005, p. 392) to declare the Pantanal at a crossroads, in the sense that “increasing economic and political pressure requires fundamental decisions to be made in the near future.”

The above challenges have been magnified by the likelihood of disturbances in the regional climate due to global warming. The scientific community has actually identified a series of potential consequences that are going to follow climate change in South America, which includes the salinisation and desertification of agriculture land, the savanisation of forested areas and a reduced availability of water (IPCC, 2007). Marengo *et al.* (2010) produced future scenarios of climatic change with the use of three regional climate models (HadRM3P, Eta CCS and RegCM3) and indicate a trend of reduction in precipitation (according to one model) and high probability of increase in temperature through the whole year (according to the three models) in the central region of Brazil. Marengo *et al.* (2012) have also estimated likely changes to the La Plata River Basin (which contains the UPRB) between 2011-2040 and an increase of 1.8oC in the annual temperature (1.2oC in the summer and 1.8oC in the winter) and a reduction in annual rainfall of 2.1 percent (-0.7 percent in the summer and -11.9 percent in the winter, which is the dry season). However, these results seem to contradict the tendency of higher flows in the Paraguay basin since the 1970s (Collischonn *et al.*, 2001), and the expected increase in soil erosion in some areas of the Pantanal due to rainfall changes (Querner *et al.*, 2005).

More important than the disagreement among hydrologists and climatologists about the course of environmental impacts, climate change is expected to aggravate existing shortcomings in the access, use and conservation of natural resources, as well as to further challenge the already hesitant environmental policies and regulatory enforcement in the three countries. To understand these even more perverse consequences of climate change, it is important to briefly revisit recent economic development and the evolving relations of production in the region (Barkin, 2009). The conversion of the uplands into large plantation farms in the Brazilian section of the UPRB commenced in the 1960s with the expansion of the agriculture frontier, which was fuelled by heavy subsidies and federal government investments in technology and infrastructure (railways, roads and grain storage capacity). Government agencies were responsible for providing credit, conducting agronomic research and disseminating technologies through rural extension. Large landowners were the main beneficiaries of economic development, at the expense of the demands of low-income, disenfranchised social groups (Ioris, 2012). Such an expansionist process continued in the following decades, but since the neoliberal reforms of the Brazilian State in the 1990s it observed a more market-oriented approach and the consolidation of the agribusi-

ness sector in the plateaus that surround the Pantanal. The growth of agribusiness has reinforced a dualistic model of development that favours plantation farmers and modern cattle ranchers and discriminates against the majority of the rural and urban population (Rossetto, 2004). The adoption of capital intensive agriculture in recent years never affected the overarching pattern of inequality, but has merely led to the fragmentation of the old farms and the reconcentration of land in the hands of newcomers (Araújo, 2006).

What is important for the purpose of this paper is that, without fundamental reforms in the structure of production and without more inclusive public policies, there is a serious risk that the impending consequences of climate change will unevenly affect different social groups, both aggravating the hardship already experienced by low-income sectors and siphoning the results of adaptation and mitigation measures to those who benefit more from current economic trends. In order to go beyond narrow development and conservation debates, it is necessary to account for a range of highly politicised issues at the intersection between interpersonal relations and socioeconomic pressures (Ioris, 2013). Whenever the responses to climate change are formulated according to the demands of agribusiness and other hegemonic sectors, these may help to mitigate climate change at the regional scale, but are also expected to produce socioeconomic distortions and result in additional socioecological risks. For instance, deprived communities are more likely to live in unsafe areas along the river courses, have more difficulty to adapt to a changing environment and fewer opportunities to influence governmental decisions (even when formal channels of consultation and participation exist, such as catchment committees and park advisory councils). Despite the obvious complexity of climate change issues, so far most of the public debate in the region has remained too focused on the physical consequences of climatic alterations and has dedicated less attention to the underlying social inequalities that magnify negative impacts and prevent the formulation of fair mitigation measures. Official publications in particular tend to concentrate on legal, administrative and technological issues, but fail to acknowledge the profound, politicised interconnections between development pressures and socio-natural relations (e.g. in Paraguay by the Secretariat of the Environment [SEAM], n/d, and in Brazil by the Strategic Issues Nucleus [NAE], 2005).

Ostrom (2012) observes that the conventional explanation of the sources of climate change is largely confined to the uncontrolled outcomes of economic development, lack of scientific information and

an inadequate environmental regulation, but without sufficiently addressing the also important socio-political and institutional issues. Following her advice, this paper aims to review, from a critical social sciences perspective, the pillars of main responses to climate change and the concrete experience in the UPRB. The next pages will contend that most of the current approaches have combined, not always in a coherent fashion, different elements of the international policy framework. The different responses identified through the research reflect contrasting rationalities of environmental conservation, social inclusion and the mitigation of climatic risks. Our discussion is based on research carried out in 2010-2012, which included 45 interviews with government officials (8 interviews), civil society representatives (12), academics (10) and business sectors (15), as well as the analysis of policies and documentation and the attendance of public events, meetings and workshops. Interviews were transcribed, coded and analysed in Portuguese and Spanish and only the extracts reproduced in this paper were translated into English. Before examining the achievements and weaknesses of the various responses to climate change – to be honest, still in an embryonic stage of development in the UPRB – a review of ideal-type approaches or paradigms within contemporary climate debates will be first introduced.

## **APPROACHES AND RESPONSES TO CLIMATE CHANGE**

Because of the number of sectors and issues involved, the policy arrangements developed for dealing with climate change in any country are prone to be complex and multifaceted. Normally, the approaches of governments and civil society organisations combine a range of interpretations of climate change scenarios, which are influenced by the specific socio-political and ecological circumstances. Therefore, a clear appreciation of interactions, uncertainty and contested knowledge, as well as the interdependency among diverse and unequal interests, is required (Fish *et al.*, 2010). Policy responses are not restricted to the economic and legal domains, but represent adjustments in a range of social institutions. Institutions are here understood as legislation, norms, cognitive frames and meaning systems that guide human action and structure social interactions (Hall & Soskice, 1996). In sociological terms, institutions are “the formative products of an amalgamation of factors, just as they themselves can and do influence such factors” (Thynne, 2008, p. 239). Institutional responses must be seen as norms that shape action, frame identities, affect the realisation of problems and influence decisions

and solutions. Such responses are not purely rational or technical, but include a range of actions that are culturally determined and constantly renegotiated between groups of interest.

In the context of the climate change debate, O’Riordan & Jordan (1999) describe institutions as the multitude of means for holding society together. The rationale behind the different reactions to the threats of climate change are both informed by the institutional arrangements and materialised through modifications in social institutions. Therefore, institutional responses go beyond the simple dichotomy between ‘adaptation’ and ‘mitigation’, but it is necessary to consider the wider variety of interpretations and reactions to climate change (Füssel & Klein, 2006). The first approach to be mentioned is the scepticism about the origins and possible consequences of climatic change as discussed under the UNFCCC. On the one hand, the Intergovernmental Panel on Climate Change [IPCC] and other international organisations have presented compelling data, within the margin of errors of the established scientific methods that indicate the existence of anthropogenic causes behind contemporary climate change. For instance, hydrological changes seem unequivocal, as well as the reduction in glaciers and in the rate of snow cover due to human-made global warming (as included in the IPCC’s Fifth Assessment Report published in 2013). On the other hand, despite of such mounting scientific evidence and concerted international efforts, there is still significant scepticism, particularly among radical right-wing political groups, about the actual causes of climatic change.

Climate scepticism refers to a sense of climate ‘denialism’ or ‘contrarianism’ that has recently been very much in the media spotlight, especially because of the unauthorised publication, November 2009, of emails exchanged between scientists that exposed their doubts climate change evidence (Nerlich, 2010). Sceptics argue that it is not possible to demonstrate, beyond doubt, that the progressive warming of the planet does not have natural causes (Poortinga *et al.*, 2011). In practice, climate scepticism has been a convenient and prominent institutional response to the climate change demands. This argument has been particularly useful for lobbyists representing the interests of those sectors that are directly responsible for large emissions of GHGs (e.g. oil industry, timber producers, energy generation, etc.), particularly after the 2008 global financial crisis that has put extra pressure on tight national budgets. It is important to realise that, although the number of sceptical scientists and opinion-makers is small, their presence in the international discussion gives a misleading impression that the debate is evenly split between

those that believe and those that dispute the anthropogenic causes of climatic change. The perverse result is that climate sceptics have had a growing influence on governments unwilling to spend resources and political capital on the adjustments required to cope with climate change.

The second approach discussed here includes measures associated with market or market-like transactions. In order to achieve the stabilisation of GHG concentrations, economists have recommended the allocation of appropriate emission reduction responsibilities among nations or administrative units that should be implemented through market-based mechanisms (Jepma & Munasinghe, 1998). Such an approach is based on the claims that a global optimisation of GHG emissions can only secure techno-economic efficiency through market or market-like transactions (Bührs, 2010). In theory, the abatement of emissions must be pursued up to the level where the margin benefit of reducing emissions of GHGs by one additional unit is equal to the marginal cost of curbing such emissions (Davoudpour & Ahadi, 2006). This sort of institutional response – that constitutes a main inspiration for public policies and is indeed the main driver of the climate change diplomacy nowadays – is directly influenced by the application of the neoclassical economic theory to the study of environmental degradation (Ioris, 2010). According to environmental economists, monetary valuation can guide the choice among numerous potential methods of improving the quantity and the reliability of environmental management. For instance, global wetlands are redefined as providers of ecosystem services, which can be quantified in monetary terms at as much as US\$ 20,000 per hectare (Keddy *et al.*, 2009).

However, it must also be observed that the reduction of wider socio-economic and environmental processes to a set of independent utility functions has become an important source of criticism levied against environmental economists. Anthoff & Tol (2010) specifically argue that the standard calculation of the costs of emissions and impacts is inadequate, because it presumes a global welfare function that ignores the differences between poor and rich countries. These authors recommend that the national government should value impacts in other regions of the world when computing a social cost of carbon that could be used in domestic cost benefit analysis. This sort of methodological adjustment, nonetheless, still fails to remove the reductionist basis of environmental economics. Methodologies adopted by environmental economists tend to restrict the reaction to climate change to the narrow determination of economic costs, benefits and effects. Economic-centred measures fall short of addressing the mounting conflicts and negative impacts associated with the emission of GHGs, as

well as the recognition of differential responsibilities. Bromley (1991) submits that, instead of focusing on the economic use of resources only, the solution to environmental problems requires first of all the determination of collective standards of performance that can reward individual initiative, experimentation and efficiency, as discussed next.

Another common response – third in our list – that has attracted great attention is systematic adaptation based on ‘experimentation’, that is, through a constant reassessment of initiatives and results (Arvai *et al.*, 2006). Systematic adaptation, at the regional and global scales, is posited as an interactive process that aims to transform social relations by creating new knowledge, networks and partnership among interdependent actors. It is described as essentially a form of learning-by-doing, a mechanism by which responses are negotiated, implemented and jointly evaluated by those involved. The process is often initiated as a result of several factors, such as a perceived environmental threat or crisis (e.g. climate change), a new regulatory demand or the availability of financial incentives. At this point, stakeholders begin to appreciate their interdependence, the need to act together and the importance of redesigning social institutions (Gupta *et al.*, 2010). Subsequently, the participating organisations focus on desirable future conditions as well as the underlying values, beliefs and principles that will guide them towards their joint ambitions and aspirations. This tends to be followed by a structuring phase in which specific goals and objectives are established, programmes of activities are designed, and roles and responsibilities are assigned to the various participating organisations and groups (Glaas *et al.*, 2010).

Systematic adaptation (or adaptive management) is essentially part of the broader agenda of environmental governance that permeates contemporary policy-making (Mitchell & Breen, 2007). Governance represents a means of describing and analysing new regulatory arrangements and institutional configurations whereby roles and responsibilities for governing are shared among state-based entities and actors operating beyond the boundaries of formal government. Governance, instead of conventional government, is described as the pursuit of more flexible strategies and mechanisms of public administration to accomplish policy goals, realise values and manage environmental risks and impacts (Howlett and Rayner, 2006). It includes different ‘modes of governance’ aiming at raising awareness, influencing personal and group behaviour and involving social actors in decision-making (Treib *et al.*, 2007). Conventional distinctions and boundaries that previously defined state-market-civil society relations have become blurred as different combi-

nations of actors have become engaged in the pursue of environmental governance and, ultimately, adaptive management (Dengler, 2007; Engle and Lemos, 2010). Huitema *et al.* (2009) even recommend that the theory of adaptive management can be even reconceptualised as ‘adaptive co-management’, which is based on collaboration in a polycentric governance system. Notwithstanding the appealing discourse, the argument of adaptive management (and the related endorsement of environmental governance type of solutions) has the serious weakness of diluting the accountability for the causes of climatic change and the uneven distribution of impacts. For instance, government initiatives in the UK have stimulated a further set of actions at other scales in public agencies, regulatory agencies and regional government (and the devolved administrations), though with little real evidence of climate change adaptation initiatives trickling down to local government level (Tompkins *et al.*, 2010). That has seriously undermined the ability of systematic adaptation to face the challenging and contested nature of climate change challenges, which gives room for the next two institutional responses.

The fourth main paradigm to be analysed is the architecture of entitlements. Most of the responses formulated today by governments and multilateral organisations have tried to overcome climate change scepticism, but have been largely trapped in the narrow debate between, on the one side, a management discourse based on a technocratic worldview and neo-Malthusian prejudices against poor populations, and, on the other side, a populist argument portraying local actors as the victims of external interventions (who should be somehow incorporated into the formulation of mitigation approaches) but without much consideration of the historical inequalities in the access to resources (Adger *et al.*, 2001). Therefore, Adger & Kelly (1999) suggest that responses to climate change should follow the lens of entitlements, an approach based on the argument that deprived conditions, such as famine, are caused by the lack of access to food rather than a lack of food availability (Sen, 1981). The line of reasoning is that the extent to which groups and communities are entitled to use resources determines their ability to cope with and adapt to climatic stress. Consequently, the focus should shift towards the determination of entitlements and obligations among the parties involved in the use and conservation of natural resources.

This fourth approach brings attention to how entitlements are defined and contested, and also the wider political and socioeconomic aspects of environmental management. “The factors which deter-

mine levels of social vulnerability define how the pattern of access to resources is constructed; this construction can be termed the 'architecture of entitlements'" (Adger and Kelly, 1999, p. 256). Instead of the exogenous preferences and costless social contracting claimed by neo-classical environmental economists, the institutional structure of entitlements (i.e. property or liabilities) directly influences the nature of the bargaining process between two or more parties. In spite of the more comprehensive understanding of the climate change dilemmas, the formulation of responses based on the theory of entitlements seems still to miss the deeper connections between local exchanges and globalised scales of interaction. Devereux (2001) directly condemns the architecture of entitlements approach for its methodological individualism and its privileging of economic aspects above socio-political determinants. Without recognising such associations between local and global politics, there is the risk of atomistic and technocratic solutions that normally end up falling under the hegemonic influence of environmental economics and environmental governance.

Finally, this schematic review needs to include a fifth institutional response to the threats of climate change that is more closely associated with grassroots activists and the campaigners of environmental justice. The emerging climate justice movement focuses on the politicised interactions between climate change threats and the erosion of social and economic rights. Haines & Reichman (2008) argue that fair approaches to climate change require understanding the strengths and limitations of conventional environmental policy-making. For those authors it is necessary to tease apart the intricacies of international law and governance to find ways to turn economic, legal, and cultural norms toward creating climate justice. The basic claim is that the creation and funding of international institutions for adaptation or mitigation to climate change inescapably involve questions of justice (Harris and Symons, 2010). Because of the perceived discrimination and injustices that are maintained or aggravated by the responses to climate change, the global movement on climate justice has criticised the ineffectiveness of top-down responses, as well as the new spaces for capital accumulation created by the expansion of 'green capitalism', that is, the accumulation of capital that benefits from the environmental crisis itself (Dawson, 2010).

The fairness element of the fifth area of institutional response implies that climate change should be related, in a transformative way, with the problems of poverty and marginalisation in the South and over-consumption and fuel dependence in the North. According to such line

of argument, the lack of effective responses to the risks posed by climate change grew almost inevitably from global inequalities, which has perpetuated highly inconsistent ways of thinking and dealing with shared risks (Parks and Roberts, 2010). Consequently, it is contended by climate justice authors that the reaction to anthropogenic global warming should target human welfare rather than provide compensation to states (seen as the primary responsible for unchecked GHG emissions) and should be funded through measures that impose similar emission costs on affluent people in both developed and developing countries. Also inequalities within the same groups reinforce the importance of finding common ground between the development and climate justice agendas, as well as to reconcile the conflicting messages and objectives of civil society (Parks and Roberts, 2010).

The above overview of the five main approaches or institutional responses to the challenges related to climate change – see Table 1 – will now inform our examination of the institutional context in the three countries that contain the UPRB and the Pantanal in South America.

**Table 1: Approaches to Climate Change: A Schematic Overview of the Bibliography**

| Approach or Institutional Response | Main reasoning  | Claims and approaches  | Examples of responses and policy implications   |
|------------------------------------|---|--|---|
| <b>Climate scepticism</b>          | Denial of the anthropogenic causes of climate change            | Major scientific uncertainty remaining and the disproportionate cost of precautionary measures | No change in existing environmental and economic policies; 'wait and see'; maintain carbon intensive economic development                   |
| <b>Marketisation measures</b>      | Neoclassical economics principles; solutions through the market | Assessment of the monetary value of ecosystem services and the costs of GHG reduction          | Market-based responses; carbon trading and carbon taxes; adoption of schemes such as REDD and other forms of payment for ecosystem services |
| <b>Systematic adaptation</b>       | Continuous reevaluation of initiatives and technologies         | Search for better environmental governance and technological improvements                      | Interactive responses; tentative initiatives and heuristic examination of results; constant adjustments and improvements                    |

|                                     |  |   |   |
|-------------------------------------|--|---|---|
| <b>Architecture of entitlements</b> | Equity between countries, groups and individuals         | Acknowledgement of the social construction of resource scarcity and vulnerability | Clarification of entitlements and obligations of all parties involved in terms of access to natural resources and the distribution of impacts |
| <b>Climate justice</b>              | Criticism of unfair production and distribution patterns | Denunciation of the exploitation of society and the rest of nature                | Struggle for a compensation for past and present inequalities; fulfilment of the demands of the more vulnerable social groups                 |

## ASSESSING APPROACHES TO CLIMATE CHANGE IN THE UPRB

The preceding review of the literature on the approaches and responses to the risks posed by anthropogenic climate change should help to understand the socio-political context and the institutional dilemmas currently affecting the management of the UPRB and the Pantanal region. Our analysis should first recognise that the UPRB does not figure very high in the list of climate change priorities of Brazil, Bolivia or Paraguay. On the contrary, in those three countries scientists and policy-makers have mostly concentrated their attention to other biomes (such as the Amazon, the Andes and the Chaco, respectively). As observed in some of our interviews:

“As a matter of fact, there is no specific legislation for the UPRB [concerning climate change], because the priority has been the Amazon. Most national policies are focused on monitoring and deforestation, which means that there are no local policies [for the UPRB] either.” (Environmental regulator, Brazil, Jul 2011)

“I think that the main obstacle is the lack of financial resources, but also the difficulty to establish alliances with other organisations due to the bureaucracy that characterises public agencies. Also there are no clear guidelines to inform the cooperation between organisations and how these can help the implementation of existing policies.” (Ecologist, Bolivia, Sep 2011)

It means that the institutional framework for dealing with climate change in the Pantanal region are mainly the residue of the public policies primarily intended for some other geographical areas in the three countries. That situation represents a considerable ‘policy-making gap’

that, in the end, has tended to undermine the advance of climate change policies within each country and between countries. The marginalisation of the region in the structures of policy-making also brings us a particular analytical difficulty, given that the current research had to deal with subtle evidences and limited information

Likewise, it is also important to acknowledge the existence of strong elements of climate scepticism in the region, which still permeate many development strategies of governments and the stronger socioeconomic sectors. Although the ecological value of the Pantanal wetlands and its surrounding plateaus are mentioned in official discourses and corporate publications, there has been significant hesitation to effectively tackle the prospects of climate change in the UPRB. That is clearly demonstrated by the delay to organise formal state regulation and to engage civil society in the aspects of the public debate that are specific relevant for coping with climate change risks.

After recognising the secondary importance of the region for national policy-making purposes and the persistence of climate change scepticism, it should be possible to analyse the institutional responses actually considered for the UPRB. Referring back to the literature review in the preceding pages, we can verify that the climate change action in the three countries has been essentially a hybrid combination of different approaches (hence the importance of the description of those five approaches). We can start our examination with Brazil, the country that includes most of the Pantanal and the UPRB territory. It is worth remembering, at least in symbolic terms, that the signature of the Climate Change Convention happened in Brazil during the United Nations Conference on Environment and Development, which took place in Rio de Janeiro in 1992. Two years later, in 1994, the Convention was ratified by the Brazilian Congress and allowed its implementation by the national state. Because of its federal configuration, the reactions to climate change had to be shared between the central government and the state (provincial) administrations, as well as by thousands of municipal authorities (Cole, 2009).

The two states that contain the Brazilian section of the river basin (Mato Grosso and Mato Grosso do Sul) have followed the example of the national government and instituted a preliminary structure of policy-making for dealing with climate change, although the approval of state legislation has proven controversial. For instance, Mato Grosso has a climate change forum since 2009, but the activities have produced limited results and serious disagreements led to the departure of some key organisations from the forum (such as the Amazon Environmental

Research Institute, IPAM, in June 2010, which published an 'open letter' denouncing the hesitation to effectively face up to the challenges related to climate change in Mato Grosso).

Based on our interviews and on the analysis of the documentation, it was possible to ascertain that most of the institutional responses formulated in the Brazilian section of the UPRB seem to gravitate around systematic adaptation measures, particularly related to new agriculture production technologies and the expansion of hydropower energy. Probably the most relevant element of adaptive management is the improvement of agriculture practices as a strategy to reduce GHG emissions. Techniques such as no-tillage, crop rotation and perennial crops have the potential to store more carbon in the soil and help to mitigate the risks of climate change; at the same time, those practices can also contribute to conserve soil and water resources at the catchment level (Tollefson, 2010). In Mato Grosso do Sul, a new law passed in 2010 (No. 3,951) introduced green certification of products as means to induce carbon capture in the soil through new agriculture practices.

Also in 2010, the federal government launched the programme 'Low Carbon Agriculture' (ABC), which provides financial incentives for the adoption of techniques such as no-tillage, reforestation and cattle-crop-forest integration. Because of the scale of the agribusiness sector, both Mato Grosso and Mato Grosso do Sul are important areas for the ABC programme and farmers in those states have expressed their satisfaction with the funds already made available by the national government (Valor Econômico, 2011). Similar reductions in terms of GHG emissions are supposed to be obtained from the operation of additional hydropower plants in the UPRB (although in this case localised impacts are typically associated with the construction and operation of hydroelectric schemes). Historically, most of the electricity generation in Brazil has come from hydropower plants, but until lately the UPRB had not been a priority area for the construction of energy schemes (Ioris, 2012).

In addition to those initiatives, the last decade, there has been a concerted emphasis in translating environmental economic principles into policy-making in Brazil. The main goal is to assess the monetary value of the impacts of climate change and formulate financial incentives to reduce the emission of GHGs. That follows what was described above as 'marketisation measures', that is, the application of solutions to environmental problems to foster economic rationality and promote management efficiency. In December 2009 a new legislation was passed in the country instituting the national policy on climate change, which

included, among many other clauses, the creation of the 'Brazilian emission reduction market' (MBRE). This initiative is aimed to manage carbon emission trade in the country and is supposed to operate through the normal stock market channels. Likewise, the National Climate Change Fund (FNMC) was also established in 2009 to raise funds to be applied in the concession of loans and in the financial support (non-reimbursable) to projects aimed at climate change mitigation and adaptation. The pursuit of economic instruments became the new face of the policy-making related to climate change in Brazil. For instance, Viglizzo & Frank (2006) calculate that the ecosystem services in Pantanal has the highest gross annual value of ecosystem services in the Plata Basin (US\$ 5,726.9/ha/year), which would serve as justification for the conversion of such services into monetary payments to those involved in their conservation. Initiatives related to emission trading have increasingly encouraged the production of biofuel, such as ethanol and biodiesel, in the agriculture areas the surround the Pantanal. An association of the biofuel Producers of Mato Grosso do Sul, known as BioSul, was already organised to represent the sector at the local and national levels.

Despite the technological advances achieved under institutional responses that follow the rationale of systematic adaptation and marketisation, it is also important to observe the narrowness of those initiatives, especially in terms of the unevenness of the actual beneficiaries. Considering together, the above institutional responses to climate change in Brazil can be blamed for having followed the same pattern of public subsidies being channelled to the stronger and better organised economic sectors, at the expense of more inclusive and publicly accessible strategies. Not surprisingly, both systematic adaptation and marketisation measures were repeatedly criticised in our interviews with by Brazilian academics and NGO activists. The main criticism is that technological improvements alone are likely to reinforce the same pattern of socioeconomic inequalities and concentrated land tenure, which in itself constitutes a serious contradiction in policies that are supposed to deal with a universal problem (i.e. the effects of climate change). In addition, there are serious suspicions of corruption related to the granting of environmental licences to new hydropower schemes, which motivated the creation of a parliamentary enquire commission in the state assembly of Mato Grosso in March 2011. As pointed out in one interview, the consequences of climate change in the region are becoming increasingly evident (although that is yet difficult to demonstrate with the scant climatological data available), but it has mainly penalised the less well off in society:

“The most vulnerable populations in the UPRB, like fishermen and collectors are already suffering the negative impacts of climatic changes. Extreme events, such as years with serious droughts and also floods have really impacted the life of local communities, particularly in terms of their infrastructure and social organisation.” (Member of a local NGO, Brazil, Jun 2011)

If in Brazilian the institutional responses to climate change have largely operated within a technocratic and business-friendly framework, the comparable initiatives in Bolivia have followed a different pattern under the government of President Evo Morales. Until his election in 2005, Bolivia used to adhere to the recommendations of the mainstream climate change community, essentially in favour of mitigation measures influenced by the principles of environmental economics. Similarly to the Brazilian experience in the period, the 1990s were a decade of intense institutional reform in Bolivia, which attempted to restructure the economy along neoliberal lines. Even a few months before the unexpected electoral result, the previous national government passed a Hydrocarbon Law and other pieces of legislation aimed to regulate the activity of national and international private operators, mainly interested in exploring the abundant gas reserves of Bolivia. With the victory of Morales, however, Bolivia took a more independent, and confrontational, attitude regarding the implementation of the Climate Change Convention. The main tone of the institutional responses to climate change under Morales has been the affirmation of the architecture of the entitlements, but in a way that realign that architecture to better distribute resource entitlements amongst the population according to climate justice concerns. In the last few years, the government has passed a series of laws that established large reserve areas for the settlement of indigenous groups and poor peasants, which contradicts the interests of agribusiness and other dominant economic groups. Furthermore, Bolivia has become a vocal opponent of the dominant framework for climate change negotiations, as its diplomatic interventions have constantly denounced mainstream climate change negotiations as neo-colonial practices (De Angelis, 2011).

In the end, the institutional responses advanced by the Bolivian government have increasingly incorporated elements of climate justice. For example, at the climate change Summit in 2009, the Bolivian government joined a coalition of smaller state and non-state actors that push for main concessions from the central economic countries. Morales

went to COP-15 in Copenhagen and proposed that northern capitalist economies should fund mitigation and adaptation mechanisms in other countries to pay for their “ecological debt with future generations and the rest of the world” (published at [www.presidencia.gob.bo/discursos.php](http://www.presidencia.gob.bo/discursos.php)). Bolivia declined to endorse the final agreement and called for an alternative summit “to defend Mother Earth, which is under attack from the irrational politics of industrialisation of the developed nations.” That was named the World People’s Conference on Climate Change and the Rights of Mother Earth, which took place in Cochabamba in April 2010 and was attended by around thirty thousand activists from dozens of countries. At the end of the conference, the “Agreement of Peoples” on Earth Day was signed, which exhorted the major powers to join the Kyoto Protocol, called for a global referendum on climate change and pushed for the creation of an International Climate Change Court. Later in the same year, Morales was one of the most critical voices during the COP-16 in Mexico, when Bolivia was the only country that refused to sign the Cancun Accord and denounced its vagueness.

The result is that the Bolivian government has raised a distinct voice in the international arena and galvanised the dissatisfaction of traditionally marginalised groups not only in South America, but also around the world. Morales derives legitimacy for his autonomous stance on climate change partly from his recent re-election in 2009 and partly from the input of the Bolivian Platform against Climate Change, a network of over 180 organised groups. The change of discourse by the national government under Morales has had repercussions for the mobilisation and intervention of civil society organisations, which have directly called for a combination of alternative technologies and the fulfilment of civil rights (e.g. Centre of Investigation and Peasantry Promotion [CIPCA], 2009).

Interestingly, despite its confrontational policy, the Bolivian government has also paradoxically welcomed initiatives more closely associated with the creation of carbon markets and other forms of payments for ecosystem services. In particular, Bolivia is one of the priority countries for the implementation of REDD, the UN programme on the Reduction of Emissions from Deforestation and Degradation in developing countries. The signature of an agreement with REDD by the Morales government in September 2010 – it is a pilot project which aims to strengthen institutional capacities and test the REDD framework; the project involves US\$ 4.7 million in financing and support from the World Bank and German international cooperation – was inescapably seen by many climate justice activists as a form of political betrayal to the very political platforms

advanced by Morales (Benton-Connell, 2011). Such institutional complexity and apparent inconsistency of the Bolivian responses to climate change was mentioned in an interview:

“The main obstacle for dealing with climate change is still the lack of political will, and the harmful influence of the business sector. There are strong economic interests involved in this whole debate.” (Environmental NGO activist, Bolivia, Sep 2011).

The situation of Paraguay is at an intermediate position between the approaches taken by Brazil and Bolivia in recent years (and probably closer to marketisation measures than climate justice). Paraguay translated the Climate Change Convention into national legislation in 1993 and in the year 2000 a regulatory system was introduced under the coordination of SEAM. Also in 2000 a national GHG inventory was published and identified the main emission sectors (despite the limited amount of data available). Although the Pantanal wetland only occupies a small percentage of the country, most of its economic activity depends heavily on navigation along the Paraguay River and the impacts of climate change are likely to pose a significant threat to the operation of international waterways (what was mentioned in various interviews and seems to be one of the main areas of concern among Paraguayans). Despite those serious consequences of climate change, in practical terms, the institutional framework developed so far in Paraguay has proven very feeble and inadequate to deal with major politico-economic pressures that insist on the maintenance of conventional forms of production and natural resource exploitation.

At the same time that various initiatives have been advanced in terms of alternative agriculture, forestry and energy technologies (Programa de las Naciones Unidas para el Desarrollo [PNUD], 2007), the agribusiness sector continues to expand due to the rising prices of agriculture commodities in global markets. Furthermore, the country has most of its electric energy generated from hydropower (i.e. the massive Itaipu dam on the border with Brazil), but the demand for oil and the high rates of deforestation remain a serious challenge in terms of GHG emission reduction. The institutional contradictions of the climate change responses formulated in Paraguay are demonstrated in the following statement:

“There is a need to revise and consolidate the institutional approaches in the whole river basin [i.e. UPRB]. There is an agency responsible for

climate change in Paraguay, but the dissemination of information is very poor. (...) The large agribusiness firms are able to use new technologies that help them to cope with climate change, but the small farmers don't have any access." (Academic, Paraguay, Sep 2011).

It is relevant to mention also that the treaty which established MERCOSUL (or MERCOSUR) was signed in Asuncion, Paraguay, in 1991. MERCOSUL is the new economic block between South American countries that intended to eliminate tariff and non-tariff restrictions on imports. The agreement included a series of legal instruments on environmental regulation and policy-making, which have the primary goal of harmonising environmental legislation. One of its administrative units is the Common Market Group (GMC), which passed resolutions on various environmental matters (for example, the Resolution 9/91 on gas emissions and acceptable levels of pollution). Negotiation between member states on environmental issues have in fact represented an important element of the cross-country cooperation, but have also revealed the weaknesses of the MERCOSUL environmental policies (Morosini, 2010).

In addition to the domestic difficulties to coordinate the different levels of government and engage the non-governmental sectors in a sustainable management of the Pantanal region, the achievement of genuine trans-boundary integration has also proved very problematic. Despite a reiterated commitment for cooperation at the high level of South American geopolitics, on the ground there have been frequent clashes between nation states, such as the increase in the price of the natural gas exported from Bolivia to Brazil (through pipelines that cross the Pantanal). Likewise, changes in land use impact the river flow regime and has harmful consequences for Paraguay, located downstream of Brazil and Bolivia. International negotiators insist on a convergence of institutional responses, but in practice economic disputes and a weak civil society seem to largely undermine the efforts of dealing with climate change in the region.

## CONCLUSION

This brief assessment on the responses to climate change risks in the UPRB shows the fragility of the institutional framework that currently deals with the conservation and sustainable use of the Pantanal wetland and its surrounding, upland areas. The timid measures taken so far to deal with the consequences of climate change have clearly reflected

hegemonic economic and political influences in the three countries that share the river basin, especially from the agribusiness sector. It is possible to verify that most government initiatives in Brazil and Paraguay have combined systematic adaptation (particularly in terms of technology amelioration) and, more recently, the influence of marketisation approaches (e.g. carbon trading and REDD). The Bolivian government has tried to implement a more autonomous and critical programme of measures associated with climate justice, but the experience has not prevented the adhesion to mainstream initiatives such as the REDD project.

In addition, the UPRB continues to occupy only a secondary position in the national climate change priorities of the three countries and local political leaders have been unable to influence the formulation of legislation and policies. This situation represents not only a significant obstacle for doing social sciences research on climate change responses, but the slow implementation of those measures in the region also suggests that the Pantanal wetland and the UPRB remain relatively marginalised in the formulation of environmental policies and even in the environmental diplomacy between Brazil, Bolivia and Paraguay. The threats of climate change for the UPRB have failed to capture the imagination of most environmental policy-maker and politicians, while the mobilisation of the private sector has also been reluctant or opportunistic. The demand for energy, natural resources and commodity production represent major pressure over biological processes and have been pursued with little consideration of the needs of the low-income population and the opinion of grassroots groups.

The regional experience is a case in point of the inherent limitations of the institutional reforms and the contradictory influences of neoclassical economics on the ongoing reorganisation of the environmental sector. Instead of promoting a genuine change in public policies, the new approaches have largely preserved the hegemonic interests of landowners, industrialists, construction companies and real estate investors, at the expense of the majority of the population and the recovery of ecological systems. The crux of the matter has been the persistent inability of governments and of the representative of the hegemonic sectors to formulate more inclusive and sound climate change policies. Centralised, conventional approaches have ultimately perpetuated a situation of high socio-ecological vulnerability and institutional unpreparedness to cope with climate change.

The more recent attitude of the Bolivian government has represented a contrasting voice in the international arena, but the same government has also accepted other mainstream mechanisms that are based on the

monetisation of costs and benefits. At the same time, formal public participation forums created in the Brazilian section of the UPRB have been a little more than a formality and have not avoided internal political friction. The climate change debate in Paraguay is still in its infancy, despite the risks posed to the navigation and socio-economy, and the country has systematically lagged behind the developments in the other two upstream nations. Taking together the current situation in the three countries, it is possible to identify only modest signs of institutional improvement in the UPRB region and many questions are left unanswered. The perverse irony is that climate change in the UPRB seems still a very abstract and cumbersome issue, although the severe consequences of global warming may be felt much earlier than most expect.

## REFERENCES

- Adger, W.N., & Kelly, P.M. (1999). Social vulnerability to climate change and the architecture of entitlements. *Mitigation and Adaptation Strategies for Global Change*, 4(3-4), 253-266.
- Adger, W.N., Benjaminsen, T.A., Brown, K., & Svarstad, H. (2001). Advancing a political ecology of global environmental discourses. *Development and Change*, 32(4), 681-715.
- Alho, C.J.R., Lacher, T.E., & Gonçalves, H.C. (1988). Environmental degradation in the Pantanal ecosystem. *BioScience*, 38(3), 164-171.
- Anthoff, D., & Tol, R.S.J. (2010). On international equity weights and national decision making on climate change. *Journal of Environmental Economics and Management*, 60(1), 14-20.
- Araújo, A.P.C. (2006). *Pantanal: Um espaço em transformação*. PhD thesis, PPGG, Instituto de Geociências, UFRJ, Rio de Janeiro.
- Arvai, J., Bridge, G., Dolsak, N., Franzese, R., Koontz, T., Luginbuhl, A., Robbins, P., Richards, K., Korfmacher, K.S., Sohngen, B., Tansey, J., & Thompson, A. (2006). Adaptive management of the global climate problem: Bridging the gap between climate research and climate policy. *Climatic Change*, 78(1), 217-225.
- Barkin, D. (2009). The construction of mega-projects and the reconstruction of the world. *Capitalism Nature Socialism*, 20(3), 6-11.
- Benton-Connell, K. (2011). *Off the market: Bolivian forests and struggles over climate change*. San Francisco: The Democracy Center.
- Brasil (2010, June 08). Desmatamento na Amazônia cai 48% entre agosto de 2009 e abril de 2010. <http://www.brasil.gov.br>
- Bromley, D.W. (1991). *Environment and economy: Property rights and public policy*. Oxford and Cambridge, Mass.: Blackwell,

- Bührs, T. (2010). Emissions trading, equity, and sustainability: The case for allocating entitlements to "individuals-in-community". *Local Environment*, 15(9), 817-830.
- CIPCA. (2009). *Propuestas de acción y políticas de respuesta frente a los efectos del cambio climático*. La Paz: CIPCA.
- Cole, J.C. (2009). *The clean development mechanism and the legal geographies of climate policy in Brazil*. DPhil thesis, Oxford University, UK.
- Collischonn, W., Tucci, C.E.M., & Clarke, R.T. (2001) Further evidence of changes in the hydrological regime of the River Paraguay: Part of a wider phenomenon of climate change? *Journal of Hydrology*, 245(1-4), 218-238.
- Davoudpour, H., & Ahadi, M.S. (2006). The potential for greenhouse gases mitigation in household sector of Iran: Cases of price reform/efficiency improvement and scenario for 2000-2010. *Energy Policy*, 34(1), 40-49.
- Dawson, A. (2010). Climate justice: The emerging movement against green capitalism. *South Atlantic Quarterly*, 109(2), 313-338.
- De Angelis, M. (2011). Climate change, mother earth and the commons: Reflections on El Cumbre. *Development*, 54(2), 183-189.
- Dengler, M. (2007). Spaces of Power for Action: Governance of the Everglades Restudy Process (1992-2000). *Political Geography*, 26(4), 423-454.
- Devereux, S. (2001). Sen's entitlement approach: Critiques and counter-critiques. *Oxford Development Studies*, 29(3), 245-263.
- Engle, N.L., & Lemos, M.C. (2010). Unpacking governance: Building adaptive capacity to climate change of River Basins in Brazil. *Global Environmental Change*, 20(1), 4-13.
- Fish, R.D., Ioris, A.A.R., & Watson, N.M. (2010). Integrating water and agricultural management: Collaborative governance for a complex policy problem. *Science of the Total Environment*, 408(23), 5623-5630.
- Füssel, H-M., & Klein, R.J. (2006). Climate change vulnerability assessments: An evolution of conceptual thinking. *Climatic Change*, 75(3), 301-329.
- Glaas, E., Jonsson, A., Hjerpe, M., & Andersson-Sköld, Y. (2010). Managing climate change vulnerabilities: Formal institutions and knowledge as determinants of adaptive capacity at the local level in Sweden. *Local Environment*, 15(6), 525-539.
- Gupta, J., Termeer, C., Klostermann, J., Meijerink, S., van den Brink, M., Jong, P., Nooteboom, S., & Bergsma, E. (2010). 'The adaptive capacity wheel: A method to assess the inherent characteristics of institutions to enable the adaptive capacity of society. *Environmental Science and Policy*, 13(6), 459-471.
- Haines, F., & Reichman, N. (2008). The problem that is global warming: Introduction. *Law and Policy*, 30(4), 385-393.

- Hall, P. and Soskice, D. (1996). Political science and the three new institutionalisms. *Political Studies*, 44(5), 936-957.
- Hamilton, S.K., Sippel, S.J., & Melack, J.M. (2002). Comparison of inundation patterns among major South American floodplains. *Journal of Geophysical Research D: Atmospheres*, 107(20), 5-1 to 5-14.
- Harris, P.G., and Symons, J. (2010). Justice in adaptation to climate change: Cosmopolitan implications for international institutions. *Environmental Politics*, 19(4), 617-636.
- Harris, M.B., Arcangelo, C., Pinto, E.C.T., Camargo, G., Ramos Neto, M.B., & Silva, S. M. (2005). *Estimativas de perda da área natural da bacia do Alto Paraguai e Pantanal Brasileiro*. Campo Grande: Conservação Internacional.
- Howlett, M., & Rayner, J. (2006). Convergence and divergence in 'new governance' arrangements: Evidence from European integrated natural resource strategies. *Journal of Public Policy*, 26(2), 167-189.
- Huitema, D., Mostert, E., Egas, W., Moellenkamp, S., Pahl-Wostl, C., & Yalcin, R. (2009). Adaptive Water Governance: Assessing the Institutional Prescriptions of Adaptive (co-) Management from a Governance Perspective and Defining a Research Agenda. *Ecology and Society*, 14, 26.
- Ioris, A.A.R. (2004). Conflicts and contradictions on the occupation of the Pantanal space. In D. Tazik, A.A.R. Ioris, & S.R. Collinsworth (Eds.), *The Pantanal: Scientific and institutional challenges in management of a large and complex wetland ecosystem* (pp. 26-38). Washington DC: USACE.
- Ioris, A.A.R. (2010). The political nexus between water and economics in Brazil: A critique of recent policy reforms. *Review of Radical Political Economics*, 42(2), 231-250.
- Ioris, A.A.R. (Ed.). (2012). *Tropical wetland management: The South-American Pantanal and the international experience*. Farnham, Surrey: Ashgate.
- Ioris, A.A.R. (2013). Rethinking Brazil's Pantanal wetland: Beyond narrow development and conservation debates. *The Journal of Environment & Development*, 22(3), 239-260.
- IPCC. (2007). *Climate change: Impacts, adaptation and vulnerability*. Working Group II Contribution to the IPCC Fourth Assessment Report. Geneva: IPCC Secretariat.
- Jepma, C.J., & Munasinghe, M. (1998). *Climate change policy: Facts, issues, and analyses*. Cambridge: Cambridge University Press.
- Junk, W.J., & Cunha, C.N. (2005). Pantanal: A large South American wetland at a crossroads. *Ecological Engineering*, 24(4), 391-401.
- Kayranli, B., Scholz, M., Mustafa, A., & Hedmark, Å. (2010). Carbon storage and fluxes within freshwater wetlands: A critical review. *Wetlands*, 30(1), 111-124.
- Keddy, P.A., Fraser, L.H., Solomeshch, A.I., Junk, W.J., Campbell, D.R.,

- Arroyo, M.T.K., & Alho, C.J.R. (2009). Wet and wonderful: The world's largest wetlands are conservation priorities. *BioScience*, 59(1), 39-51.
- Marengo, J.A., Ambrizzi, T., da Rocha, R.P., Alves, L.M., Cuadra, S.V., Valverde, M.C., Torres, R.R., Santos, D.C., & Ferraz, S.E.T. (2010). Future change of climate in South America in the late twenty-first century: Intercomparison of scenarios from three regional climate models. *Climate Dynamics*, 35(6), 1089-1113.
- Marengo, J.A., Chou, S.C., Kay, G., Alves, L.M., Pesquero, J.F., Soares, W.R., Santos, D.C., Lyra, A.A., Sueiro, G., Betts, R., Chagas, D.J., Gomes, J.L., Bustamante, J.F., & Tavares, P. (2012). Development of regional future climate change scenarios in South America using the Eta CPTEC/HadCM3 climate change projections: Climatology and regional analyses for the Amazon, São Francisco and the Paraná River basins. *Climate Dynamics*, 38(9-10), 1829-1848.
- Mitchell, S.A., & Breen, C.M. (2007). The role of research in informing the governance process of the use of ecosystem resources. *Water Policy*, 9(SUPPL. 2), 169-189.
- Morosini, F. (2010). The MERCOSUR trade and environment linkage debate: The disputes over trade in retreaded tires. *Journal of World Trade*, 44(5), 1127-1144.
- NAE. (2005). *Mudanças do clima*. Cadernos NAE. Brasília: Secretaria de Comunicação de Governo e Gestão Estratégica, Presidência da República.
- Nerlich, B. (2010). Climategate': Paradoxical metaphors and political paralysis. *Environmental Values*, 19(4), 419-442.
- Neves, A.C.O. (2009). Conservation of the Pantanal wetlands: The definitive moment for decision making. *Ambio*, 38(2), 127-128.
- O'Riordan, T., & Jordan, A. (1999). Institutions, climate change and cultural theory: Towards a common analytical framework. *Global Environmental Change*, 9(2), 81-93.
- Ostrom, E. (2012). Nested externalities and polycentric institutions: Must we wait for global solutions to climate change before taking actions at other scales? *Economic Theory*, 49(2), 353-369.
- Parks, B.C., & Roberts, J.T. (2010). Climate change, social theory and justice. *Theory, Culture & Society*, 27(2-3), 134-166.
- PCBAP. (1997). *Plano de Conservação da Bacia do Alto Paraguai*. Brasília: MMA.
- PNUD. (2007). *Cambio climático: Riesgos, vulnerabilidad y desafíos de adaptación en Paraguay*. Asunción: PNUD.
- Poortinga, W., Spence, A., Whitmarsh, L., Capstick, S., & Pidgeon, N.F. (2011). Uncertain climate: An investigation into public scepticism about anthropogenic climate change. *Global Environmental Change*, 21(3), 1015-1024.

- Querner, E., Jonker, R., Padovani, C., Soriano, B., & Galdino, S. (2005). Regional hydrological impacts of climatic variability and change: Impact assessment and decision making. Proceedings of Symposium S6 held during the *Seventh IAHS Scientific Assembly* at Foz do Iguaçu, Brazil, April 2005. IAHS Publ. 295.
- Rossetto, O.C. (2004). *Vivendo e mudando junto com o Pantanal: Um estudo entre as transformações culturais e a sustentabilidade ambiental das paisagens pantaneiras*. PhD thesis, CDS, UnB, Brasília.
- SEAM. (n/d). *ONU-REDD Programa nacional conjunto (borrador)*, Asunción: SEAM, INFONA, PNUD, PNUMA, FAO.
- Sen, A. (1981). *Poverty and famines: An essay on entitlements and deprivation*. Oxford: Oxford University Press.
- Swarts, F.A. (Ed.). (2000). *The Pantanal: Understanding and preserving the world's largest wetland*. St Paul, Minnesota: Paragon House.
- Thynne, I. (2008). Climate change, governance and environmental services: Institutional perspectives, issues and challenges. *Public Administration and Development*, 28(5), 327-339.
- Tollefson, J. (2010). Intensive farming may ease climate change. *Nature*, 465(7300), 853.
- Tompkins, E.L., Adger, W.N., Boyd, E., Nicholson-Cole, S., Weatherhead, K., & Arnell, N. (2010). Observed adaptation to climate change: UK evidence of transition to a well-adapting society. *Global Environmental Change*, 20(4), 627-635.
- Treib, O., Bähr, H., & Falkner, G. (2007). Modes of governance: towards a conceptual clarification. *Journal of European Public Policy*, 14(1), 1-20.
- Valor Econômico (2011, September 23). Criadores do MT comemoram crédito para agricultura de baixo carbono. *Valor Econômico* newspaper.
- Viglizzo, E.F., & Frank, F.C. (2006). Land-use options for Del Plata Basin in South America: Tradeoffs analysis based on ecosystem service provision. *Ecological Economics*, 57(1), 140-151.
- Zeilhofer, P., & Moura, R.M. (2009). Hydrological changes in the northern Pantanal caused by the Manso dam: Impact analysis and suggestions for mitigation. *Ecological Engineering*, 35(1), 105-117.

