Knowledge, institutions and collective action at the frontier

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For Panel on 'How does resource management knowledge develop?' IASCP 2004

Abstract
Much has been written about the prospects for sustainable development and possible conservation strategies for Amazonia. Some suggestions have focused on so-called traditional resource management, yet most resource managers in Amazonia are fairly recent migrants to the region. Knowledge, institutions and collective action are thus highly dynamic. This paper examines the evolution and development of knowledge amongst colonist or migrant farmers in the frontier environment of eastern Amazonia. It focuses on the Marabá area in Brazilian state of Para, where colonists from different regions of Brazil have migrated over the last 30 years. We adapt the Traditional Ecological Knowledge concept to analyse taxonomic knowledge, by examining soil types identified by smallholder farmers; systems knowledge, by examining nutrient flows on individual farms; and social institutionalisation of knowledge, by looking at different forms of collective action developing at the frontier. Even very recent migrant farmers rapidly develop taxonomic knowledge of their environment, for example they have detailed knowledge of soil types and of forest plant species. However, migrant farmers demonstrate much more diverse understandings of processes and ideas about how systems work and interact, such as nutrient flows and soil degradation. These perceptions and understandings are rather more divergent from conventional scientific conceptualisations than are taxonomic insights. New forms of collective action are developing at the frontier. The paper analyses three major rural organisations in Amazonia: the Rural Workers' Union Movement, the Rubber-tappers' National Council and the Landless Workers' Movement. These collective action institutions reflect the diverse knowledge of different farmers and institutionalise knowledge within different production, exchange and management systems. The analysis highlights the dynamic and adaptive nature of knowledge at the frontier and links the evolution of knowledge explicitly to different forms of collective action. These in turn represent different resource management strategies and are likely to be key in determining the future sustainability of the frontier, in terms of both the environmental conservation and the well-being and welfare of its human population.

Traditional Ecological Knowledge and Amazonian migrants

This research was conducted in the Marabá region of Brazil, in eastern Amazonia. The context of this research is somewhat unusual for studies of Traditional Ecological Knowledge as the resource managers involved are recent migrants to the region. They are not long-established in their current localities, and therefore in one sense their

knowledge can be viewed as neither 'indigenous' nor 'traditional'. However it is, to an extent, place-based and displays the values and meanings associated with a 'sense of place' (Berkes 1999: 6). By applying the framework of Traditional Ecological Knowledge proposed by Berkes, we can start to identify the ways in which social learning develops and the dynamics of different forms of knowledge, associated values and meanings, and social institutions. As we have previously shown (Muchagata and Brown, 2000), some of the findings are counter-intuitive in terms of the relevance and transferability of non-placed-based knowledge. In this paper, we extend our discussion significantly to examine the different forms of social organisation and collective action which are evolving in eastern Amazonia and the potential pathways for sustainable resource management. Thus the social learning and collective action related to different forms of knowledge is highlighted. We might postulate then on the role of traditional ecological knowledge and social learning in the so-called sustainability transition.

The definition of Traditional Ecological Knowledge proposed by Berkes (1999) views knowledge as both cumulative and dynamic, building on experience and adapting to change. It requires that we take account of how knowledge is embedded within the management strategies, social institutions and ultimately the worldviews of different actors. It also views knowledge and practice and institutions as evolving and adapting to changes in contexts and circumstances (Berkes et al., 2000). Berkes identifies four inter-related levels of ecological knowledge shown diagrammatically in Figure 1. The first, which is based on empirical observations, consists of local knowledge of animals, plants, soils and landscapes. According to Berkes local knowledge in itself is not enough to ensure sustainable use of resources, although it might be sufficient to fulfil survival objectives. At the second level, local knowledge is associated with a set of practices, tools and techniques, which requires an understanding of ecological processes. A third level develops social institutions, social organisation, co-operation between resource users to enforce systems of management. Fourthly, a worldview, or paradigmatic knowledge, gives meaning to individual perceptions of the environment, and in turn shapes observations and social institutions. When we consider our findings in the context of this framework, then we can see the significance of colonists' knowledge first to the implementation of sustainable resource management strategies

for frontier regions such as Marabá, and secondly to the evolution of social institutions which will support long-term sustainable development in the region.

Figure 1: Traditional Ecological Knowledge framework

The Context: The dynamics of the frontier

Colonist farmers represent an important group of Amazonian forest dwellers, but are often portrayed (in contrast to indigenous groups) as practicing non-sustainable land use and resource management. Explanations in the literature include their poor knowledge about the frontier environment, lack of collective action and institutions to manage natural resources. Colonists' resource management is generally understood to be driven by individualistic behaviour, accumulation strategies and response to market forces (Toniolo and Uhl, 1995, Schneider, 1995). Thus it is argued that the immaturity and instability of the frontier regions, where most colonists live, coupled with the dynamic patterns of migration, are the most important obstacles for collective action. The literature often presents structuralist explanations for the environmental and resource management strategies. However our analysis presents a different perspective, examining values, meanings and understandings and discusses how natural resources are used as socially constructed within a framework of evolving local institutions. Many farmers' organisations have emerged in different parts of Amazonia during the last two decades and are attempting to transform the region and the way the environment is managed. Farmers' strategies in Marabá have evolved from protests and often violent campaigns for land rights, to more concrete proposals for the development of the region. We have examined three institutions; the Union Rural Workers Movement (MSTR), the Rubber-tappers' National Council (CNS) and the Landless Workers Movement (MST). The historical settlement of Marabá region can be characterised in four main stages. They are summarised in Table 1.

Table 1: The evolving frontier in Marabá

Period	Factors affecting settlement	Settled zones	Characteristics of colonist settlement	Characteristics of large holdings
Up to mid 1960s	Existence of large forested areas and access to abundant natural resources.	Close to urban centres, such as Marabá, São João do Araguaia and Itupiranga.	Subsistence agriculture and extractivism.	Large *castanhais*. Limited livestock production.
1960s and 1970s	Road building, official colonisation, fiscal incentives for livestock.	Eastern part of the region and areas close to roads (Transamazônica and BR 222).	Migrants from Central and Northeast Brazil. *Lotes* of 100 ha, equally for the official as for the spontaneous colonisation.	*Fazendas* owned by investors from southern Brazil, as well as the local oligarchy. Large *castanhais* continue to exist.
1980s till mid 1990s	Large development programmes and associated infrastructure. Land concentration in other parts of the country.	*Castanhais* and all the municipality of São João do Araguaia, parts of Marabá, Also areas from the municipalities of Jacundá and Itupiranga.	Migrants coming mainly from Maranhão and other Northeast states. 50 ha *lotes* on average. Many land conflicts.	Near-disappearance of *castanhais*. Medium sized (often from aggregation of small *lotes)* to very large *fazendas* for cattle ranching.
1990s	Land concentration in other parts of the country, but also within the region – both inter- and intra-regional movements	*Fazendas* with and without forest areas close to main roads More remote areas in the municipalities of Marabá and Itupiranga.	Migrants from Maranhão and Northeast, but also migration within the region. *Lotes* of 50 ha or less. Organised land occupation with conflicts. Large settlement projects in remote areas	*Fazendas* of diverse size. *Fazendas* close to towns increasing pasture areas to diminish risks of land occupation. Less rich ranchers moving further to the frontier

Table 2 shows how land is distributed between small and large landholders, as well as conservation and Indigenous areas. Land has been constantly appropriated by smallholders in organised occupation actions, and in certain long settled areas some colonist *lotes* have been purchased by *fazendeiros*. In the late 1990s the process of organised occupation was much more intense, as demonstrated by the number of new settlement projects created, shown in Table 3.

Table 2: Land distribution in Marabá region

Type of occupation	Area (1000 ha)	Percentage
Colonists	941	32.5
Colonists and Fazendas mixed	143	4.9
Fazendas	1 243	43.0
Parks and Forest Reserves	366	12.6
Indigenous People Land	177	6.1
Towns	11	0.4
Other (army, state companies)	13	0.4
Total	2 894	100.0

Source: Reynal, 1999

Table 3: Number of new settlements and families settled in Marabá region 1987-2000

Period	number of new settlement projects	number of families	number of new settlements/year
1987-1995	17	898	1.9
1996-1998	36	7658	12
1999-2000	34	4719	17

Source: INCRA, 2001

The frontier is highly dynamic. During the last 30 years territory previously appropriated by a local oligarchy has been completely transformed in a process involving the state, corporate enterprises, landowners and landless migrant farmers. Currently the smallholders occupy more than one third of the territory and nearly 50 percent of the agricultural land, compared with nearly nothing three decades ago. The evolution of Marabá frontier has been complex, and unlike other frontiers, smallholders are still present and have not been replaced by larger farmers at the regional level. Simultaneously there exists a process of land re-concentration in some localities while new spontaneous settlements are occurring.

Since this is a frontier region, the length of settlement is one of main determinants of the agricultural systems adopted by farmers. In newly settled areas farms still have a comparatively large amount of forest and thus the nutrient reserve needed to establish new crop areas, the *roças*. As the system evolves forest gives way to crops and pasture. A combination of factors contribute to increase or slow the speed of farm evolution: a key element is the availability of capital to invest in agricultural and livestock activities. Other factors, however, can also be very important, such as the natural resource endowment (especially the type of soil), the economic setting, and access to roads and markets. A 'standard' evolution sequence of the farming systems for the Marabá region has been described by de Reynal et al.(1995) and Muchagata (1997) as being characterised by these phases, installation, diversification and specialisation, outlined in Box 1.

Box 1 Evolution of frontier farming systems

First phase – installation:
A farmer (sometimes alone with the rest of the family following one or two years later) occupies a plot or *lote* completely covered by forest, in a recently opened locality, which has no infrastructure or services. There, the farmers will clear a plot in the forest (around three ha on average) in a slash-and-burn system, and will install the first rice *roça*. At this time, the farm household will be very dependent on the forest resources: almost everything in the house will be made by members of the household, and timber and non-timber products are important source of income. Another important cash source can be labour, sold to neighbour *fazendeiros.* Given the instability of land tenure, the *lote* boundaries are not clearly defined and need to be protected. Moreover, many farmers are not sure whether they will stay in the area in the long-term, so they will try to sell as much timber as possible and establish pasture to add value to the land.

Second phase - system diversification:
After four to five years of settlement the *lote* changes significantly. The family have improved their house and built structures to produce cassava flour; they also produce beans and maize, mainly for household consumption but they sell any surplus. They may start a small but diversified orchard around the house and have some poultry and pigs. Although the forest cover remains important, practically all the *lotes* have some pasture around the house and, depending on the farmers' strategy, there will be also some fallow land. Farmers who have more capital initially may have acquired cattle, but generally having not more than 10 or 15 animals.

Third phase - system specialisation:
If there are no significant economic constraints as outlined earlier, cattle-rearing is the main activity and the farm is dominated by pasture. At this stage local infrastructure is well developed and farmers are able to sell milk or cheese. Income is supplemented by sale of calves. The herd may number up to 120 animals. Crops like rice or cassava remain for subsistence, if at all, and the role of the forest remains as a nutrient reserve. This imposes serious restrictions on the sustainability of the farming systems, as the forest is being reduced each year.

Taxonomic knowledge of recent migrants

Colonists are often regarded as having less sophisticated knowledge about the natural environment (Morán, 1981) and as such are assumed responsible for less sustainable natural resource management practices compared to other Amazonian populations. However earlier research in Marabá has demonstrated that colonists have detailed knowledge of aspects of the natural world, for example forest ecology (Muchagata, 1997). This showed that colonist farmers used 142 forest plant species, which is similar in magnitude to that found in studies of indigenous and other groups in Amazonia. When colonist farmers' knowledge of soil properties was investigated 143 different soil units were identified (see Muchagata and Brown, 2000). For each unit, farmers identified between two and five soil layers and described them. Farmer's knowledge of soils demonstrated:

- Farmers recognised soil types not just by surface characteristics or a function of cropping yields, but also by sub-surface features, including layers, depth, texture and presence of stones. Farmers provided detailed descriptions of soil profile, down to more than 100cm or 200cm. Box 2 shows the farmers and scientific descriptions of soil types in one of the localities studied.

- Farmers had good notion of distribution of soils in their localities and the sketch maps they drew showed similar distribution patterns to conventional soil survey maps.
- Farmers perceived more subtle changes and variations in soil than scientific classifications; they related landscape changes and soil characteristics such as colour and texture to crop growth and development.
- The level of detail and quality of information provided by farmers varied with the length of time and extent of contact they have with soil types. Hence the soils which are farmed more intensively were better known, as were soils in areas which had been settled for longer periods.
- Links between soil types and productivity were sometimes assumed where practices differed and so where comparison was unfounded.

The findings indicate that farmers have very detailed taxonomic knowledge of soils, but implies that process knowledge is more diversified and diffuse.

Box 2: Descriptions of soil profiles in Consulta

Pedological profile **Scientific description**	**Soil description** **by Farmers**
Plinthic Tropaquult **High part of the landscape** 0-25cm-Yellowish brown (10 YR 5/6); silt loan; granular; sparse iron nodules; abundant roots. 25-45cm-Reddish yellow (7,5 YR 6/6); silt loam; blocky, many nodules; quartz pieces of different sizes; many roots. 45-80+cm-Red (2,5 YR 5/6) with brownish yellow mottles (10 YR 6/8), silt clay, blocky; few nodules; common roots	**High Clay Yellow** **(Barro amarelo do alto)** 10 cm Yellowish red, gravel and clay, no sandy, very abundant biological activity and roots 50 cm-yellowish, gravely, with moderate stone and clay, few roots 100cm-yellow, very abundant clay with moderate gravel; many roots
Plinthic Tropaquult **mid-low part of the landscape** 0-40 cm-Yellow (10 YR 7/6), silt loan; granular and blocky; abundant roots. 40-80cm-Brownish yellow (10 YR 6/6), silty clay loam; blocky; sparse small iron nodules; many roots. 80-180cm- Strong brown (7,5 YR 5/8); silt clay blocky; small nodules; common roots. 180-200+cm- Reddish brown (5YR 5/4) with red, yellow and grey mottles; silty clay; blocky; few roots.	**Low Clay Yellow** **(Barro amarelo do baixo)** 100cm-yellowish, clayey, little sand, with very adundant biological activity and roots co-existing with: 100cm-whitish, gravely moderate clay with very few stones and little roots 100cm- Purplish yellow, clayey with few stones 200cm-Purple.

Tropaquent 0-30 cm- Brownish yellow (10 YR 6/6); sand; subangular blocks; abundant roots. 30-80cm- Reddish yellow (7,5 YR 6/8) with many red, yellow and grey mottles; silt loan; unstructured; with small greyish nodules and small quartz pieces; many roots. 80-110+cm- Yellowish red (5 YR 5/8) with mottles like above; silt; greyish nodules, quartz pieces bigger than above; few roots.	**Low sand land** **(Terra arenosa do baixo)** 30cm-white, sandy with moderate clay and stone, little gravel, very abundant roots and biological activity 100cm-yellow, clayey with little sand, gravel and stone; moderate roots but little biological activity.
1.1.1.1 Tropaquent 0-10cm- Light brownish grey (10 YR 6/2); sandy; granular and subangular blocky; abundant roots. 10-90cm-Reddish yellow(7,5 YR 6/8); with darker yellow mottles; silt loam; unstructured; many roots 90-190cm- Light red (2,5 YR 6/8) with yellow mottles; silt loam: small; common roots 190-200+cm- Light red (2,5 YR 6/8) with yellow and grey mottles; silt; iron grey nodules; quartz pieces; few roots.	**High sandy land** **(Terra arenosa do alto)** 20cm-white, sandy with moderate gravel, stone and clay, very abundant roots and biological activity 100 cm-yellow, clayey with little sand, moderate roots 100cm- purplish, clayey with little sand and stone

Process and systems knowledge

We also examined farmers' understandings of processes and agro-ecological systems. We examined farmers' perceptions of the nutrient flows on their farms, exploring farmers' own models of the agro-ecological system and how they managed natural resources on their plots (see Muchagata and Brown, 2000). Farmers produced diagrams of nutrient and material flows on their farms and in explaining these, demonstrated their perceptions and understandings of systems processes. The diagrams emphasised material and nutrient flows and the relative importance of off-farm and forest resources (see Figures 2-4 for illustration). The diagrams drawn generally represent very diversified farming systems. The interactions between different components (crops-livestock-forest) of the system are important but the degree of nutrient cycling is relatively poor. For example few farmers recognised the contribution of nutrients form forest burning as a crucial factor in nutrient conversion in the systems. Importantly, the knowledge of processes for example nutrient cycling was very uneven between farmers, even those who were neighbours working in the same locality. For example, some farmers highlighted the contribution of manure or

leaf nutrients to soil then to plants then link this with their families, or off-farm or to markets, whereas others farmers made no link between soil and plant growth.

Insert Figures 2-4 Farmers representations of agro-ecological systems

Farmers' perception of change also reveals knowledge of systems and processes. We asked farmers about their perceptions of change in soil and soil fertility, the links with farming and resource management practices, the use of fire, and what they felt about the future and the sustainability of farming systems at the frontier. Key findings (further discussed in Muchagata and Brown, 2000) are:

- Farmers' perceptions of change were related to their length of settlement in the region.
- Perceptions of fertility were closely linked to presence of forest; this was especially true in newly settled areas where 'virgin' (uncultivated) soils were present.
- Farmers recognised both positive and negative changes in soil fertility.
- Changes in soil fertility were sometimes attributed to exposure to the sun and to perception of climatic changes.
- The presence of weeds, rather than loss of productivity *per se*, is a key concern for farmers and the main indicator of degradation. Other indicators include physical characteristics of soil such as development of sand layer.
- Fallow was seen as having negative impacts of fertility – primarily because of the association with weeds – again this was related to length of time farmers had been settled in the region.
- Farmers see advantages and disadvantages in the use of fire in terms of its impacts on weeds and pests and on soil properties ('strength'). Views are related to land uses, so fire is more beneficial in pasture areas than cropped areas. It is seen as a means of 'taming' the land.
- Techniques for improving fertility cited by farmers include mechanisation and use of inorganic fertilisers.
- Cropping was not seen as a sustainable form of land use, but pasture is seen as a more stable system, if effective control of weeds and fire can be achieved.

This analysis then leads to linking perceptions of sustainability to resource management strategies. It takes us to the level of ecological knowledge within the TEK framework, and to examine the role of social institutions, organisations and collective action in shaping knowledge and resource management.

Social Institutions and emerging forms of resource management

We have examined the emergence of different forms of collective action by colonist farmers in Marabá. Three organisations, their history and resource management strategies were discussed by Muchagata (2002): the Rural Workers' Union Movement (MSTR), the Rubber-tappers' National Council (CNS) and the Landless Workers' Movement (MST). The characteristics of these organisations are summarised in Table 4.

Table 4: Comparison of farmers' collective action organisations in Marabá

	MSTR	CNS	MST
Numbers and type of farmers at the regional level	Represents around 20,000 families. Less than 10% of the members pay contributions	Represent agro-extractivist populations. Around 70% of the rural families develop some kind of extractive activity.	Around 4500 families settled or in camps and affiliated to the associations, plus an unknown number of landless in towns and rural areas
Environmental concerns discourse/practice	Concerned with ecological sustainability of smallholders' agriculture, but also supports rural development projects harmful to the environment (such as FNO credit)	Conservation of forest and other natural resources is a key issue	Documents rarely cite environment concerns. In practice develops some projects to conserve natural resources
Type of technical projects proposed	Agroforestry and marketing of agriculture and forest products, but in practice has promoted livestock production	Improvement of extractive practices and marketing of forest products.	Agriculture collectivisation and modernisation based on machinery and chemical fertilisers, industrial scale enterprises and some agroforestry initiatives
Main activities	Proposal of policies for credit and land reform; support to land occupations, support for rural groups access to all sorts of development projects	Lobby for creation of extractivist reserves/ settlements and proposal for policies that support extractivism. Support to production and marketing at RESEXs and PAEs	Land occupation, organisation of production and marketing at the settlements, policies for land reform and agriculture; general policies for democratisation and access to resources and services

Participation in local level decision making	High Locally elected representatives	Low Operate at municipality level	High Local associations at each settlement, elected representatives of groups or camps
Key partners	CPT (Church) Local and regional NGOs Academics in Pará	Unions Academics in Acre and Southern Brazil National and mainly international NGOs Some civil servants in Brasília	

Contrary to conventional orthodoxy, farmers' organisations recognise the need to address issues of conservation of natural resources for the consolidation of colonist agriculture in the region. They have supported local groups in implementing alternatives at the collective level for improving resource utilisation. The feasibility of such work and its chances of success also rely upon the existence of important social capital at localities, the way external organisations take into account social organisation, and the limits and possibilities of the economic and natural environment. These organisations share the same basic constituency, the landless migrants and new settlers, thus their competing or complementary views on rural development have co-existed in the same place or locality. For example, some MST members also take part in the unions and the CNS is supposed to represent all those who develop any extractive activity, that is, most of the colonists in Marabá region. As none of these organisations is hegemonic the resulting picture of the family-based agriculture in the frontier is heterogeneous and results from multiple influences. These organisations struggle for the same cause, having in common the same adversaries (landowners, the state, corporate enterprises) so they necessarily perceive each other as complementary, although in their activities they give emphasis to different issues**.** However the organisations propose different models of collective action in terms of resource management. The CNS proposes extractivist practices, integration of forest and marketing of forest products. The MSTR proposes mixed farming systems, including community forest management. The MST attempts more intensive, mechanised and collective farming practices.

Each organisation views the environment and proposes different strategies for resource use. Generally, it could be said that environmental concerns are of higher importance to the CNS than to the unions and are peripheral for the MST. This is

evident in their political discourse. In practice, things are more complex than that. The main issue for these organisations, and their only means of survival, is to work for the improvement of life and production conditions of their public. How much this is dependent on the conservation of the rain forest is most of all an ideological position. In the Amazonian context, where environmental issues necessarily make up part of the political arena it is important to mark out a position in favour of the environment to capture the support of other actors, such as NGOs and academics. The theoretical debate on social movements, especially in Latin America has acknowledged the importance of these movements, that are new in the sense that they are challenging the subordinated position of popular classes and are defining power relations in the continent as never done before. The discussion on the MSTR, the CNS and the MST exemplifies how these movements have been able to change access to land and resources and create new forms of property regime and resource management. This analysis reinforces the role of farmers' organisations in shaping the frontier and demonstrates how the agency of organised farmers can transform economic structures. It shows that collective action has been extremely important in frontier transformation.

The frontier is a space of rapid transformations and the process of social differentiation there is very quick. In recent years, it has been possible for an almost completely dispossessed landless person to become a smallholder and within a couple of years, with credit support, this landless person could dramatically increase his/her capital and become a cattle owner, to the extent in some situations of becoming almost a small *fazendeiro*. The work of farmers' organisations was instrumental in achieving these changes. More than 15,000 families have had access to land in the Marabá region in the last 25 years, and this would have been impossible without the strong presence of farmers' organisations. The social institutions exemplified and embedded within these organisations demonstrate how diverse knowledges and practices are transformed in different management regimes and different forms of collective action.

Conclusions – shared visions of sustainability or contested frontiers?

The final level of the TEK framework suggests that shared understandings, or worldview, or paradigmic knowledge gives meaning to individual perceptions of the environment and in turn shapes observations and social organisations. It is part of the

dynamic process of social learning. We can perhaps identify some aspects of this social learning process emerging amongst colonist smallholders in Marabá through the organisations we studied. We can see the highly dynamic nature of knowledge and practices developing and that there are important elements of adaptive management and social learning emerging. The sharing of knowledge in this context has much in common with the idea of 'fusion' knowledge proposed by Brown (2003) or 'hybrid' knowledge described by Blaikie *et al.* (1997). But whether shared visions or paradigms of sustainability are yet developed remains to be seen.

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Acknowledgements

Part of the research upon which this paper is was funded by the UK Department for International development (DFID) for the benefit of developing countries. The views expressed are not necessarily those of DFID.