Land Use and Land Degradation In Southwestern Niger: Change And Continuity

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1. Summary of Research Results (for references, see end of section 2)

The rural environments of Sahelian West Africa are too readily identified with environmental and economic crises. Rural livelihoods undoubtedly suffered seriously during and after the major droughts of 1968-1973 and 1984, and during periods of economic downturn in the post-colonial period. Sahelians suffer hardship during major demographic, climatic and economic changes of unpredictable magnitude, which often occur at too rapid a pace to allow indigenous capabilities to adapt and adjust. Decades of regional development intervention have had little or uncertain impact in the region. But it is facile to assume a simple relationship between land degradation, drought, food supply, and the survival strategies employed by rural people. Among the more complex and vital issues are relations between actively constructed livelihoods of individuals and groups, particularly complex household units, and natural resources in rural environments. The latter provide not only challenges, but also opportunities. In the conditions of the Sahel where climate is insufficiently predictable to permit reliable harvests, 'diversification' away from, but still incorporating, agriculture is acutely visible in many communities. *But is it possible to gauge the net effects of these activities on welfare, subsistence, vulnerability, and wealth generation over time? And how best to link these activities to the management of, and condition of, natural resources*? Many, often conflicting, hypotheses are circulating on these issues.

In an effort to displace 'global' broad-brush statements about deforestation, soil loss, and nutrient deficits brought on by human actions, researchers now argue that understanding a rural system, through formal scientific method and a host of participatory and landscape analysis techniques, is not only a valid endeavor for research, but can assist in the design of more effective, locally targeted, and potentially sustainable management efforts. Southwestern Niger has provided a good area in which to examine the veracity of widely-held claims about Sahelian crisis and hardship, and offers a suitable environment in which to bring together scientific investigations of agrarian systems and the natural environment and a range of social, historical, and participatory investigations.

This report of a just-completed project builds upon the findings of an earlier study. A one year GEC Starter Grant was awarded to the project team for research in southwest Niger in an area inhabited by Zarma farmers and some semi-sedentary Peulh pastoralists (L320253247). Detailed socioeconomic studies were carried out in 1995 and 1996 at Fandou Béri, east of Niamey (Batterbury *et al.*, 1996). The present grant period began in December 1996, and fieldwork took place in 1997 with some monitoring continuing up until October 1998.[1] Three years of investigation in a single community, therefore, form the basis of this report.

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[1] It is not possible to completely separate the findings reported here between the two separate ESRC awards. The present grant was awarded to build upon the first, to quantify and clarify key relationships. In addition, several linked student projects have been conducted in Fandou Béri over the period, and this report is therefore an amalgam of all this work.

The key findings of the research relate to the identification of:

- how social, environmental, and economic changes have played out at the local scale, and how small scale dryland farmers respond to those changes over the last thirty years
- processes of land degradation - analysis of its extent and its social relations
- the nature of current livelihood systems, in which a mix of 'capital assets' are created and used.

Fandou Béri is 55 km from the major capital city of Niamey, and is situated at approximate limits of its urban 'hinterland'. Niamey exerts a noticeable influence on economic and social life in the village. As the economies of urban hinterland areas in West Africa are predicted to become increasingly influenced by the rapid growth in urban markets over the next decade (Club du Sahel 1995), Fandou Béri's location would be an important location for future monitoring of how production for the market and urban-rural interactions change over time.

i. Processes of land degradation

Beginning with 'natural capital', our analysis of land degradation found a complex local pattern (see the papers by Warren, 1998 and Warren and Batterbury submitted). The relationships between erosion (through wind and water), soil fertility and agricultural practice were explored for a limited number of fields and their farmers, first using the caesium-137 technique to measure net soil flux combined with interviews and focussed discussions. The method was chosen for its relative simplicity, but given restrictions of time and budget, even this method could discover only a small part of the pattern. For example it has generalised soil loss for a 30-year period and our sampling technique has had to generalise by field (smoothing over interesting within-field patterns).

Nonetheless, the rates of soil flux we found tally with short-term measurements found by other methods at a nearby site (see Warren and Batterbury submitted). The results suggest, with little doubt, that the net rate of erosion at Fandou Béri is severe by the supposed standards of West African erosion. However there are very few measurements of erosion in West Africa with which to compare these findings (again see Warren and Batterbury submitted). Erosion is mainly by wind, but also, in the upper parts of the catena, by water. In some cases soil deposition is as much of a problem as erosion, burying and killing seedlings in the early season.

One of the most interesting outcomes of this part of the research is that our preliminary analysis is showing that the 'social' or 'cultural' controls on the rate of erosion on fields are stronger than the 'natural'. Rates of erosion appear to be related to a number of social factors, many related to wealth. A preliminary stepwise regression shows erosion on agricultural land to be most strongly positively related to paid labour in agriculture, numbers of household animals and extent of male migration in that order. Interpreting these 'field-scale' patterns is clearly difficult, but we have made some attempts (Warren 1998, Warren and Batterbury submitted, Chappell *et al*.

1998b). It appears that relatively high rates of erosion on agricultural land are 'tolerated' by Zarma farmers because the farming system has partially diversified away from agriculture. High erosion on a particular field may be compensated for by a) farming another plot more intensively and b) meeting household food requirements through other sources of income. Thus, the correlation between net erosion and agricultural productivity was found to be poor. In addition, and related to this pattern, erosion, may also be the consequence of a drought-mitigation or labour-shortage-mitigation strategy. It seems that many fields are planted each year, but if, early in the season labour is short for weeding or if the rainfall is bad, then some fields will be abandoned and, the crops being in early growth stages, the soils will erode. Erosion on one field is, to an extent, compensated for by the deposition of the eroded material on nearby fields (particularly fallows). But two things must be borne in mind: a) our measurements are for net erosion (thus not distinguishing between episodes of deposition and erosion, but giving the overall 30-year loss rate), and b), the finer soil particles, which are most important to fertility, are mostly, and almost immediately blown well beyond the village lands (the *terroir*.)

Farmers routinely lodge millet stalks (*paillage*) explicitly to protect against wind erosion, but, unlike other regions of dryland west Africa (eg. central Niger, central Burkina Faso) there is almost no organised, physical protection of soil through conservation work. It may be that returns from agriculture here are too low, relative to other returns on labour or capital, to justify any further investment. The soil fertility lost to erosion or taken by crops, is countered by fallowing (during which a nitrogen-fixing soil crust develops, and potassium- and calcium-rich dust accumulates – Piper, 1998), by the very occasional use of inorganic fertilisers, by contracts with the Peulh for animal stabling on fields after harvest (less common since the Zarma cannot often afford to pay the Peulh for this service), or by the encouragement of termites. All of these processes are currently in decline - strongly linked to livelihood choices described below - thus aggravating the problem of land degradation.

ii. Social, environmental and economic change: understanding the human response

The people of Fandou Béri are aware that they live in a changing environment, and even identify many of the changes described above as degradation. They identified significant alteration in vegetation cover and soil characteristics of their lands over the last fifty years (see Batterbury and Longbottom, 1996). Several species of tree and shrub have all but disappeared from the *terroir*, the 35km^2 (approx.) area over which village leaders have land rights or derived rights of use. They also report that the productivity of soils has diminished over 50-80 years. Aerial photographs, the first taken in 1950, show the cropped area has extended to cover a large percentage of the *terroir*. Organic matter levels in soils are perceived as low and still declining.

Population density was around 20 persons km^2 in the early 1990s. Most families cultivate two or three fields totaling 2-10 ha^{-1}. Yields of millet, the staple crop, fluctuate annually but average between 300 and 400 kg ha^{-1}, and the use of organic manure and particularly fertilizer is limited. Other inputs (improved cereal varieties, pesticides, animal traction) are not widely used. Evidence of the intensification of agriculture through more labour investment, or through these

other technologies, suggests intensification is also patchy, and has proceeded slowly given the low population density, high rates of out migration, and lack of major technical innovation in farming. There is extensive fallowing of fields, although the practice is complex. Often one large field is cultivated, parts of which are in fallow and parts cultivated at any one time. Fallowing practice is very variable, small parts of fallows being brought back into cultivation by women for high-value crops at times. The lengths of fallowing period are almost certainly declining, for a number of reasons, among them the perceived requirement that a field must be 'productive' to assert formal tenure. Labour is a critical factor in agriculture; labour availability correlates with crop yields. Due to increased outmigration from the village there is a problem with male labour shortage and many families cannot afford to hire in agricultural labour.

Moving to regional controls on land use and decisions, the political economy of resource use in this region of Niger has changed rapidly since the middle 1990s. Changes in the political economy do matter, and have been expressed as a downturn in development assistance, rising prices for agricultural inputs, a withdrawal of state services including (periodically) schooling and healthcare, and in unpredictable demand for labour in regional labour markets away from the community. Two military coups have occurred since 1995, and international structural adjustment loans and other aid donations have been disrupted.[2] There are no development projects working in the community[3], but a former seed multiplication project influenced farming practices.[4] This and other evidence suggests that Fandou Béri's farmers are keen on utilizing any potential external interventions that may help improve productivity, but do not have access to many. Due to its peri-urban location, however, this region is unlikely to receive as much development assistance than poorer-off provinces further from Niamey.

iii. Livelihood systems: how do they operate?

Through eliciting oral histories and following through with repeat surveys of activities and budgets for a sample of men and women, a history of the livelihood strategies employed by the community has been developed. Diversification away from reliance on agriculture must be seen as an adaptive strategy in this dryland region (Mortimore and Adams 1999). Agriculture has dominated the production system since the establishment of the village, although at various times villagers were taken as laborers to work on projects for the French colonial administrators, and

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2 The goals of the World Bank 3-year Enhanced Structural Adjustment Facility (1996-1999), which expired in July 1999, were to clean up the nation's public finances and public services, increase internal revenues, hold inflation to 3% and reach economic growth of 4%. In 1998, Niger's GDP increased by 4% and inflation was at 3.4%. But Niger was not included on the list of countries receiving debt relief from the G7 initiative in 1999. It lies as the 173rd of 174 nations in the UNDP's Index of Economic and Social Development.

3 A small seed supply scheme recommenced in 1999, however.

4 In the 1970s and 1980s an agricultural development project paid farmers to produce seed stocks of improved millet, using improved farming technologies and practices. After the project was withdrawn farmers were unable to sustain yields without the subsidized fertilizer they had been using. We have many reports of sharp falls in yield. Improved crop varieties from the project were, however, conserved and continue to be used, although many farmers have now reverted to local varieties.

the deployment of other income sources was stepped up after the imposition of taxation demands by the colonial regime in the early 20th century. All households cultivate to meet their subsistence requirements, but several have operated 'dual demand' systems for decades, involving minimal cash crop production (mainly, in past times, of cotton).

Three major twentieth-century famines had repercussions for the community. As a separate but linked development, economic migration, notably of younger men who work as ambulant traders in West African coastal countries has increased markedly from the 1940s to the present, and especially since the drought years of the 1980s. Today young unmarried men choose in the dry season but to trade locally, to purchase cattle and sheep to raise and then sell at higher prices, or to leave Niger in search of work. Not all can marshal the necessary resources to depart after the harvest, however. Money earned by men abroad goes to pay for food, and ritual and social obligations, especially for cloth for their wives and bridewealth payments. Some men enjoy the challenge of migration; others only go by necessity because they are pushed by their families or require capital. All agree that migration is not as lucrative now, as it was only a few years ago.

The communal sharing of financial and material resources is constrained. Each household, and each individual, retains a tight reign over their finances and often earns cash independently of kin or neighbours. Livelihood systems are constructed through active decisionmaking within households. Other individuals, even kin, often pay each other for goods and services. The adoption of Islamic inheritance laws for property and land (with land usually divided between sons) has led to the loss of communal lineage fields. Cooperative villages institutions exist but are few; for example a youth group is active.

The Zarma practice extensive agriculture on large, spatially fragmented fields and at present have few animals by comparison with the Peulh. They are, however, keen on animal ownership and express interest in increasing animal holdings and decreasing farmed area (where this does not prejudice tenure), in accordance with a 'diversification' model. Several families of sedentarized Peulh have small fields in the *terroir*, and they use more manure from their animals to crop continually on small fields. Zarma animals are entrusted to the Peulh who take them northward to good grazing during the wet season, and a major livestock route between Mali and Benin passes close to the village. Unfortunately the smallness of our sample of Peulh households does not allow very secure generalisations about them. We believe, though we cannot show conclusively, that Peulh fields are less eroded than Zarma, probably because of the regular input of manure, and the guaranteed availability of labour.

Livelihood activities are gendered. Women are engaged in many income-generating activities in addition to daily chores, including the sale of bush sauce ingredients and prepared foods, the cultivation of high-value crops on corners of fallow, the sale of wood, petty trading, mat making, drawing water, and looking after sheep and goats. In accordance with Islamic semi-seclusion, much trading goes on compounds and trips to market are constrained. Women buy and sell animals, and can have considerable social and economic power in some households.

Conclusion

Research has build on a good set of base-line data on the pre-existing physical background of a community[5], by adding a data-base on erosion rates, added detailed social and economic information about a sample of households, and questioned people's perceptions of change and the livelihood strategies they employ. From the mid 20th century, Zarma farmers have tackled an adverse physical environment and responded through shortening fallow rainfed cultivation 'at home' and economic diversification 'at large'. The local agrarian system is dynamic and ever-changing in response to livelihood decisions and environmental perturbations. The research has uncovered a very suggestive set of relations between erosion and social factors. The choices, preferences and opportunities facing Sahelian agricultural systems suggest this and other communities will continue to respond to change through these mechanisms. Predictions show a rapid increase in regional markets and cash-based economies in the urban hinterlands of West Africa over the next decade, and it will be important to observe changes as they apply to villages like Fandou Béri.

2. Report of Research Activities

Objectives

The mid-award report (December 1997) revised the project objectives from the original proposal, to read as follows:

> 1) To identify livelihood strategies, agro-pastoral systems and the natural resources on which they depend in Fandou Béri, SW Niger.
>
> 2) To evaluate soil erosion and deposition on selected fields
>
> 3) To identify social and economic change influencing livelihood strategies and agro-pastoral systems
>
> 4) To identify diverse human rationalities relating to these issues.

The stated goal of the project was confirmed as being

> To isolate the key elements in the relationship between environmental degradation and livelihood strategies in SW Niger over the last 40 years.

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5 Collected as part of the HAPEX-Sahel experiment in 1992, and in nearby research projects described below.

These revised objectives, each working towards an overall goal, was seen as necessary to guide the research assistants in data-collection and to bind the different disciplines at work more closely together.

Methods and Activities

The project methodology has evolved since 1995, beginning with fieldwork using focus groups, PRA techniques and semi-structured interviewing in 1996, before investigations in 1997 were made of biophysical resources, fields, and social relations/livelihood systems by means of soil sampling, monitoring exercises and interviewing. In 1998, continued monitoring, extension of the dataset and cross-checking was possible before data were transferred to computer, a GIS was created, and analysis began. Throughout, a 'nested' approach has been used. Information was collected on soils and plants, in fields; these fields are used by individuals; who form part of households; who are members of a community and its lands. This 'local political ecology' approach has tried to combine different research cultures - natural science, and 'softer' social science - in a single study.

Preliminary Visit to Niger 2-14th March 1995.

The first period of fieldwork in Niger in March 1995 visited several fieldwork sites, as well as NGOs, government offices, and international organisations. The predominantly Zarma village of Fandou Béri was visited as a promising location for detailed investigation and surveys, since it lies within the zone for which detailed scientific monitoring had already been carried out, both during the HAPEX-Sahel environmental experiment, by ORSTOM, and by research students. Several days were spent in the village collecting background information, talking to villagers, and sampling a limited number of soil profiles to extend an earlier survey of soil erosion by Chappell (1995).

London Workshop, UCL, 31st March 1995

We held a small workshop in London on our return, to exchange information and ask for comments from other ESRC-GEC participants and researchers. We submitted a proposal named SERIDA (**S**ocial and **E**nvironmental **R**elationships **I**n **D**ryland **A**griculture) for funding to the EC in September 1995, and adopted this acronym.

Detailed Socio-economic fieldwork in Fandou Béri and Hamdallaye, Niger: Dec 11 - Jan 15 1996.

Five weeks of fieldwork were carried out by Simon Batterbury, assisted by an anthropology masters student, Judy Longbottom. Working with an experienced local assistant, they studied villagers' perceptions and perspectives on land use change and livelihood opportunities, through group meetings and interviews, visits to local markets, field walks, and informal observations. Six farmers and their families were surveyed in detail, and archival material was

collected about the region. Details from this fieldwork appear in a paper (Batterbury and Longbottom 1996).

Project re-funded, further fieldwork, Dec 26th 1996 - mid 1997

The project received renewed funding from GEC and re-commenced in December 1996. Two part-time research assistants begun work - Micha Weigl (anthropologist) and Nik Taylor (range manager/geographer). Two visits by the PIs established a project house in Niamey, dealt with logistics, and re-engaged local field assistants (Siddo Seyni, Ramatou Talphi). From January to April 1997, the assistants conducted intensive village field, vegetation and agricultural surveys, and worked with existing legal and traditional institutions in the village to arrive at their sample of 16 individuals and their fields. These were sampled for later Caesium analysis in the lab.[6]

An office was established at ICRISAT (the *International Crops Research Institute for the Semi-Arid Tropics*) in their Sahel Centre station at Sadoré near Niamey. ICRISAT is part of the consultative group for international agricultural research (CGIAR). We became linked to the MUSCLUS (**MU**lti **SC**ale **L**and **U**se **S**ystems) programme run by Dr Niek van Duivenbooden (van Duivenbooden 1998), and we attended an international meeting on 'Soil Fertility Management in West African Land Use Systems' at ICRISAT in March 1997.

Growing season to December 1997

After a pause in data collection and visits to other projects, from May until the close of the harvest season further semi-structured questionnaires were designed and executed by the RAs, with input from Siddo Seyni, the Pis, and the villagers. The aim was to move up from the closed field system to a greater focus on household, group and community issues. These were as follows: household production and exchange by men and women; surveys of agricultural producers; weekly monitoring of activities; livestock ownership and sales; and village events. Some ethnic and socio-historical information was also collected. The respondents were the members of the same households as had participated in the field surveys.

The two RAs directed surveys under the daily direction of Siddo Seyni and Ramatou Talphi. Two UCL masters students, Henny Osbahr and Christie Allen, flew out and completed MRes fieldwork in the village on fallowing practices (**Appendix 1**) and perceptions of soil fertility respectively .

A credit scheme was initiated for village women, in order to provide start-up funds for a several individuals to purchase animals for fattening and later sale. This was funded from the

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6 30 samples were taken in each field and their total weight taken. All 30 were then mixed together. 1/30th of the mixed sample was taken and the weight of the sub-sample noted.

personal funds of the PIs and has continued to operate. In late 1998, it was reported that most participants make enough to reinvest in animals of higher value (e.g. cows), some had also used part of their profit to buy millet or maize to feed their families.

Early 1998

Nik Taylor analysed and classified the data in the UK, transforming them into a standard database format (see Figure 1). Siddo Seyni continued low-level monitoring in Fandou Béri. Four additional households were added to the household surveys, although not with the same level of detail as for the 16 core households. Henny Osbahr returned to the village in May to conduct extensive fieldwork on fallowing systems and soil fertility for a PhD (**Appendix 2**).

June - end 1998

Field monitoring resumed under Nik Taylor's and Andrew Warren's direction in June 1998, through until September when end-of-fieldwork meetings were held in London.

Two more Masters students conducted work on soils and on water balance (Trevor Piper, Stephen Matthews).

GPS equipment borrowed from ICRISAT permitted precise field size measurements and creation of a village map using Arcview software, working at ICRISAT and latterly at UCL.

1999

Data analysis, GIS work, continued Caesium measurements, numerous presentations, and extrapolation of findings continues in the UK.

Results[7]

Understanding the landscape, understanding the community

There are parts of the Sahel, written about in hopeful terms, where year-round irrigated farming, lucrative cash crop production, or very intensive cultivation is practiced (Mortimore 1998, McMillan 1995). The Zarma Plateau, on which Fandou Béri is situated, does not share these characteristics. Most of the agriculture uses sandy, low pH soils derived from late Pleistocene now-stabilised dunes. The low pH is associated with low nutrients, especially phosphorus-availability. Surface water for any form of irrigation is limited. Away from the rich borders of the River Niger, wood cutting, grazing and extensive cultivation practices have reduced vegetation cover, particularly in the close-settled zone around Niamey. Although the region has been inhabited for centuries, a general view is that has now reached an "advanced stage of environmental exhaustion" under human use (Spath and Francis 1994). Although vegetation and soil characteristics are highly variable, certainly this is a challenging environment for the Zarma, Peulh and other groups that depend upon it in part for their reproduction. Indigenous methods of land husbandry are under stress, with many farmers habitually leaving the area periodically or relying heavily on non-farm income. Low external-input rainfed agriculture is still practiced by most Zarma households, but often in combination with pastoral activities and seasonal economic migration (Painter 1987).

We have been researching *how this system has changed and evolved, and how it works.* We have chosen to explore these issues in a single community. Our basic unit of the study is Fandou Béri (13^{o} 33' N 2^{o} 22' E) (**Figure 2**), a predominantly Zarma community with poor, sandy soils (Psaments) on stabilized dunes and a mean annual rainfall of c.560 mm (1908-1989) and 547 mm (1991-1995) (1997: 551mm). The village is sufficiently far from Niamey to be out of the close-settled zone of this large city, but close enough for there to be frequent trading and wood cutting for the Niamey market. Villagers have experienced a trend over the last 20-30 years of shortened fallow periods, fluctuating yields (depending on rainfall and other factors), increased male out-migration, and a withdrawal of rural development interventions.

One of the main reasons for the selection of Fandou Béri for study was that it is covered by unusually good environmental data, although less was known about its society and people. It is covered by excellent Japanese survey maps at 1:50,000. It is in the East-Central Site for HAPEX-Sahel (The Hydrologic-Atmospheric Pilot Experiment, a programme sponsored by NASA). HAPEX has provided good satellite and air photographic imagery, and made

[7] **Acknowledgements**: We would like to extend our thanks to all our research assistants, students and local collaborators involved in this project since its beginnings as an ambitous idea in 1994. Especial thanks are due to the villagers of Fandou Béri, from whom we have taken much, learned a lot, and to whom we have given a little over the last three years. Without the support of the Institute of Hydrology (and their battered Landcruiser), the logistical support of ICRISAT, and the tolerance of the ESRC-GEC office, we would not have been able to complete this work.

various ground experiments in 1992. SPOT and TM imagery and air photographs for 1950, 1975 and 1992 have been obtained. A nearby site, beyond the village of Banizoumbou to the east, has been intensively monitored as part of HAPEX and other programmes by ORSTOM and ILRI teams from Niamey over several years. Soil maps are available for the *terroir*, both as HAPEX results (Legger 1993) and from earlier studies, such as those of Manu *et al*. (1991) and Taylor-Powell *et al*. (1991), who also conducted social surveys a few kilometers to the west. **Figure 3 and 4** are taken from the HAPEX work and show the location of the village. Five sub-sites where extensive hydro-ecological data were collected on areas of fallow grassland, fallow bush-grassland, millet crop, tiger bush and degraded fallow bush are shown in **Figure 3**. The village of Fandou Béri is in the centre of **Figure 4**. ICRISAT personnel also conducted research on soil variability in cultivated fields on the sites used by Manu and Taylor-Powell (Brouwer, various). International (ICRISAT, ILRI, Hohenheim University) and national (INRAN) organisations have had a series of experiments on manuring, wind erosion, phosphate use, and fluxes at Banizoumbou, close to Fandou Béri to the east (Bationo, *et al*. 1992, Buerkert, various, Gandah, *et al*. 1998, Bielders *et al*. 1998, Williams *et al* 1995, and work by Pierre Hiernaux and Matt Turner). ORSTOM, the French scintific institute, has some continuing research in this area on groundwater, rainfall spatial variability and wind erosion (for example Rajot *et al*. 1996). Chappell (various) conducted a soil erosion study on part of the *terroir* using ^{137}Cs.

Despite the existence of these data, few studies have extended them by examining the workings of a full agrarian system, with a view to understanding land use and livelihood dynamics together. In rural research, assumptions may be tested after a close reading of other local studies and research sources, and via the local application of much more general 'models' or 'frameworks' about human-environment relationships. The approach of this project differed slightly from other ESRC-GEC projects in West Africa.[8] We did not wish to confine study to discrete 'processes' until we had discovered which processes *mattered* for explaining change and human adaptions. Rather, the community was used as a base to explore diverse processes and from there to offer these up to existing hypotheses and models.

Soils and Land Degradation

We begin with a particular set of relationships; those between the natural resource base and agriculture/resource use. A schematic cross-section of a soil toposequence typical of the *terroir* is shown in **Figure 5**.

The soil toposequence extends from a ferricrete-capped plateaux through a "skirt" to a broad valley, within which there is an incised dry stream channel which bisects the settlement. The plateau is used as a fuelwood resource, and is uncultivated. The parent material of soil on the

8 Roz David on migration and gender; Lockwood on demographics; Mortimore and Adams on agricultural intensification; Woodhouse on governance; Fairhead on forest history.

plateau (*tondobon* in Zarma) is very hard or stony, humus-poor, sesquioxide–rich and with mainly kaolinitic clays. The soils are gravely loams over cemented ironstone gravel (Manu *et al*. 1991). They are acid (pH < 5), of low nutrient status and have little water storage capacity because of their shallow depth and large content of coarse fragments. The surface has bare patches interspersed with bands of vegetation of varying sizes, oriented with their long axis parallel to the contour (Valentin and d'Herbès 1996). The patches appear as stripes when viewed from the air, and are appropriately named brousse tigrée or 'tiger bush' (Thiéry *et al*., 1995 modelled a tiger bush system a few kilometers to the east of our site). The soils under the vegetation stripes are different from those between them; pH is 5 to 6 and they are humus-rich, and approximately 20 cm thick above the ferricrete cobbles.

Localised rills and surface wash from the plateaux feed gullies through the plateau edge. Further down the toposequence, the "skirt" is an area where hummocky terrain may indicate spatial variation in soil loss. A number of local soil types are recognised here including *gangani*, a relatively clay-rich soil, perhaps the exposed B horizon of an ancient sandy soil. Some *gangani* soils are cultivated, and we have sampled the erosion on a few. Vegetation-capped pedestals or mounds of acid soil (pH < 5) are 30 to 40 cm high and from 10 to 30 m wide. They are probably the remnants of wind erosion. The vegetation here is sparse (villagers report that it was well vegetated in the 1950s, however) and the surface very compacted.

Outwash fans from the gullies on the skirt take sediment onto the edge of the sandy soils which are developed on Late Pleistocene dunes in the valleys between the plateaux (Bergoeing and Dorthe-Monachon 1997). We ourselves have dated similar deposits in the valley of the River Niger to the last glacial maximum (LGM)(Rendell *et al*. 1998 and forthcoming). These deposits appear to have quite well developed, now acid soils, and are the site of most of the cultivated and fallow fields at Fandou Béri (**Figure 6**). A now dry, sinuous valley is incised into the sands in the vicinity of the village, feeding a much larger hydrographic system to the east (Bergoeing and Dorthe-Monachon 1997).

Zarma farmers have detailed knowledge of soil fertility and erosion, as reported in an earlier unpublished paper (Batterbury and Longbottom 1996). In brief, indigenous soil classifications recognise several processes and at least seven major soil categories, most of which are farmed (**Figure 7**). These range from the uncultivated plateau tops (*tondobon*) to the clay-rich valley bottoms and ancient interdunes (*botogo*). Some terms, such as *tassi gandi*, describe soils from the deposition of sands by water or wind erosion. The villagers also recognise soils on which a rich crust has developed during fallow periods – *korobanda*. An MRes dissertation by Piper (1998) describes the apparent nitrogen-fixing properties of these crusts, while Osbahr (1997) has analysed the pattern of regeneration between short and long fallows (**Appendix 1**).

In association with the HAPEX-Sahel experiment, Chappell undertook an NERC-funded study of soil budgets in part of the Fandou Béri *terroir* , close to the tiger bush area shown

on **Figure 6**. The results of this analysis, reported in Chappell in various publications, found that the net soil flux for his study area was found to be - 23 t ha^{-1} yr^{-1}**. Figure 8**, from Warren (1998) presents some of the early results of our analysis. This also shows high and even higher rates, many in the region of 30 ha^{-1} yr^{-1}. The relations of these figures to those of what has been estimated for this area in earlier studies is discussed in Warren and Batterbury (submitted). This suggests, *prima facie*, that erosion problems may be even more serious than has been feared by most authorities. The question of the rates and significance of erosion in the Sahel is discussed in Warren and Batterbury (submitted), where it is concluded that not enough is known about either to make serious policies for erosion control.

The significance of these high erosion rates at Fandou Béri itself is also debatable, and we are still engaged in analysing our data in this respect. Soil erosion removes nutrients and decreases soil depth, thus decreasing water-holding capacity, which is likely to be critical in this environment. Farmer's perceptions of soil fertility at Fandou Béri are covered in Allen (1997:31), where *tassi* (sandy) soils are identified as suffering fertility decline more than *botogo* (clay-rich) soils**.** Available water capacity for each soil type is vital, particularly under rainfall deficit conditions. With Professor Agnew (Manchester) we are engaged in developing a model of the relevant processes that is calibrated with data from Fandou Béri, collected in the village by Matthew (1998). It could well be, however, that little of soil productive capacity is lost following erosion, for many of the sandy soils are so deep that it would take centuries to reduce their capacity. In similar soils in Nigeria Olofin (1992, quoted by Mortimore 1998) has calculated that "soil life" is "many decades". A similar situation (deep soils which do not lose productivity with erosion for many decades) occurs in loess soils of the mid west USA (Larson *et al*. 1983). In Fandou Béri, this may partly explain why farmers show little interest in halting water and gully erosion, but our ongoing analysis shows, to date, that the social relations of erosion are much more complex and highly relevant (some of the early analysis is reported in Warren and Batterbury, submitted and Batterbury, 1999).

A major issue is that over the years, increasing land pressure has meant that farmers have had less and less time to leave their fields fallow between millet planting in order to recover soil nutrient losses**.** In past times, fields have been left fallow for at least 10 years. In recent years, however, this has commonly been reduced to 5 years or less, with some plots not fallowed for several years (Osbahr, 1997). There are signs of wind erosion in many fields around Fandou Béri. The boundaries of fields are raised where blown sand has accumulated round clumps of *Andropogon* grass. Farmers reported to us that the loss of soil from their fields due to winds was a problem. Indeed, we saw this ourselves in 1997, when the rains were very sporadic and many were followed by significant dust storms. They also mentioned that the downslope transport of soil by water frequently buried millet seedlings, requiring the land to be resown. Our interviews revealed a feeling that wind erosion had increased due to stronger winds and the inadequate vegetation cover of recent times.

Social change and land use change - strongly linked

Fandou Béri is one of a number of Zarma villages which traces its origins to a period dating between 300 to 100 years ago when the Zarma were expanding outward from the fertile Dallols to the west, in search of new agricultural lands. Batterbury and Longbottom (1996) describe in some detail the changes in land use, environment, and the social and economic situation at Fandou Béri. The paper was included with the Starter Grant report (Batterbury *et al*.1996) and its findings have been updated and refined since then.

Land claims were established by digging of wells, and the oldest well at Fandou Béri may date from the late 17th century.[9] In common with other Zarma settlements, the village changed its location several times to enhance its security against attack, since warfare between Zarma communities occurred until the arrival of the French colonial authorities at the end of the nineteenth century. Surrounding villages have, like Fandou Béri, expanded and gained their own chieftainships. Of the present inhabitants, there are six major lineages tracing their origins back to the time of the founding and of the first chief, Kodeza. There is intermarriage between these and other lineages. In terms of ethnicity, the second most important group is the Peulh, who numbered 21 families in 1998, and who originate mainly from the Dosso region (several from Bini Bayoro). The majority farmed fields before starting to come to Fandou Béri over 40 years ago but always some of the family were occupied solely with herding. Fandou Béri is on an important livestock corridor, which is convenient for transhumance to northern pastures.

The village relies on strong links to Hamdallaye, a roadside market town and minor administrative centre (it is also where the USA Peace Corps occasionally train their volunteers). Local governance revolves around the Fandou Béri *chef du village*, a post once occupied by Zarma warriors but now by an 'elected' official (who is responsible for collecting taxes). The present chief won his position through political bargaining some years ago. Also important locally is the *chef du canton* at Hamdallaye. The Peulh have their own "garso" who represents them in the case of disputes. Political parties were active, but quietly dropped their main campaigning and social activities with the military coup of 1996. The pattern of nucleated villages in the surrounding region has created local centres of power and of Islamic authority. This is, however, a far from stable pattern. Social tensions over the chieftaincy and inter-village relations do influence the landscape. Areas of the terroir are disputed with neighbouring communities and this influences the pattern of farming - shown particularly as a reluctance to place land in long fallow if its ownership is questioned. A long-running dispute with the village of Kalassi to the west resulted in the French imposing a *terroir* border in 1955, and serious land disputes have continued sporadically until the present (**Appendix 3**). To the east, land rights with neighbouring groups are not clearly defined at all. A satellite community to the north-east of Fandou Béri, where the present chief resides, is situated

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9 Pottery shards collected from Fandou Béri and analysed at UCL date from this period. In addition, much older neolithic material appears on palaeosols and on surfaces above it. Dates of the establishment of the well, and hence the present village, are not clear. Oral accounts vary, with some placing the village origins five generations ago, in the 1800s.

closer to this zone of conflict. Negotiated solutions to land conflicts are made tricky by impending national land legislation that established tenants rights to land (Lund 1998, Lavigne Delville 1999).

The territories of present-day Niger were one of the last in West Africa to be brought under French control at the turn of the century. As Stoller (1995:98) argues, we need better understanding of the colonial and post-colonial regime that focus on indigenous perceptions of its impacts. Fandou Béri actually increased its political power with the arrival of the French, who chose to run a dirt road, built with forced labour, past the village, and like many other settlements along the colonial routeways of Niger, used the village as a staging post for troops and conscripts. Villagers today do not report colonial policy as especially significant. But in fact, as in most Zarma villages, taxation demands, forced labour, and price policies for export crops were responsible for increased movements of people around the region. Households suffered a periodic inability to mobilise sufficient labour to meet their subsistence food requirements as men migrated to find cash to pay taxes, or left to evade the authorities (Olivier de Sardan 1984). In particular, Fandou Béri suffered loss of productive labour to colonial projects such as the building of Niamey town, in the first 20 years of colonial rule. From 1911, when taxes were payable in francs, efforts to meet tax demands included local cash crop production. A bad famine "djamma" occurred in 1928-31 when only four families remained in the village and there were many deaths; this regional event has been strongly linked to colonial negligence (Salifou 1975). By 1950, at the time of the first air photograph of the village, the predations of the colonial regime had diminished, and the agricultural system largely supported the food resulted in migration and energy requirements of the 250-300 village residents, supplemented by local commerce and exchange. The exception was a year of heavy rain and a food shortage in 1953, described in Batterbury and Longbottom (1996) and documented in Grolle (1997). From 1975 engagement with the state under a new political regime (President Kountché and his 'land to the tiller' and anti-corruption campaigns) increased; the present laterite road was improved in that year, and some aid reached the village.

Land cover at this time was dominated by bush areas exploited for wild foods and fuelwood, and agricultural use was confined to a belt of land on sandy soils with long fallows (of approx. ten years). Around 20-25 lineage fields were farmed, and Raulin (1961) shows the approximate limits of land rights (the *terroir*) controlled by Fandou Béri around that date. We estimate the *terroir* at around 35km^2 (with fields outside this area), making it smaller than the lands of Darey (65 km^2) and Tondikiboro (80km^2), a 300+ year old Zarma village to the east (Loireau 1995). Spatial analysis has been made in two ways. Firstly we have obtained and analysed air photos from 1950, 1975 and 1992. For 1950 and 1992, areas of fallows, ancient fallows, and current fields were identified from a combination of desk analysis and ground truthing (**Figure 9, 10, 11**). As the area under cultivation or fallow has increased, and uncultivated areas have been cut back to 34% of the *terroir* , the majority of this on very unproductive land. Farmers did not, in interviews, regard pressure over land access as greatly significant, although the land conflicts in **Appendix 3** suggest otherwise.

Secondly, an Arcview GIS system has been created using geo-referenced points and field boundary calculations. Any field-based data for the plots farmed by twenty households may be displayed spatially. A base map and a soils map are shown as **figures 6 and 7** and can now display most of the socio-economic and agricultural data we have collected. Important too are the perceptions of villagers of the changes referred to above. These have been summarised in **figure 12**, and it is noticeable that the 'present' is not necessarily viewed as more arduous than 'the past', particularly by women.

Changes in agricultural production

Three major processes were noted in the agricultural system; these were ascertained through interviews, field walks, and the collection of oral histories. The first is the *fragmentation of production units* which has resulted in spatially separated fields belonging to the same individual. This increased work for those without a means of transport in an area too sandy for easy travel by bicycles and motorbikes. However, 75% of surveyed farmers now have three or more fields of different soil types, which is a useful risk-spreading mechanism. Although land is never sold and some of the *terroir* is in fallow or unproductive in any given year (see **figure 10**), there is little good quality land remaining to loan to immigrant farmers or to the sedentary Peulh.

The Peulh comprise 21 families (as yet none have intermarried with Zarma). All the Peulh farm on tenanted land, usually a portion of Zarma 'fallow' so as not to permit the Peulh any later claims to the land. They have developed a more intensive farming system based on heavy animal manure inputs and occasional use of fertiliser. Their millet yields are a little higher than the Zarma due to abundant manuring (c 300-500 kg ha^{-1}).

The second process is the *extensification of the productive area*, amply demonstrated by comparing the GIS maps for 1950 and 1992 (**figures 9, 10**). Much of the *terroir* showed signs of cultivation at the time of air photography in 1992. By contrast with the Peulh, the particular labour and tenure constraints facing the Zarma have meant they have larger, and generally less productive fields, and fewer animals. This pattern of extensification, partially linked to population growth, shows similar trends to those found elsewhere in the region (Heasley and Delehanty, 1996).

Thirdly, is a move to incorporate *more animals* in the farming system. Six of 20 households expressed a strong desire to own more animals as a deliberate measure to extend the resilience of their farming system to drought and poor production. Animal ownership increases financial resilience in most years. It is practiced by men and women, by whoever can afford the entry costs to animal ownership. Detailed animal sales and animal-purchase data were collected. They indicate small stock may be bought and raised with little initial investment, with Tabaski (March/April) providing a potential 100% markup for the sale of male sheep, thus permitting further purchase and investment (see below). In general, Zarma are less interested and skilled at livestock rearing than the Peulh. As Heasley and Delahanty

(1996) noted, it is somewhat ironic that although the Peulh are entrusted with Zarma cattle and smallstock, it is the Peulh that control the manure produced by these animals, and Zarma must enter into a contract to stable animals on their fields after the harvest, and thus to obtain benefit from that manure.

For each of 20 fields, we have created a 'field history' that traces inputs, soil amelioration, yields, fallows, cultivars, and planting dates. These may be compared with rainfall data over 30 years and the erosion figure. Preliminary analysis is reported in Chappell et al (1998b) and when this work is complete, agronomic decisions may be contextualised in the context of household livelihood decisions and the three trends noted above.

In terms of development interventions to aid agriculture, the village received limited support in the 1960s under the 'animation rurale' initiatives of President Diori (1958-1974), but at the same time that rural taxes were held at extortionate levels (Stoller 1995:147). More important was the opening of the village market in 1973, and the local Seed Multiplication Project (1979-1987). This technological initiative (run on the FAO model, with Peace Corps and government support) significantly influenced the predominantly subsistence farming systems. The Project offered pesticides, improved seeds and fertilizers, and purchased the surplus grain at good prices for sale elsewhere. Several farmers profited from this scheme, and in **figure 13**, which provides some background on the farming system, the inputs of fertilizers to the land up until the late 1980s can be clearly seen. The legacy of the scheme has been a desire for fertilizers to restore the productivity of the land; farmers remember the days of the Seed Project with great fondness, but cannot afford these inputs today. In 1997, only four farmers purchased improved crop varieties from a Hamdallaye cooperative, none in our sample. All later reported poor harvests due to rainfall and insect attacks.

Farmers are also inclined to dismiss other fertility-restoring techniques such as the use of compost pits and stone bunding as unworkable or too difficult, when compared to fertilizer inputs. Organic matter is applied, where Zarma can afford to do so. Scientific analysis of manure inputs by ORSTOM and ILRI at nearby Banizoumbou reveals that there may be small but important gains to be made through better incorporation of dung on fields.

Cotton has disappeared from the *terroir* since the 1980s droughts, with hibiscus, sesame, okra, groundnut and 'wild' sauce ingredients replacing it as sources of cash income. Transportation to reach markets has improved markedly since the construction of roads and motorised vehicles; day trips to the markets of Hamdallaye or Dantiandou are possible, and Niamey can be reached in a few hours although rural transport by bus or *taxi brousse* is expensive. Donkey carts, a twentieth century innovation, allow harvest products to be transported to the granary and serve other purposes, although these are costly to rent and insufficient in number for the whole community.

Constructing livelihoods - combining agriculture, migration, and markets

These agricultural activities are only part of the story (see Batterbury, 1999). Livelihood systems also include significant migration, trading, and livestock rearing activities.

Major components of livelihood systems are the strategies pursued to gain sufficient food or funding to see the household through periods of major food deficit. 'Households' refer here to married individuals (a man and up to four wives), and their dependents. More complex arrangements do exist. But fissioning of a household through marriage or relocation does not necessarily sever financial or social ties between its component members. As Olivier de Sardan (1984) notes, patron-client relationships also endure in communities that once has strong divisions between nobles and slaves as well as between lineage elders and the young.

Strategies to respond to change are several. Firstly, males of working age *leave the village* for long periods, usually to work as ambulant traders in Ivory Coast, where they have established their own social networks and in some cases, families. The migrant stream from the Sahel has been ascribed symbolic and economic value by scholars including Jean Rouch (1954) and Thomas Painter (1987), respectively. It is realistic to state that Nigerien migration streams occur for a variety of reasons that have altered over time and clearly require sustained analysis (Rain 1999).[10]

In Fandou Béri, 68% of households in our sample had migrants in 1997. The cost of transport for their trips is high, and remittances to the village are frequently sporadic and spent on items such as grain purchase and clothing. Migration is viewed as an economic necessity by the majority. It brings cash and new ideas into the community. A wide range of responses were received to the question "why is circular migration is so prevalent?". A successful migrant, who brought back 250,000CFA (c$400) in 1997, responded that he "had the money to go" while another replied that he was leaving to make up a likely household food deficit. Migration was practiced by older household heads (going predominantly to Ivory Coast) and by married and unmarried sons, with the latter favoring a wider range of destinations including Torodi in Niger, Benin and Nigeria. Headloading of textiles for sale in rural Ivory Coast is the traditional activity practiced by the Zarma. Peulh families migrate in their own way, with some household members talking livestock north during the growing season.

With many families absolutely unable to survive on their own agricultural production, migration provides one alternative to provide necessary cash. But migration is not always lucrative, and money does not always find its way into the household budget. Money is also spent on bridewealth and personal needs. Although returning migrants were extremely reluctant to divulge their true remittances, analysis of household budget information shows

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10 "..people use forms of mobility - especially circular ones - as a de facto component of production systems. Urbanization and modernity have altered these forms, but the forms continue, and the relationship between changes in mobility practices over time and environmental changes, particularly changes in land uses and settlement patterns, begs for a more comprehensive treatment." (Rain, 1999; internet exerpt)

these to be sporadic and variable, and range from a few thousand CFA (not enough for a sack of millet) up to the sums mentioned above. Clearly there is diversity in migrant experience, and some migrant success. We are keen to stress, however, that migration is not a 'last ditch' coping strategy in this region. It is undertaken as a conscious choice; only three male farmers in our sample listed migration as a primary response to poor household grain production, and in some cases the household elder stays put and releases his sons to travel in the hope that their cash will return to the village. Women, who do make trips to the city and to relatives but hardly ever undertake the trip to the coast, were adamant that migration is always a gamble - one partially dependent on the character and skill of the men involved.

Secondly, as a complement to migration, men and women remaining in the community make and sell produce, and their own labour, for *cash benefits* - what Mortimore and Adams call "business" (Batterbury 1999, Mortimore and Adams 1999). Zarma farmers have always engaged in some production for the market, even if this has often been at a fairly low level by comparison with their Hausa neighbours (Olivier de Sardan 1984). In addition, they trade and sell, and have other practices like *maraboutage* - Islamic prophesy and healing for those with religious training - that yield cash payments, that require travel.

Zarma women have their own circuits of capital and social solidarities, and we studied these in some detail (Longbottom 1996, Batterbury 1999).[11] They raise animals, sell fuelwood, make and sell mats, collect wild foods and sauce ingredients (e.g. *foyutto , Ceratotheca sesamoides*), and cultivate varying quantities of groundnuts and other crops, all which involve bartering and trading skills and, for some, visits to markets. Again these activities vary in their financial reward, and Zarma women show average incomes of 5-10,000 CFA per month ($8-16). A woman selling 'galettes' snacks from the home, for example, made 8,000CFA ($13) a month in 1997; a sale of bed frames made 2,500CFA ($4) a month on average. Smallstock prices are highly variable depending on the season. Old women specialize in making *sumbala*, a popular, pungent sauce ingredient made from hibiscus seeds and sold for around 250CFA per transaction. Jewellery made from beads bought in the local market are made and sold by young girls. Older girls find paid work drawing water for others and some may make food for sale at the local market. Animal raising is seen by women as the most secure source of income, more so than petty trading or cash cropping. Other activities pursued by women include the sale of fodder, renting out of equipment held by the household such as ploughs and carts, fetching water for others, and producing

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11 Our own efforts to support a credit scheme to permit women to purchase animals, and a host of interviews and focus groups, revealed some of these social networks. As Rain notes for Maradi, sub-household gender relations are clearly expressed in Niger society: "Women act out of solidarity with other women in the village, sharing food and labor with other households, cooking for each other, and lending each other their children for work. One benefit of cloistering, or female seclusion, for rural women is that the restricted access by men enhances female solidarity, which affords women the chance to operate in a female-only world. Empowerment through Islam can be a positive reality that Western outsiders rarely see. When nothing else works, women simply cope, making do with what they have. " (Rain 1999: internet excerpt)

foodstuffs for sale from the house. The profitability ranking of the major activities pursued by women was viewed as:

1) - best	Rearing animals
2)	Petty commerce, or preparation of foodstuffs for sale
3)	Cultivation of crops for sale
4)	Gathering sauce ingredients and grasshoppers for sale
5) - worst	Making mats.

These are broadly supported by detailed income data on each product – in particular, sales of crops are shown to be diverse and widely practiced, but involving small sums generally between 750 and 3,000 CFA per crop item per year.

Despite the importance of migration - so many men are absent from the village in the dry season that it appears to be the most common response to any form of local difficulty - there are those men who choose to engage in "business" closer to home. Local market trading and livestock sales are important. Some 75% of household heads trade in livestock, and 25% work as paid laborers on the fields of others. Three are *marabouts.* Some 25 % trade locally at market, often through marking-up and reselling products like paraffin, matches, *kola*, or foodstuffs (their sons engage more infrequently in this activity, preferring the migration option).

In 1995, a bad year for grain yields, all but five household in the village experienced a food deficit, with most having insufficient food to see them through to the 1996 harvest. In 1997, a bad year for rainfall, all but two households in our sample had a food shortage. The evolution of the problem into 1998 is shown in **figure 14**. As the need for purchased millet or cheaper sacks of maize grows and granaries are depleted, the market price for grain rises and so does the need for cash (previous price rises had already been experienced, particularly after the 1994 devaluation). Generally, it is possible to state that almost all Zarma households (but not necessarily all individuals within those households) are obliged to seek credit or to rely on non-agricultural sources in an average year.

Croll and Parkin's (1992:12) term "productive *bricolage*" is useful to describe how livelihood strategies involving diverse elements are constructed. It implies that livelihoods are pieced together, changeable, may not always work as well as planned, and have multiple components that are a product of adaptation, learning and experience. We did not observe a 'stage model' of coping strategies that draws farmers off the land only in times of crisis (i.e. farming - then buy livestock - then trade - then migrate if all else fails). Rather all these activities are part of the '*bricolage*'. Internal to a household, all may be pursued in any given year. This behaviour is reflected in **figure 15** where some of the activities of sixteen households are shown, relative to food production and needs. Note that each household had to trade (usually below average) grain production in 1997, a year of poor rainfall, with non-farm activities. The figure shows that - for example - households that failed to meet their

millet needs have non-farm activities to fall back on or animal stocks and, in some cases, balanced their expenditures. The terms of trade for migration and business are constantly altering, as are the pricing of inputs to agriculture like fertilizer.

These activities can be represented schematically in a sustainable livelihoods model (**figure 16**) that tries to show how livelihood decisions - adaptive strategies and processes - act recursively to change the conditions of vulnerability and the stock of 'capitals' on which individuals draw. **Figure 17** is a preliminary effort to apply this model to Fandou Béri. Livelihood decisions have repercussions for the vulnerability context in which farmers work, although some aspect of environmental variability, particularly rainfall, will always lie outside their control. One can envisage the relative importance of different processes, patterns, and events altering for different time periods.

Remaining tasks

The challenges faced by men, women and children of Fandou Béri are individual in nature, but the context in which those problems are managed involves household relations, institutional structures, and of course the local environment (Farringdon *et al.*, 1999). The biggest task we now face as researchers is to make concrete linkages between variables such as erosion rates, crop yields, position of fields, deployment of labour, land quality, diversification strategies, household budgets, and future decisions (as demanded by the sustainable livelihoods approach in **figure 16**). Our primary sources of information - farmer interviews and monitoring (**figure 1**) - permit these basic variables to be linked, and we have begun a statistical analysis of these relationships as illustrated in **Appendix 4**. A multivariate Principal Components Analysis (PCA) was conducted to explore the relations between net soil erosion on farmers' fields (measured by Caesium 137) and social and economic variables. It was found that proxy indicators for wealth, tenure, and labour are key variables that strongly influence the data pattern, and to a lesser extent soil fertility and the surface area cultivated are also important. Proceeding to a multiple regression analysis, the variables statistically influencing the erosion data may be identified. Using the variables identified by the PCA, we obtain an equation that explains 56% of variance, as follows:

> Erosion (i.e. net soil loss) = 40.7 -2.98PaidLab (paid labour on fields) +0.083Thhanimals (total animals owned by the household) -.057Surfarea (surface area cultivated) +0.88Mmig (numbers of male migrants in the household for that year).

Thus, although sample sizes for these analyses are very small and the data should not be over-interpreted (though the relationships *are* significant), more field labour seems to correlate with less erosion, and a larger numbers of animals owned correlates to more erosion. Two other variables are also important; the surface area farmed (smaller fields, less

erosion), and numbers of migrants (more migrants, more erosion). The statistics suggest that erosion rates are higher in households where there are other options, and where perhaps, as part of a risk-spreading strategy, fields are cleared but not then sown or tended and so erode early in the season. There is some evidence from our dataset that these are poorer households, more reliant on their own labour. **Figure 15** apparently demonstrates a diversification strategy that helps to minimise the effects of soil erosion on household reproduction.

These are preliminary results, and we are aware that there is a variation in temporal scale between the datasets. As of August 1999, we have not been able to interrogate our database much further to thoroughly investigate the reasons why some individuals "get on" while others merely "get by" or even "struggle to get by" (Davies *et al*. 1998). This is a difficult task, for the next few months of writing and reflection. The ultimate aim is to show, in a concrete way, how a livelihood system (comprised of human adaptive strategies and processes, as well as a host of norms, rules, sanctions, and outside influences) generates certain levels of resilience, assets, and flows of people and capital. Although we have illustrated how individuals in Fandou Béri draw upon a range of capital assets, the balance between those assets and the ways in which they are appropriated within and across families has not yet been fully interrogated and cannot be reported here.

Outputs

Please see section 4: Dissemination.

Conclusion

Twenty years of work on coping and survival in dryland environment has left a puzzling picture. Vulnerability is variously ascribed to colonial predations, economic collapse, climatic unpredictability, stress, poor soils or even a lack of obedience to religious deities. Responses to these stresses can take the form of passive and open resistance, flight and entrepreneurial skill, diversification away from agriculture, and penitence (Campbell 1990). The residents of Fandou Béri have responded to change through a suite of strategies that share common elements with other dryland communities, although each community and each individual has constructed their own path. A ‘subsistence logic’ (Olivier de Sardan 1995) actually involves giving up the struggle to subsist from the land alone, through diversification. Diversification is handled differently by men and women, who have different activity portfolios from which to choose. In each household, however, it is common to find circular migration combined with low input, rainfed farming on unproductive, extensive and fragmented fields. Inside the household, one sees further tradeoffs between labour, and productive and reproductive activities. The village is nested within an unstable and unforgiving regional political economy characterised by low - and often no - international or non-governmental support or state

interventions (Raynaut 1988).[12] A lack of real progress in the rural development efforts of the latter suggests real, top-down efforts will be needed in Niger to supplement farmers' own efforts.

These local livelihood responses cannot be viewed shorn of their temporal dimensions. Several phases of social, environmental, and economic change have affected Fandou Béri and other similar communities. In the 20th century, *Social* change has been hastened by the arrival of roads, French colonial forces, and the cessation of warfare with neighbouring groups. The power of original lineages has remained strong and land is jealously protected; this, along with Islamic inheritance laws and anticipated tenure changes at the national level (Lund 1998), has fragmented fields, and ensured their intensive use. Ethnic relations between Zarma farmers and sedentary Peulh have been maintained, despite occasional conflict and distrust. A marked decline in agricultural productivity per unit area in the 20th century has been associated with the decline of the bush fallow system, the loss of organic matter in cultivated soils, continued and perhaps accelerating erosion, the removal of tree cover (partly to supply the nearby urban market), the adoption and later abandonment of cash cropping, and population growth. *Economic* obligation began to impel the male population to earn a living from seasonal economic migration many decades ago, and much of their lives are now spent outside the community and in trading activities. Relatively favourable livestock price differentials have allowed some to trade in animals and to increase herd size, but lack of cash currently prevents the full exploitation of entrustment systems and kralling for the mutual benefit of Peulh and Zarma. Women, long denied the opportunity to trade and to earn on their own account (Diarra 1974), now play a strong, but proscribed, economic role. The national and regional political economy makes the search for cash both imperative and extremely difficult, and there is no state support for villagers in terms of credit, advice, or guaranteed earning possibilities. All of these factors will remain important as the predicted growth in trade and population in West African rural hinterlands (such as that in which Fandou Béri is located) occurs over the next few decades. In *environmental* terms, farmers face periodic drought, fluctuating rainfall, and soil erosion and soil fertility problems. Wind erosion is acknowledged to be widespread. It appears to be especially high on fields that are hazarded as parts of risk-spreading strategies, and appears to occur on the fields of households in which there are other opportunities to gain income. These farmers realise that they cultivate degraded soil types, some of which are very susceptible to topsoil loss. Erosion and declining soil fertility go hand in hand, with a general lack of incentive and capital to reinvest in land and agriculture.

This story helps to challenge orthodox views on Sahelian livelihood systems, or at least to tinge them with realism. Environmental doomsters still survey the Sahel, and identify population growth, environmental degradation, and political negligence as linked factors in a

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12 International support does exist in the region but not in Fandou Béri. A large rural development programme, PURNKO, supports the survival of West Africa's last herd of giraffes, around Koure to the south.

spiral of poverty and further degradation. Fandou Béri should illustrate some or all of these trends, if they exist (although it is located within reach of a major city and thus should have privileged access to markets). Yet the village has weathered crises. Population growth has not been rapid. The rain-fed fallow agricultural system still produced all or some food needs. There is pressure on resources after many decades of human habitation, but land conflicts are occasional. Government institutions, for good or bad, are certainly less of a constraint on individual's life chances than they were under colonial administration.

There is evidence, then, that networks of affinity and trust pull households and individuals together, even as minor conflicts - some dating back to pre-colonial social relations - may pull them apart. Access to resources are maintained by *switching between capital assets*, despite the definite existence of poverty at certain times and for certain people. Environmental degradation is occurring, but is actively managed as part of a diversified livelihood system that mitigates its effects by diverse income generating activities. Migrants leave the community for work, but to seek cash, not a life elsewhere, and they do return. Women have their own cycles of capital generation that also augment household incomes. Despite a loss of biomass at the expense of seasonal cultivation, a variety of important trees and shrubs are still protected. All this points to the fact that there are far greater complexities in human behaviour and resource endowments in the Sahel than the 'doomsters' would have us believe.

Acronyms used

HAPEX-Sahel	The Hydrologic-Atmospheric Pilot Experiment, run by NASA
ICRISAT	International Centre for Research in the Semi-Arid Tropics
ILCA	International Livestock Centre for Africa
IoH	Institute of Hydrology
ORSTOM	L'Institut français de la Recherche scientifique pour le Développement en Cooperation, France
PRA	Participatory Rural Appraisal
SERIDA	Social & Environmental Relations in Dryland Agriculture

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Figure 1. Data collected as part of the SERIDA project, 1995-1998

a) Village or *Terroir* (community) scale
Trimble GPS used to calculate the approximate boundaries of village land rights, and other plots owned by 20 sample farmers.
Series of air photographs, some corrected to GTM
Oral village histories of development project impacts and government schemes, commerce and marketing, and socio-religious change
Village demography from canton and village tax records, also revenue generated from taxes
Historical evolution of transport infrastructure and road network
Change in land use over time, from Arcview analysis based on air photo interpretation
Cropping data by year, from farmer accounts
Ethnobotanical surveys by line transects in sample fields and also through PRA sessions with woman and men, repeated several times. Includes ranking of the value of species for cooking, etc.
The nature of village organisations, social institutions, and reciprocal networks
Property rights and the history of certain land disputes
Availability of credit, and take-up of credit
Market activity by women and men.
Grain price fluctuations at regional market and other staple prices
Climate and meteorological data from auto and manual rain gauges over 5 years, long regional times series to 1910, several rain gauges for 1997
Social events, activities
Total monthly revenue generated by women from cash crop sales 1996-98 for 20 households.

b) Household and sub-household scale data
Detailed composition including social positionalities and identities, ethnicity, history
Total labor resources. Days of labor required by household 1996-1998, fixed average cost /labor day 1996-97, peak labor demands (requirements and costs). Monitored weekly.
Fields farmed per household, cultivation dates by year, property rights and ownership information
Total millet yields by year (variable periods plus full surveys 1996-7) and related to surplus and deficit
Fallow strategies
Indigenous views of soil fertility change, field-by-field and soil-type by soil-type.
Changes in fertilizer and pesticide applications over time, rising and falling with the introduction and then withdrawal of a seed multiplication project in the vicinity (1978-1989)
Household budgets - major incomes and expenditures 1996-1998, linked to price data for major expenditure items. Gendered breakdown showing male and female investment strategies.
Livestock ownership - type, number, multiple uses, husbandry and feeding practices, entrustment systems for grazing and watering
Wood use, consumption, sales
Food consumption by household - subsistence and purchased, for certain weeks
Women's cropping practices. Land rights, holdings, outputs.
Entire range of female income generating activities.
Entire range of male income generating activities.
Migration by position in household, remittances, destinations, length/years.
Historical impact of drought, pests, former development projects, land disputes on households
PRA sessions with farmers that identified cropping and land use changes over 30 years.
Accurate land holdings measured for 20 households using GPS.

c) Field scale
Especial focus on links between soil erosion - ^{137}Cs, measured for 30 year time period. Calculated net deposition/erosion models.
Field position noted with a base station GPS, displayed on Arcview
Conservation techniques
Field surveys by field walks and crops cultivated
Proportion of field farmed
Yield histories and labor inputs
Manure inputs

d) Additional archival and regional research
Comprehensive literature reviews
Regular contact with other scientific teams in the area
Comparative field visits
Discussion and critique in British and European research fora

Figure 11. Land Use and cover change, 1950-1992

Land Use	Area ($km^{2)}$		% of *terroir*	
	1950	1992	1950	1992
Scrub/bush	73.8	32.9	76.4	34.0
Tiger Bush	4.5	4.0	4.7	4.1
Current Fields	10.9	22.6	11.3	23.4
Recent fallows	3.95	26.5	4.1	27.4
Old, detectable fallows	3.4	10.6	3.5	10.9
Settlement	.05	.06	0.1	0.1
Total	96.56	96.58	100	100

Source: ground-truthing and air photo interpretation

Figure 12 General changes noted since the 1940s, by gender

Men

In the 1950s, surplus grain was sold to pay for animals
There were only 20-25 lineages present in 1950
There were only 20 big lineage fields plus some individual ones; now there are many more and loans have increased
Kola, salt, spices and tobacco purchased during trips on foot to Hamdallaye or Niamey prior to 1950s.
Migration in the 1950s was commonly by camel, horse or foot to Ghana. , Ivory Coast or Nigeria.
In 1950 only 2-3 people migrated on foot to Ghana or Ivory Coast - now almost whole male population is involved
In the 1950s most cultivation took place close to the village (see air photos).
Black & fertile sands still existed in 1950, but are now all gone
Crop yields have declined, particularly since the mid 1960s. Food deficits prior to the 1960s were less numerous, but more serious.
The worst period in recent history was 1954-1964 when the village was isolated, there were food deficits and many medical problems and deaths. Niger 'woke up' in 1975 (under Kountche's rural development efforts in his new government). The best period was from 1978-1987 when the rains generally recovered, there was a laterite road, a school, a market, a borehole and the seed cooperative.
More quick maturing millet varieties are used today
Farmers now have 3-5 fields each
Cotton is no longer grown
Adoption of Islamic inheritance laws over time
State support has always been minimal - and was greatest to in 1984 during the famine, when government grain was delivered to each household.

Women

Life was' easier back then'.
Short term migration (in weeks) of husbands was common in times of food stress.
In the 1940s-1950s the surrounding bush contained many wild animals: lions, hyenas, monkeys, antelopes. Bushmeat was eaten and sold, but now there is none
Hyenas attacked domestic animals within enclosures
Almost no contact with the state or development programs in the 1950s. After 1975, however, government edicts (the reform programmes of President Kountché) permitted some relaxations in travel and social strictures for women.
'Forest' surrounded the village in the 1950s making wood collection easier.
Men retained much greater control over domestic items and dictated activities in past times.
People had the same range of domestic animals, and women retained animals given to them at marriage.
Traditionally woven cloth (usually only one pagne per women) has been replaced by cotton printed cloth.
There are now more wells.

Restrictions on trading and market selling were enforced in the old days. Milk, butter, and sauce ingredients were sold by women past reproductive age only. Kola, salt and tobacco were purchased during trips on foot to Hamdallaye or Niamey.
Donkey carts and trucks eased transportation and mobility after the 1960s.

Figure 13. Additional details on the agricultural system

All farmers in the sample survey used local millet varieties as their staple crop, with only two in 1997 using improved varieties as well. Most intercrop millet with cowpea. Six (of 20) fields also contained hibiscus and two contained sesame - both crops solds for cash. Intercropping was universally regarded as a method to minimise the spread of pest attacks, particularly on cowpea, and as a minimal source of soil improvement from cowpea stover. Intercropping patterns are not static over time, although most farmers learned their present crop mixes and planting strategies from their parents. One farmer changed his planting pattern after participating in the seed multiplication project of the 1980s. Fields sizes generally vary between 1-6 ha^{-1}. As the following table shows, fertilisers have not been applied in recent years due to availability and cost, but were used extensively during the lifetime of the seed project (prior to 1987).

Fertiliser and manure applications by year (numbers of fields; n=20)

	Chemical fertiliser applied	Manure applied
1997	none	6
1996	none	4
1995	none	4
1994	none	4
1993	none	4
1992	none	4
1991	2	6
1990	2	4
1989	2	5
1988	2	5
1987	8	6
1986	6	5

1985	8	5
1984	3	5

Figure 14. The evolution of food security variables in 1997-8

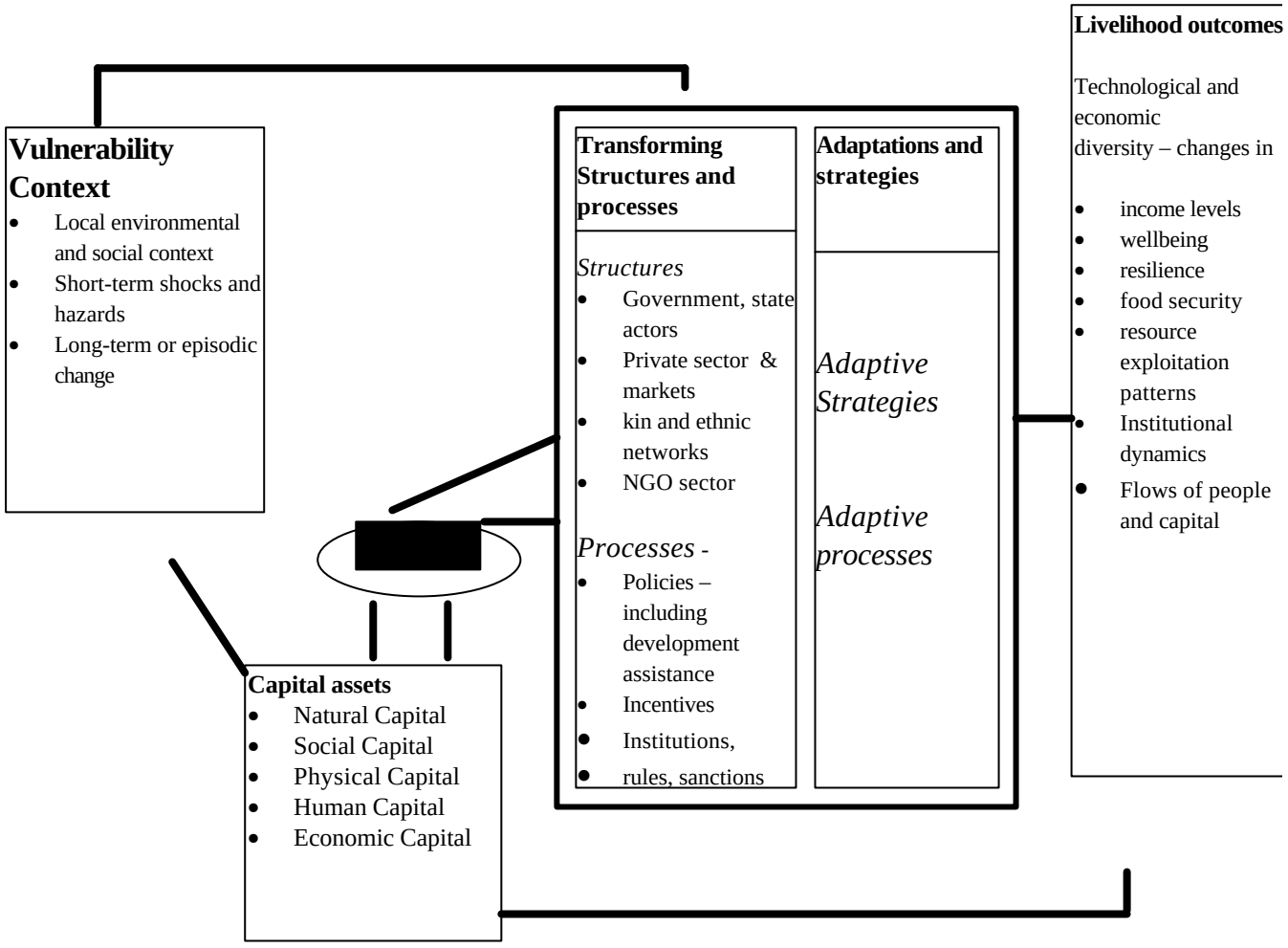
(All in FCFA $1US =620CFA approx)

	Price of Millet sack 50kg bought locally (CFA)	Indicative animal price (male sheep)	Village wide assessment of food situation	Credit and borrowing
April 1997	11000		average	
May 1997	14000		average	
June 1997	15000	12500	becoming difficult	millet borrowed from others, some laboring for food
July 1997	17500	11500	difficult for some households	millet borrowed from others, some laboring for food
Aug 1997	17500	9500	difficult for some households	severe rationing. Borrowing continues.
Sept 1997	16000	10000	Generally difficult	Borrowing, particularly from elsewhere in family continues.
Oct 1997	unavailable	12500	OK - granaries replenished	food generally available
Nov 1997	15000	11000	Some begin to buy millet	food generally available
Dec 1997	17000	11000	Some continue to buy millet	food generally available
Jan 1998	17000	25000	Generally OK	food generally available
Feb 1998	18000	25000	rationing - difficult	credit not used, but grasses cut, sold for cash (paille) to buy maize
Mar 1998 Note: 24 huts burned down in the village	19000	30000 (festivals)	Some food shortage. Shortage of seeding stock.	little borrowing capacity available - local merchant unwilling to lend
Apr 1998	25000	15000	Beginnings of food shortage for some households	villagers take credit where available; sell animals; visit family
May 1998	25000	15000	serious food shortage	villagers take credit where available; sell animals; visit family
June 1998	22500	10000	serious. Food not prepared more than three times a week	villagers take credit where available; sell animals; visit family

Figure 15. Comparing across households - farm and non-farm activities in 1997

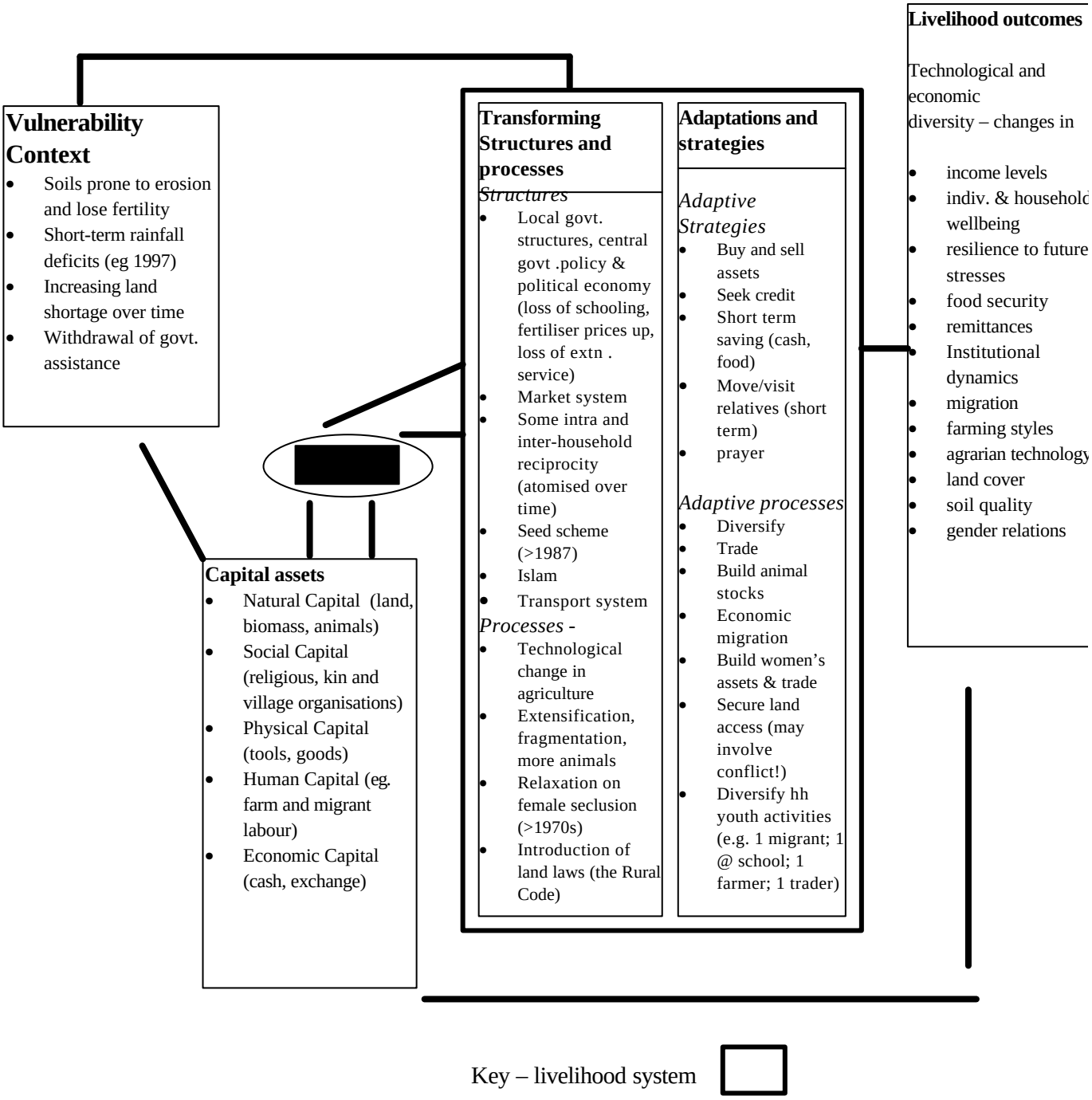
House-hold	Millet harvest (bottes)	Household millet requirements (bottes)	Annual HouSehold income (CFA)	Annual household expenditure (CFA)	Household financial balance (CFA)	Household animal ownership (TLU's)	Numbers of migrants	Total hh size	Local pettty tradin g?	Remarks - hh status
1	146	300	179425	188650	+9225	2	0	12	son	Some influence
2	153	400	542125	507450	-34625	73	1	8	no	Chief
3	191	360	250825	820100	-569275	12	4	27	no	Religious leader
4	146	300	208300	351800	-143500	6	2	8	no	Religious leader
5	129	300	119225	169000	-49775	3	3	12	Hh head	
6	178	250	375875	246700	+129175	13	1	8	no	Wife is prominen entre-preneur
7	161	200	137475	110900	+26575	7	0	8	no	
8	235	200	215925	227350	-11425	5	0	7	Hh head	
9	174	330	183225	264100	-80875	9	0	9	no	
10	270	250	262025	320575	-58550	22	3	16	Hh head	
11	191	360	209800	224885	-15085	5	2	10	no	
12	74	150	N/A	N/A	N/A	18	2	8	no	Religious leader
13	187	200	196050	200750	-4700	10	1	3	no	
14	144	300	224125	316600	-92475	74	2	5	no	Peulh
15	67	300	206925	136600	+70325	51	0	6	no	Peulh
16	210	450	414825	366000	+48825	141	1	4	no	Peulh
17	288	300	N/A	N/A	N/A	13	N/A	17	N/A	
18	220	300	N/A	N/A	N/A	17	N/A	13	N/A	Chief's son
19	150	300	N/A	N/A	N/A	90	N/A	14	N/A	
20	291	500	N/A	N/A	N/A	12	N/A	15	N/A	

Figure 16. The Sustainable Livelihoods model (Batterbury & Forsyth 1999, based on Scoones 1998 and Carney 1998)



Source:Batterbury & Forsyth 1999, adapted from Carney 1998, Scoones 1998

Figure 17 : Sustainable rural livelihoods for Fandou Béri



4. Dissemination

Research is already being disseminated to various audiences through participation in workshops, presentations, and papers. These are listed here, and some are included as Appendices. We first presented our work in-country at ICRISAT in March 1995 during the Starter phase, and have discussed findings and methods with the national agricultural service INRAN, and with several NGOs and academics during several subsequent field visits to Niger. Many academic presentations have been made in Britain, Europe, and the USA. Several academic papers have been published or are in press, and the project has appeared as a case study in a policy document for the British aid agency, DFID. Lastly, we organised a major international conference in London to provoke wider debate and interest in these issues drawing from Sahelian and European expertise.

In terms of future work (in the present absence of funding for fieldwork) we envisage Fandou Béri as a 'case study' that may improve understanding of the Sahelian environment, and the data collected may feed into future projects. For example, data has been shared with Henny Osbahr's closely related ESRC-funded PhD research on livelihoods and soils. Our GIS system is being compared with that of a neighbouring village, Banizoumbou, by ICRISAT in Niamey. Data will be soon be made available to IoH for research into decision-support systems. Dr Len Milich of Arizona State University has included Niger in a proposal to investigate climate predictors and drought in the Sahel. Prof Clive Agnew is working with Dr Adrian Chappell and Prof. Warren on water-balance modelling and Sahelian climate.

The project web site is http://www.lse.ac.uk/depts/destin/simon/serida.html, and the major findings will be posted there.

Advice to policymakers

In 1999, the UK Department for International Development (DFID) published this book:

> Scoones, I and C Toulmin. 1999. Policies for Soil Fertility Management in Africa. DFID issues series, London: Department for International Development. 128Pp.

In addition to reviewing and advising on soil management policy in Africa, the book developed an analysis of recommendations for different production systems using fifteen cases of research projects across the continent. Fandou Béri was included as a case in Appendix 5, and discussed as an example of a "low rainfall site experiencing difficulty" along with other research cases in Zimbabwe and Mali. It was noted that in this case,

> "...all cultivable land is around the village is now cultivated, and there is little fallow land available. Low inherent potential of the soils, combined with limited access to livestock, mean that levels of soil fertility are low. Where livestock manure is available, yields can be substantially improved...Access to markets is not particularly poor...but yields and returns are not sufficient to provide much incentive to intensify. All sites rely heavily on migration for remittances which further limits investment of labour effort in conservation and soil enhancing practices, much of which must be

> done during the dry season.Off farm incomes are important as a supplement to poor crop yields, and include collection of firewood, trading and various craft activities...prospects for this kind of farming system depend greatly on their being able to find crops with a sufficient profit margin to enable investment in purchased inputs, as a supplement to organic sources. The high level of out-migration may make it difficult to intensify the system through heavy inputs of labour, hence the need to rely on a mix of inorganic and organic inputs."
> (Scoones & Toulmin 1999:54-55).

In addition a proposal has recently been submitted to the ESRC to convene a series of six workshops on "*Transformations in African Agriculture: natural resources, livelihoods and markets*". These meetings would involve academics, DFID and NGO policymakers in discussion of the main challenges facing African agrarian systems over the next two years.

We were less successful in disseminating this research in Niger, since results have become available after ESRC funding ended. Villagers have been appraised of project activities, several discussions and meeting were held in Niamey with NGOs, and some scientific collaboration continues.

International Conference Organised

Simon Batterbury and Andrew Warren convened "*The African Sahel: Twenty-five years after the great drought*" at the Royal Geographical Society, London, in May 1998. There were 175 delegates, and eight speakers; Claude Raynaut (Bordeaux), Mike Hulme (UEA), Jean Marie Cour (Club du Sahel), Gaoussou Traoré (CILSS), Mike Mortimore, J.J.Rob Groot (Wageningen), Brigitte Thébaud and Camilla Toulmin (IIED). The following day, a 50-person technical meeting chaired by S. Batterbury and C. Toulmin assessed the past, current and potential linkages between research into natural resources and socio-economic change in the Sahel, and brought together African and European policymakers and donors to discuss policy issues. Agricultural transformations, and our project, were discussed and documents were exchanged. Several African scholars attended including Drs. Mamman (Sokoto), Ouedraogo (Ouagadougou) and Amanor (Legon, Ghana) and the aid agencies DFID, Caisse Francaise and DANIDA. This workshop was addressed by Roy Stacy, Director of the OECD's Club du Sahel. The meeting was widely praised, and received funding (£5,960) from the Department for International Development's West and North Africa Department, plus support from IIED's drylands programme.

A report was produced:

> Batterbury, SPJ. 1998. The African Sahel 25 Years After The Great Drought : Assessing Progress And Moving Towards New Agendas and Approaches. 28Pp + 50pp research summaries. http://www.brunel.ac.uk/depts/geo/sahelrep.html

It summarizes the papers, key findings, and possibilities for future collaboration. This is also available on the internet, and reports features in *The Geographical Journal*, *Haramata*, and *Environmental Conservation*. The journal *Disaster Prevention and Management* featured the site and gave it an award (see http://www.mcb.co.uk/portfolio/dpm/issues/008001/net.htm#37)

Alister Scott of ESRC-GEC attended and wrote resumés of the presentations, which were all published on the DFID/IDS "*ID21*" web site /email information service (http://ww.id21.org). A summary appeared in the *ESRC-GEC Newsletter*.

Papers by each of the presenters, and an additional introduction and a paper on soil erosion research, have been submitted for consideration as a special issue of *Global Environmental Change* as follows (Fandou Béri is discussed in the ninth paper, and Nigerien rural issues in several):

1.) Simon Batterbury and Andrew Warren "The African Sahel 25 Years After The Great Drought: Assessing Progress And Moving Towards New Agendas And Approaches "
2.) Claude Raynaut "Societies And Nature In The Sahel : Ecological Diversity And Social Dynamics"
3.) Mike Hulme "Sahelian Desiccation 1973-1998"
4.) Jean Marie Cour "The Sahel In West Africa: Countries In Transition To A Full Market Economy"
5.) Gaoussou Traoré "Is the Sahel prepared to take up the challenges of the 21st century?"
6.) Mike Mortimore and Bill Adams " Farmers Adapting to Drought "
7.) Henk Breman J.J.Rob Groot, and Herman van Keulen "Resource Limitations In Sahelian Agriculture"
8.) Brigitte Thébaud "Sahel Pastoralists 25 Years After The Drought"
9.) Andrew Warren Simon Batterbury " Soil Erosion In The Sahel Of West Africa"

Dissemination to scientific, academic, and policy audiences through articles and chapters

The following papers have been produced to date:

Batterbury, S.P.J. 1996 "The Sahel of West Africa: a place for Geographers?" *Geography* 81 (4) (No. 353): 391-395. (Audience: educators. Compares Fandou Béri with sites in Burkina Faso)

Batterbury, SPJ, Taylor, VNH , M Weigl. 1997. "Security and Change in Southwestern Niger" *Development Research Insights* (IDS, Sussex) 21:2 (audience: policymakers. http://www.ids.ac.uk/ids/publicat/insights/feb97.html)

Chappell, A.fc. The limitations for measuring soil redistribution using 137Cs in semi-arid environments. *Geomorphology* (based on NERC funded PhD research in Fandou Béri)

Chappell, A., 1998. Mapping 137Cs-derived net soil flux using remote sensing and geostatistics. *Journal of Arid Environments*, 39: 441-455. (based on NERC funded PhD research in Fandou Béri)

Chappell, A. 1996. Modelling the spatial variation of processes in the redistribution of soil: digital terrain models and 137Cs in southwest Niger. *Geomorphology* 17: 249-261. (based on NERC funded PhD research in Fandou Béri)

Chappell, A. and Oliver, M.A. 1997. Geostatistical analysis of soil redistribution in SW Niger, West Africa. In E.Y. Baafi and N.A. Schofield (Eds) *Quantitative Geology and Geostatistics*, Volume 8/2. Pp961-972. Kluwer. (based on NERC funded PhD research in Fandou Béri)

Chappell, A., Oliver, M.A., Warren, A., Agnew, C.T. & Charlton, M. 1996. Examining the factors controlling the spatial scale of variation in soil redistribution processes from southwestern Niger. In Anderson, M.G. & Brooks, S.M. (eds.) *Advances in Hillslope Processes* pp 429-449. Chichester: John Wiley. (partially based on NERC funded PhD research in Fandou Béri)

Chappell, A., Oliver, M.A., and Warren, A. 1996. Net soil flux derived from multivariate soil property classification, SW Niger: a quantified approach based on 137Cs. In B. Buerkert, B.E. Allison, and M. von Oppen (Eds) *Wind Erosion in West Africa: The Problem and its Control*. pp. 69-85. Margraf Verlag, Weikersheim, Germany. (based on NERC funded PhD research in Fandou Béri)

Chappell, A., Valentin, C., Warren, A., Charlton, M.d'Herbés, J.-M. 1997. Testing the validity of upslope migration in banded vegetation from south-west Niger *Catena*.

Chappell, A., Warren, A. Oliver, M.A. and Charlton, M. 1998. The utility of 137Cs for measuring soil redistribution rates in south-west Niger. *Geoderma*, 81, (3-4): 313-338 (based on NERC funded PhD research in Fandou Béri)

Chappell, A, Warren A., V.N.H Taylor, and M. Charlton. 1998 "Soil Flux (Loss and Gain) in Southwestern Niger and Agricultural Impact." *Land Degradation and Development* 9: 295-310.

Longbottom, J. C 1996. From SOAS to Niger: Reflections on learning and doing anthropology. *Anthropology in Action: Journal for Applied Anthropology in Policy* 3 (2): 38-41

Warren, A. 1998. Land Degradation in the Sahel: Some Observations. In Reenberg, A, H Marcussen & I. Nielsen (Eds.)*Sahelian Perspectives - Myths and Realities* . SEREIN Occasional Paper No 6. pp1-12. Copenhagen: Institute of Geography.

Warren, A. 1998. Environmental science and desertification at the frontier, in *The arid frontier: interactive management of environment and development*, Eds. Bruins, H.J. and Lithwick, H., Kluwer, Dordrecht, 117-127.

Warren, A & Batterbury, SPJ. Submitted. "Soil Erosion in the Sahel of West Africa: A Review of Research Issues and an Assessment of New Approaches" Special Issue on the Sahel, *Global Environmental Change (Dec2001)*

Other publications and unpublished material

Batterbury, SPJ with Longbottom, J.C. 1996. Social and Environmental Change in a Village in SW Niger, 1900-1996. Unpublished paper, 28pp.

Batterbury, S.P.J and A Warren. 1996. "Approaches to Environmental History and Agricultural Change in Sub-Saharan Africa." *Workshop on Environmental and Economic Change: Understanding Dynamic Processes in Sub-Saharan Africa*". UCL, CSERGE. January. Unpublished paper.

Batterbury, SPJ and Taylor, VNH. To be submitted. Zarma Livelihoods and African Environmental History: Studying 20th century social and environmental change in south-west Niger. Draft for *Land Degradation and Development*

Batterbury, SPJ. submitted. A local Political Ecology of Livelihood Diversification in Semi-Arid West Africa (Niger). Draft for *Ecumene*

Batterbury SPJ, Warren A, Waughray D. 1996. "Social and Environmental Relationships, Land Use and Land Degradation in Southwestern Niger". Starter Grant Report to the ESRC Global Environmental Change Programme. 109pp.

Taylor, VNH, Weigl, M., Waughray D, Warren A, Batterbury SPJ. Field Coordinators Progress reports and field trip reports. Various Dates, 1997 and 1998.

Warren, A, Osbahr, H et al. In progress. Summary paper on the social relations of land degradation.

Theses /dissertations completed and in progress

(these are not included for lack of space - copies are available on request)

Allen, C. 1997. *Indigenous understanding of soil fertility and management issues in the Sahelian village of Fandou Béri , south-western Niger*. MRes thesis, Environmental Science, University College London.

Chappell, A. 1995. *Geostatistical Mapping and Ordination Analyses of 137CS-Derived Net Soil Flux in South-West Niger.* PhD thesis. London: Department of Geography, University College London.

Longbottom, J.C. 1996. *Productive Bricolage: Changing Livelihoods And Gendered Strategies In Response To Food Insecurity In Southwest Niger*. MA thesis, Social Anthropology of Development, School of Oriental and African Studies, University of London.

Matthew, S. 1998. *The Development of a Soil Water Balance Model as an Efficient Tool for Agroclimatic Research in the Sudano-Sahelian Zone*. MRes thesis, Environmental Science, University College London.

Osbahr, H. 1997. *Indigenous Knowledge, fallow systems and indicator species; a case study from Fandou Béri Southwestern Niger.* MRes thesis, Environmental Science, University College London.

Osbahr, H. In progress, 1997-2000. *Livelihood strategies and soil fertility in Fandou Béri, south-western Niger*. PhD in Geography, University College London. (ESRC funded)

Piper, T. 1998. *An Investigation into the Effect of Algal Crusts on Soil Fertility in the Sahelian village of Fandou Béri, southwest Niger*. MRes thesis, Environmental Science, University College London.

Presentations:

Batterbury, SPJ. 1996. Sahelian Livelihoods in Transition: Social and Environmental Change in Southwestern Niger. Research Seminar Series, African Studies Centre, University of Cambridge. Invited seminar. November.

Batterbury, SPJ. 1997. Social and Environmental Change in the West African Sahel (Niger and Burkina Faso). African Societies in Transition Series, Department of Geography, University of Oxford. Invited seminar. January.

Batterbury, SPJ. 1998. Rural Development and the Environ
ment in West Africa: Geographers Learning from Farmers. Institute of Education, University of London. October.

Batterbury, SPJ. 1999. Political Ecology, Scale and Time: development and environmental change in Africa. Colloquium Series, Maxwell School of Citizenship and Public Affairs, Department of Geography, Syracuse University, USA. March 2nd.

Batterbury, SPJ. 1999. Political Ecology, Scale and Time: development and environmental change in Africa. Colloquium Series, Department of Geography, University of Minnesota, USA. Feb 5Th.

Batterbury, SPJ. 1999. Political Ecology, Scale and Time: Re-encountering Development and Understanding Environmental Change in Africa. Colloquium Series, Department of Geography, University of Kentucky, USA. 25Th Jan.

Batterbury, SPJ. 1999. A Political Ecology of Livelihood Diversification in Semi-Arid West Africa (Niger). Presented at international session on 'Livelihoods and landscapes in transition: cultural and political ecologies of contemporary rural change', Association of American Geographers meetings, Honolulu, Hawai'i, March.

Batterbury, S.P.J. 1999. Project presentation at 'African Environments: Technology, Modeling, and Political Ecology' . Invited panellist, expert workshop of African, European and American scholars, fully funded by the National Science Foundation. University of Kansas, USA, September 8-11.

Batterbury, S.P.J. 1999. Political Ecology, Environmental History. Learning from studies of environmental change in West Africa. Inaugural lecture series, Centre for Earth and Environmental Science Research, Kingston University, 28th April.

Batterbury, S.P.J. 2000. Reflections on Methodological Complexity: Lessons from South-West Niger. To present at international session on 'Mixed Landscapes, Mixed Methods', Association of American Geographers meetings, Pittsburgh, USA, April.

Batterbury, SPJ and Taylor, VNH. 1998. Zarma Livelihoods and African Environmental History: Studying 20Th century social and environmental change in south-west Niger. Presented at international session on 'Access to resources/environmental history', Association of American Geographers meetings, Boston, USA, April.

Batterbury, SPJ and Warren, A. Nov 1996. Social and Environmental Change in SW Niger. ESRC Global Environmental Change participants workshop, Hamilton House, London. ESRC event.

Batterbury, SPJ and Warren, A. 1997. Project presentation. Meeting with SEREIN, Institute of Geography, University of Copenhagen. March.

Batterbury, S.P.J, Warren A & Osbahr, H. 1999. Zarma Livelihoods: Social and Environmental Change in the 20Th Century In South-west Niger. Presented at the conference on 'African Environments Past and Present,' St Antony's College, Oxford University, June.

Rendell, H.M., Clarke, M.L., Warren, A., Chappell, A. and Taylor, N. 1998. Episodic sand movement in western Niger. International Conference on Aeolian Research (ICAR-4), July, Oxford (Abstracts, p66).

Osbahr, H. and Allen, C. 1997. Research Presentations. ICRISAT, Sadoré.

Osbahr, H. 2000. Livelihood Strategies and soil fertility in Fandou Béri, south-western Niger. Association of American Geographers meetings, Pittsburgh, USA, April.

Warren, A. Jan 1997. Dry Science. Inaugural lecture, Professor of Geography, UCL

Warren, A. 1997. British Council lectures on land degradation. University of Khartoum, Sudan.

Warren, A. 1998. Land Degradation in the Sahel: Some Observations. The Danish Sahel Workshop, January, Sönderborg, Denmark.

Warren, A. 1999. Project presentation: sustainability, soils, and dryland farming. Department of Geography, University of Bergen, Norway. September.

Warren, A. 1999. Sustainability in the Sahel. Department of Geography seminar series, UCL, November.

Warren, A. 2000. What do we need to know about Soil Erosion in the Sahel? Presented at Association of American Geographers meetings, Pittsburgh, USA, April 2000.

Warren, A and Chappell, A. 1997. Soil Flux in Niger and Its Agricultural Impact. 50Th anniversary meeting at the Wind Erosion Unit (USAD), Kansas State University, Manhattan Kansas, May.

Warren A., Taylor, N. 1997. Field Histories in semi-arid Niger. Workshop on Sustainable Livelihoods in Marginal Environments, 10-11 April, Univ. of Sheffield. ESRC event.

Proposals

Workshop Organised

8. Major Difficulties

- *Personnel issues* - The loss of our Co-PI Dominic Waughray and his skills in environmental economics, was not foreseeable. This meant that the economic component of the study has been downscaled. In addition, and in order to compensate for this, additional fieldwork was carried out in 1998, and the RA worked beyond the end of his contract to improve quality and accuracy of our dataset. Micha Weigl's anthropological expertise was lost to the project in late 1997.

- A *GIS system* has been developed that links to the large socio-economic and agricultural database collected for Fandou Béri. Although it now works well, it has taken beyond the end of the project to design and make use of this system for representing spatial patterns and key variables, given the long learning curve involved for the project team.

- Niger's *political situation* remained in flux throughout the lifetime of the project. We have seen two military coups in 1996 and 1999, and the country awaits a democratically elected government. The economic crisis continues. Occasional difficulties - corruption, minor hostility and the usual logistical breakdowns were experienced. International aid disbursements to Niger have been strongly affected by the political situation, and our plan to continue working in the village in 1999-2000 in cooperation with a development project or donor therefore looked less and less likely as time went on.

- In addition, partly as a result of its location in Niger, our *research host* - ICRISAT - has changed its operations in Niger and is moving many facilities and staff to Mali or further afield. This affected our plans for dissemination and future collaboration. Like some other CGIAR centres, they have faced severe cutbacks. ICRISAT's scientific personnel has been reduced, and non-scientific staff have been laid off, amidst strikes and animosity at the time.

- In Fandou Béri, considerable data were collected through a combination of scientific, qualitative and quantitative investigations and we tried to rise to the challenge of inter-disciplinary work. Our mode of operation from the outset has been to conduct 'hybrid' and multi-method investigations at a single site, and only later did we focus in on the multiple dimensions of key 'processes' (such as soil erosion, or agricultural decisionmaking). We lacked, therefore, an initial organisational 'theory' to guide data interpretation. With hindsight, interpreting the patterns coming out of the large economic and social dataset has posed significant challenges that a narrowed, more closely targetted investigation may not have faced to the same extent.

- We have not been able to obtain continued funding for a further fieldwork phase. It was not possible to approach the EC in 1996 and 1997, for example, because of their stance on the military regime in Niger. Niger is not a DFID priority country. We were not

included in the Desert Margins Program organised by ICRISAT and INRAN, which has received some international funding. But efforts to attract additional funding to continue the work have been partially successful, with the award of money for dissemination through the Sahel conference, and for six student projects in the village (one funded by the ESRC - **Appendix 2**).