Active Learning for Understanding Land Degradation: African Catchment Game and Riskmap

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Abstract
Land degradation is the result of the intersection of a complex set of biophysical and socio-economic factors. The capacity of an individual or community to address land degradation is likewise constrained. While it is quite possible for professionals and learners to grasp the main issues around land degradation from a theoretical perspective, internalising the reality of what it means to be the resource degrader is more difficult. We have developed two active learning methods that aim to address this problem. The first is the African Catchment Game, a role-playing game based on Graham Chapman's Green Revolution Game, adapted for the southern Africa context and incorporating a land degradation component. In this game participants play out the complex dynamics of rural-urban-global linkages against a background of environmental hazards. The second is based on Save the Children Fund's RiskMap computer simulation that models risk in terms of rural livelihoods for different income groups. Ethiopia is used as the example. This paper evaluates the two active learning techniques as tools for exploring the relationships between land degradation and poverty through an evaluation of participants' experiences. The analysis shows clear potential for developing alternative teaching curricula that are aligned to our theoretical understanding.

KEY WORDS *constructivist teaching pedagogy; curriculum design; rural development; Africa; complexity; role play; livelihood strategies; development practitioners*

ACRONYM
ACG   African Catchment Game

Introduction

Land degradation through soil erosion has long been recognised as an environmental problem caused by inappropriate farming practices. As early as 1939 Bennett produced his book on soil conservation, no doubt in response to the perceived global land degradation of the 1930s. Jacks and Whyte's (1939) *Rape of the Earth: a World Survey of Soil Erosion* was published in the same year. Nearly 50 years later the problem was still with us, but the academic paradigm was changing. In 1987 Blaikie and Brookfield developed the concept of the political economy of soil erosion, and more recently Gray and Moseley (2005) wrote about the political ecology of soil erosion. The concepts of political economy or political ecology arose from the realisation that technical solutions on their own

are ineffective and that we need to understand the socio-economic and political factors that underlie degradation. Although our intellectual understanding of land degradation has expanded to encompass its biophysical and socio-political dimensions, the problem seemingly remains as intractable as ever (Dunn, 1992; Gibbon, 2002).

The questions that this paper starts with are 'Why, with so much research effort devoted to land degradation problems, are we still so far from a universal panacea? Are we misunderstanding the process of soil erosion, or are we inept at applying the correct solutions?' Is it the case, as a number of authors have suggested (Martwanna and Chamala, 1991; Salvador *et al.*, 1995; Stonehouse, 1995; King, 2003) that we need to alter our teaching curriculum to match the approaches adopted in our research agenda? Significant research approaches since the mid 1980s have embraced systems thinking (Conway, 1987; Bawden, 1995), soft systems (May *et al.*, 2003), participatory and action research (Chambers, 1983; May *et al.*, 2003). Our teaching approaches, however, are still often rooted in traditional methods that transfer theoretical knowledge in a top-down, scientific-rational way.

By way of explanation we begin with the premise that the will and capacity to utilise land in a sustainable manner depend on a complex group of interacting factors that can be difficult to unravel. This is well summed up by Campbell *et al.* (2002, xiii) in their review of household livelihoods in semiarid regions, where they stated that: 'Any simple model of change ... is severely limited when confronted with the complexity of rural production systems, with their multiple pathways of change and multiple causalities'.

Attempts to address the problem of land degradation often come through the efforts of outside agencies that advise farmers and other land users on sound soil conservation practices (King, 2003). If development practitioners or conservationists are to promote effective policies that sustain land productivity rather than promote land degradation, the practitioner needs to be able to empathise with the real decision makers – those who live on the land and make decisions about the use of its resources. Likewise, erstwhile practitioners, students who study land degradation, need to experience the decision-making process of the resource users if they are to understand and theorise about the causes and consequences of land degradation and the potential for soil conservation. With this

background in mind, this paper reflects on the outcomes of a course that is underpinned pedagogically by simulations developed to promote learning through participation. This course falls clearly within the 'process' tradition of learning (Martwanna and Chamala, 1991), which has the expressed aim of increasing student awareness of the complexity of the rural livelihoods and implications for land degradation in rural Africa.

We start with an overview of how the Honours course, which is the subject of this paper, evolved from two separate courses (that examined land degradation and rural development as separate processes) to an integrated course that considered the synergies between resource utilisation and rural development. We engage students in this synergy through the process of active learning, specifically through role-playing games. The body of the paper explains how we use two simulations, the role-playing African Catchment Game and the computer-based RiskMap, to facilitate the students' experiential learning. After explaining the structure of each game in turn we evaluate its effectiveness in helping students get to grips with the complexity of the political ecology of land degradation through their own reflections.

Evolution of teaching pedagogy

At Rhodes University we have developed a course that has a core objective of giving our students the experience of being decision makers in the rural economy. The course has an interesting history that explains our own changing understanding of the land degradation problem. The course is offered at Honours level; this is the year following the completion of a three-year Bachelors degree. These are students who are likely to use their geographical training in some professional context. In 2002 we were teaching two courses: 'Rural development' and 'Land degradation'. We realised that there were areas common to the two courses; for students to recognise land degradation problems they needed to understand rural development issues and *vice versa*. We therefore started a combined course called 'Rural development and land degradation' in 2003. The course took a political ecology approach to land degradation, with a strong emphasis on the positive and negative outcomes of rural development policies, political agendas and so on.

Finally, in 2005 we renamed the course to reflect its philosophy more accurately. It has

become known as 'Rural economy and land utilization in Africa (RELUA).' This name recognised that

1. rural areas may not be 'developing' in any real sense;
2. rural economy implies the importance of livelihoods and making a living, and
3. resource utilisation may be both destructive (degradation) and constructive (conservation).

Focusing on degradation alone seemed to be too negative.

To support student learning in this course we employ a number of constructivist learning activities. According to Rovai (2004), constructivism is learning through experience and involves the core components of experience, knowledge construction, reflection and sharing. The course structure is shown in Figure 1. We make regular use of concept maps to facilitate the internalisation of learning before the next activity takes place, thus ensuring that our students move through the phases of Kolbe's experiential learning cycle

Figure 1   The structure of the rural economy and land utilisation in Africa course 2004.

(Fox and Rowntree, 2004). Two of the learning activities are described in detail here. The first is a role-playing game, 'The African Catchment Game', and the second is a computer simulation 'RiskMap'. While the role playing game immerses the learners into a 'real' situation in which their decisions can have far-reaching, but often unpredictable consequences, RiskMap allows learners to be more analytical in exploring how different groups of people in a rural society respond to a range of environmental situations.

The value of both activities was enhanced by being embedded within a course that is structured to provide a supportive framework for learning (Figure 1). For example, RiskMap is backed up by an activity in which the learners compile a portfolio on the geography of Ethiopia, are given journal readings on original research, and exposed to images of Ethiopia through DVDs, travel books and so on. Throughout the course the students developed their own concept maps that portray their understanding of the rural economy and resource utilisation in Africa. The final map is accompanied by a written reflection that explains how the map developed through the different course activities. These maps proved to be a useful tool by which we as teachers could assess the development of the students' understanding. Our philosophy is based on the Active Learning paradigm that, as Ramos (2005) notes, has as its core collaborative learning for social change. He states that

> In this age of heterogeneous changes and multi-fold social challenges, we need to be able to bridge learning about our futures with action and innovation in the present, in a way that is effective and accessible for lay communities and organisations, not just experts. Ramos (2005, 83).

Through this course our students are the lay communities who, through their professional careers, may come to guide the futures of rural Africans.

The Africa Catchment Game

The African Catchment Game was developed from Chapman's Green Revolution Game and Exaction (Chapman and Tsakok, 1984; Chapman, 1987). These games were developed by Chapman in the 1980s to highlight the importance of decision-making by rural peasants in India. Significantly, Chapman's philosophical approach was strongly influenced by systems thinking at much the same time as Conway (1987) and
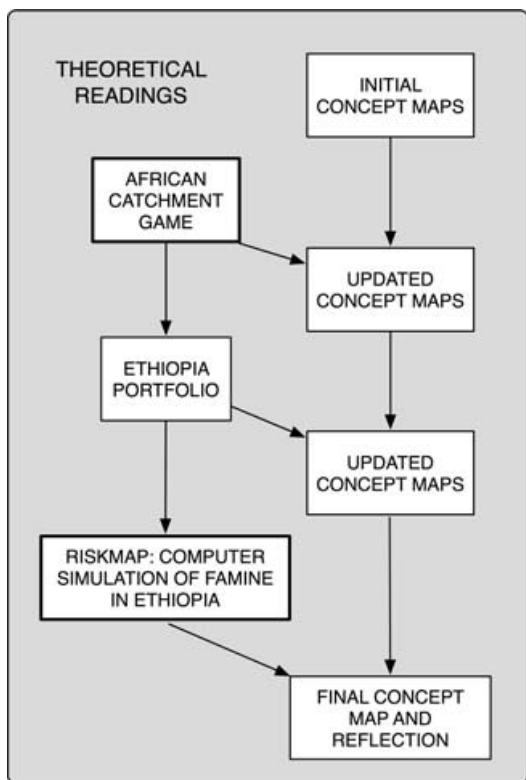
Bawden (1995) were advocating the need for systems thinking in agricultural research and education. The initial game (Green Revolution) was based on a simple rural economy. At the behest of the World Bank this was developed into a more complex whole country game (Exaction). According to Chapman and Tsakok (1984), both games incorporate a similar set of dimensions: a dynamic physical environment, agronomy, society, politics and economies. The game, therefore, is strongly rooted in integrating different disciplinary themes.

We have taken the game of Exaction and modified some of the basic parameters so as to more closely model the southern African situation. Key changes include the incorporation of a large-scale commercial farming sector, complete with starting assets and debt, cattle and HIV-AIDS. We also introduced a simple land degradation/soil conservation process. In the original game productivity would remain static unless increased through fertiliser application. Fertility would not decline. In our version we introduced a more dynamic process through which fertility could either decrease or increase depending on agricultural practices as follows:

1. continuous cultivation leads to a drop in soil fertility that is delayed but not prevented through the use of inorganic fertiliser;
2. fertility can be maintained through regular fallowing, and
3. organic manure (from livestock) improves the long-term soil fertility.

This simple model was designed to encourage students to engage with the following questions:

1. What are the biophysical requirements for sustaining soil fertility?
2. What are the long-term economic effects of poor farming practice that leads to a drop in productivity?

3. What conditions, experienced by households from the different socio-economic groups, would act as incentives and constraints to the practice of soil conservation?

Playing the game
Playing the game as part of the Rural economy and land utilisation in Africa course routinely follows a five-step process. Prior to the game the participants are given a set of readings about game playing. The various aspects of the game, its basic rules, progression and nature of the physical pieces used are explained to the players in a classroom situation. We play the game itself in an out-of-town location to ensure that participants are taken out of their own reality and are also dissuaded from finding alternative evening activities.

The game is played with between 21 to 35 players. We therefore play with a combined group of third year undergraduate students (as part of the course Environment and development in Africa) as well as the fourth year Honours students. This means that many of the Honours students play the game in two consecutive years, thus increasing their appreciation of its learning outcomes.

To play the game we need a large room to accommodate all players and their assets. The room is divided into two areas representing the rural sector and the urban sector, with a trading and banking zone linking the two.

On arrival at the venue the first activities are to lay out the room, allow players to choose roles and give a full briefing on how the game works. The roles in the urban and rural sectors are given in Table 1. Farmers play in pairs to prevent pilfering of farm assets. All other roles are played by individuals, but alliances often form, for example between the buyer and seller.

At the beginning of the game assets are handed out to each player (or player-pair). For

Table 1   Urban and rural roles. Numbers in brackets are the maximum numbers that can play.

Rural Manager	Rest of the World Manager	
Rural Sector	Urban-Rural Interface	Urban Sector
Commercial farmers (2 × 2) Subsistence farmers (8 × 2)	Banker (1) Seller (1) Buyer (1) Trader (1)	President (1) Minister of Home Affairs (1) Minister of Land and Water (1) Industrialist (2) Urban labour (2) Refugee (2) (can also be placed in the rural area)

the farmers, chance cards determine the family size and livestock numbers per family. Commercial farmers have nine fields each, two of which are irrigated and planted to sugar cane; subsistence farmers each have a garden and three fields.

The game follows a series (normally five to six) of annual cycles of production that start with the announcement of the rainy seasons. Each game cycle lasts for approximately one hour and normally five or six cycles are played in one day. The game cycle is illustrated in Figure 2.

There are three seasons – germination, middle growth and flowering – each of which may receive rain or drought according to cards turned over by the rural game manager. While all farms experience the same weather conditions, individual farms may be subject to pest attacks. After announcement of the rains the farmers calculate their rice or sugar cane production depending on the type of crop planted, the sequence of rain and drought, pest attacks, use of irrigation, application of inorganic or organic fertiliser, and application of pesticide. Likewise calves will be born to cows that have been serviced by a bull, and last year's calves grow up. During the rest

of the year's cycle the players must cultivate their fields, plant seed, sell their produce and buy farm inputs. Rice is measured in maunds (the unit used in the game, equivalent to one tenth of an adult's annual consumption). Ten maunds of rice are required per year to feed each adult, five per child. At the end of the year, any family member not consuming sufficient rice dies. At the same time the rural game manager announces births and natural deaths from chance cards.

Meanwhile, in the urban sector, the government is formulating policy and trying to raise revenue to run the country, the industrialist is manufacturing farm inputs for sale to the farmers or for export, the urban labour is dependent on jobs in the industrial area and the banker, and the trader and seller are trying to keep goods and money flowing freely. The Rest of the World Manager deals with the export sector and foreign exchange dealings.

The rules of the game are relatively simple.

1. Every adult must eat ten maunds of rice to stay alive, each child five maunds.
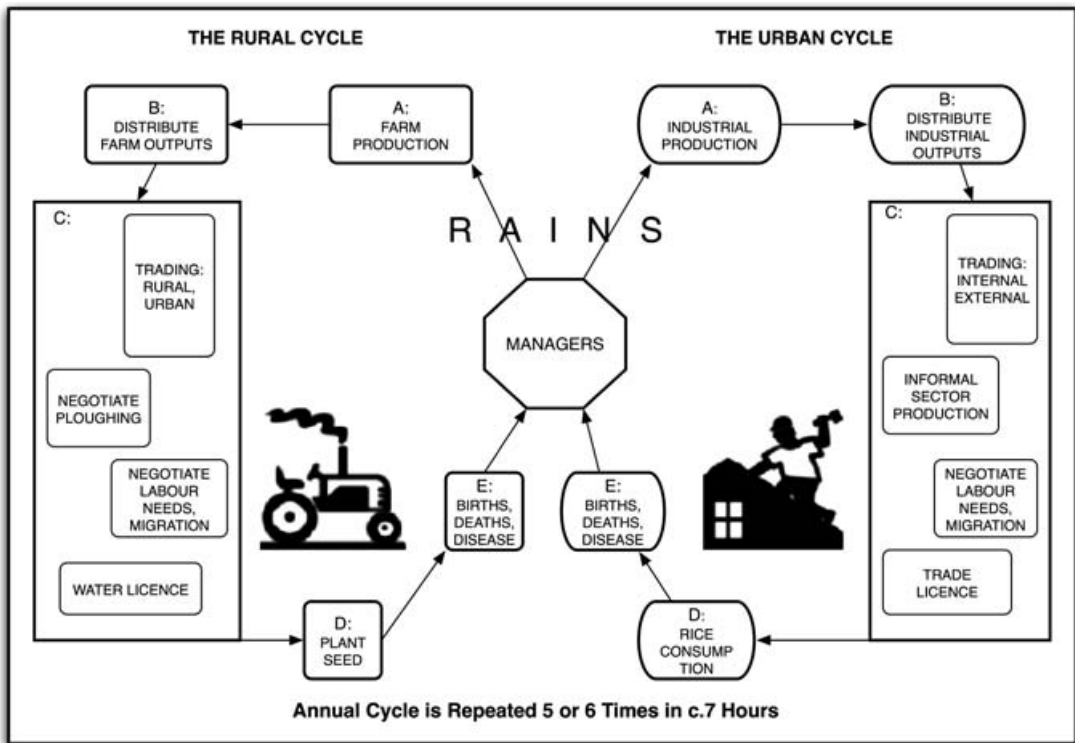

Figure 2   The game cycle.

2. Farm productivity is determined by: rice variety sown, the sequence of rain and drought, and pest attacks; mitigated by irrigation, pesticides, fertiliser (inorganic or organic) and fallowing.
3. Industrial output is subject to hazards such as water shortages and electricity failure, and machine failure, determined by turning over a set of cards.
4. Global prices fluctuate according to cards.
5. The banker, buyer and seller are seated at the interface between the rural and urban sector and are accessible to all game players, but no one can move between the urban and rural sector without some form of transport.
6. The trader starts the game with a bicycle, the commercial farmers each have a farm vehicle and the government has one Mercedes car. The physical token for transport is a badge worn by the user.
7. Rice can only be stored in a 'go down' or granary, which can be manufactured by the industrialist and purchased by the farmers.
8. The President determines who can trade with the rest of the world by issuing trade licences.
9. All game activities must stop when the coming of the rains is announced.

From these simple rules a great number of game variations can develop. Each game consists of a complex set of transactions and networking; no two games are the same and the outcome of a game cannot be predicted in advance.

At the end of a day's play the players record their starting and finishing assets and make brief notes on what happened during the day. This is followed by a short debriefing session. The whole process is repeated the next day. Players may keep or change roles as they wish.

Two days after the game session the players are required to write a reflective account describing and interpreting what happened to them in the game. This exercise helps the students to consolidate their learning and put it into the context of the course. It is from these reflections that we as teachers are able to learn of the students' experiences.

What students experienced
The learning outcomes are best examined through looking at the student reflection exercises that they were required to write a few days after playing the game and the final reflections accompanying the concept maps at the end of

the course. The work of the Honours class of 2003 is examined in detail below. First we need to examine the broader context since 30 Third Year students participated in the same simulation and they also wrote reflection exercises – though they were more limited in scope.

The third years' reflection exercises showed that almost all of them had passed beyond the describing and observing phase of Kolbe's learning cycle to exhibit good examples of reflecting or concluding. Only three gave simple descriptive accounts whereas 17 had developed their insight through reaching logical conclusions. The remaining 10 students showed analytical and theoretical learning and four of these went further still. They compared the African Catchment Game to Risky Business, a computer based agricultural simulation that they had read about (Stewart *et al.*, 2000).

Melita, for example, wrote:

> Both games seek to enable students to learn through their own actions and how their decisions and forces out of their control can affect how successfully they are able to survive.

Bronwyn wrote in a similar vein:

> I feel that both games provide a similar educational experience, in that they increase your awareness and understanding of various principles and methods. They both stimulate learning so you actively learn, thus retaining more than you realise.

Both of these quotes show how the students have been introduced, through participation, to understanding about the interactions of systems.

Five students made up the Honours class: Taralyn and Jona from South Africa, Nomi from Lesotho, Phumzile from Swaziland and Olu from Nigeria. All students came from urban backgrounds. In the game Phumzile and Olu were subsistence farmers, Nomi was a commercial cattle rancher, Taralyn and Jonathan were refugees in the rural area. Seven quotes have been selected for discussion.

They learnt that in order to practise sustainable agriculture one not only needed to be aware of the consequences of land degradation, but one also needed the physical, human and financial capital to practise soil conservation. The stresses of survival and lack of access to land or to alternative sources of income were seen as significant deterrents to conservation.

> Whilst playing the catchment game, it became obvious that the issue of environmental

degradation in the Third World is a livelihood issue. It made me discover that as long as people are concerned and preoccupied with surviving, they will never have time to concentrate on soil conservation issues. (Phumzile concept map reflection.)

As Lal (2001) notes, in small farms the over-utilisation of land due to land shortage will always be a major contributing factor to soil degradation ... . In our case, as refugees we only had two plots of land and this had to be used to feed ourselves. To survive, soil erosion preventative measures were not always adopted and this led to our land steadily declining from high to low productivity levels. (Taralyn, ACG reflection.)

An important concept running through many of the participants' reflections was that of developing risk aversion strategies to cope with the vagaries of life in Africa. Jonathan in his concept map reflection noted that:

I think risk aversion is the single most important concept that I have gained from this course, that is why I believe the catchment game is a vital teaching tool. (Jona, concept map reflection.)

On the second day some participants had learnt from the experience of the previous day and were able to put into effect risk-aversion strategies. In this second game Olu was running a government farm and had access to increased assets and was able to protect himself from drought and pest attacks.

I had to modify my survival strategy (from) Saturday's game because of the experience I had when I played the role of a smallholder farmer. I provided my farm with all inputs that would produce high yields even in the worst situation where there would be drought and pest attacks during the whole planting season. (Olu, ACG reflection.)

Through playing the game the internal and external complexity of rural development and its links to the urban and global economy became apparent; solutions to land degradation would have to match this complexity.

Where land is not the scarce resource, cash or labour may be the limiting factors. This was the case for my group who were cattle ranchers in the ACG. Other small-holders within the game may have had labour, but not enough land to plant rice for their subsistence needs. What this (game) highlighted in terms of rural development was that local communities are dynamic and internally differentiated, and their environmental priorities and natural resource claims are positioned differently and governed by varying institutional dynamics, as well as differing and sometimes conflicting power relations. (Nomi, essay comparing RiskMap and the ACG.)

The students as participants began to appreciate the gap between the expert knowledge of professionals and the realities of life as experienced by people living on the land or in urban areas who are trying to make a go of it.

It made me think about how we as environmental professionals even begin to address the problems of rural development and land degradation when we are dealing with such a myriad of problems. Where do priorities lie when addressing the problems related to rural development and land degradation? This is a question that I definitely cannot answer. (Nomi, ACG reflection.)

A particularly telling observation came from Jona, whose whole perception of the challenges facing rural Africa was turned around.

I had always assumed that the challenge for a rural person was to uplift themselves and progress forwards. After this game I now understand that for many people the challenge is survival, successfully supporting oneself and family. I realise that (not recognising) this paradigm shift from upliftment to survival is one of the major stumbling blocks of aid policies. (Jona, concept map reflection.)

Through these quotes we can see that the students not only better understand the constraints to soil conservation experienced by the individual householder, but that they have also become aware of the complexity of life in rural areas, of surviving through uncertainty, and the importance of the household's asset base. In short, the simulation has succeeded as a type of process teaching and, having shown that they have learned, the students should be better prepared to grapple with real-world problems faced by a rural development agency or soil conservation office.

RiskMap

RiskMap was developed as an early warning system to monitor food security and is based on

the Save the Children Fund-United Kingdom's household food economy approach (Moseley and Logan, 2001). In our course we use it as a teaching tool to raise our students' awareness of how geography and social groupings contribute to the complexity of household food economies and the response to food deficits. Through this understanding the students can better contextualise the possible causes and responses to land degradation in a rural area of Africa beset by drought. The students apply RiskMap to Ethiopia.

RiskMap is a computer model that allows users to examine, for a given country, the ways in which different households respond to food shortages. The model is based on real field data collected in rural areas and analysed by economic group – modal, rich, poor. The country is subdivided into food economy zones based on ecological regions and the agri-economy (Moseley and Logan, 2001). For Ethiopia, annual data from 1985 to 1999 are available for each subregion. Outputs are available for each economic group, describing the actual deficits for the different income sources and how these deficits were made good – or not – as the case may be.

Model users start by examining the 'real' situation year-by-year; they can then run the model to manipulate parameters so that different scenarios can be examined for their consequences in terms of food deficit and response. We ask the students to run scenarios such as 'what will be the effect on food security and household response if land degradation has reduced productivity by 10%?'

Students are asked to select two regions for comparison, one from a highland region dependent on cropping, and one from a lowland region dependent on livestock. For each region they had to:

1. Compare the real situation in good and bad years.
2. Compare the deficits and coping mechanisms for different income groups.
3. Run the model assuming that productivity has been reduced as a consequence of land degradation.
4. Consider the likely consequences of, and response to, land degradation for the different economic groups in the two geographic regions.

Model outputs
Examples of model outputs as presented by the students are given below. Model outputs can be in the form of tabulated data or pie charts.

The first set of analyses compares the household food economies of Tigray, a mountain area largely dependent on cultivation, and Ogaden, a lowland area where livestock are far more important. The first output, given in Table 2, is the percentage of 'normal' annual food need per household category for the two regions. It is clear from this table that the different income groups rely on different food sources, and that this varies between the two regions. In Tigray the rich are far more reliant on their own food crops and livestock whereas the poor have a wider range of food sources. In Ogaden it is the rich who rely most on their own livestock, whereas the poor are more reliant on food crops. In general the poor are less reliant on the land and more reliant on purchases. This highlights the importance of a cash income to this group. The implications are that the rich families are those who will both lose most through land degradation and who have the resources to implement soil conservation. Poor families will be less impacted directly by degradation, but neither will they have the resources to prevent it. These results raise

Table 2 Food sources by household category ('normal' year).

| Food source | Percentage of food needs per household category | | | | | |
| | TIGRAY (highland zone) | | | OGADEN (lowland zone) | | |
	Poor	Median	Rich	Poor	Median	Rich
Own food crops	35–45	55–60	80–90	15–20	5–10	0–5
Milk or meat	0	0–5	5–10	10–20	30–40	60–70
Fishing	0	0	0	0	0	0
Wild foods	0	0	0	5–10	0–5	0
Gift or relief	35–45	10–15	0	15–20	0–5	0–10
Purchase	20–30	30–40	5–10	40–50	45–55	30–35

important pointers as to who should be targeted in soil conservation projects.

The next table, Table 3, gives the results for one of the worst drought years, 1990. The poor of Tigray Highlands have the largest deficit, mainly through a lack of relief. The rich have a lower deficit, but it can be seen that their crops have suffered badly. In the Ogaden Rangelands the rich suffer from loss of meat and milk, while loss of income becomes more of an issue for the other two groups. These results reinforce the conclusion drawn above that it is the rich who are most dependent on the land and will suffer the most from direct loss of agricultural productivity. At the same time the rich are less vulnerable as they can fall back on food stocks and savings. The poor are reliant on gaining employment or, in the Ogaden Rangelands, gathering wild foods, an important food source for all groups in this area.

The next example shows how RiskMap was used to explore the tasks.

1. Run the model assuming productivity has been reduced as a consequence of land degradation.
2. Consider the likely consequences of and response to land degradation for the different economic groups in the two geographic regions.

The results of this analysis for poor households in the Ogaden Rangelands food economy region are presented as three pie charts in Figure 3. The first chart represents a 'normal' year, where normal refers to that experienced most frequently. It can be seen that in this region poor households are more or less equally reliant on food crops, milk and meat and wild foods, but nearly one half (44%) of their food is purchased. The drought of 1985, illustrated in the second chart, caused the production of food crops to be reduced by one half. If the overall productivity of food crops and livestock products is reduced by a further 10% as a result of land degradation, illustrated in the third chart, the food crop deficit is increased and there is also a small deficit in livestock products. Of note is the increased income deficit due to decreased employment opportunities. This reduced the household's capacity to purchase food.

What the students experienced

Three quotes have been selected to exemplify the learning experience of the five Honours students who undertook the RiskMap exercise in 2003. These quotes tell their own story and illustrate how the students were able to link a reduction in food self-sufficiency to land degradation, to assess the differential impacts on

Table 3   Deficits and coping strategies for 1990, a severe drought year.

DEFICIT 1990	AREAS and their DEFICITS (%)					
	TIGRAY CENTRAL			OGADEN RANGELAND		
	Poor	Mode	Rich	Poor	Mode	Rich
Income	12	16	–	22	24	6
Food Crop	24	40	54	16	7	–
Milk/Meat	–	–	4	14	32	59
Fishing	–	–	–	4	4	–
Relief	36	9	–	–	–	–
TOTAL DEFICIT	74	65	58	56	67	65
COPING STRATEGIES						
Food Stocks & Relief	–	–	35		5	15
Wild foods	–	–	–	16	17	14
Cash savings	–	5	17		4	19
Employment	20	18	6	15	15	11
Livestock sales	–	–	By employing	1	1	–
Other trade	–	–	the above,	–	–	–
Non-food production	–	–	all the deficit	–	–	–
Non-market redistribution	1	1	is overcome	–	–	–
TOTAL REMAINING DEFICIT	53	41	0	24	25	6

'Normal' year

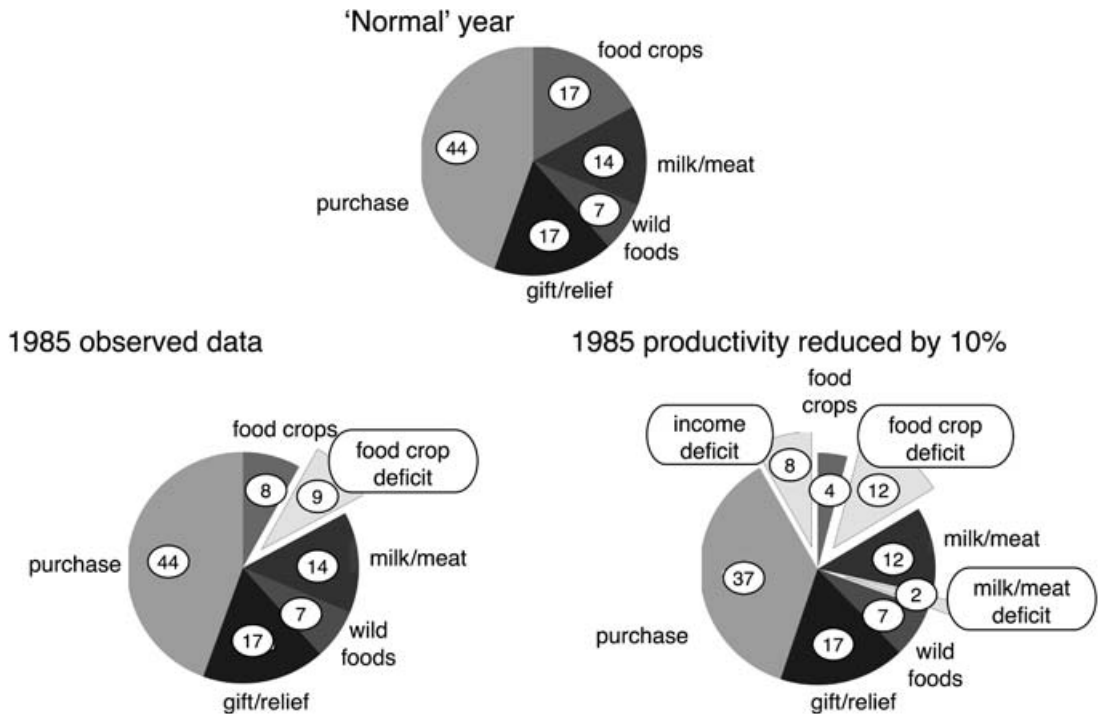1985 observed data

1985 productivity reduced by 10%

Figure 3   The impact of a 10% reduction in land productivity on poor households in the Ogaden rangelands in 1985, a year of moderate drought. The chart of the 'normal' year shows the percentage by food source as experienced most frequently.

different economic groups and their potential or inclination to adopt soil conservation measures.

The first two quotes are from Jona who starts with a straightforward descriptive observation on the effects on food self sufficiency of reducing the productive potential of the land:

> By modelling a 20% decrease in the productive capability of the land as a result of degradation, it was evident that this had a dramatic effect on the ability of rural Ethiopians to consistently meet their food requirements. (Jona, concept map reflection.)

Jona then goes on to analyse how land degradation will impact on the different economic groups:

> Risk map also enhanced this understanding, whereby it became evident that the more the land became degraded, the more the poor became vulnerable. This is because they have a low asset-base, no food stocks and no cash savings to fall back on in food deficit years. The rich and modal groups at least have some food stocks, cash savings and assets to use for purchasing food during really bad times. (Jona, concept map reflection.)

The last quote, from Nomi, shows a high level of insight that extends her thinking beyond the RiskMap exercise itself; she realised the danger of applying simplistic models to solving problems within a complex of rural environment.

> Risk map reversed a commonly held conception, developed through the exhaustive reading of literature, that emphasises the dependence of rural people on the land ... the model indicated that they have other sources of income to depend on. This indicated to me the possible reasons that attempts at addressing land degradation issues fail in a lot of African countries. This was a very insightful exercise. (Nomi, concept map reflection.)

The strength of RiskMap is the way that it makes students aware of how different social groups in different geographic areas develop their own survival strategies to cope with drought-related risk. The varying dependence on land will affect their vulnerability to land degradation as well as their willingness to invest in soil conservation measures. This in turn will impact on the effectiveness of soil conservation strategies, as noted by Nomi above.

Conclusion

Through the two learning activities, the African Catchment Game and RiskMap, the students experienced the complexity of rural livelihoods in Africa and began to make connections between this complexity and causes, consequences and strategies for controlling degradation. The students gained different but complementary insights from the two activities that were quite different in their approach.

Through the African Catchment Game the learners gained real experience in an imaginary world. In the words of Chapman (1989, 311):

> In sum, these simulations replicate the reflexive complexity of reality because they create a true reality in which the clock cannot be turned back, in which ignorance, apathy, fear, excitement, ambition etc. play as important a role as in everyday life.

In RiskMap the learners work with real data from a real country to explore the relationship between livelihood strategies and risk, but do not enter the lives of the people themselves. They experience an objective reality.

> Risk map reinforced the concepts ... by providing 'real numbers'. The use of actual figures 'made real' for me what previously were abstract concepts. (Jonathan, student reflection 2004.)

Nomi makes the perceptive observation that development practitioners must recognise that rural livelihoods are not necessarily dependent on agriculture, but on a whole range of options, an assessment reinforced through the two learning activities.

> Riskmap and the ACG indicated how varying factors influence livelihood options of people in rural areas. The two simulations indicated how policy and interventions by extension officers should adopt a sustainable livelihoods framework of analysis, as this allows for a deeper understanding of the different livelihoods and the choices that rural people make, and thus underlying factors can be targeted in mediation. Without a firm understanding of the reasons that people make the choices that they do, agriculture will continue to be viewed as the mainstay of rural development even in areas such as Ethiopia that have inherent impediments to agricultural growth. (Nomi 2003 essay comparing the two activities.)

Role-playing games have been used since the 1980s as participatory tools to help both development practitioners and rural communities in developing areas to come to grips with their own complexity (Chapman, 1989). More recently, role-playing games have been used as an adjunct to modelling multi-agent systems so as to better address the complex social issues surrounding the use of common natural resources such as water (Daré and Barreteau, 2006; Farolfi and Rowntree, 2006). In this paper we have described the use of role-playing games and simulation models to promote active learning by students, most of whom had little experience of African rural societies. Their reflections, examples of which are presented above, confirm that the students have begun to confront the complexity that underlies the political ecology of land degradation. We have achieved this through aligning our teaching pedagogy with the new paradigms that have been so influential in the research field. It is our hope that as future professionals they have become better prepared to contribute to the development and practice of development policies that support the sustainable use or natural resources and curb land degradation.

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