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Environmental Assessments of Landscape Changes

Interdisciplinary studies in rural Tanzania

Uppsala 2004

Doctoral dissertation for the degree of Doctor of Philosophy in Environmental Analysis presented at Uppsala University in 2004.

ABSTRACT

Simonsson, L., 2004. Environmental assessments of landscape changes. Interdisciplinary studies in rural Tanzania. *Geografiska Regionstudier*, no. 58, 58 pp. Uppsala, ISBN 91-506-1736-2. English text with a summary in Swedish.

This thesis aims to show how biogeophysical and social processes are interlinked in landscape change, and to propose approaches for interdisciplinary environmental assessments (such as EIAs), concentrating on developing countries' situations, and representation of findings from such studies.

Landscape in its holistic sense is a very good concept and basis for intellectual and practical use in environmental dialogues. However, landscapes are valued and assessed differently, depending on cultural background along with individual characteristics.

Methods of conducting interdisciplinary environmental assessments need to vary, but it is important to follow a structure to avoid too broad and general studies that only assemble a few factors and present them without an integrated synthesis. This thesis has suggested one research sequence and structure that has proven to be practical and possible to execute in areas where data is scarce and where local involvement is a major component. It extends the observation period in time and space where remote sensing analyses are integrated with interviews, archive material, land-cover assessments and soil analyses.

Case studies from Tanzania have been used to investigate how perceptions of land and resources manifest themselves at local scales and how this information can contribute to sustainable environmental planning. Preferences and perceptions of land as being 'important' and 'good' do not always correlate with favourable biogeophysical conditions, indicating that both social services, such as health care, access to markets, education and employment, as well as "non-rational" factors are essential to consider in environmental planning and management.

This study has partly been part of a larger research project investigating the links between human livelihood and biodiversity in miombo woodlands. It has been shown how miombo woodland is important to local populations as it provides material goods as well as many intangible services. However, it is also associated with problems and dangers, which are important to consider and understand in planning for the environment and sustainable development.

Key words: Environmental assessment, interdisciplinary methodology, landscape, perceptions, preferences, land, forest, miombo woodlands, resources, biodiversity, Tanzania.

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SUMMARY IN SWEDISH

Avhandlingen behandlar det holistiska landskapsbegreppet och hur det kan användas som en gemensam bas för tvärvetenskapliga studier i miljöanalyser och miljöbedömningar.

Fallstudier utförda i Tanzania har legat till grund för diskussionerna som förs i avhandlingen. Dessa fallstudier har utförts i två skilda områden som valts ut på olika kriterier, men båda har utgått från större områden och sedan övergått i koncentrerade studier på lokal (by)nivå.

Resultaten är främst ämnade för arbete i utvecklingsländer där data ofta är otillräckliga, och där studien utförs av experter med annorlunda perspektiv än de som kommer att beröras av det föreslagna projektet.

En metodologisk ansats har använts och utvecklats där tekniker och metoder från flera vetenskapliga fält, med olika informationskällor med olika noggrannhet, kompletteras och interagerar i en följd över olika geografiska skalor. Dessa inbegriper bland annat fjärranalys, intervjuer, jordanalyser och arkivstudier.

Avhandlingen har åskådliggjort betydelsen av att landskapet ses som en helhet där mänskliga och naturliga processer interagerar i olika rums- och tidsskalor. Vidare påvisas hur uppfattningar om miljö, landskap och naturresurser skiljer sig åt beroende på perspektiv. Fysiska, mätbara, och synliga objekt betonas ofta av "främmande" personer, vilket dock måste kompletteras med insyn i sociala och historiska faktorer för att ge en nyanserad helhetsbedömning av ett landskap.

Fallstudierna har visat att lokala uppfattningar om områden som anses vara "bra" eller "viktiga" inte nödvändigtvis överensstämmer med de områden som är av god biogeofysisk kvalitet för t. ex. odling. Faktorer som tillgång till sjuk- och hälsovård, skola, marknader och arbete, men även "icke-rationella" faktorer är betydelsefulla vid val av plats för bosättning och odling.

Denna studie har delvis varit del av ett större forskningsprojekt som har undersökt hur mänsklig aktivitet interagerar och påverkar biologisk mångfald och förändringar i marktäckning i torrskogar av *miombotyp*. Resurser av både konkret och abstrakt natur, som återfinns i denna typ av skog är av stor vikt för lokalbefolkningen. Människor är starkt beroende av produkter från *miombon* men resultaten visar att denna fragmenteras och försvinner i fallstudieområdet. Skogen associeras dock även med problem och faror. Dessa inställningar och uppfattningar om närmiljön är viktiga att studera för planering som syftar till att vara uthållig för ekologiska och mänskliga system.

PREFACE

The thesis is based upon the following papers, which in the text are referred to by their Roman numerals:

- I Strömquist, L., Yanda, P., Msemwa, P., Lindberg, C. and Simonsson-Forsberg, L. 1999. The extended baseline perspective – utilising landscape information to analyse and predict environmental change. A Tanzanian example. *Ambio* 28(5): 436-443.
- II Strömquist, L., Simonsson, L. and Backéus, I. 2003. Assessing miombo woodland changes by field based remote sensing and GIS. A case study of the Ihombwe area, Tanzania. *Forest Ecology and Management*. Accepted.
- III Simonsson, L. 2003. Landscape as an arena for applied environmental studies. *Norwegian Journal of Geography* 57(1): 40-48.
- IV Simonsson, L. 2003. Landscapes and biodiversity. Land preference studies in a miombo woodland area in Tanzania. Submitted to *Agriculture, Ecosystems & Environment*.

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Important information

Note that the name of the author of this thesis, Simonsson, L., is the same person as Simonsson-Forsberg, L. as the family name has been shortened since the first paper was published.

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The disciplinary belonging of this study has not been obvious and has created various discussions. It is a thesis in Environmental Analysis at the Faculty of Sciences. However, it is also a study in the integrated subject of Geography, i.e. not Social and Economic Geography or Physical Geography. Therefore I am very grateful to the Department of Social and Economic Geography that allowed me to publish this thesis in their series '*Geografiska Regionstudier*', and for kindly permitting me to finalise my writing at their Department.

This study is based on other people's knowledge. Therefore the greatest thanks goes to the people of Gidas, Sangaiwe, Mwada, Bubu, Nakwa, Riroda, Endaberg, Ihombwe and others in Babati, Kilosa and Morogoro who have lent their valuable time and offered their knowledge to me. Also, in Tanzania special thanks are due to Mr Henry Kessy for being an excellent field companion and translator, and to professor Pius Yanda who despite his busy schedule always have been willing to discuss and assist in finding material. Clas Lindberg's love for the Tanzanian people was so evident that it also became mine for which I am most grateful. *Asante sana!*

For other scientific matters I have drawn upon the knowledge and experience of my supervisor, professor Lennart Strömquist, and the 'men of the miombo forest': Ingvar Backeus, Per Brandström, Allan Carlson, Börge Pettersson and Urban Emanuelsson. All students who have participated in the miombo project have contributed with data and information that has been valuable to this study.

The interesting and rewarding journey from the natural sciences into the realm of the social and humanistic sciences was made possible through patient supervisors, colleagues and fellow course students "on the other side". Especially important to me was the course "*Europas gränser*" 1999 where I met my friend and discussion partner Kristina Tegler.

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Hilde and George in London and in Sweden. My partner in travelling crimes –Erik – whenever we happen to be in the same place. The best time of the week which no thesis in the world can stop – Tuesday evenings with horses and friends that always have been great and absolutely necessary for the handling of university and work issues. Reality check-ups every Christmas with Malin, Fredrik, Ulrika, Jonas, Daniel and Sara. Annie, Markus, Sofie and Magdalena who have made sure that laughter were present also outside working hours. Encouraging and supporting times with Mamma, Bengt, Daniel, Fredrik, Ebba, Bim, Göran and all others in my immediate and extended family. Zeb for being the loveliest creature on the planet who cure bad times and replace them with pure energy. Erland, you are probably the most understanding and patient man in the world! I will always owe you for everything.

Sommarro, New Years Day, 2004

Louise Simonsson

ABBREVIATIONS AND ACRONYMS

CBA:	Cost Benefit Analysis
EIA:	Environmental Impact Assessment
FAO:	Food and Agriculture Organization of the United Nations
GIS:	Geographical Information Systems
LCA:	Life Cycle Analysis
NTFP:	Non Timber Forest Product
NTSP:	National Tree Seed Programme (Tanzania)
RA:	Risk Analysis
SADC:	Southern African Development Community. Member states are: Angola, Botswana, Democratic Republic of Congo, Lesotho, Malawi, Mauritius, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia, and Zimbabwe.
Sida:	Swedish International Development Cooperation Agency

INTRODUCTION

In debates about environment and development, people are often seen as exploiters and destroyers of natural resources. Changes in land-use and land-cover (that may in fact in many cases be natural variability) are often associated with bad management practices by local rural people. Underlying drivers of change are, however, usually more complex than that, involving various processes in the landscape with different scales in time and space. This thesis will discuss these problems based on case studies in Tanzania.

Gómez-Sal et al (2003) argue that the definition of sustainability must include references to the ecosystem and to a healthy and natural, integral environment that supports productive human activities. Consequently, to separate the cultural system from the natural ecosystem is impossible. The loss of useful knowledge on the resources and the ecosystems that generate them – cultural erosion – is then considered to be as serious as the physical erosion caused by abandonment of adapted uses of ecosystems. There is thus an urgent need for those involved in environmental studies and environmental management projects (donors, consultants and researchers alike), active in the Third World, to discuss and become aware of differences in perspectives, to be able to achieve sustainable solutions for people and nature.

In the popular view of Africa, people are often excluded both literally, and in the imagination of, the “natural” landscape. However, if landscapes are not defined as scenery only but as encompassing both the conceptual and the physical, then what some call ‘wilderness’ is a cultural landscape to its present or former inhabitants who fill it with places, tracks, traces and meaning. Different perspectives answering to different rationalities then enter into its evaluation. Landscape could in this sense be a useful concept and act as a common arena for various disciplines in environmental studies, where human and natural interests can be communicated without having to be viewed as separate systems. Integration and assessment for the purpose of managing public resources hence require more than the disciplines of the natural sciences, as well as incorporation of local knowledge and perceptions.

There is indeed a growing consensus about the suitability of a multi-criteria approach when dealing with natural resource management problems and environmental planning, areas where there are many conflicting interests (Gómez-Sal et al 2003). However, much could be achieved in the name of integration were there to be less professional and academic territoriality, more sharing of knowledge and expertise, and more mutual trust and understanding (Scrase & Sheate 2002). Thus, to achieve this, interdisciplinary methods and approaches are crucial.

SCOPE AND OBJECTIVES

This thesis aims to show how biogeophysical and social processes are interlinked in landscape change, and to propose approaches for interdisciplinary environmental assessments (such as EIAs), concentrating on developing countries' situations, and representation of findings from such studies. Often, links between human and natural processes are not recognised, which creates difficulties when environmental change is to be predicted and explained.

The underlying assumption for this work has been that people's perceptions of landscape and environment differ, why they are important to recognise and analyse. Case studies have been used to investigate how perceptions of land and resources manifest themselves at local scales and how/if this information can contribute to sustainable environmental planning. Furthermore, case studies will demonstrate whether the holistic concept of landscape is a suitable arena for interdisciplinary environmental studies.

My own academic experience has meant that research questions had to be developed during the project. It mainly started with a natural science perspective and has then widened to incorporate issues and methods of social and humanistic sciences. Therefore this dissertation should be viewed as an interdisciplinary thesis where the main discipline is geography with an environmental and developmental focus. This thesis is thus meant primarily for a natural science audience, those interested in interdisciplinary research, and/or those who are professionally involved in environmental planning and management in developing countries.

Research structure

This dissertation builds upon two main case studies from Tanzania. Both case studies commenced with regional perspectives and then zoomed in to local scales at village levels. The independent research project, here referred to as Case study I, somewhat focused the research questions for Case study II. Case study II was part of a larger Sida-financed interdisciplinary research project on "*Fragmentation of miombo woodlands and its implications for biodiversity and human livelihood*". Naturally, issues in Case study II therefore centre on biodiversity in a miombo woodland's setting. Case study II had to answer various research questions put forward from everyone involved in the project, which of course put high demands on site selection.

Tables 1 and 2 explain the research sequences and details of the Case studies.

Table 1. Selection criteria and research interest of Case study I

Location	Selection criteria	Research issues	Results presented in
Babati District	<ul style="list-style-type: none"> - Large quantity of data available - Prehistoric and historic human inhabitation proven - Dynamic natural and human environment - Large scale projects with outside involvement (e.g. tsetse clearings in the 1940s and today's LAMP¹ project) - Great variation in 'landscapes' 	<ul style="list-style-type: none"> - Assessment of land-use changes - Assessment of natural resource use - Perceptions of land 	
Seven villages: Bubu, Gidas, Endabeg, Mwada, Nakwa, Sangaiwe, Riroda	<ul style="list-style-type: none"> - Socio-economic statistics were available - Aerial photographs were available - Different natural and social settings, such as: central /remote, forest/savanna, livelihoods (pastoral, agro-pastoral, agricultural), and ethnic compositions. 	<ul style="list-style-type: none"> - How are natural and cultural processes interlinked in this landscape? - Are there important aspects of landscape character and change invisible to the eye of an "outsider"? - Can qualitative and quantitative information be expressed simultaneously to reach interdisciplinary syntheses? 	Simonsson 2000
Focus studies: Gidas and Sangaiwe villages	<ul style="list-style-type: none"> - Represents common findings well - Interesting linkages and findings - Sangaiwe is bordering a National Park increasing the influence of the so called 'natural' 	<ul style="list-style-type: none"> -Shows linkages between natural and human influence well -Contributed to the landscape idea as expressed in this thesis -Synthesised methodology (map-making with several sources of information in combination with remote sensing analyses) 	Strömquist et al 1999 (<i>Paper I</i>); Simonsson 2003 (<i>Paper III</i>)

¹ Land and Management programme financed by Sida, administered by Orgut Consulting AB.

Table 2. Selection criteria and research interest of Case study II

Location	Selection criteria	Research issues	Results presented in
Morogoro region	<ul style="list-style-type: none"> - Areas of miombo woodlands present - Information available and co-operation possible with Sokoine University - Information available on historic land-use - Infrastructure (railways and mototracks) present since German colonial times 	<ul style="list-style-type: none"> - Assessment of natural resource use - Assessment of extent of miombo woodlands - Assessment of local knowledge and NTFP utilization in miombo woodlands 	Chilimo 2001
Kilosa District	<ul style="list-style-type: none"> - Several different types of settlements - Area of immigration and population growth - Interesting geomorphological features - Information available on historic land-use and forest management 	<ul style="list-style-type: none"> - Linkages between miombo forest and geomorphology - Assessment of differences in miombo woodlands depending on settlements and infrastructure 	Ahlberg 2003; Thorén 2004; Holmborn 2003; Backéus et al 2004
Focus study: Ihombwe village	<ul style="list-style-type: none"> - Isolated in reserved lands during a long period of time - Unusually, for the District, large unreserved miombo tracts within village lands - Bordering a National Park increasing the influence of the so called 'natural' 	<ul style="list-style-type: none"> - Perceptions of land and forest - Linkages between biodiversity and human settlements (disturbance) - Local and external resource-use in miombo woodlands - Drivers of land-use changes 	Fors 2002; Brus & Norrlund 2004; Strömquist et al 2003 (<i>Paper II</i>); Simonsson 2003 (<i>Paper IV</i>)

BACKGROUND

Perceptions of the whole

The holistic implications of the systems approach (such as holistic landscape approaches) have often been criticized as being a naïve and an unrealistic fantasy (c.f. Naveh 2000). Indeed, like any scientific concept, a system is a construct of our mind. This is thus contrary to the Newtonian-Cartesian science paradigm, by which scientific descriptions are believed to be independent of the human observer. According to Descartes, the understanding of nature and realization of certainty are achieved first by a separation from the natural world, then by its precise measurement. This has led to a utilitarian criterion of truth, and a reduction of the 'object' of knowledge to an instrumental relation or quantifiable value which has been further developed into a statistical technique (Naveh 2000). The Cartesian paradigm has led not only to the belief in the objectivity of scientific knowledge but also to its certainty. However, when we deal with human-influenced and modified landscapes we need to learn to deal with uncertainties, complexities and fuzziness.

Thus, for instance, if we look at the forest through a narrow reductionistic window, we will be able to observe and study nothing more than the sum of its trees plus many other organisms and other elements, such as soil, water, and air, existing together as unstructured aggregates. If on the other hand, our view of this forest is guided by a holistic systems approach, we perceive the forested landscape as an adaptive ecological system², an interaction system, which is more than the sum of all its components.

Koestler (1969) claimed that neither parts nor wholes in this absolute sense exist, and that this is true not only in the domain of living organisms but also in ecological and social organization. Instead there are intermediate structures on a series of levels of ascending complexity. However, this theory is not easy to practice and comprehend throughout a project, and analysis and holistic character are difficult to integrate (Antrop 2000). A more operational definition is that each element only gets its meaning, significance or value according to the context or the surrounding elements. This has the following important consequences:

- The value of an element is not absolute, as the same landscape element may have larger or lower value according to its geographical situation;
- Changing the element, also changes the whole; and
- Changing the context changes the quality of the included element.

In current landscape theory, there is considerable consensus about conceiving landscapes holistically (Antrop 1998).

Seeing the whole

A *landscape* is more than what meets the eye. We perceive, understand and create the landscape around us through the filter of our social and cultural background and milieu. According

² Naveh & Lieberman (1984) introduced this concept as the adaptive ecological Gestalt.

to postmodernistic thoughts in geography it has become impossible to deny that our own explanations are culturally constructed; even if they refer to an independent reality. A full understanding of how people perceive and experience landscapes thus assumes that we do not rely totally on the exclusively visual. However, what is registered in a landscape analysis will ultimately be the result of a subjective choice as to what is considered as significant in the landscape, and depends on factors such as ethnic affiliation, gender, economic interest, social class, professional and academic training, etc.

Perception also generally differs between “insiders” and “outsiders” as illustrated in Figure 1. Most ‘experts’, developers and policy-makers are outsiders to the area where they are to work. This is particularly important in developing countries.

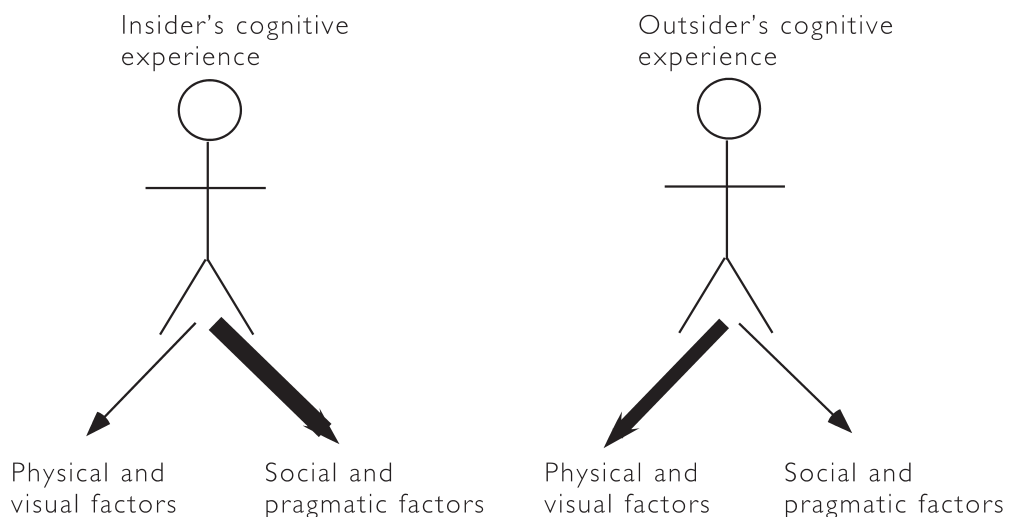


Figure 1. *Landscape appreciation in typical insiders and outsiders.*
After: Aasbø (1999)

Also, a social value could be national and regional identity. For example, in the minds of many Swedes much of the identity of the home district is connected with nature and the landscape³. The old Nordic (with a Germanic origin) apprehension of ‘land’ and “*landskap*” indeed emphasised a close relationship between land (land, soil), law and people: the land as an expression of its people (c.f. Olwig 1996). From this perspective land does not have any meaning without the consideration of the people’s history and identity.

Local people’s participation in environmental management

While most conservation practitioners now advocate the involvement of local communities in their programs, there is only limited evidence of local people’s views being assessed and incorporated into the planning, management and implementation of projects. Moreover, there is little recognition of the complexities of participation, and methodological difficulties are often swept under the carpet (Grimble & Laidlaw 2002). Recognizing the divergent interests within local communities, practitioners are also beginning to appreciate the need for research that examines decision-making patterns of local populations with respect to natural resource use. For resource conservation to be effective, it must understand and work within the existing

³ Compare for instance the study by Ihse & Lindahl (2000) where a holistic landscape analysis was performed and where it was stated that “cultural values are associated with more than six-thousand-year history of cultivation”.

social environment (Holmes 2003). To identify local-level variation in use-interests, and how this variation manifests itself in resource-use decisions, is a necessary step, one that begins to move away from the notion that communities are homogenous groups with fixed interests and social norms. Identifying a resource's perceived utility may not directly result in quantifiable outcomes of conservation efforts, such as increased biodiversity. It does, however, offer a tool for better understanding of why and how local community members make decisions about resource use, which is a critical step in realizing conservation and development objectives for sustainable environmental management.

Tanzania is an example of a country that has put emphasis on conservation of its environment and natural resources. It also is one of the countries with most land set aside for conservation of nature in the world, often with exclusion of human activities. The most common argument for this being that population increase and bad management practices will eventually deplete the country of its rich biodiversity and natural resources. However, it has slowly been realised that conservation cannot only concentrate on environment and biodiversity issues; it also needs active participation of local people⁴.

EIA as a guarantee for sustainability and public participation?

Rachel Carson, who in 1962 pointed out the dangers of uncontrolled industrial development, had a great impact on environmental debates. The linkages between environment and development were then pronounced in the Stockholm Conference 1972, followed by the 1987 report of the World Commission on the Environment and Development - 'Our common future' (Brundtland 1987). Considering the time when these arguments were put on the global political agenda, it is perhaps not strange that it was the biogeophysical environment which came to be heavily emphasized in the debates, legislation and conventions that came out of this, for some, new realisation and awakening. Tools and guidelines on proper practice also emerged to ensure more sustainable environmental management and planning.

Environmental Impact Assessment (EIA) is one example of a "how to think before you act practice", as it is principally a predictive exercise that aims to identify and estimate the characteristics and significance of impacts associated with a proposed development action or plan. The supply of such information to the decision-making process is intended to result in better project planning, more environmentally sensitive development, and ultimately enhanced environmental protection (Wood 2000). Actually, EIA was formally established in the USA already in 1969, and was introduced in an EC Directive in 1985. EIA has then contributed to redressing to some degree the earlier neglect of environmental effects of projects and policies, and similar procedures are now legally required (at least for major projects) in most countries. Efforts to gain stronger recognition of the environment in policy processes are ongoing, however (Scrase & Sheate 2002). Today law in many countries requires EIAs, as well as by most donor agencies, such as Sida which state "An environmental impact assessment (EIA) shall be part of the documentation on which decisions are based for all activities supported by Sida" (Sida 2002: 7). This means that EIAs shall be made for all projects and programmes supported by them.

The diversity of EIA approaches reflects the diversity of human-environment interactions at various spatial and temporal scales under different geographical, jurisdictional, social and economic circumstances. The early methods range from relatively simple lists of possible environmental impacts of the intended action, to more systematic descriptive checklists identifying a wider range of effects. More sophisticated methods include various kinds of

⁴ An increase in rural population could actually lead to increased local biodiversity as a more intensive use of landscape can create more diverse environments (Fairhead & Leach 1996, and Kandeh & Richards 1996).

matrices mapping the linkages between specific project actions and valued environmental characteristics in an easily understandable format, different sorts of networks and diagrams displaying not only the direct impacts but second and higher order consequences as well, and map overlays using a set of transparent maps or GIS, each showing one specific aspect of environmental impacts, to provide a spatial assessment of the proposed actions for the whole geographical region. Modelling and other integrative techniques are the most advanced approached applied in EIAs but they tend to be the most expensive and most time consuming as well.

In the environmental assessment field distinct 'tools' or 'approaches' have developed, such as EIA, LCA, CBA, RA and multi-criteria assessment. The differences between these approaches reflect their different disciplinary and practical origins, and while there may be ways in which they are incompatible or competing, in other respects they are often complementary and could be integrated in a consecutive, encompassing or overlapping manner (Baumann & Cowell 1999). However, it has been argued that the dominant direction in which the various approaches are evolving, is characterized more by disciplinary protectionism, a lack of mutual understanding and respect among practitioners, and wider scepticism as to the consistency and merits of individual tools (Petts 1999). Other problems reported with these tools are that the dominant mind-set has been one of positivism and determinism, which entails a disinterest in historical and social context, and emphasis on quantification and technical rationality (Scrase & Sheate 2002).

Landscape assessments in EIAs normally imply visual landscape assessments. This thesis will not promote or propose methods for visual landscape assessments. There is not a lack of guidelines, methods, or examples of such studies. In fact, most EISs address the landscape and visual impacts of development. A recent survey of U.K. environmental statements indicated that 25% of all the predictions identified relate to this impact category (Dipper et al 1998). In EIA the landscape and visual impacts of a development proposal will typically be addressed using a combination of landscape evaluation and visibility impact assessment. Techniques of visibility impact assessment are largely concerned with the extent to which a development can be seen from the surrounding area, and generally do not attempt to quantify human reaction or perception of the intrusion (Wood 2000). In contrast, in this thesis methods of landscape evaluation focus on the integrated assessment and perception of landscape in the baseline assessment will be stressed. Several authors (e.g. Zube 1984, Jones 1991, Uzzell 1991, Scott & Canter 1997, Bruun 1998, Olsson 1999, Widgren, 1999) have stressed the importance of using senses other than just sight when researching landscape, and that the information from other senses also should be included.

SETTING THE SCENE

History of land and forests in Tanzania

The papers included in this thesis all discuss and relate to land and forest issues. Therefore, this short introduction and background to characteristics and conditions of management of land and forests in Tanzania is meant to place today's situation, and this research, in a wider context which is very important for the understanding of the present situation. Also, as Case study II is concerned with miombo woodlands the conditions in this type of ecosystem are presented very briefly here.

Rural settlement planning in Tanzania

In Tanzania, one can distinguish between five different periods of time in relation to management and protection of land. These periods are the pre-colonial period, the German colonial period, the British colonial period, the independent socialist period, and the market economy and democracy period. The political objectives during these periods have influenced the prevalent modes of forest and land management and ownership (Ylhäisi 2003).

In pre-colonial times most people lived in a subsistence economy⁵. Large areas of forest were constantly cleared for cultivation, and the presence of erosion and shortage of fuel wood were occasionally reported by early travellers⁶ (Koponen 1988). However, almost all societies in pre-colonial times had different kinds of protected areas and species, even though they were not recognised by the Europeans. Hunter-gatherers normally have less protected forests than settled agriculturalists, but they have protected trees, rocks, caves or springs (Ylhäisi 2003). More mobile and nomadic people such as pastoralists and cattle herders often have sacred trees and mountains. In addition, the land management system "*Ng'riti*", setting aside land for later use, was also a pre-colonial arrangement, which originally referred to a grazing area but today also includes residual pockets of woodlands (Alden Wily & Dewees 2001).

To facilitate land acquisition and to control land use, especially in rural settlements, all land in Tanzania, whether occupied or not, was declared 'crown land' during the German colonial period in 1889 (James 1971). That declaration was later enacted into law in 1923 by the British, and became the Land Ordinance which has, with minor revisions, guided land administration in Tanzania to the present. Local people were then isolated from the best lands: forests, game seasonal routes, water sources and the best agricultural lands, which had obvious implications for cultivation, grazing and collection of timber and fuel wood. This new form of governance eroded the authority of traditional institutions and had a negative effect on social conventions at village level that previously controlled natural resource use. The centralised system of land-use planning and management thus dates back to the German and British colonial governments in the early 1890s when most of the present pieces of legislation, which also guide the current practice, were enacted.

In 1938 savanna forest was "discovered" by the British (Tanganyika Forest Department 1939) and sizeable additional areas of miombo woodlands were then added to the old German forest

⁵ However, industrial activities also occurred, as for example the production of iron.

⁶ They often followed the caravan routes so their observations probably cannot be viewed as being representative for the majority of the Tanzanian lands.

reserves, but the railway connections contributed to the exploitation of these forest resources. Meanwhile, the demise of the moist tropical forests was principally a result of clearing for export crop plantations of coffee, tea and rubber. Other densely forested areas were cleared for sisal plantations, as was the case in the Morogoro Region, and many drier wooded areas were cleared for cotton, tobacco, and cashew. The unsuccessful attempt by the British to turn Tanzania into a major groundnut exporter also caused massive deforestation in Southern and Central Tanzania. Meanwhile, probably the first centralised rural land-use plans in Tanzania were the 1927 Land-Use Schemes, which meant that small holder families had to change from extensive to intensive cultivation and restricted farming activities to one acre farms. The intentions were to minimise or restrict the perceived land-use problems associated with shifting cultivation and scattered settlement pattern.

The government of independent Tanzania continued the reserved area policy and expanded their number. In 1961, after Independence from Britain, the first five-year national development plan (1961-1964) initiated the rural Resettlement Programme with strong support from the World Bank (Lerise 2000). The planning concept was that several residential clusters of hamlets were to accommodate about 60 families in plots of about half an acre. However, most settlements were not sustainable, as soils became unproductive due to continued use without sufficient maintenance and families increased in number without corresponding increase in farmland. Most families then moved out of the villages to other villages or to towns. In 1965 the programme was abandoned. Still, under the Arusha declaration the idea of rural resettlement was revived in 1968, and smallholder families living in scattered settlements in the countryside again had to shift to new sites and establish compact settlements. Then in 1972 the idea of rural resettlement was transformed into the 'villagisation' programme under *Ujamaa*, socialism, which was implemented by the central government in most of rural Tanzania. It constituted an enormous spatial reorganisation of the countryside leading to substantial changes in land use and in the settlement pattern. The forceful 'villagisation' programme resulted in the uprooting of over 9 million rural people from the traditional villages into new locations with serious environmental problems. Uniform village size was used all over the country irrespective of the ecological differences and old traditional methods of land use. For example, 'villagisation' in Tanzania promoted community settlement in areas only used seasonally in the past (Quinn et al 2003). The programme also led to the dissolution of native local governments, authorities which had existed before independence. Today people are moving back from the villages they were forced to live in to their former agricultural areas (Ylhäisi 2003).

By 1995 there were approximately 8,100 registered villages in Tanzania, with a population of over 25 million people. This means that more than 80% of Tanzania's population live and work in such villages. According to the local Government laws of 1992 a village council shall administer every village, which is also responsible for spatial planning within the village lands. The overall responsibility for land-use planning at village level also rests with the village council. Normally, village councils obtain support from ward or village level extension staff in formulating plans before they are submitted to the Village Assembly and other authorities for approval. The Village Council through its sub-committees may also decide on land-use matters and perform development control functions within the village. Usually, a village land-use plan consists of a report and maps that address village land resources assessment and show how the village land should be used and managed. However, Nnkya (1999) argues that the land use planning system has been entangled in a practice which emphasises production of lay-out plans to facilitate allocation of plots, while other environmental concerns have become of peripheral interest.

Miombo woodlands – an important and widespread forest type

The communities within or adjacent to forest in eastern and southern Africa are generally rural, poor and dependent on forests (predominately woodland, dominated by the miombo type) as integral to their agricultural or pastoral livelihood (Alden Wily 2000). The vast majority of Tanzania's forest, 96% or 32 million ha, is not forest as conventionally understood, but savanna woodland. Most of this woodland in turn falls into the 'miombo' category, a terminology given to the distinctive dry forest formation of southern and eastern Africa, covering an estimated 2.7 million square kilometres in the region as a whole (Campbell 1996). However, it has also been argued that the major parts of the Tanzanian miombo woodland in fact mostly are regenerated and cultivated farmlands (i.e. not natural woodlands) (Alden Wily & Dewees 2001).

In Africa dry miombo woodland, dominated by *Acacia*, *Combretum*, *Pterocarpus* and *Terminalia* tree species, is a habitat type for which there is an increasing threat of deforestation due to escalating human demand for wood resources (Holmes 2003). In Tanzania both wet and dry miombo are found. The wet miombo (rainfall ≥ 1000 mm per annum) is a floristically rich woodland with dominant tree species such as *Brachystegia floribunda*, *B. graberrima*, *B. taxifolia*, *B. wangerrmeana* and *Marquesia macrourea*. The dry miombo woodland (rainfall ≤ 1000 mm per annum) is on the other hand floristically poorer. It is dominated by the tree species *Brachystegia spiciformis*, *B. boehmii* and *Julbernadia globiflora*, and some *Acacia* spp. are often found in association with this woodland type, particularly along drainage lines. With only seasonal rain, most miombo are vulnerable to high-intensive fires in the dry season while several common species actually depend upon fire for seed germination. Table 3 clearly shows that the dry miombo woodland dominates in Tanzania and in other eastern and southern African countries.

Table 3. Distribution and area of the wet and dry miombo woodlands in selected Eastern and Southern African countries

Miombo woodlands	Malawi		Mozambique		Tanzania		Zambia		Zimbabwe	
	km ²	(%)*	km ²	(%)*	km ²	(%)*	km ²	(%)*	km ²	(%)*
Wet	28,452	30.2	35,019	4.5	137,288	15.5	343,122	46.3	0	0
Dry	29,430	31.3	404,435	51.6	325,605	36.7	147,516	19.9	177,345	45.9
Total miombo woodlands of total land area	61.5%		56.0%		52.2%		66.2%		45.9%	

*Proportion dry and wet miombo woodlands of the country's total land area

After: WWF (2002)

Miombo woodland is highly valued throughout the sub-continent for its multitude of products and services, from timber to fuel wood, grazing to medicinal plants, catchment to microclimate. It plays a direct role in the livelihood of million of the citizens of the ten states where miombo occurs (Campbell 1996). In Tanzania, forests and miombo woodlands are a valuable renewable natural resource on which million of people depend for fuel wood, building poles, charcoal, timber, medicines and honey (Kindo et al 2002). In fact, the miombo woodlands in Tanzania produce most of the charcoal and, to a lesser extent, firewood for the urban population (Monela et al 1993). In addition, woodlands (and forests) are known for environmental conservation

through controlling water infiltration into the soil, climatic amelioration, as the home of a multitude of flora and fauna, and for their support in agricultural production. However, miombo regeneration is actually favoured when farming follows woodland clearance, and cultivated sites are quickly reforested through natural regeneration, mostly from root suckers, once farming is no longer productive (Campbell, 1996).

Forest reserves in Tanzania

Forest and woodland areas in Tanzania cover some 44 million hectares (of which 98.3% is miombo woodland), which is about 40% of the total land area. About two-thirds of forest land is within public lands, and the remaining one-third is 'reserved' and includes all forests with water catchment functions.

'Reservation' is a land management rather than a tenure category, which does not in law necessarily endow ownership upon the state – a fact made explicit in recent land legislation, and to be reflected in the new forest legislation that was agreed in 2002 which recognizes a range of 'reserves', the tenure as well as authority (jurisdiction) of which falls to various parties. In Tanzania, a strict interpretation of tenure makes it clear that 'reserves' are in reality owned by the nation as a whole, and that the Government is only the jurisdictional authority, or manager, not the owner⁷ (Alden Wily 1999). Unreserved forest on the other hand, which is forest not within gazetted Forest Reserves, represents the greater proportion of the national estate (see Table 4 below). Most of this is miombo woodland.

Table 4. Officially protected areas in Tanzania

Type of area	Total number	Occupied/ unoccupied	Area (km ²)	Proportion of the total land area of Tanzania (%)
National parks	12	Unoccupied	38,428	4.1
Conservation areas	1	Occupation in specific areas	8,300	0.9
Game reserves	28	Unoccupied	104,012	11.0
Game controlled areas	38	Occupied	90,864	9.6
Total			241,604	25.6
Forest reserves (productive)	540	Unoccupied	108,000	11.4
Forest reserves (protective)	n/a	Unoccupied	24,000	2.5
Community-based forest management	555 ^a	-	3,486	0.4
Total forest reserves	n/a	Unoccupied	136,230	14.4
All forest land	-	-	440,000 ^b	46.6
Total land area of Tanzania			945,087	

Source: Alden Wily & Dewes (2001) and Tanzania Country Study on Biological Diversity (1998)

⁷ 'Forest reserve' is a familiar category in Anglophone Africa, referred to as 'gazettement', and has its sister term of 'permanent forest' or 'national forest', or '*forêt classée*' in Francophone Africa. In virtually all Sub-Saharan states, this categorization carries an assumption that this category of forest is owned and managed by the state.

In Tanzania the existence of formal local government structures at community level is incorporated into community-based forest management. The communities develop their own forest management regulations and their own mechanisms of management. These include the right to levy fines upon illegal users and to control the use of these revenues. The lands owned by the community are important for social well being, and access to land resources is a question of survival for the majority of the people in Africa. Missano et al's (1993) study from Mtwara region in Tanzania showed that about half of the population in the two villages studied were dependent on forest products for their food requirements.

Forest policies in Tanzania

In 1963, the forest policy in Tanzania had two main objectives: to produce enough forest products to meet Tanzanian demand at all times and to protect the main water catchment areas. Neither local people nor their management systems were mentioned. In 1989 the Tanzania Forestry Action Plan still recommended that Tanzania should gazette additional forest reserves. Local people and participation were mentioned but real action for genuine co-operation on decision-making was not required and implemented. In the national Forest Policy of 1998 the management of forest resources on the basis of sustainable development was emphasised. The main objectives of the 2002 Forest Act (2002) are: "to promote, to enhance the contribution of the forest sector to the sustainable development of Tanzania and the conservation and management of natural resources for the benefit of present and future generations. Encourage and facilitate the active participation of the citizen in the sustainable planning, management, use and conservation of forest resources through the development of individual and community rights, whether derived from customary law or under this Act, to use and manage forest resources." Ylhäisi (2003) therefore concludes that the control of natural resources is being returned, to some extent, to the pre-colonial time.

Kohler (2001) made a comparative analysis of forest laws in selected African countries⁸, where it was found that Senegal and Tanzania's laws take first steps towards a redistribution of roles. Furthermore, the conversion of forestland is only subject to an EIA⁹ in Burkina Faso, Cameroon, Gambia, Senegal and Tanzania. Tanzania is also the only country in Kohler's study that has partly regulated the involvement of the public in forest development decisions. In addition, according to Wily (2001) the possibility to be autonomous managers of all, or part, of a government forest reserve in or adjacent to their area is most developed in the Tanzanian Forest law in the region. Mainland Tanzania also has the most developed community forest jurisdiction in the SADC region, which gives the local community powers to manage the resources within its local sphere (Alden Wily 2000). Tanzania's forest policy framework is therefore claimed to be one of the most constructive and forward looking in Africa (World Bank 2002). However this thesis discusses problems and issues associated with forest and land management at the local level implying that conflicts and environmental security is yet not at hand everywhere in Tanzania. Although policies have important implications for people and environment (as shown by the history of Tanzania) the examination of local people's situation has to be ongoing, as policies not always reflect real situations.

⁸ Benin, Burkina Faso, Cameroon, Ethiopia, Gabon, Gambia, Guinea, Lesotho, Madagascar, Senegal, Tanzania, and Zimbabwe.

⁹ Forest clearance of more than 5 ha needs an EIA undertaken and approved by an independent consultant. Also private and community forests will need relatively detailed management plans (The Forest Act 2002).

THE STUDY AREAS

The framework for the case studies that this thesis builds upon was explained in Tables 1 and 2, and locations of the study areas are shown in Figure 2.

The Tanzanian environment has been shown to be one of the places inhabited by humans for the longest time on Earth (c.f Leakey 1969, Peters & Blumenschine 1995). Consequently humans have been an active agent in the East African environment during a very long period of time. This is supported by, for example, the many sites of prehistoric art in the centre of Tanzania, as well as findings of pottery and grinding stones alongside indications in the vegetation of a long tradition of livestock keeping and some agriculture. Actually, there is also archaeological evidence from several places within Tanzania that during the Early Iron age there was a serious depletion of resources (Schmidt 1997). Moreover, Eriksson (1998) has also shown that accelerated erosion processes in central Tanzania (which by many development agencies are regarded as something new to the area) were in fact initiated 900 years ago. Kjekshus's (1977) argument that the East African Man maintained an ecological control system throughout the 19th century has been criticised as being a romanticised view of pre-colonial conditions. However, he does show the relationship between politics, demographics, economy, epidemics and environment in the area, which also has been emphasised later in other types of research (e.g. Giblin, 1996, Cohen & Odiambo 1989, Christansson 1988 and Koponen 1988). Many development schemes have been carried out in Tanzania. Some have acknowledged the political and ecological history and how it links to present day conditions, but many examples of the opposite also exist.

The Babati area was selected primarily because of its dynamic character in a region where humans undoubtedly have co-evolved with the physical environment for a very long period of time, but which is still considered by many as recently exploited wilderness. In addition, this area has been in the centre of interest for various investigations and studies of many disciplines and development projects. This was a necessity when aiming to conduct a holistic assessment. The availability of material was also important to consider, both for theoretical and practical reasons.

Babati District lies largely within the eastern branch of the Great Rift Valley at an altitude of between 900 – 2,000 metres above sea level (masl). It is made up of dry, salty flatland with inselbergs to the north, which then southwards turns into rolling green hills with red soils and a fresh lake (Lake Babati). The Lake Babati surroundings are characterised by an undulating terrain of hills and plateaux covered by red loamy soils, and intersected by wide plains of light-coloured sandy soils and *mbugas* in local depressions and valley floors. The 'natural' vegetation of the district ranges from open grasslands, to *Acacia-Commiphora-Combretum-Grewia* "savanna woodland", to miombo woodland and to montane rain forest on some of the higher situated forest reserves. The ethnic mosaic is rich in the District, which reflects recent immigration as well as a very long history of human habitation. Most groups are considered agropastoral but some more traditionally nomadic pastoralists also frequent the District.

The location of the Case study II in Morogoro region is within a miombo woodland area, which was the prerequisite in the selection process. The study area is situated in the fringe zone bordering a major fault system at 500 – 1,500 masl. The development of the physical landscape is quite complex (as explained more in detail in Paper II). In the region there is a significant trend of increased fragmentation and decline in woody vegetation. Many large plantations are found in the region, both abandoned (e.g. sisal) as well as some that are still productive (e.g. sugar).

The focused study site, the village lands of Ihombwe, is less densely populated than other parts of the district¹⁰, and there are still rather large tracts of “undisturbed” miombo. Part of the objectives for the project was to determine if and how biodiversity has altered in relation to human activities. In this area most people are subsistence farmers with little tradition of livestock keeping. However, as land and resource shortages begin to appear in the rest of the country agropastoral and pastoral groups are moving into the area. During the colonial and post-colonial history the central part of the study area has been increasingly affected from the outside by a more or less continuous penetration by roads and railways, also facilitating extraction of its resources. Moreover, the proximity to Dar es Salaam, and Morogoro town, increases the pressure on such commodities as firewood and charcoal.

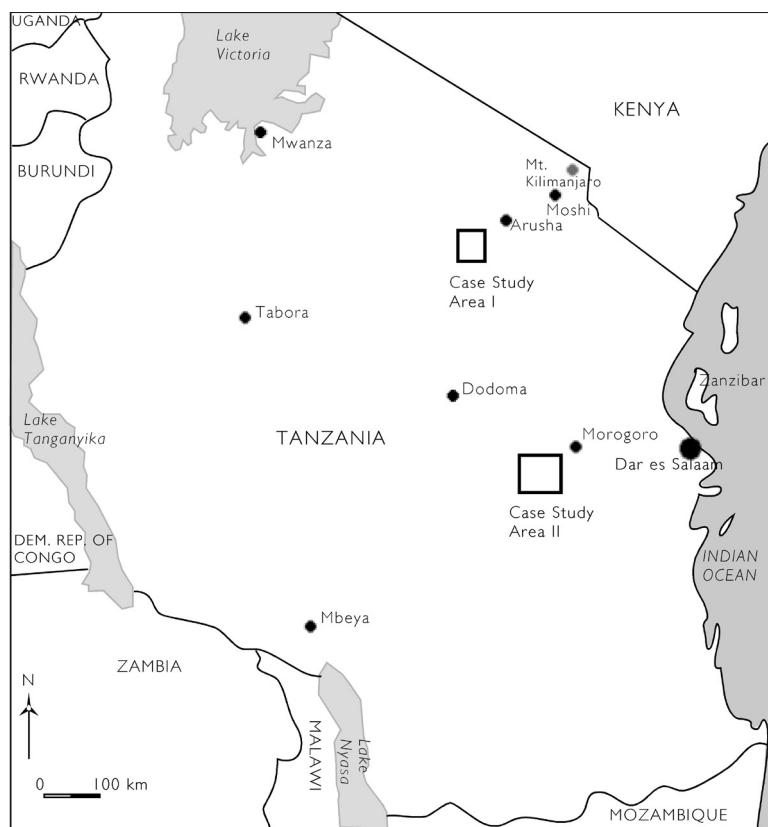


Figure 2. Locations of case study areas

¹⁰ In fact Kilosa district is coming to experience land scarcity and many households own no land in the district (c.f. Ellis 2003).

METHODOLOGICAL APPROACH

Landscapes are complex systems about which decisions must be made with imperfect knowledge. Perception, as a complex learning processes, analyses the observation immediately and interactively and links the results with our knowledge and past experience. Thus, landscape observation is primarily subjective and can be understood only relative to the characteristics of the observer (Antrop 2000). Therefore, landscape planning requires tools that synthesize conventional methods and use both qualitative and quantitative data (Marcucci 2000). Nonetheless, planners are compelled to facilitate decisions even in the face of imperfect knowledge.

To reach a proper understanding of the driving factors in these systems and their behaviour is impossible with a single research methodology (Bouma 1998). This being a thesis aiming and advocating for interdisciplinarity, several methods were needed, which is why it is more appropriate to discuss the methodological approach than the specific techniques. Figure 3 shows the general sequential outline and coarsely describes what methods have been applied. To fit existing research methodologies within a research sequence, methodologies should be designed or adapted so that information and understanding obtained with a single research methodology is complementary to other methodologies operating at different scales and/or in different phases of research (Verburg & Veldkamp 2001).

The demand of practical methods that can be used in time- and cost constrained projects and in areas of scarce data has also been considered here. Therefore rapid appraisal methods and practical field measurements have mostly been used in order to be able to follow up on any anomalies directly. Professional laboratories have not been consulted, as it would make local involvement and discussions hard. However, it is recognised that in large projects this could be a requirement.

Scale and representativity

Scale most often refers (cartography excepted) to any specific geographically or temporally bounded level at which a particular phenomenon is recognizable. There is reasonable disagreement on the precise extent or definition of any scale (e.g. where are the boundaries of something “local?”), and there is rarely perfect congruence of, for example, a spatial and a functional unit identified at the same scale (Sayer 1991). People impose a definition of scale for a particular issue and for particular purposes. As such, scale is a heuristic employed by scientists and managers to organize their understanding of the world and the relationships and interactions therein (e.g. ecologists find it useful to think of trees, forests, and biomes whereas politicians find it useful to think of cities, counties, states, and nations)¹¹. In fact, because scale in this sense is largely socially constructed, the conceptualization of scale brought to any specific case by particular players is mutable and amenable to adaptation so as to best fit the management of the environmental problem at hand (Cash & Moser 2000).

¹¹ In a Southern African context *region* often implies the member countries of the Southern African Development Community (SADC).

In this study ‘local’ refers to village, and regional¹² to landscape levels that comprise larger sets of communities, both vegetational as well as human. The links between these scales are of course not clear, and strict boundaries are hard to define, but processes and linkages between them are considered of great importance. For example, the linkages between social phenomena at different scales are made complex by the fact that people also are connected via non-governmental institutions and social networks that are less strongly correlated with spatial scales – e.g. through markets and industries, clans, religions, professions, or voluntary associations (Ostrom 1998). Moreover, wildlife migrations, water runoff and other biogeophysical elements also move in and out of different components of “scales”. Therefore the local also has to be seen in a regional context and the regional needs to be understood from the local.

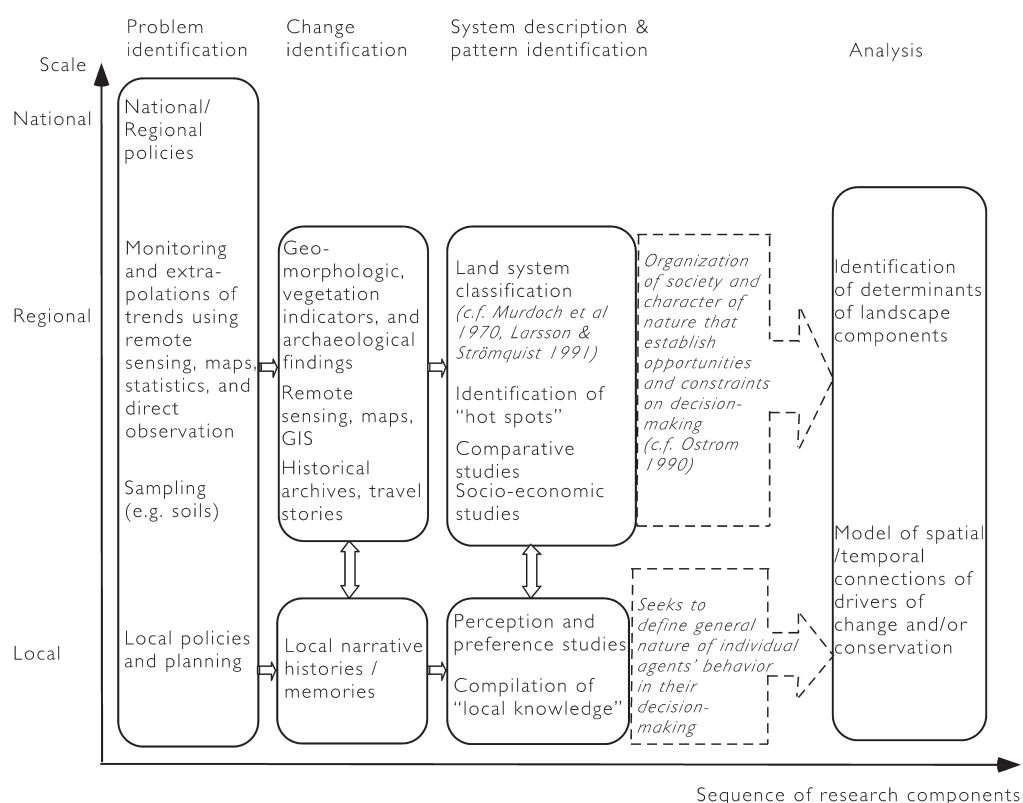


Figure 3. Sequence of research components for landscape dynamics studies and a suggestion for structure of interdisciplinary environmental assessments.

Hot spots here refer to locations with high rates of change

As discussed in Paper IV, the problem arises when an environmental phenomenon is managed at an institutional scale whose authoritative reach does not correspond with the geographical scale or particular spatial dynamic of the environmental problem (Cash & Moser 2000). And the same could be said for scales in time where observed changes might in fact be natural variability (see Paper I). This will be discussed further in the coming sections.

Generalization is a problem of extending the findings beyond the set of observations. The degree of representativity of the sample is the only guarantee of the extrapolation of the data within the population from which the sample has been selected. The majority of Tanzania's

¹² Otherwise 'region' is the largest administrative unit in Tanzania.

rural area is a mosaic of ‘village areas’. Therefore the village lands¹³ are considered here as being representative of the Tanzanian rural lands. However, they are not seen as isolated “islands”, and the social and natural exchange is recognised (as examined in Paper III).

Furthermore, it is of course difficult to say when samples of individual opinions can be extrapolated to whole populations. A trade-off has to be found between a large sample size, which requires large field teams, and very consistent and homogenous measurements carried out by a single field surveyor or a small team over a smaller sample of farms. In this study the investigated area has been restricted in order to have manageable samples of informants that still can be regarded as representative. Informants have been selected on a basis of location, gender, age, and, if applicable, ethnicity. Hence to include the different groups of individuals the whole village area has been considered, consulting people near and far away from the village centre and main roads.

Also to be defined are the limits of the extrapolation of the findings, in this case extension beyond the explored range. With interpolation, the problem is whether findings for the villages are applicable to neighbouring sites, and if so, whether there are geographic limits beyond which some significant variations will occur. Remote sensing can contribute to these (anthropological) problems, and has in this case been used in the initial stage of the study both in the selection process of villages and to select locations within the villages.

Landscape types may thus be combined in different ways, forming different spatial patterns or regions. The geographical arrangement of these spatial units can be studied on consecutive scale levels forming the chorological hierarchy. Many methods of land classification or landscape evaluation are based on such a system.

Sources of information

Evidence for landscape analysis can be found in two broad categories: documentary evidence, and field evidence. Documentary evidence, which is useful for the more ‘historic’ periods, includes both primary and secondary data such as written documents, drawings and paintings, photographs, maps, meteorological records, census statistics, surveys, aerial photographs and remote-sensing data. The availability of spatial data in digital form is also becoming more and more important in landscape analysis as GIS offer powerful tools for spatial analysis. Field evidence is valuable for understanding both ‘historic’ and ‘prehistoric’ periods, as well as the contemporary landscape. Field evidence includes ecological data, archaeological data, and anthropological data. Individual landscapes will have distinct data requirements and unique sources. In this respect, each is a puzzle whose pieces exist in libraries and archives, in scientific labs, and on the land and people itself.

The analysis of a holistic phenomenon such as landscape is thus not straightforward. Many approaches are possible depending on the goals or perception one has, the structures that are recognised and are considered important. Equally important are the data available to study the landscape. Three main approaches can be recognised according to Antrop (2000):

1. The thematic approach – the analysis of landscape components.
It analyses different landscape components one after the other and, finally, tries to make a synthesis. The result is a set of thematic maps that are analysed independently,

¹³ In Tanzania the Village Area represents a discrete area, the boundaries of which have of necessity been generally agreed with neighbouring registered villages. Village areas tend to be very large and inclusive of sometimes vast tracts of unoccupied grazing and woodland areas. Areas of social settlement (homes) and cultivations (fields - *shambas*) tend to be concentrated in one or several parts of the Wider Village Area. In addition, ‘sub-villages’ play an increasingly important role in local level management and governance, and the elected ‘chairmen’ of each sub-village have, since 1992, held ex officio seats in overall village government, the Village Council (Alden Wily 1999).

making use of different techniques (e.g. landform). Overlay techniques are frequently used to look for spatial associations and relationships between the different themes. Synthesis is achieved by composite maps.

2. The regional or spatial approach – hierarchical land(scape) units.
This approach works in a more holistic manner. Satellite images and aerial photographs are preferred data sources. Methods of land classification or land evaluation are used to differentiate the area of study into landscape units, which are structured in a hierarchical and spatial way. The result is a chorological classification of the area and the description of different landscape types.
3. Landscape metrics approach – attempts to quantify holistic characteristics.
Aim to describe quantitative characteristics of the landscape structure. Many of these indicators refer to abstract holistic characteristics of the landscape, such as heterogeneity, diversity, complexity, and fragmentation. Techniques of raster maps are frequently used. The purpose of landscape metrics is to obtain sets of quantitative data that allow a more objective comparison of different landscapes for grouping or differentiation. The landscape metrics are also intended to monitor changes in landscape structure.

‘Approach 1’ is not recommended for the landscape approach advocated here. ‘Approach 2’ was used as a basis in Paper III, and in Paper II ‘Approach 3’ was the main, general, procedure. For clarification, this thesis does not recommend that these are seen as complete methods to be used separately, but they could be starting points for discussions of methodology, and may make the holistic landscape assessment processes less confusing and complex for projects which is why they are mentioned here.

The specific techniques used have been described in each Paper. However, some general tools and sources of information are clarified here.

Remote sensing methods include analyses and interpretations of panchromatic aerial photographs (scale 1: 25,000) and visual interpretations of classified and unclassified satellite images (from Landsat TM: 30 x 30 m pixels; and MSS: 80 x 80 m pixels).

GIS is here used as a tool, not as the ultimate goal. It has been used both to create maps as a basis for interviews in the field (see Paper I), as well in the analysis of the gathered data and information. Raster based programs have mainly been utilized, but in combination with vector based GIS as data collected with a hand-held GPS have been incorporated.

Maps have been used extensively throughout the study as sources of information. Topographical maps (scale 1: 50,000), geological maps (scale 1: 250,000) and various historical maps at different scales (mainly from District reports 1930-1960 consulted in the archives of the Institute of Commonwealth Studies, London) but also illustrations and maps (as well as written information) from travel reports (e.g. Baumann 1894, Meyer 1914, Joelson 1928, Perham 1976, Nash 1984) from the beginning of the last century.

The physical, chemical, and biological properties of soils act as factors of status and control, thus exerting a decisive influence on practically all economic and environmental processes (Frede et al 2002). Soil sampling (from approximately 20-30 centimetres depth) has therefore been conducted in both case studies. As described in Papers I and III, pH were measured with a liquid crystal electrode portable pH-meter as described by Landon (1996). Colour was determined by the revised Munsell Standard Soil Colour Chart (on dry and wet soil) and texture was established through Hurni’s (1985) criteria. The characteristics of soil mentioned in Paper

IV were established in the same way as in Case study I (Papers I and III).

Interviews were conducted in a semi-structured manner with open-end questions at household to village community level. In addition, key informants were consulted and passive observations of meetings were also practiced. All household interviews were marked for their location with a hand held GPS.

SCALES OF TIME IN THE UNDERSTANDINGS OF LANDSCAPES

In a landscape individual elements can change, even disappear, but the landscape, as a whole (in a holistic sense) does not necessarily change in the same way or rate (Antrop 1998). Two main factors of landscape change can be recognised: the natural processes, and the human activities. Although each of them follows rules, which are somewhat different, they intensively interact in the whole of the actual world. As a living being and part of nature, natural processes also act upon humans. The interaction of the elements must thus be considered, especially the interaction of natural and cultural ones. It follows that landscape history must also take a holistic view of landscape, integrating natural and human activity as parts of a single evolving system (Marcucci 2000, Nassauer 1995, Crumley 1994).

However, the dynamics and ecological systems working in the landscape are not uniform but rather characterised by variability both in magnitude and duration. Brunsden (1996) claim that since tectonics, sea level and climate control landform changes, it is reasonable to expect that change will also be unsteady and episodic at all scales. The same argument is taking place also within the social and humanistic sciences. Crumley (1994), for example, writes that each disturbance parameter has a threshold or crisis level that, if reached, triggers some cultural response. Thresholds are determined by, transmitted through, and vary with the corpus of cultural knowledge possessed by a given society. Therefore an observed change in the physical or living environments might reflect an adjustment to past events, or the passing of certain thresholds, rather than reflecting present social and environmental conditions and processes, as shown in Paper I.

The perspective on landscape change offered by the experience of a single human generation is too myopic to describe that landscape accurately. Such a short-term view gives the impression of an unchanging environment or, at best, a brief slice of landscape development (Marcucci 2000). The same argument applies to synoptic short-term field visits when static views are created of what might be typical or atypical for the area, as discussed in Paper I. However, studying and monitoring all of the interfering changes that occur in the landscape is impossible. Also, the changes of one component seldom reflect the overall change of the landscape. Different processes act simultaneously on different scales so that complexity differs at any given point in time.

All papers (I-IV) stress the importance of recognising the many processes that are active in a landscape that work with different time frames. Figure 4 illustrate the time frames for some selected key processes that bring about change in a landscape. This is also to a large extent in accordance with Marcucci's (2000) findings, based on his work from Pennsylvania, USA, that there are five general categories of keystone processes: geomorphological processes, climate change, colonization patterns and growth of organisms, local disturbances of individual ecosystems, and cultural processes.

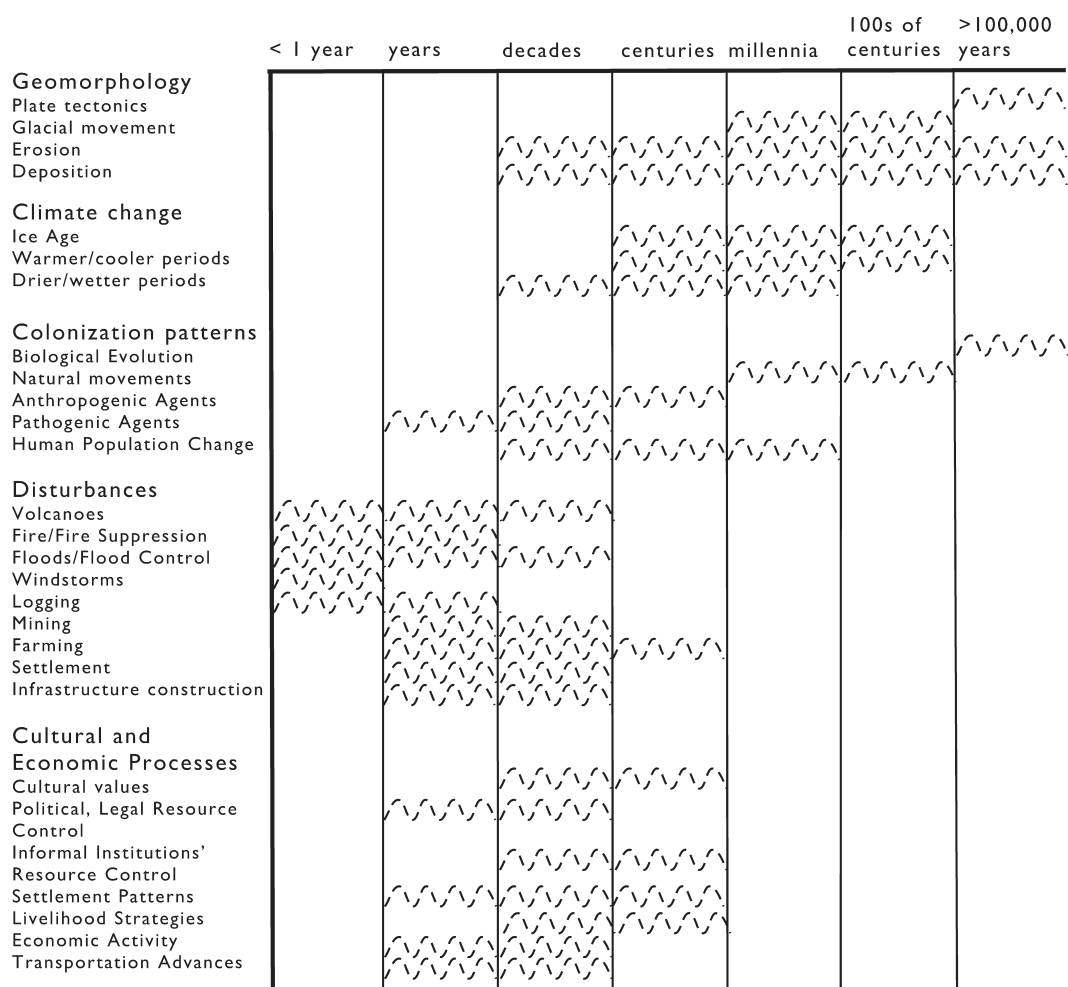


Figure 4. *Length of time for selected processes to affect landscape change*

The time line for each process is not straight and dashed to further underline the variability, the difference in magnitude and occurrence of episodic events, to emphasize that each process in itself is complex and interrelated. Nor is time to be understood from this figure to be linear.

The long-term natural geomorphological processes, occurring over thousands or millions of years, refer to the creation of landforms that involve plate tectonics and glaciations. Papers I and II show examples of how these processes and their variables also are relevant in the East African context but with perhaps sometimes a different focus and additions. The Babati case study area is situated in the vicinity of the East African Rift Valley, where tectonic activity obviously has shaped ancient landscapes, and still is a main parameter in the landscape forming processes. Glaciations has not been a prominent land forming factor in Africa as the African portion of Gondwanaland since the break-up has remained largely in, or near, its present tropical setting (Lewis & Berry 1988). However, glacial movement is included in the figure 4 considering its importance for many other regions of the world. However, erosion and deposition are important land forming processes that can be considered as short-term as well as long-term processes.

Mass movements are often instantaneous events whereas the denudational (erosional) and aggradational land surfaces of Africa, as described by King (1951), vary in age from Jurassic to Holocene.

Climate is an important variable in Africa, where fluctuations on shorter and longer time scales are common. Climate in turn also affects many other natural and anthropogenic activities, and it relates to cycles of glaciations and the long-term migration of species. Precipitation is, for example, a dominant factor for the distribution of miombo woodlands, and the excessive rainfall on a shorter time scale has received attention from policy-makers, as the example from Babati shows (Paper I).

When landscape change is to be understood and predicted in tropical Africa it is important to consider the highly dynamic nature of the tropical African environment. Relatively stable, virgin vegetation may occur in parts of the rainforest, but is otherwise rare. The role of fire is particularly important and an important management practice for miombo forests. Colonization patterns of animal populations, especially in the case of large herbivores, may also have a significant impact on landscape. Furthermore, pathogens can cause highly noticeable impacts in a short period of time. In East Africa the drought combined with rinderpest¹⁴ epidemic in the later 19th century had a major impact on environmental conditions. The spread of thorn bush and tsetse fly increased, and the ecological impact of the change is still visible in the landscape today (see Paper III).

Thus, landscape disturbance is a broad category that includes both random events and chronic occurrences. Disturbances may be endogenous or exogenous, and can affect the direction and speed of landscape change. The impacts of disturbance may be minimal; alternately disturbance may be pervasive and chronic leading to an entirely new landscape. Human disturbances may cause total landscape change in the space of years, and remain unpredictable with respect to their long-term outcomes or reversibility. For example, the rapid disappearance of miombo woodlands and the inherent loss of biodiversity could be a non-reversible impact, changing the landscape completely.

The fifth category of landscape-forming processes is cultural. Often, the overall culture is a plurality of beliefs coming from differing groups that are related solely by geographical proximity. Society refers to the relationships and interactions of between individuals, groups to groups, and individuals to groups. Economy refers to the connection between individuals or groups and resources. A definitive list of landscape-forming cultural processes is not possible, but includes perpetuation and change of values and perceptions, informal and formal institutional control of land, settlement patterns, livelihood strategies, technology advances and economic activity. For example, changes in livelihood strategies cause shifts in how different natural resources are used and perceived, which in turn can cause landscape change.

Paper III discusses and shows how present land cover is a product of interactions of thoughts and actions in time and space where the physical, ecological, demographical, mental, societal and political come together in a landscape context. This reasoning leads to the conclusion that there is no such thing as an environmental baseline, rather a baseline that has to be extended in different temporal and spatial perspectives to fully understand and predict environment and related social change (as argued in Paper I).

¹⁴ Rinderpest is a contagious viral disease of cattle and some species of wildlife.

LAND-USE AND LAND-COVER CHANGE

All Papers included here deal with the complexities of understanding, evaluating and monitoring land-use and land-cover change in different ways, where landscapes are considered multi-dimensional, as argued by Schoorl & Veldkamp (2001), with vertical (on-site) and horizontal (off-site) properties and processes. Since landscapes are composed of many different components that have their own dynamics, studying landscape change needs careful thought about the nature of things that will be studied. Zebisch et al (2004) argue that for sustainable future planning it is essential to investigate possible land-use changes and the impact on ecological functions and processes at the local level. It is believed to be known that changing land use affects on-site landscape properties, for example soil degradation and increased erosion after deforestation. Boserup's (1965) work on agricultural growth in relation to population growth suggests that fallows can be incrementally shortened up to a point under swidden or shifting cultivation, but then the invasion of weeds provides an incentive for a major shift to eliminate fallow altogether. In Tanzania, agricultural production seems to have more or less kept pace with population growth in the long run, although fertilizer and other technical inputs are used less now than in the days when they were supplied at subsidized prices by crop parastatals (Ellis 2003). Conversion of forest or grassland to cultivated lands is also the worst scenario in terms of soil productivity and quality (Schoorl & Veldkamp 2001). Processes causing these effects operate in all types of landscape, although they are not always that evident and show lower rates when there is a continuous vegetation cover. However, emerging, often interdisciplinary, studies of environmental change and diversity describe complex and uncertain, but often very resilient, physical and social landscapes. Although many areas definitely have experienced dramatic changes, it seems that many contradictory descriptions and evaluations of change and variation have less to do with changing or different environmental conditions than with changing or different perceptions of the environment and land-use practices (Dahlberg 2000).

Change can only be expressed when a comparison between at least two time situations is possible. In order to be detected, the magnitude of change must also show observable or measurable differences between the moments of observation, and this has much to do with the degree of detail and accuracy of the documents used as well as their comparability (Antrop 1998). Paper I and Paper II discuss land-cover and land-use change from rather short temporal perspectives, based on maps and remote sensing analyses. The sources differ in quality, and detail why the coarsest scale had to be used for comparisons. A raster based GIS technique was therefore considered as the most appropriate method. However, as the Gidas example in Paper I clearly showed, it needs to be supplemented with other forms of knowledge, using other forms of classification and basis for understanding. It also shows that change cannot only be described numerically and statistically. Environmental and landscape changes also need to be analysed from a geographical and social position.

The exigencies of holistic description for moving and changing configurations become quite unwieldy, and the problem of strategic focus becomes acute. Remote sensing data could focus

some of the questions further. Guyer & Lambin (1993) argue that ethnographic methods can be inadequate to the holistic task when dealing with temporal change in open systems¹⁵. Although the comprehensive coverage that remote sensing allows cannot substitute for close study by ethnographic methods, for ecological and land use issues, it can help focus the questions, provide confidence in samples, and aid in the examination of hypotheses that are otherwise too complex to address. Further, with the synoptic view of landscapes afforded by remote sensing, it becomes possible not only to describe particular landscapes with greater confidence, but ultimately to work toward comparison and generalization about land use dynamics from a holistic standpoint (Guyer & Lambin 1993). Remote sensing analysis also offers solidity to local studies of short time periods. It therefore potentially mediates a stronger engagement between ethnographically based studies and the great generalizations that continue to animate land use studies, especially in areas of the world such as Africa that lack source material from which to construct a detailed and long-term agricultural history.

Paper II aims at showing how these tools work in a miombo woodland situation and how biodiversity changes in this environment could be analysed. A rapid change of the woodland cover was observed, indicating that biodiversity will be affected. Biodiversity of ecosystems is strongly related to the land-use composition and the land-use patterns, and has become a major issue in the context of land-use change investigations (Zebisch et al 2004). One of the conclusions in Paper IV is that remote sensing is a good basis for interdisciplinary environmental assessments. Roy & Tomar (2000) also agree that remote sensing and GIS provide appropriate data and an effective tool, respectively, for studying biodiversity at various levels.

¹⁵ In Guyer & Lambin's (1993) study remote sensing analysis made three major contributions. First, it provided a means of matching the patterns from a haphazard sample to the population. Second, the results tended to give greater confidence to inferences from the sample about ecological dynamics, and thereby allowed them to address the literature on paths and thresholds in intensification in savanna agriculture using primarily the sample alone. Last, analysis and interpretation of the remote sensing data allowed questions asked about other components of the total ecology for which ethnography on the ground is particularly difficult.

RESOURCE-USE AND LIVELIHOOD

Papers I and IV discuss the implications of environmental and landscape change for local people primarily dependent of natural resources for their survival.

Forest products – dependency on forests for livelihood

In this research, forests (or woodlands) and their intrinsic values and importance for local people's livelihood have been investigated in particular. That people are heavily dependent on the forest (miombo woodlands) is made very clear in Paper IV. Haule et al (2002) also showed for nearby Kilombero that wildlife and forests provide important services to local people. They estimated that access to cheap meat was the most important benefit, although people were reluctant to speak about their habits of consuming game meat (as was the case in the Ihombwe study as well).

The NTFPs are important forest products especially of the dry lands, where they form alternative sources of livelihood. They also contribute to poverty alleviation through generation of income providing food and improved nutrition, medicine and foreign exchange earnings. The Forestry and Beekeeping Division Tanzania (1999) stresses the importance of the following NTFPs as vital to people in Tanzania: Fuel wood and charcoal (demand is expected to rise with population growth and it has become a commercial good that is being hauled for long distances), bamboo, palm products, medicinal plants (economically medicinal plants function well to a good number of people and are very important in the society), food plants and fodder (wild foods greatly improve nutrition and increase food security, particularly for rural poor without families would go hungry or become malnourished). All of these products were mentioned in the Ihombwe study (see Paper IV).

Some of the values of bioresources relate to the abundance of the resource while others are derived from diversity itself. In Paper IV one of the reasons to move into the area was because of the availability of traditional medicine. Also, in Haule et al's (2002) study traditional healers were very important and all medicine used by traditional healers was related to, or harvested in, the forest. However, the utility of fuelwood, for example, collected by rural people is likely to be more dependent on its availability and abundance than its diversity, though people will also be aware of critical differences in the burning and heating qualities of different species. Generally, then, biodiversity is used to reduce risk and improve sustainability and productivity, and forms an essential part of many poor people's livelihood.

External and internal demands of forest products

Paper II shows how miombo woodlands are decreasing at an alarming rate, which also means that biodiversity and resources will be lost. The main direct causes are logging and land being opened up for cultivation, and in general deforestation very often is related to agricultural expansion and clearing of forest. In Tanzania another important factor is that firewood consumption is very high, actually the highest compared to all other SADC countries (FAO 2001). However, in

Tanzania not only small scale farmers clear land for subsistence farming. For example, in Tabora region (western Tanzania) the miombo woodland required for tobacco curing alone amounts to about 8,675 ha per year (Ramadhani et al 2002). Kindo et al (2002) summarised the major threats to forests in Tanzania as being: deforestation (about 130,000-500,000 ha of forest lands are estimated to be cleared annually because of demands for agriculture, settlement, grazing, wood extraction and energy), fires (increasingly threatening the future of miombo woodlands and closed forest ecosystems), insect pests/pathogens (especially affecting plantation forests), seed procurement, and poor seed supply (the NTSP zonal seed centres are mainly concentrated in the East with poor communication to the western parts of the country and seed source trees that are being cut down).

Policies have an important role to stimulate functions, such as conservation, commercial logging or profit making and improvements in livelihoods. The changes in policies over history seem to support this view, but Ylhäisi (2003) claim that now more profits will stay in the areas where the natural resources are found¹⁶. This is not, however, supported by the findings in the Ihombwe case study where it was shown (Paper IV), by indirect and direct observation, i.e. by botanical, remote sensing analysis and interview evidence used independently and in combination, that clearings and extraction of forest products (both legal and illegal) were due to activities by 'outsiders'.

The consequence of the new forestry laws is that new development, conservation, and other projects cannot be planned any more in the villages without consent and participation of the local communities (Ylhäisi 2003). However, land scarcity and frequent disputes with immigrating pastoralists to Kilosa district mean that Ihombwe will have to set aside an area of the village lands for pastoralists (see Paper II) to graze their animals. This means that people who are now cultivating in, or near, this area will have to move to other areas in the village. The best 'other' areas are naturally already occupied and there will be no reimbursement (neither monetary nor in form of labour assistance) for moving and preparing new land, even though one full harvest will be missed as the decision was taken not considering the agricultural calendar and seasons. Furthermore, as discussed in Paper II, the real pressure on the land in Ihombwe is also higher than what the population density statistics show, which the District authorities might not have considered in their planning¹⁷.

Resource conservation through cultural customs

Restrictions due to traditional sacrifices and pilgrimages have conservation values by preserving key habitat areas and species such as drinking water for wildlife. However, sacred areas, sacred species and taboos are often not seen or known to 'outsiders', still they play an important role for conservation, as discussed in Papers III and IV. It was shown in Paper IV that areas considered important not at all overlap with the ideal locations for settlements and farming. Burial grounds and sacred areas of different importance and for various purposes and groups of people were also present to a great extent in Ihombwe.

Marginalisation and vulnerability

More than forty years after attaining independence in 1961, Tanzania indeed remains one of the poorest countries in the world. Poverty in Tanzania is considered much worse in rural

¹⁶ For clarification it should be mentioned that Ylhäisi (2003) refers to the situation after the new forest law (The Forest Act 2002) and these studies were conducted before this law became operational.

¹⁷ The low population density of Ihombwe village was the District authorities' main argument in choosing this location.

than in urban areas, with an estimated 39% of rural citizens being poor compared to 24% of urban citizens¹⁸ in 2000-01 (Ellis 2003). Indeed the environment in the Third World is largely a livelihood issue (Bryant & Bailey 1997: 159) and changes in environmental quality impact directly on human welfare. This is particularly true for the poorest¹⁹, many of whom depend directly on the physical environment and especially on common property resources because they cannot afford access to others. The poorest thus suffer directly from the effects of environmental degradation, condemned by poverty to live in the least desirable, usually the most degraded, environments (Kirkby et al 2001). The concept of marginality, which can be applied to people and environments, illuminates restrictions in marginal people's options in the management of sensitive environments (Blaikie 1985) and why marginality is closely related to the vulnerability of both people and environments (Blaikie et al 1994).

Although changes in environmental quality impact human welfare risk perception varies with livelihood situation. In Quinn et al's (2003) study in semi-arid Tanzania the most frequently identified problem is lack of access to water, followed by lack of access to schools, medical facilities and other amenities, which is in line also with the findings from this study (see Paper IV). If people are required to live in non-preferred areas either by force (as for example during the 'villagisation' programme) or through constrained own choices (as when infrastructure is that important that it overrides agricultural preferences which constitutes the main livelihood) non-sustainable situations and vulnerability will arise for both social and ecological systems.

¹⁸These figures should of course be treated with caution, and urban poverty in particular is often underestimated in official statistics.

¹⁹Poverty here refers to the denial or lack of opportunities to meet social, economic, environmental, cultural, or political choices either for present or for future generations, and it does not mean poverty of income alone. Similarly, natural capital contributes not only to economically productive choices but also to many other choices such as spiritual values, freedom to enjoy pollution free environment, and enjoyment from pristine surroundings, old growth forests, etc. Hence natural capital is not to become reduced with development; and natural capital plays a critical role in economically rich as well as in economically poor countries (c.f. Grima et al 2003.).

PERCEPTIONS OF FOREST AND LAND

An understanding of how local people perceive their problems is a crucial element in the design of projects designed to encourage and support community-based management regimes to enable people to improve their lives, and the environment on which those lives depend (Quinn et al 2003). Both case studies in this research have dealt with how, and what, people perceive as problems, as well as with what is perceived as functional and advantageous in their local landscapes.

Nearly 100% of the respondents in Paper IV thought the forest were important to them, the reasons being: It improves the rains (40%), it provides products (35%), it can be turned into agricultural land (15%) and it is essential for life (10%). However, 84% also considered that there were problems associated with the forest where wildlife is the main factor causing problems. Haule et al (2002) too found that living close to wildlife also involves disadvantages and conflicts. While the benefits from living close to wildlife are important, the disadvantages are several, which include damages to crops, predation on livestock and injuries to human beings. In the Ihombwe study people mention wildlife as the biggest and often only problem with the forest, and they also refer to indirect problems of injuries as “*It is easy to sprain an ankle when running away from a leopard*” etc. However, the biggest problem associated with wildlife is the direct damages to crops, but families also have to spend valuable time on protecting crops against animals, which also is evident from Case study I. In Haule et al’s (2002) study a school survey showed that 88.4% of the pupils had participated in crop protection.

Perceptions of resource-use rights

Land tenure is an important factor, which will ultimately affect the conservation of forest genetic resources. Where land is communally owned, usually community members would have open access to resources of the land. However, in most cases community rules do exist which often enforce the management and utilisation of these forest resources. As shown in Paper IV, many people, 25% and 22% respectively, were not aware of any restrictions on forests resource use or entry restrictions, even though the village includes several different categories of forest reserves and is bordering a National Park.

Lerise (2000) argues that because of lack of interactions with local institutions, land development decisions, as well as land use conflicts, were dealt with by villagers themselves with little or no input from the central government planning experts in the Ministry of Lands or in the regions. Therefore the government’s expectation that the spatial planning system and land-use plans would guide land development and become a tool for resolving land-use conflicts remains a dream; but by combining the villager’s perception and efforts in spatial planning with that of central-government planners, land-use conflicts in rural Tanzania could probably have been effectively dealt with and minimised. The village council in Ihombwe and its Environmental Committee experience severe problems of enforcing their management and restrictions rules towards outsiders, who can be most intimidating and dangerous when they arrive with weapons and are involved in illegal activities.

Perception of status of land and ideal locations for settlements

Both Case studies have dealt with the issue of preferred lands and ideal locations within the village lands. As Paper III showed, land considered 'good' does not necessarily overlap with the land already in agricultural production, and in fact it is presently unsettled. Partly, the explanation could be found in that people are aware of that *if* they had access to for example other tools and machinery, and *if* in an ideal world wildlife were to keep out of those areas, and floodings would not occur, those areas could potentially give higher yields. However, nothing in the soil analyses indicate that these areas would be of better quality, although as they are currently not in use they may be less 'exhausted' than the areas presently used for agricultural production. Equally interesting are the areas considered as being the least preferred. Namely, they do overlap with the current location for settlements and fields (also including some high-yielding fields), and they also overlap with some areas that are perceived as 'important'.

As explained in Paper IV, the population in Ihombwe is more content with their current location (57% thought their present location was the best possible) than in the Babati study. Also unlike Paper III, the Ihombwe population consider other factors that would make their every day life easier the most important if they were to move. Hence, the physical state of the land does not seem to be as highly prioritised. As people seemed more content here with their current location, they could more easily pick out sites that were *not* preferred, based on socio-economical and ecological factors. Paper IV indicates the important factors in perception of land as a base for livelihood to local farmers as shown in Figure 5 (Fig 6 in Paper IV). The main categories: physical factor, infrastructure, biological and institutional, naturally somewhat reflect the questions put to the respondents. However, several factors were raised independently by the respondents, and the sub-categories were answers to open-end questions. The external factors affecting land preferences are broadly the same for both case studies.

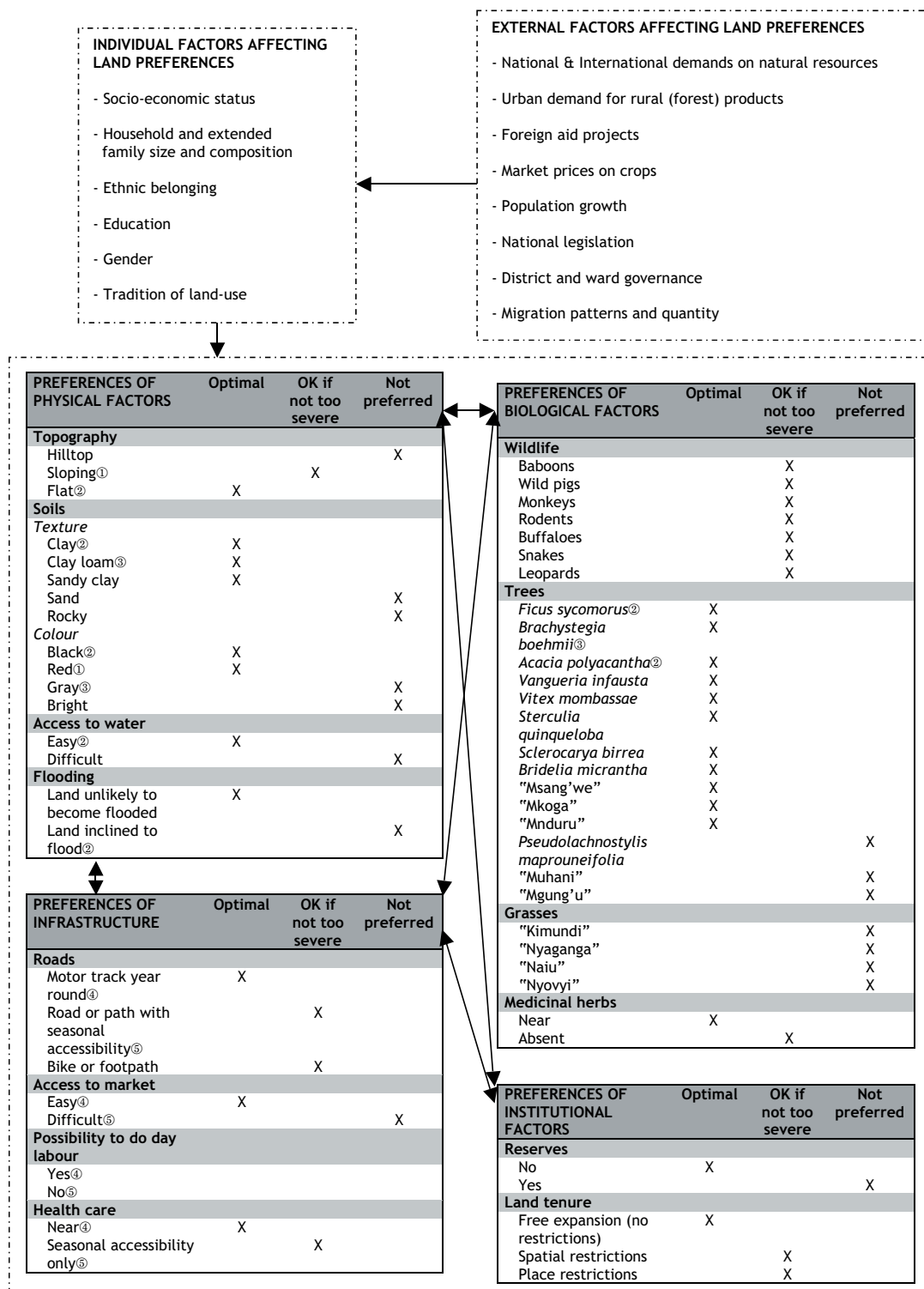


Figure 5. Factors important in determining land preferences on a local scale. The encircled numbers indicate dependence between factors, i.e. factors with the same number are strongly related.

LANDSCAPES IN ENVIRONMENTAL ASSESSMENTS

The perspective on the causes of environmental problems in Tanzania today is perhaps not so much different from that at the beginning of the century. The policies and laws were created to stop small-holders and pastoralists from using the land for shifting cultivation and grazing instead of in a 'productive' way that was not in the economic interest of the colonial states. Reserves were established to control land-use and to "protect" natural resources, and in contrast to the "abundance" of nature humanity's "absence" was the keyword. During the decades after Independence the arguments were pretty much the same, local people lived too scattered and used land in a non-productive way, hindering development and economic growth. All of these large-scale programmes then implemented have proven to be environmentally, and socially, non-sustainable. Today policies and discussions revolve around how to include humans in environmental conservation. However, when problems of environmental and developmental character are discussed the main opinion is still that shifting cultivations, settlements, grazing, fires, and fuel wood extraction by local, small-scale farmers, are causing the most difficulties. The linkages between people and nature are still seen in a one-way direction, which is that people are using the land and its resources in a wrong manner, leading to land degradation and therefore hamper development. I would argue that Western perspectives in this way still determine values of people and nature in Tanzania, and most likely in other developing countries as well.

Throughout this thesis (Papers I-IV) it has been argued that to move away from this compartmentalized perspective, holistic landscape approaches could illuminate these issues and hopefully offer other insights to environmental management. Landscape is a useful and dynamic concept that allows complexity in time and space, and that drawing conclusions from the visible landscape only does not identify underlying driving forces of change needed to establish future impacts and trends.

In Paper III it is said that landscape is the part of the environment that is the human habitat, perceived and understood by us through the medium of our perceptions. Paper IV emphasises that in the dialogues on biodiversity it is vital to recognise human actors in the landscape in order to understand *why* caring about biodiversity matters and how it relates to sustainable livelihoods. Both Papers (III and IV) therefore argue that 'landscape' is more appropriate to use for this purpose than is 'environment', as it is more flexible and cannot exist without dependence on the observer. This awareness is important as development agents, consultants, and tourists with the Western, past and present, envisioning of the relationship between African places and peoples are not just "points of view". They actually become powerful and coercive for the people they envision (Broch-Due 2000). They can also, through policies and other political and economical instruments, become realities in their own right, transforming the peoples and places that they were originally intended to describe.

Figure 6 (this is Fig 7 in Paper III) below aims illustrate the major factors needed to consider in a holistic landscape assessment based on the findings from Case study I. This 'model' is discussed more in depth in Paper III.

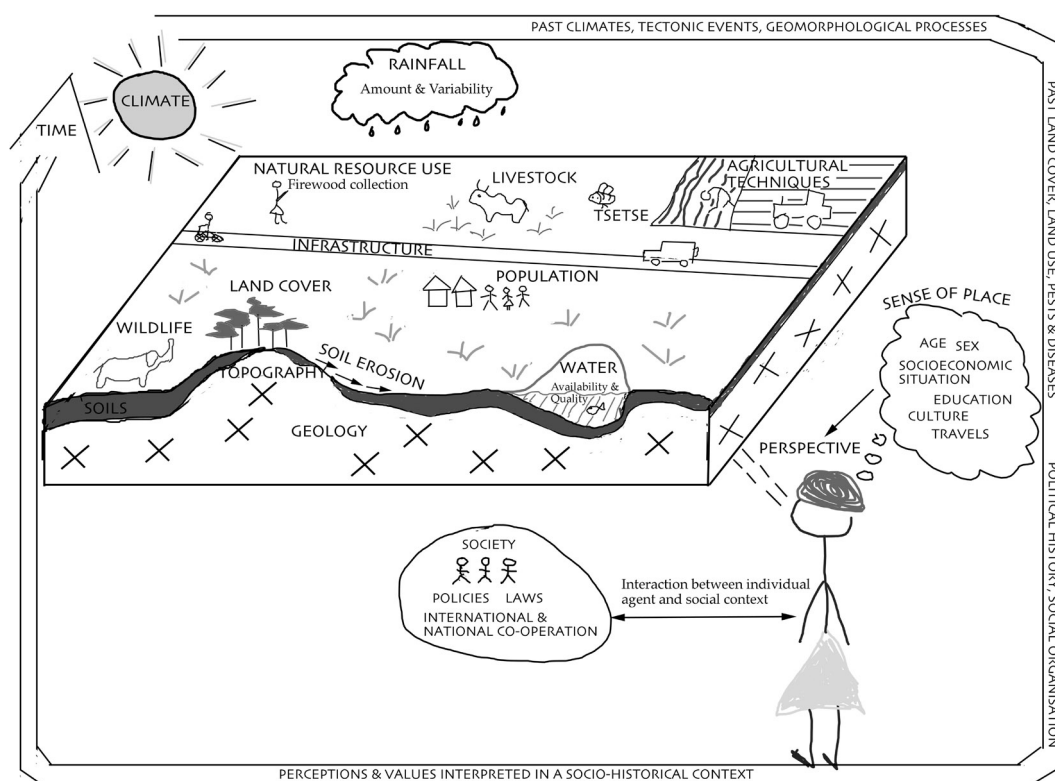


Figure 6. Important factors in the shaping and interpretations of landscape.

Representing the landscape

As shown in Papers III and IV the map is an excellent tool for communication of knowledge, especially in trans- and interdisciplinary work where a common arena is needed which everyone can relate to no matter what language or technical jargon or background. Map-making is also a good medium for “entering” the landscape, to make careful studies of details, and to make new discoveries of patterns and to handle complexity and large sets of data and information, and also to remember details after the field visit.

Planning for distant places, both geographically and conceptually, means that the level of uncertainty rises and unintended outcomes abound. Whatever is written on a page is given a newfound tangibility and value of truth through visual aids (e.g. maps and satellite images). It is therefore very important to use such material sensibly and with caution. Still, in Paper III it is proposed that the map could be used as a source of representation, where quantitative and qualitative information can be displayed simultaneously on a background of the recognisable biophysical landscape to provide a more nuanced image of the state of things. In addition, as a method mapping alone cannot bridge natural and social sciences in landscape research, but for those trying to deal with the difficulties in interdisciplinary methodology the map could diminish the gap between them and stimulate inter- and transdisciplinary communications (as discussed in Papers III and IV).

CONCLUSIONS

- The landscape is a common arena that scientists from the natural, social and humanistic sciences and local people can relate to. Thus the concept of landscape in a holistic sense acts as a good base for interdisciplinary assessments of environmental change both for long-term strategic sustainable planning, as well as for planning projects such as EIAs.
- Remote sensing and GIS are tools that with experience and local knowledge is a good supplement and basis for landscape studies. They cannot alone reveal areas of potential risk and vulnerability, nor explain changes, but they are very useful supplementary tools that can be used as a good basis for inter- and transdisciplinary discussions.
- Maps and map-making can serve as a medium for creating a dialogue and communication between local people, experts, and decision-makers where a satellite image, aerial photograph, or 3D image can be a good foundation where quantitative and qualitative information can be assembled and analysed.
- Integrated research is not simply a question of creating an arena where disparate disciplinary contributions can be placed alongside one another. Methodologies are needed that have the ability to meet these practical requirements but still convey the message of the complexity of interactions between natural and human systems. Methods of conducting interdisciplinary environmental assessments of course need to vary, but it is important to follow a structure to avoid too broad and general studies that only assemble a few factors and present them without an integrated synthesis. This thesis has suggested one research sequence and structure (Figure 3) that has proven to be practical and possible to execute in areas where data is scarce and where local involvement is a major component, and that extends the observation period in time and space.
- The observed changes indicate that the miombo woodlands are decreasing at a rather alarming rate in the Ihombwe area as a whole. The deprivation of the miombo woodlands would not only imply a loss in biodiversity *per se* but also a substantial loss of resources for the local population. The miombo forest is important and invaluable to local populations as it provides material goods as well as many intangible services. However, it is also associated with problems and dangers, which are important to consider and understand in planning for sustainable development and especially in discussions of conservation of natural resources and biodiversity.
- Site-specific preferences of land are complex where certain plants and soils may indicate agricultural potential. Other important factors are proximity and accessibility to water, markets, employment and health services.
- External forces should not be underestimated as disturbances and extractors of natural resources in local rural systems. They may cause increased vulnerability for local people and unsustainability for both social and ecological systems and bring about landscape changes.

- Landscapes are valued and assessed differently, depending on cultural background along with individual characteristics, and physical and visual elements are often stressed by “outsiders”.
- Landscapes can be said to create a tangible bridge between human minds and nature. It is likely that some misunderstanding and shortcomings in environmental management and planning are due to the fact that “outsiders” cannot as easily detect these cultural landscapes in, for example, Africa. That they still are viewed mainly as natural landscapes, even though they have been inhabited and cultivated for thousands of years, needs to be changed and this thesis have provided examples of how the seemingly ‘natural’ really is a union with ‘cultural’.

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