An ecology of difference: fence-line contrast photographs as scientific models in ecology

Eirin Hongslo[1]
Norwegian University of Life Sciences, Norway

Abstract

Political ecologists have long acknowledged the links between knowledge and power. Recently there has also been a growing interest in detailed studies about knowledge production within critical political ecology. This article is a study of the use of photographs in scientific articles on dryland ecology, and investigates the functions of photographs. Contrary to the straightforward manner in which they are presented, photographs are not value-free documentary proofs of 'how things are.' Rather, photographs constitute arguments in their own right. Using photographic and textual theory, this study analyzes two articles that include photographs of fence-line contrasts between two different management regimes. Contrasting areas divided by a fence-line is a methodology that demonstrates how management differences lead to differences in vegetation. In a Southern African context, however, differences across a fence tend to encompass deep racial and economic divides, and the fence-line photos risk encompassing these differences. This article argues that the fence-line contrast photographs in this study function as models that order the causal links between vegetation dynamics, land tenure and land management. These models correspond closely to equilibrium models in range ecology, and the fence-line photographs thus contribute to a degradation narrative that has been influential for land reform policies in Southern Africa, and that feeds into land use policies that favor private land ownership in communal areas.

Keywords: Critical political ecology, fence-line photography, scientific models, rangeland ecology, Southern Africa

Résume

Les écologistes politiques ont depuis longtemps reconnu les liens entre le savoir et le pouvoir. Récemment, il a également eu un intérêt dans les études détaillées sur la production de connaissances au sein de l'écologie politique critique. Cet article est une étude de l'utilisation des photographies dans des articles scientifiques sur l'écologie des zones arides. Il étudie également les fonctions de photographies. Ils ne sont pas simples ou sans valeur. Au contraire, les photographies sont des arguments dans leur propre droit. En utilisant la théorie photographique et textuelle, cette étude analyse deux articles qui comprennent des photographies de contrastes long des clôtures, entre deux régimes de gestion différents. Contrastant zones divisées par un 'fenceline' est une méthodologie qui démontre comment les différences de gestion conduisent à différents types de végétation. Dans un contexte de l'Afrique australe, les divisions raciales et économiques profonds peuvent également être exposés. Cet article soutient que les photographies de 'fencelines' dans cette étude sont des modèles qui commandent les liens de causalité entre la dynamique de la végétation, le régime foncier et la gestion des terres. Ces modèles correspondent étroitement aux «modèles d'équilibre» dans l'écologie des pâturages. Les photographies 'fenceline' contribuent ainsi à un récit de dégradation qui a eu une influence sur les politiques de réforme agraire en Afrique du Sud, et qui se nourrit dans les politiques d'aménagement du territoire qui favorisent l'appropriation privée de la terre dans les zones communes.

Mots-clés: écologie critique politique, fenceline photographie, les modèles scientifiques, l'écologie des pâturages, de l'Afrique australe

Resumen

Desde hace mucho la ecología política ha reconocido los vínculos entre el conocimiento y el poder. Últimamente en la ecología política crítica ha crecido el interés en hacer estudios detallados de la producción

---

[1] Dr. Eirin Hongslo was formerly Associate Professor, Department of Landscape Architecture and Spatial Planning, and Department of International Environment and Development Studies (Noragric), Norwegian University of Life Sciences, Ås, Norway. She passed away in February 2017. Thanks to Randi Kaarhus, Tor Arve Benjaminsen, Sian Sullivan, Matthew Turner, Carsten Ohlmann, Jørgen Alnæs, Synne Movik, Frode Sundnes, and two anonymous referees for valuable comments.

del conocimiento. Este artículo es un estudio del uso y las funciones de las fotografías en los artículos científicos sobre la ecología de zonas áridas y semiáridas. Aunque las fotografías se presentan como representaciones neutras, no son pruebas objetivas de "como son las cosas". Al contrario, son argumentos en si. Utilizando teorías del texto y de la fotografía, el estudio analiza dos artículos que incluyen fotografías que contrastan dos regímenes de manejo de paisaje, separados por una barda. Esta metodología de contrastar a dos lados de una barda busca mostrar como diferencias en gestión generan diferencias en vegetación. Sin embargo, en el Sur de África estas diferencias a menudo incluyen profundas divisiones económicas y raciales que no están identificadas en las fotografías. Este artículo argumenta que estas fotografías funcionan como modelos para ordenar una serie de relaciones de causa entre vegetación, tenencia de la tierra, y gestión de tierras. Estos modelos implícitos asemejan conceptos de equilibrio que operan en la ecología de los pastizales, y las fotografías de bardas contribuyen así a una narrativa de degradación que ha tenido un impacto sobre las políticas de reforma agraria en el Sur de África, y que apoya políticas de uso de suelo que favorecen a la extensión de la propiedad privada en las áreas comunales.

Palabras clave: Ecología política, las fotografías de bardas, los modelos científicos, pastizales ecología, África del Sur

1. Introduction

During fieldwork in Namaqualand (South Africa) in 2005 and 2006, I encountered fence-line contrast photographs: pictures of fences cutting the landscape in two, under a blue sky.[2] The fence is not the only thing that divides the landscapes in the photos; so too do the physical features, with one side displaying conspicuously less vegetation than the other. The first fence-line contrast I saw was on the cover of a book about degradation in communal areas in South Africa, entitled *Nature Divided* (Hoffman and Ashwell 2001). The only direct reference to fence-line contrasts in the book is the very first paragraph of the preface:

> In the same way that South Africa's population has been divided along racial lines in the past, so too have its landscapes. The land of the former homelands and self-governing territories has been used very differently from that of the commercial areas of the former Republic of South Africa. This division of nature has had important implications for land degradation in the country as a whole (Hoffman and Ashwell 2001: no page number in original).

This paragraph captures the politicized nature of Southern African landscapes. Later, I found fence-line contrast photographs in coffee-table books displaying Namaqualand during the flowering season: colorful displays of landscapes covered in flowers, a different color on each side of the fence, providing an obvious contrast. I also found numerous less colorful, but similarly conspicuous photos of contrasts in scientific articles on ecological dynamics.

Fence-line contrasts are not just fictions constructed for scientific purposes: they exist in the landscape for all to see. During my fieldwork, I found marked differences along fence-lines within the communal area where I stayed, and between the communal area and neighboring private farms owned by white commercial farmers.[3] Such contrasts have captured the attention of scientists and photographers alike.

The similarity of composition in fence-line contrast photographs is striking and aroused my curiosity. Save for a few aerial photographs and satellite images, most photographs center on the shape of a "T", with

[2] In fence-line contrast studies, the concept of "fence-line contrast" is used with at least three different meanings. First, it denotes a genre of ecological writing, namely a "fence-line contrast study." Second, it denotes the physical landscape: a fence separating two diverging landscapes. Finally, it denotes a photograph depicting this phenomenon.

[3] "Communal area" is the expression often used to refer to the areas that were designated for colored and black farmers during apartheid, that are now managed communally by all citizens in the community. These are often contrasted with commercial areas, which are privately owned (mostly by white farmers). The use of the terms communal/commercial is considered awkward by many, since "communal" refers to tenure, while "commercial" refers to the relationship between production and market, but I use it here since these are the words most commonly used in Southern Africa.

the horizontal line marking the horizon and the vertical line marking the fence. The T formation is, apparently, an aesthetic convention, and calls for further inquiry.

This article combines perspectives from political ecology and Science and Technology Studies (STS). It is predicated on the notion of knowledge as inherently political (Goldman *et al* 2011; Jasanoff 2004). It follows a tradition of debate within political ecology and particularly *critical political ecology* (Forsyth 2003) or the *politics of ecology* (Turner 2015) about the co-production of knowledge and power. As Turner (2015: 3) recently pointed out, political ecologists have long criticized "truth claims made in the name of environmental science" (cf. Fairhead and Leach 1996; Forsyth 2003; Goldman *et al.* 2011; Homewood and Rodgers 1987; Leach and Mearns 1996; Scoones 1996; Stott and Sullivan 2000). Recently, and taking a slightly different turn, the growing body of literature on the *politics of ecology* investigates environmental knowledge production and its political influences and implications (Turner 2015). These studies, often inspired by STS, seek to understand processes of knowledge production in depth, in order to discern the power dimensions of environmental knowledge and perception (Forsyth 2003, Turner 2015).

Visual representations in science take many forms: diagrams, graphs, drawings, and photographs, depicting all kinds of objects; and such images are produced by means of a range of technologies. Visual representations play a crucial role in scientific communication and in the establishment of scientific facts. They "are more than a simple matter of supplying pictorial illustrations for scientific texts. They are essential to how scientific objects and orderly relationships are revealed and made analyzable" (Lynch 1988: 203). Today, photography is used both as evidence, theory, and, I will argue, as models in a range of fields: history, geography, sociology, social anthropology, biology, landscape architecture, and planning. Kwa *et al.* (2009) point out that photographs sometimes play a somewhat confused role in sciences such as geosciences and ecology, and that scientists are often ambivalent with regard to photographs of landscapes. On one hand, researchers use photography in scientific texts, but on the other, they may argue that models of vegetation dynamics, for instance, are much more important than pictures.

As researchers have pointed out before me, images never "present innocent interpretations" (Rosner 2001: 392), but nor do other types of data or interpretations. All research processes, starting from raw data, involve interpretations, suppositions, and simplification on their way to becoming published texts. Nevertheless, we often tend towards a dual relationship vis-à-vis imagery in scientific texts. Often, we treat images as products "that tell a story that is single, static, and – if the writer is ethical – true" (Rosner 2001: 392). We often fail to consider the filtering of information leading to a photograph or diagram, and consequently tend not to scrutinize visuals as we would scrutinize a text. In that sense, we are often illiterate with regard to image-reading (Kress and Van Leeuwen 2006), as well as to its effects in building arguments and theory. However, this does not mean that we always accept images. Kjeldsen (2002), while agreeing that photographs simplify and manipulate ideas, questions the claim that they are more powerful and more readily accepted than linguistic arguments. On the contrary, he writes, we tend to argue against visual representations in much the same way as we argue against oral or written representations.

Several works of political ecology and environmental history have used photography to uncover land changes in vegetation, or the lack thereof (Benjaminsen 2001; Benjaminsen *et al.* 2006; Fairhead and Leach 1996; Hongslo *et al.* 2009; Rohde and Hoffman 2008; Tiffen *et al.* 1994). All these articles question the notion of degradation orthodoxies by investigating vegetation history. This study takes a different approach. It investigates the use of landscape photography within ecology, and, thereby, how political assumptions intertwine with knowledge production.

As a contribution to the STS literature, this article discusses the importance of visual arguments in scientific texts, and uses a particular genre of landscape photographs as a case study. While the use of photography in botany and microbiology has been studied (e.g. Lynch 1988; Lynch 1991; Rosner 2001; Tucker 2005), few have analyzed the function of landscape photographs in ecology. Kwa *et al.* (2009) provide a notable exception. They discuss the contribution of landscape photographs in scientific literature and whether they can be considered as theory and data. This article contributes to that discussion, as well as to discussions on the influence of photography in the interface of science and policy.

This article presents a case study of two articles that include fence-line contrast photographs and aims to answer three questions: How does the composition of scientific photographs influence the message? How do scientific texts interpret photographs? How are the photographs and their textual context positioned in wider societal debates?

2. Photographs as models

Scientific publications in a broad range of academic fields, from cartography, geography and landscape ecology, to physics, chemistry and microbiology, have used photographic depictions. Not surprisingly perhaps, geographers adopted the use of aerial photography for map-making and studies of environmental change, and during recent years, environmental problems have often been conceptualized through the use of landscape representations (Widgren 2004). Ecologists, on the other hand, hesitated in their use of landscape photography as they found that photographs did not discriminate between important and less important elements, and thus became too "noisy" (Kwa 2009). However, as governments began to provide aerial photographs, this skepticism diminished, and in the 1980s, analysis of aerial photographs became commonplace in ecology (Kwa 2009).

Ever since it became a realistic option, the use of photography has been a matter for debate (Tucker 2005). As is currently widely recognized, a photograph is the result of a number of choices made by the photographer and the publisher. The choice of motif, perspective, focus, use of shutter and diaphragm, as well as preparation such as cropping and editing, all affect which aspect of reality is captured and in what way. It is common to regard these effects as "internal attributes" of the photograph, but as Barry (1997: 150) points out, this is the most problematic effect of taking photographs at face value. In an analysis of photography used in science, these choices require closer investigation.

This article is premised on the notion that images, like written texts, convey messages and, taking this idea further, that they constitute arguments. Visual representations and text overlap in the messages they can convey, yet they are not quite the same: some things can be expressed both visually and verbally, whereas some things can be "said" only visually, others only verbally, and the way the message is conveyed will differ (Kress and Van Leeuwen 2006). Whereas texts vary in the use of word classes and semantic structures, visual representations vary in their use of color or composition (Kress and Van Leeuwen 2006). Photographs guide the reader to see what the author wants to communicate (Rosner 2001). They are able to capture a wider range of detail in smaller spaces than language, and consequently contain a wider range of meanings (Kjeldsen 2002). This saturation of meaning runs the risk of luring the viewer in all kinds of directions. The photo may blur the message or argument and demand a broader context for its interpretation.

However, the need for context to construct meaning is not unique to photographs, and certainly does not disqualify photographs from representing arguments. Most oral or written statements need a wider context to be "correctly" interpreted (Blair 2004; Kjeldsen 2002). Visual images and text are equally imprecise and ambiguous, and as they often occur together, the construction of meaning from each form depends on the other (Kjeldsen 2002; Kress and Van Leeuwen 2006). The context provided by the scientific text (e.g. captions, headings, bold text, layout) invites the reader to interpret the photograph in a particular direction and to "see what is being said" (Lynch 1988: 203; Foster 2003; Lynch 2006). It opens up some avenues for interpretation and closes others (Kress and Van Leeuwen 2006; Scott 1999). The wider social and historical context adds further new layers of meaning (Kjeldsen 2002; Schwartz and Ryan 2003).

Thus, photographs are important beyond their use as illustration. Kwa *et al*. (2009) hold that in landscape ecology and geography, "the aesthetic features of landscape pictures play a role in many stages of research […]. They have served (and continue to serve) to define the object of investigation. In this sense, pictures contain 'theory' as much as they represent data". Lynch (1988) discusses the importance of aesthetics in defining objects of investigation in research on cell organisms, where researchers are uncertain about what they will find. Researchers interpret raw data, and then draw diagrams of cell organisms. Visual representations at once conceptualize research findings and aid researchers in seeking similar phenomena in their own research, and once a motif is established, researchers will to some degree, consciously or not, look for the same motif under their microscope or in the field (Lynch 1988).

Like Lynch (1988) and Kwa *et al*. (2009), I argue that the conspicuous visual appearance of the study object, in my case, fence-line contrasts, is decisive when selecting what to study, but I contend that the importance goes further and that photographs may represent scientific models. Like metaphors, models often represent something by way of something else. Models further simplify empirical findings and build theory (Kaarhus 1992). Models are in a sense empty structures that must be filled with observations in order to say something meaningful about the world (Kaarhus 1992). Models do not "contain the 'essence' of reality" but attempt to "represent some significant differences" in whatever we want to explain (Kaarhus 1992: 89). In order to analyze how a particular model informs research, we need to study the texts in detail.

3. What is a fence? Change and difference in Southern African rangelands

Fences have a variety of meanings. Fences protect animals from predators, thieves, and sicknesses. They protect flowers, succulents and bushes from grazers. They draw the line between "hunters" and "poachers", wealth and poverty, a prisoner or a free person. Fences have cultural and physical meanings, and the meanings intertwine in complicated ways. Fences represent claims to property (Chaumba *et al.* 2003; Rose 1994). They can exclude people and animals from greener pastures, and may act as manifestations of social divisions (Peters 1992). Although barbed wire is efficient in keeping living creatures away, fences are little more than markers, and would not have the power to exclude if the exclusion did not have a meaning beyond the physical structure and formed part of a social contract between the excluder and excluded themselves. As such, fences may be considered statements in a frozen negotiation between the people that live with them (Fortmann 1995; Rose 1994).

The two photographs analyzed in this study are taken in Namibia and South Africa respectively. South African and Namibian landscapes are extraordinarily orderly. An effect of the former apartheid regime in South Africa (and South West Africa, as Namibia was formerly called) was the meticulous ordering of people and land into white, colored and black areas (Dodson 2000). These divisions were "textual" in the sense that they were carefully organized according to written plans laid down by the apartheid government (de Wet 1995). The legacy of apartheid prevails. Fences in South Africa and Namibia mark borders between properties, between white and black, poor and rich, communal and private land. Two decades after the law that prohibited black and colored farmers from purchasing land and climbing the social ladder was retracted, the fences still mark the landscape, as well as the economic and structural hindrances that persist.

In South African and Namibian landscapes, fences have an additional connotation. They are signs of proper rangeland management. The rangeland succession model has informed rangeland policies in South Africa and Namibia for decades, and still does (Benjaminsen *et al.* 2006; Lebert and Rohde 2007; Rohde *et al.* 2006; Sullivan 1996). The ecological model predicts that vegetation in dryland areas continuously strives towards a natural equilibrium. After an external disturbance (e.g. drought, grazing, fire) the area will recover its equilibrium if it is left to rest (Bartels *et al.* 1993). Continuous disturbance may cause permanent degradation; therefore, low stocking rates and fallowing of pastures become important factors in sound management of the land. The rangeland succession model has been widely criticized; in particular its relevance in dryland areas has been questioned (Ellis and Swift 1988; Homewood and Rodgers 1987; Scoones 1989; Sullivan 1996; Sullivan and Rohde 2002; Turner 1993). The criticism emerged as researchers developed new ecological models more relevant to dryland areas. The non-equilibrium model assumes that climatic factors, rather than grazing, are drivers of environmental change (Behnke and Scoones 1992; Caughley 1979; Sandford 1983; Scoones 1989; Scoones 1996; Scoones *et al.* 1993). Hence, stocking level is not as crucial for healthy ranching as was previously thought. In a similar vein, the state-and-transition model assumes that rangelands change discontinuously and sometimes irreversibly and inconsistently (Westoby *et al.* 1989).

The rangeland succession model recommends that commercial holdings should be fenced into camps (paddocks) and grazed in rotation, always saving forage for meager years. The South African and Namibian Department of Agriculture have favored rotational grazing in paddocks in commercial rangelands since the 1950s. For decades, white commercial farmers received considerable subsidies to fence their farms, along the borders as well as around paddocks (Archer 2002). In these rangelands, fences and standing grass are signs of

successful management, signs that are frequently mentioned by communal and commercial farmers, as well as extension officers and politicians. As we shall see, the fence marks a contrast satiated with meaning.

4. The difference that makes a difference – composition in fence-line contrast photographs

The social anthropologist Gregory Bateson famously asked: "What is the difference that makes a difference?" The human mind, Bateson contends, registers difference and change only. Consequently, it registers all new information as being different from something that we already know. Furthermore, in order to conceive a difference as a difference, the compared elements must exhibit a certain element of "sameness." However, one thing can be similar to (or different from) another in a wide variety of ways. A bike and a bus, for instance, are similar in the sense that they are both a means of transportation, made of metal and with wheels, but they have different numbers of wheels, are driven in different ways, with different risk, etc.

Humans tend to communicate through story-telling, and in principle, any object or idea A can be related to any item B, provided a story is told that connects and separates them (Bateson 2002). Therefore, in comparing one thing to another, we create a "story"; that is, we make choices as to which differences or similarities are important in a particular context. This process of drawing things together and holding them apart can also be illustrated by Stephanie Lavau's (2008) concept of *cleaving*. The word "cleave" has a double meaning: "to hold firmly" and "to split apart." In comparing things, that is exactly what we do. We insist on them being equal enough to compare, while being different in a way that makes a difference. In the same manner, the fence insists on connection and separation at the same time. The cleaving of dichotomies forms the basis of fence-line contrast studies. The fence-line contrast thus resonates with the basic manner in which humans register the world: by way of meaningful contrast.

5. Methodology

The first studies of fence-line contrasts, differences in vegetation cover along a fence, appeared in the USA in the 1960s (Cook *et al.* 1965), and the fence-line methodology is still widely used. In preparing this article, I searched a number of internet databases (covering the major journals in geography, ecology, botany, soil science, and agricultural science) for articles that used the fence-line contrast methodology.[4] I used the keywords "fence", "fenceline" "fence-line" and "fenceline contrast" and when the searches resulted in too large a pool of findings, I combined these keywords with relevant keywords like ecology, species, and soil. I then used the "related articles" function, and searched in the reference lists of the articles to find relevant articles that had not appeared in the database search. In my sample, I included all studies that explicitly or implicitly used fence-line contrast, regardless of whether or not they used photographs, and searched until I reached a saturation point, at which searches led to no new findings. The resulting pool of articles (76) included studies from the USA, Australia, New Zealand, Mongolia, Germany, Norway and Finland, but the majority of articles were from Southern Africa (46). Amongst these articles, I found 15 that contrasted two or more commercial paddocks (camps) or farms, 17 that contrasted commercial farms and communal areas, and nine that contrasted grazed areas (commercial and communal) and conservation areas. The remainder (5) were classified as "other" (comparing commercial farms with road verges, communal farms, experimental plots, and so on). From the 76 articles, I purposefully selected two articles. I sought articles that contained a fence-line contrast photograph, including at least one communal area. Thus, the choice fell to two articles from Southern Africa, one from Namibia and one from South Africa.

This study is a qualitative analysis of two fence-line articles that contrast a communal area with a government scientific farm and a private farm, respectively. I investigated how the photographs portray the differences across the fence, and what meaning they attach to the differences, both in terms of ecological and social contexts. I combine different methodologies for analyzing photographs in conjunction with text. Firstly, I use compositional and semiotic analysis to analyze the photographs. The tools of compositional analysis are "not often made explicit" in the field of art history, and include an "element of intuition" (Rose

[4] ISI Web of Science, Agris, Biological Abstracts, CAB abstracts and Google Scholar.

2005: 70). The method includes analysis of the structure of the image, or how the elements of the picture combine (the content, the light, the colors, how it is organized, how the viewer is placed and so on), and finally the effect of these combinations. As Rose (2005) points out, compositional analysis concentrates on the image itself, but offers little in the analysis of the interrelations between the image and the surrounding text. Barthes (1977) distinguishes between signs which are denotative and connotative.[5] At the most immediate level is the denoted meaning of the image, which is the image's literal meaning, or what we actually see. Barthes (1977) admits that such a level is by its nature constructed, as the literal meaning can never be fully isolated from its interpreted meanings, but he retains this level because of its usefulness in analysis. The connoted meaning of the image is the meaning that can only be understood though cultural and social lenses. For instance, an image of a man dressed in red with a white beard may remind the viewer that it is Christmas soon. This meaning is, in itself, detached from what we see, but crucial to our understanding and interpretation of the image. Secondly, this study draws on discourse analysis (Rose 2005) in that it explores the meaning offered by the cultural context of the articles.

6. Analysis

The first image in this study (Image 1) shows a typical fence-line contrast photograph. It is taken from Hoffmann and Zeller (2005) and denotes a fence separating two landscapes, a barren-looking one to the left and an ordered, grassy area to the right. The fence divides the land from left to right, and gives both sides equal position in the photo (as opposed to giving any one side a foreground position). This positioning communicates objectivity and trustworthiness and is often used in scientific imagery (Kress and Van Leeuwen 2006). The photographic angle is wide and shows hilltops in the distance and a landscape that continues into the distance on each side. The viewpoint suggests that the photographer is standing slightly above the motif. This vantage point signals detachment and power over the subject (i.e. the land), as opposed to a view from below which would signal smallness and fear on the part of the observer, or eye-level that suggests realism (Barry 1997; Rosner 2001).

One aspect of the caption formulation captured my attention: "Fence-line contrast of the study sites." The writers are apparently aware that they are contributing to a photographic genre within ecological scientific writing. Here, *fence-line contrast* clearly refers to the photograph or concept, and not to the physical landscape. In their description of the study area, *fence-line contrast* acquires an additional meaning: "The region is characterized by fence-line contrasts caused by varying land use practices" (Hoffmann and Zeller 2005: 92). Here *fence-line contrast* is represented as a physical "element" that can be found in nature. Hence, "fence-line contrast" has different meanings that can be fine-tuned for different circumstances: a photograph, a genre of ecological studies, and a physical structure. Fence-line contrast studies use these meanings interchangeably and sometimes confusingly.

One may interpret the fence-line motif in this example as a landscape motif. As Cosgrove points out: "Landscape is not merely the world we see, it is a construction, a composition of that world. Landscape is a way of seeing the world" (1998: 13). The perspective in the photograph has repercussions for what differences we perceive to "make a difference." A different perspective would grant importance to another set of differences and similarities, and would offer another way of seeing the world. We could imagine, for instance, a close-up of grass tussocks on one side and bare ground on the other.

So what messages or arguments can a particular landscape photo convey that a different perspective could not? First, the inclusion of a wide area on both sides of the fence gives the impression that the difference portrayed is representative of the landscape. Of course, we do not know if the grass tussocks on the right side of the fence are grazed down to the ground just outside the frame. Nor do we know if the left side is vegetated outside the frame, as the appearance of bush cover to the far left might indicate. As Rosner (2001) points out, we have to trust the ethics of the authors in what they have chosen to portray.

[5] "Denotative" and "connotative" refer to levels of semiotic meaning. Barthes (1977) described the denotative as being the immediate sign, or the sign that one sees in the photograph (a tree, grass, a fence), while connotative meanings are cultural meanings that are associated with these signs (ecological health, good management, exclusion).

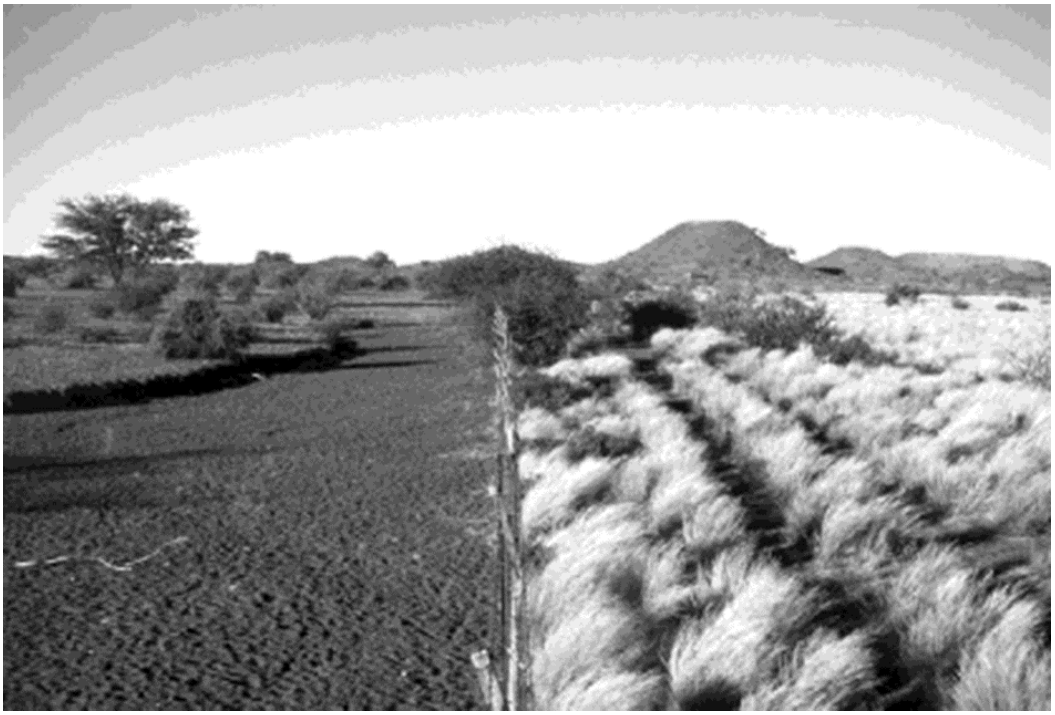

Image 1: Original caption: "Fig. 1. – **Fence-line contrast of the study sites.** Left: overgrazed communal farming area of Nabaos; right: moderately grazed governmental (sic) farming area of Gellap-Ost" (Hoffmann and Zeller, 2005). Reproduced with permission from the authors.

Second, the two landscapes are visually different (one is vegetated and the other less so). Even a fairly simple motif like the fence-line contrast is ambiguous (Kjeldsen 2002), and as Bateson (2002) points out, any A can in principle be connected to any B by way of a story, or a causation link. So what does "difference" mean here? What features, differences and similarities does the photo privilege above others? At one level, the answer is the difference between "vegetation cover" and "no vegetation cover". The article specifies "vegetation cover" as 10% cover of the perennial grass Stipagrostis uniplumis.

Third, the landscape perspective privileges harmony and order, with the height of the horizon figuring as the formal organizer. A low horizon produces unity in the landscape, as the "elements are projected onto one another and hence fused, at least to some extent" (Kwa 2009: 72). A high horizon, on the other hand, reveals more of the spatial fragmentation and thus more "disorder." An aerial photograph would be the "logical endpoint" of a low horizon. Similarly, "long distance produces a high depth of field, further enhancing unity in the landscape" (Kwa 2009: 72). The horizon in Image 1 is above the center, but still low, giving each landscape a harmonious and unified look. We see here how the low horizon orders and harmonizes the landscape, and efficiently communicates the difference in landscape: a 10% cover of grass would look much sparser on an aerial photo than the apparently dense grass cover we see in the photo. However, as Hoffmann and Zeller (2005) point out, it is exactly the difference between the 10% cover on the right side, and the lack of the same on the left, that makes a difference for the presence of small mammals. The authors indicate that this limited grass cover is a significant source of food for rodents. When grass cover drops to below a certain level, the rodents' survival rates drop. The actual level of coverage required is not specified.

The article also mentions other possible visible differences in vegetation cover that are significant for rodents. Bush cover is low on both sides, but the size of each individual bush is greater on the government farm than on the communal area. The photograph does not portray the difference in canopy size, however. Finally, the landscape view indicates that the two areas lie in close proximity to each other and consequently are sufficiently similar to compare.

The text in Hoffmann and Zeller (2005) offers a context for interpretation of the photo. The photo caption does not comment on what we see in a material sense. It implies that differences in the landscape are the result of diverging management practices and dissimilar land tenure. We see here how the text serves to interpret or connote the image. "Overgrazed" is contrasted with "moderately grazed" and "communal farming area" with "government farming area". Overgrazed and moderately grazed refer to different levels of *grazing*. Grazing unites the areas, but its intensity differs. There is a difference in degree on a continuum, and the article does not specify the point at which one becomes the other. The difference between "communal farming area" and "government farming area" is more clear-cut. An area is either one or the other, and each category has a range of implications for management practice.

The fence-line contrast photograph is positioned under the subtitle 'Study area', a neutral description indicating that it is not data, or a model. Underneath the subtitle is this description:

> [t]he study was conducted on two neighbouring areas with **different land use practices** (Fig. 1), approximately 20km northwest of Keetmanshoop. One study plot was **highly overgrazed**, mainly by goats within Nabaos **communal areas** (here the exact position is provided). The other plot (distance 1.5km) was within the **government karakul sheep breeding farm** in Gellap-Ost (exact position again). In contrast to the **uncontrolled** grazing in Nabaos, Gellap-Ost uses a **rotating grazing system with a lower stocking rate**. (Hoffmann and Zeller 2005: 92, my emphasis)

The authors explicitly mention the difference in land use practice as being the cause of the fence-line contrast and the text thereby confirms the thesis in the caption: they consider differences in tenure and stocking rates consequential for the interpretation of the visual difference. "Uncontrolled grazing" on the left side is contrasted with "rotating grazing systems" and "lower stocking rate" on the right side, indicating that the left side is different in both respects.

We begin to see how the connotations implied by the text take the form of dichotomies. Rather than the photo representing the difference, it works as a scientific model that orders the relationship between vegetation dynamics, tenure and land management. If we combine the basic structure of the model (A≠B) with the information we gain from the description of vegetation, grazers and the occurrence of small mammals in the rest of the text, the model appears as follows (Figure 1):

Nabaos	**Gellap-Ost**
"Communal farming area"	"Government karakul sheep breeding farm"
"Overgrazed"	"Lower stocking rate"
"Uncontrolled grazing"	"Rotating grazing system"
No perennial grass cover	10% perennial grass cover
Grazed predominantly by goats	Grazed solely by karakul sheep
Unsatisfactory occurrence and diversity of small mammals	Satisfactory occurrence and diversity of small mammals
Represented by: bare-looking area	Represented by: grass-covered area

Figure 1: Model represented by Image 1.

Here the vertical line symbolizes the fence, while the two columns represent either side of the fence. By dichotomizing the characteristics on the two sides of the fence, Hoffmann and Zeller (2005) indicate that the characteristics are comparable; they are equal and different at the same time (Bateson 2002; Lavau 2008). Simultaneously, through the photograph, the characteristics that represent each side are grouped together, creating new associations and possible causal relationships. So now "communal", "overgrazed" and "uncontrolled grazing" are grouped on one side and are all represented by the bare area, while "government karakul sheep breeding farm", "rotating grazing system" and "lower stocking rate" are grouped together on the other, represented by the grassy area.

If we were to assemble a narrative from the article, it would be that communal management, overgrazing and uncontrolled grazing cause bare areas that lack perennial grass species (depicted) and large-canopy bushes. The lack of perennial grasses and large bushes causes low occurrence and diversity of small mammals. On the basis of their findings, Hoffmann and Zeller (2005) argue that there is a need to consider conserving communal areas to improve living conditions for small mammals.

We see how the photograph (Image 1) and the text interpreted by way of the model contribute to the view that there is a fundamental difference between communal and government farms. In this instance, there is reason to believe that the photograph gives a slightly skewed view of the difference in vegetation on the two sides of the fence. As mentioned earlier, the body text in the article reveals that the vegetation in the two areas is fairly similar, in both species richness and cover, while the difference in the photo is marked.

The second photograph in this case study is taken from a much-cited article by Todd and Hoffman (1999) entitled: "A fence-line contrast reveals effects of heavy grazing on plant diversity and community composition in Namaqualand, South Africa." Here, "fence-line contrast" refers to the physical landscape divided by the fence, although it could also refer to the photograph. As in Hoffmann and Zeller (2005), the photograph is positioned early in the article, after the section describing the study area, within the section on methods. Again, the positioning of the photo within the article indicates that it is intended to be an illustration of the study site, rather than a representation of data or theory.

The viewpoint in this photo (Image 2) is to the right of the fence. The fence meets the lower edge of the photo at the golden section on the left hand side, whereas it is almost centered where it meets the horizon right in the middle of a valley between two hilltops[6] (For more on "the golden section" see for instance McManus and Weatherby 1997). The distance between each hilltop and the upper edge of the photo corresponds to the distance between the road crossing from left to right in the lower part of the image and the lower edge, thus focusing our attention on the middle part of the photo. By adhering to these photographic conventions, the photograph appears to be more aesthetic, more readily conceivable, and curiously more authentic.

Todd and Hoffman's (1999) primary concern is vegetation, and more specifically changes in vegetation. The caption gives an indication of which characteristics are thought to make a difference in the photograph. The first sentence of the caption indicates that the difference in land tenure between the two areas (commercial vs. communal) is significant. The second sentence indicates another significant difference: the difference in dominating species (R. robusta vs. G. africana). Ecologists and other specialists familiar with Southern African grazing systems will appreciate that R. robusta is a valued fodder shrub, whereas G. africana is considered a weed and is poisonous to livestock at certain times of the year. This information thus carries an important connotation: R. robusta connotes valuable fodder, while G. africana connotes degraded pastures.

[6] The golden section is an ancient aesthetic principle. It is believed that humans perceive motifs as being divided into three horizontally and vertically, thus producing nine imagined squares divided by two horizontal and two vertical lines. Landscape photos can take advantage of the golden section by placing significant features in their motif on these four lines. The effect is to draw attention to the object on the line, and the viewer will perceive the image as aesthetically appealing (McManus and Weatherby 1997).

Image 2: Original caption "*Figure 1.* The fence-line contrast between communal and commercial rangeland. The communal rangeland, dominated by Galenia africana, is on the right, while the commercial rangeland, dominated by Ruschia robusta, is on the left" (Todd and Hoffman, 1999).

The description of the study area details the differences on the two sides of the fence. In the communal areas of Namaqualand, stocking rates have been consistently much higher than recommended by the South African Department of Agriculture, while the commercial areas have kept within the recommendations for the last thirty years. Further, the commercial farms apply rotational grazing, while the communal farmers have livestock that graze the land more or less continuously. In the article, "heavily and continuously" is juxtaposed against "moderately and rotationally." Again, we have the connotations of good and poor land management: "moderately and rotationally" connoting good management, and "heavily and continuously" connoting poor management.

In their description of the study site the authors write: "The high stocking rate on the communal rangeland has clearly impacted on the vegetation as marked fence-line contrasts are evident (Figure 1) and large areas have become dominated by Galenia africana L., a highly unpalatable shrub" (Todd and Hoffman 1999: 170). Here they refer both to the fence-line contrasts in the landscape and to the fence-line contrast photograph. They indicate that fence-line contrasts are indeed common and conspicuous on the borders between communal and commercial landscapes. However, a closer investigation of the text reveals that the differences are not as marked as the photograph indicates. Despite the higher stocking rates on the communal side, the study found no significant difference in species richness between the communal and commercial areas. However, the composition of species differed. While the perennial cover was 20% lower on the communal side than on the commercial side, the annual cover was 11% higher. There was no difference in the cover of the unpalatable G. africana, but the number of individual shrubs was much higher in the

communal area. Differences were found in the overall shrub volume, and the occurrence of the three most common palatable shrub species was markedly lower on the communal side. While the occurrence of G. africana seedlings was higher on the communal side, the occurrence of seedlings of the three most palatable species was lower. This indicates that recruitment of G. africana is higher than recruitment of the three palatable species on the communal side of the fence. In summary, the similarities between the two sides seem more notable than the differences, even to the authors who attributed the lack of difference to the extremely high rainfall in the year of the sampling. They leave us wondering how representative the fence-line contrast photograph is for this specific study area. Moreover, if the photo is not representative of appearances in the field, why was it included?

This thought returns us to the function of a photograph beyond data or illustration, as a model of causes and effects besides purely ecological issues. As argued previously, fence-line contrast photographs have functions beyond showing how things are, and may suggest relationships between tenure, land management and vegetation dynamics. We have already established that the "differences that make a difference" in Todd and Hoffman (1999) are disparities in vegetation cover and structure, in tenure, and in management (difference in stocking rate, and continuous vs. rotational grazing in paddocks). Thus, we have differences at both the denotative and connotative levels (see Barthes 1977). The vegetation differences are found at the denotative level − we can for instance (with the help of the authors, if we are not experts ourselves), see a difference in the shade of color between the shrub species R. robusta and G. africana. Other differences, like the difference in seedling activity of the shrubs, are not visible at the landscape level. Nevertheless, they are important in the construction of the connotative meaning of the photograph. On the connotative level, we also have the difference in tenure and the difference in management that were mentioned above. If we aggregate these differences it suggests a simple scientific model that informs Todd and Hoffman's (1999) article we get Figure 2:

Neighboring private farms	**Poulshoek**
"Commercial farm" "Stocking rates at 12 ha per small stock unit or lower" "Moderately and rotationally grazed" "Dominated by Ruschia robusta" Represented by: darker area on the left side	"Heavily grazed communal farm" Mean stocking rates "twice that recommended for the region by South African Department of Agriculture" (12 ha/ssu) "Heavily and continuously grazed" "Dominated by Galenia africana" Represented by: lighter area on the right side

Figure 2: Model represented by Image 2.

The vertical line in Figure 2 symbolizes the fence, and we see how the fence cleaves the concepts into two sections. "Commercial farm" is contrasted with "heavily grazed communal farm" (the grazing level on the commercial farm is not mentioned, but is assumed to be moderate). "Heavily grazed communal farm" implies both management and tenure issues. In the second point, the stocking rates on the two sides are compared with each other, and with recommended stocking rates. The third point refers to management practices, while the fourth point refers to the vegetation cover, as represented in the photograph. By partitioning the landscape into two separate sections, the middle line in the model also unites the concepts on each side. They all represent and explain each other, and are represented by the photograph. Hence, we see that commercial tenure, moderate stocking rates, rotational grazing, and R. robusta all connote "good management", while heavy grazing, communal farm, high stocking rates, continuous grazing, and G. africana connote "poor management."

7. Fence-line contrasts as arguments and scientific models

Scientific knowledge, according to Goldman *et al.* (2011: 11), is "the outcome of messy and situated practices: practices that are shaped by particular historical, socioeconomic, political and cultural contexts." Jasanoff (2004: 2) holds that "knowledge and its material embodiments are at once products of social work and constitutive of forms of social life." This study investigates how such "messy" processes co-produce knowledge and political assumptions through the combined use of images and written text. Images are important tools in terms of the rhetoric they embody. They are not innocent and value-free representations of the world (Rosner 2001), but convey messages and constitute arguments in their own right. This analysis of two fence-line photographs suggests that rather than being merely objective representations of the field area, the photographs are ripe with theory and implicit assumptions. These assumptions form causal chains in which communal land tenure is associated with overstocking and land degradation, and private tenure is associated with conservative stocking levels and healthy land management practices.

Authors of scientific works who employ photographs in their writing often fail to recognize the argumentative power of images. Hoffmann and Zeller (2005), and Todd and Hoffman (1999) include fence-line photographs as part of the description of their study area. The photographs are included to guide us in seeing what the area looks like, in an objective sense. The images show a marked difference between two landscapes and substantiate the difference through the collection of data on species richness and vegetation cover. However, using photographs to represent what an area looks like is not as straightforward as one may think. As argued above, photographs are not neutral, but constitute statements with both denotative and connotative meanings. The point is not that the photo "lies." The scant representation of the landscape in the fence-line photographs in Hoffmann and Zeller (2005) is little different from similar interpretations of data in other texts. Rather, I show how photographs contribute to representations of landscapes and management systems in ways that readers may not detect on their first viewing, both through the composition of the photograph, and through the interpretation of the photograph in the article text.

As we have seen, the precondition for comparison is that the entities compared are similar and yet different (Bateson 2002), or that they are "cleaved" (Lavau 2008). Consequently, the act of comparison is in itself a statement. In their seemingly neutral accounts of vegetation differences over a fence, Hoffmann and Zeller (2005) and Todd and Hoffman (1999) indicate causal relationships between land tenure, land management and vegetation cover. By comparing and contrasting, the fence-line contrast photograph insists that the areas are *comparable.* One may ask, though, in what ways communal land is comparable to private land or a government test farm. First, the photographs document the fact that the areas lie adjacent to each other, and consequently exist in the same physical environment. This implies a range of expected similarities in physical condition (soil, vegetation, and so on) and thus provides room for comparison. Second, both areas are used for livestock production.

Besides similarities, there are differences: first of all in the appearance of the two landscapes, but also in tenure (communal vs. private), stocking rates, and management arrangements (rotational vs. continuous). Interestingly, although the visual differences in both photographs are conspicuous, the findings of Hoffmann and Zeller (2005), and those of Todd and Hoffman (1999) do not reveal marked differences in species richness or vegetation cover in the two areas. Further, although the differences they document are significant for the topic they studied, these differences are not always visible on a landscape level, as in the case with the seedling activity recorded by Todd and Hoffman (1999).

The comparison may encompass a normative judgment or an element of surprise that the areas do not look more alike. A normative judgment would imply condemnation of one side of the fence, or alternatively praise for the other side. A surprise would imply expectation that given the similarity in physical condition and use, the areas should be more similar than they appear to be. There is little evidence to indicate that the authors were surprised to find differences between the two areas. On this basis, I argue that photographs are not included primarily to show the reader "how things are" at a denotative level, i.e. that the areas are different. Rather, it is at a connotative level that the meaning of a photograph is most significant: the areas are different because the area on one side of the fence is mismanaged, while the area on the other side is well managed. As such, photographs encompass theory (cf. Lynch 1988) and structure knowledge on

management, tenure and vegetation dynamics. As scientific models, they suggest relationships of cause and effect that go beyond ecology and reach into political and socioeconomic conditions. In connecting tenure, land management and degradation, and implicitly assuming a causality between the three, Hoffmann and Zeller (2005) and Todd and Hoffman (1999) contribute to a wider narrative on degradation in Southern Africa.

Warnings of degradation in communally managed rangeland areas have been common since the early 19th century (Beinart 1996). According to this degradation narrative, communal tenure leads to overstocking and consequently to degradation. Therefore, a change in tenure (e.g. privatization) is considered a measure to counter tendencies of degradation (Ellis and Swift 1988; Rohde *et al.* 2006). The degradation narrative is in keeping with the rangeland succession model in the field of ecology, which assumes a tendency in nature to develop in succession towards a natural climax (Scoones 1996). According to the rangeland succession model, stocking pressure can be leveled to match successional trends, thus creating an equilibrium which corresponds to sustainable yield of livestock harvest (Rohde *et al.* 2006). Another important tenet of the rangeland succession model is rotational grazing, which recommends that areas should be left to rest and recover for a period of the year in order to secure seeding and regrowth (Benjaminsen *et al.* 2006; Rohde *et al.* 2006).

The rangeland succession model has been questioned since its inception and has been hotly debated since the 1980s (Benjaminsen 1997; Homewood and Rodgers 1987; Rohde *et al.* 2006; Scoones 1989; Turner 1993, Westoby *et al.* 1989; Wolmer 2007). Nevertheless, this model continues to inform land policies in Southern Africa (Archer 2002; Benjaminsen *et al.* 2006; Rohde *et al.* 2006; Scoones 1989). Land reform processes in South Africa during the last decade have subscribed to the degradation narrative, and subsequently turned away from a pro-poor strategy towards encouraging privatized tenure and support for emergent farmers in communal areas (Benjaminsen *et al.* 2006; Lebert and Rohde 2007; Rohde *et al.* 2006).

A study by Benjaminsen *et al*. (2006) analyzes landscape change in Namaqualand, South Africa, without using the logical framework of the degradation narrative. Their article presents two aerial photographs of a fence-line contrast over time, from 1960 and 1997 respectively. In the 1960 aerial photograph, the sides look equally bare while in 1997 the private area is much more densely vegetated than the bare communal side. The signs in the photographs are the same as in Hoffmann and Zeller (2005) and Todd and Hoffman (1999). Bare land represents high stocking rates, and vegetated land represents lower stocking rates. Here, however, the time series shows a different dynamic than one might presume based on the 1997 photography alone. The communal side had remained unaltered, while the commercial side had become more vegetated. The cause of the denser vegetation on the commercial side was destocking by commercial farmers following official stock reduction schemes in the 1960s and 1970s. Thus, Benjaminsen *et al.* (2006) question assumptions of degradation in Namaqualand along trajectories. As the communal side has remained largely unchanged over decades, the study by Benjaminsen *et al*. indicates that high stocking rates are, in fact, less detrimental than the warnings have predicted. Benjaminsen *et al*. (2006) recognize the importance of stocking rates in terms of the effect on vegetation cover, but question the explanatory power of tenure. Second, they decouple tenure and stocking rates, and hold that the cause of the change was a change in policy for commercial farmers.

We could have imagined other conclusions based on the underlying models that the fence-line photographs represent, even without taking discussions on ecological dynamics into account. During and after apartheid, the degradation narrative has been applied to argue for smallholders' rights in South Africa (Beinart 1996; Dodson 2000). The degradation narrative served two purposes for the anti-apartheid movement. First, it illustrated the "greed" of the well-supported commercial white farmers, who along with the state were seen as being responsible for the relocation of poor farmers to homelands and rural colored areas. Second, it illustrated the inequalities of a system where black and colored farmers were restricted to small portions of the country's land. Thus, where "the Native Economic Commission had blamed African culture and attitudes for ecological degradation in the reserves, it was not difficult to invert the argument and pin the responsibility on the restrictive policies of apartheid" (Beinart 1996: 61). By searching for the cause

of overstocking within apartheid policies, the anti-apartheid movement shifted the blame away from black farmers and sought a solution to degradation problems in the redistribution of land to the poor.

As I have shown in this article, considerable evidence exists to question the relevance of the links between stocking rates, land tenure and land degradation. The two studies analyzed are not alone in assuming these links and reinforcing the perception of communal areas as permanently degraded and in need of profound changes (see for instance Dreber and Esler 2011; Rutherford and Powrie 2010, 2011; Scholes and Biggs 2005). As the main topic of these articles is not necessarily the link between grazing, tenure and degradation as such, but for instance between grazing and biodiversity, the links appear in introductions or other sections that are, most likely, considered peripheral. I argue, however, that these photos arguably have a much more central place in the arguments posed in these articles. The image of the fence-line contrast becomes a model that organizes causes and effects in rangeland management, thereby underlining a perception of difference between communal and private tenure and management practices, and consequently contributing to a wider degradation narrative that is still influential in Southern Africa.

References

Archer, S. 2002. Technology and ecology in the Karoo: a century of windmills, wire and changing farming practice. In S. Dovers, R. Edgecombe and B. Guest (eds.) *South Africa's environmental history: cases and comparisons*. Cape Town: David Philip Publishers. Pp.112-138.

Barry, A.M.S. 1997. *Visual intelligence: perception, image, and manipulation in visual communication*. Albany, N.Y.: State University of New York Press.

Bartels, G.B., B.E. Norton and G.K. Perrier. 1993. An examination of the carrying capacity concept. In R. H. Behnke Jr., I. Scoones and C. Kerven (eds.) *Range ecology at disequilibrium. new models of natural variability and pastoral adaptation in African savannahs*. London: Overseas Development Institute. Pp. 89–103.

Barthes, R. 1977. Rhetoric of the image. In R. Barthes and S. Heath (eds.) *Image, music, text*. New York: Hill and Wang.

Bateson, G. 2002. *Mind and nature: a necessary unity*. Cresskill, N.J.: Hampton Press.

Behnke, R.H. and I.Scoones. 1992. Rethinking range ecology: implications for rangeland management in Africa. *Environmental Working Paper No. 53*. Washington D.C.: The World Bank.

Beinart, W. 1996. Soil erosion, animals and pastures over the longer term. In M. Leach and R. Mearns (eds.) *The lie of the land: challenging received wisdom on the African environment*. London: James Currey. Pp.54-72.

Benjaminsen, T.A. 2001. The population-agriculture-environment nexus in the Malian cotton zone. *Global Environmental Change* 11(4): 283-295.

Benjaminsen, T.A., R. Rohde, E. Sjaastad, P. Wisborg, and T. Lebert. 2006. Land reform, range ecology, and carrying capacities in Namaqualand, South Africa. *Annals of the Association of American Geographers* 96(3): 524-540.

Benjaminsen, T. 1997. Natural resource management, paradigm shifts, and the decentralization reform in Mali. *Human Ecology* 25(1): 121-143.

Blair, J.A. 2004. The rhetoric of visual arguments. In C.A. Hill and M.H. Helmers (eds.) *Defining visual rhetorics.* Mahwah, N.J.: Erlbaum. Pp.41-62.

Caughley, G. 1979. What is this thing called carrying capacity? In M.S. Boyce and L.D. Hayden-Wing (eds.) *North American elk: ecology, behavior and management*. The University of Wyoming. Pp.2-8.

Chaumba, J., I.Scoones, and W.Wolmer. 2003. From jambanja to planning: the reassertion of technocracy in land reform in south-eastern Zimbabwe? *The Journal of Modern African Studies* 41(4): 533-554.

Cook, C.W., M. Kothmann and L.E. Harris. 1965. Effect of range condition and utilization on nutritive intake of sheep on summer ranges. *Journal of Range Management* 18(2): 69-73.

Cosgrove, D. 1998. *Social formation and symbolic landscape*. Madison, WI: University of Wisconsin Press.

de Wet, C. 1995. *Moving together, drifting apart - betterment planning and villagization in a South African Homeland*. Johannesburg: Witwatersrand University Press.

Dodson, B. 2000. Dismantling dystopia: new cultural geography for a new South Africa. In R. Fox and K. Rowntree (eds.) *The geography of South Africa in a changing world*. Oxford: Oxford University Press.

Dreber, N. and K. J. Esler. 2011. Spatio-temporal variation in soil seed banks under contrasting grazing regimes following low and high seasonal rainfall in arid Namibia. *Journal of Arid Environments* 75(2): 174-184.

Ellis, J.E. and D.M. Swift. 1988. Stability of African pastoral ecosystems – alternative paradigms and implications for development. *Journal of Range Management* 41(6): 450-459.

Fairhead, J. and M. Leach. 1996. *Misreading the African landscape: society and ecology in a forest-savanna mosaic*. Cambridge: Cambridge University Press.

Forsyth, T.J. 2003. *Critical political ecology: the politics of environmental science*. London: Routledge.

Fortmann, L. 1995. Talking claims - discursive strategies in contesting property. *World Development* 23(6): 1053-1063.

Foster, J. 2003. Capturing and losing the 'Lie of the Land': railway photography and colonial nationalism in early twentieth century South Africa. In J.M. Schwartz and J.R. Ryan (eds.) *Picturing place: photography and the geographical imagination*. London: Tauris. Pp. 141-161.

Goldman, M.J., P. Nadasdy and M.D. Turner (eds.). 2011. *Knowing nature: conversations at the intersection of political ecology and science studies*. Chicago: University of Chicago Press.

Hoffman, M.T. and A. Ashwell. 2001. *Nature divided: land degradation in South Africa*. Cape Town: UCT Press.

Hoffmann, A. and U. Zeller. 2005. Influence of variations in land use intensity on species diversity and abundance of small mammals in the Nama Karoo, Namibia. *Belgian Journal of Zoology* 135: 91-96.

Homewood, K. and W.A. Rodgers. 1987. Pastoralism, conservation and the overgrazing controversy. In D. Anderson and R. Grove (eds.) *Conservation in Africa: people, policies and practice*. Cambridge: Cambridge University Press. Pp.111-128.

Hongslo, E., R. Rohde and T. Hoffman. 2009. Landscape change and ecological processes in relation to land-use in Namaqualand, South Africa, 1939 to 2005. *South African Geographical Journal* 91(2): 63-74.

Jasanoff, S. 2004. *States of knowledge: the co-production of science and social order*. London: Routledge.

Kaarhus, R. 1992. Hvordan bruker vi modeller? *Norsk antropologisk tidsskrift* 3(1): 79-91.

Kjeldsen, J. 2002. *Visuel retorik*. PhD, Department of Information Science and Media Studies. Bergen, Norway: The University of Bergen.

Kress, G., and T. Van Leeuwen. 2006. *Reading images: the grammar of visual design*. London: Routledge.

Kwa, C. 2009. Painting and photographing landscapes: pictorial conventions and gestalts. *Configurations* 16(1): 57-75.

Kwa, C., M. Hemert and L.van der Weij. 2009. Visualising landscapes: do pictures represent theory or data? In H.J. Scholten, R. Velde and N. Manen (eds.) *Geospatial technology and the role of location in science*. Netherlands: Springer. Pp.47-58.

Lavau, S. 2008. *The many lives of the Goulburn River: sustainable management as ontological work.* PhD, School of Philosophy, Anthropology and Social Inquiry. Melbourne: the University of Melbourne.

Leach, M. and R. Mearns (eds.). 1996. *The lie of the land: challenging received wisdom on the African environment*. London: James Currey.

Lebert, T. and R. Rohde. 2007. Land reform and the new elite: exclusion of the poor from communal land in Namaqualand, South Africa. *Journal of Arid Environments* 70(4): 818-833.

Lynch, M. 1988. The externalized retina: selection and mathematization in the visual documentation of objects in the life sciences. *Human Studies* 11(2): 201-234.

Lynch, M. 1991. Science in the age of mechanical reproduction: moral and epistemic relations between diagrams and photographs. *Biology and Philosophy* 6 (2): 205-226.

Lynch, M. 2006. The production of scientific images: vision and re-vision in the history, philosophy, and sociology of science. In L. Pauwels (ed.) *Visual cultures of science: rethinking representational practices in knowledge building and science communication*. Hanover, N.H.: Dartmouth College Press. Pp.26-41.

McManus, I.C. and P. Wheatherby. 1997. The golden section and the aesthetics of the form and composition: a cognitive model. *Empirical Studies of the Arts* 15(2): 209-232.

Peters, P.E. 1992. Manoevres and debates in the interpretation of land rights in Botswana. *Africa* 62 (3): 413-434.

Rohde, R. and M.T. Hoffman. 2008. One hundred years of separation: the historical ecology of a South African 'coloured reserve'. *Africa* 78(2): 189-222.

Rohde, R.F., N.M. Moleele, M. Mphale, N. Allsopp, R. Chanda, M.T. Hoffman, L. Magole and E. Young. 2006. Dynamics of grazing policy and practice: environmental and social impacts in three communal areas of southern Africa. *Environmental Science and Policy* 9(3): 302-316.

Rose, C M. 1994. *Property and persuasion: essays on the history, theory and rhetoric of ownership*. Boulder: Westview Press.

Rose, G. 2005. Visual methodologies. In G.Griffin (ed.) *Research methods for English studies.* Edinburgh: Edinburgh University Press.

Rosner, M. 2001. Theories of visual rhetoric: looking at the human genome. *Journal of Technical Writing and Communication* 31(4):391-413.

Rutherford, M.C. and L.W. Powrie. 2010. Severely degraded rangeland: implications for plant diversity from a case study in Succulent Karoo, South Africa. *Journal of Arid Environments* 74(6): 692-701.

Rutherford, M.C. and L.W. Powrie. 2011. Can heavy grazing on communal land elevate plant species richness levels in the Grassland Biome of South Africa? *Plant Ecology*: 212(9): 1407-1418.

Sandford, S. 1983. *Management of pastoral development in the Third World*. Chichester: John Wiley.

Scholes, R.J. and R. Biggs. 2005. A biodiversity intactness index. *Nature* 434 (7029): 45-49.

Schwartz, J.M. and J.R. Ryan. 2003. *Picturing place: photography and the geographical imagination*. London: Tauris.

Scoones, I. 1996. Range management science and policy. In M. Leach and R. Mearns (eds.) *The lie of the land: challenging received wisdom on the African environment*. London: James Currey. Pp.34-53.

Scoones, I. 1989. Economic and ecological carrying capacity: implications for livestock development in the dryland communal areas of Zimbabwe. *Pastoral Development Network Paper* 27b. London: Overseas Development Institute.

Scoones, I., C. Kerven and R.H. Behnke (eds.). 1993. *Range ecology at disequilibrium: new models of natural variability and pastoral adaption in African savannas*. London: Overseas Development Institute.

Scott, C. 1999. *The spoken image: photography and language*. London: Reaktion Books.

Stott, P. and S. Sullivan (eds.). 2000. *Political ecology: science, myth and power*. London: Arnold.

Sullivan, S. 1996. Towards a non-equilibrium ecology: perspectives from an arid land. *Journal of Biogeography* 23(1): 1-5.

Sullivan, S. and R. Rohde. 2002. On non-equilibrium in arid and semi-arid grazing systems. *Journal of Biogeography* 29(12): 1595-1618.

Tiffen, M., M.J. Mortimore and F. Gichuki. 1994. *More people, less erosion: environmental recovery in Kenya*. Chichester: Wiley.

Todd, S.W. and M.T. Hoffman. 1999. A fence-line contrast reveals effects of heavy grazing on plant diversity and community composition in Namaqualand, South Africa. *Plant Ecology* 142(1-2): 169-178.

Tucker, J. 2005. *Nature exposed: photography as eyewitness in Victorian science*. Baltimore: Johns Hopkins University Press.

Turner, M.D. 1993. Overstocking the range: a critical analysis of the environmental science of Sahelian pastoralism. *Economic Geography* 69(4):402-421.

Turner, M.D. 2015. Political ecology II: engagements with ecology. *Progress in Human Geography*. Online First.

Westoby, M., B. Walker and I. Noymeir. 1989. Opportunistic management for rangelands not at equilibrium. *Journal of Range Management* 42(4): 266-274.

Widgren, M. 2004. Can landscapes be read? In H. Palang (ed.) *European rural landscapes: persistence and change in a globalising environment*. Dordrecht: Kluwer Academic.

Wolmer, W. 2007. *From wilderness vision to farm invasions: conservation and development in Zimbabwe's Southeast Lowveld*. Oxford: Currey.