AN ENVIRONMENTAL HISTORY OF THE MGENI RIVER ESTUARY: A STUDY OF HUMAN AND NATURAL IMPACTS OVER TIME.

by

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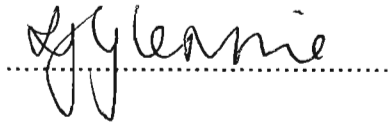
DECLARATION

This study represents the original work by the author and has not otherwise been submitted in any other form for any degree or diploma to any university. Where use has been made of the work of others it is duly acknowledged in the text.



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ABSTRACT

South African estuaries have high biodiversity value and provide many benefits to society, including food, real estate, a place for recreation and economic enterprise. However, they are facing growing human pressures such as urban encroachment, development in river catchments and interference in hydrological cycles.[1]

This dissertation provides an exploratory study of the environmental history of the Mgeni River Estuary, KwaZulu-Natal in an attempt to improve the understanding of the forces that drive environmental change. Through the application of the techniques and methodologies of environmental history, it explores the dynamics, characteristics and impacts of human interaction with the Mgeni River Estuary over time. It focuses on the emergence of a capitalist/ industrial society in the twentieth century as this period has been characterised by the most significant environmental alteration and degradation.

With the aid of the techniques and methodologies employed, the study highlights a complexity of natural and human events that have altered the estuary over time. Comparative analysis of aerial photographs between 1937 and 1996 reveals that physical changes to the estuary were linked to prevalent social and economic activities. The study describes cultural beliefs, modes of resource use and the political economy as significant and interwoven factors that facilitate environmentally intrusive activities.

The study has provided insights into the complexity of factors that influence the rate and extent of change of an estuarine system. It concludes that to improve the understanding of the causes of environmental change, it is necessary to look further than the physical impacts on the environment to the attitudes and beliefs that underlie them. While the solutions to the problems facing the Mgeni River Estuary are not easily at hand, such analysis should assist policy makers and managers in finding a way to initiate more sustainable estuarine development in the future.

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[1] P. D. Morant & N. W. Quinn, 'Influence of Man and Management of South African estuaries', in B. R. Allanson & D. Baird, eds, Estuaries of South Africa, (Cambridge University Press, Cambridge, 1999).

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ABBREVIATIONS

A. D.	Anno Domini
CSIR	Centre for Scientific and Industrial Research
CSO	Colonial Secretary's Office
D'MOSS	Durban Metropolitan Open Space Survey
HWM	High Water Mark
KZNNCS	KwaZulu-Natal Nature Conservation Service
LWM	Low Water Mark
MASL	Metres Above Sea Level
NEMA	National Environmental Management Act
PAR	Pietermaritzburg Archival Repository

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CHAPTER ONE

INTRODUCTION

This dissertation provides an exploratory study of the environmental history of the Mgeni River Estuary primarily through the interpretation of aerial photographs. The study area is located in the city of Durban, KwaZulu-Natal,[1] and is thus subject to a variety of human pressures that range from urban and industrial developments to agriculture, recreation and resource use. As KwaZulu-Natal continues to grow, so too will the number of pressures impacting on the Mgeni River Estuary. Through application of the techniques and methodologies of environmental history it will be shown how human interaction with the environment has over time brought radical change to the estuary. The objective of this study is to make policy makers and managers aware of the nature of environmental changes in the Mgeni River Estuary and, through the methodologies of environmental history, insights will be provided for more sensitive future development. Presently, plans are in the pipeline for development to take place up along the north coast. When this development occurs, lessons learnt from the Mgeni River Estuary could assist in initiating more sustainable development of other estuaries, such as the Thukela Estuary.

Because environmental history is a relatively new discipline and its theories, techniques and methodologies provide the foundation for this dissertation, it is necessary to undertake an examination of the theories, techniques and methodologies that are appropriate to this dissertation.

Environmental History: definitions, theories and techniques.

Environmental history emerged in the latter half of the twentieth century due to growing concern for the accelerating rate at which environmental degradation was taking place. Concern for the environment has been evident in the customs and

[1] KwaZulu-Natal was formed in 1994, when the province of Natal and the former KwaZulu homeland were incorporated into one entity.

practices of the earliest human societies but it was not until the onset of industrialisation and technological advance that concern for the environment became more insistent. The reason for this concern was that prior to industrialisation a symbiotic relationship was maintained between impacts on the environment and its ability to absorb these impacts. This relationship was to be upset, however, with the advent of modern science, technology and industry which intensified human manipulation of the environment. With the spread of industrialisation and population growth, environmental issues that were once locally confined have become regional or even global problems. In the wake of these developments environmental history has emerged as an important tool with which to help solve environmental problems.

To define this new discipline is difficult but, essentially, environmental history attempts to demonstrate that there is a dialogue between humanity and nature in which cultural and environmental systems interact powerfully, shaping and influencing each other without either side wholly determining the outcome.[2] Consequently, the environmental historian has been forced to adopt a multi-disciplinary approach when trying to understand environmental problems. This has necessitated the environmental historian becoming conversant with the methodologies of a number of disciplines such as botany, zoology, geology, anthropology, palaeontology, archaeology and economics, among others.

Donald Worster is a leading figure in the discipline of environmental history. Worster has interpreted environmental history as dealing with the role and place of nature in human life. He rejects the conventional assumption that human experience has been exempt from natural constraints, that people are a separate and "supernatural" species and that the ecological consequences of their deeds can be ignored.[3] Worster has identified three levels of inquiry which should be applied to environmental history. 'The first level of inquiry is to seek an understanding of nature

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[2] W. Cronon, 'Modes of Prophecy and Production: Placing Nature, History, and Narrative', The Journal of American History, Vol. 78, Part 1, (March, 1992), p. 13.

[3] D. Worster, ed, The Ends of the Earth: Perspectives on Modern Environmental History, (Cambridge University Press, Cambridge, 1988), p. 290.

itself. The second level necessitates a study of the socio-economic realm as it interacts with the environment. Third and last is what Worster has classified as the most intangible level, gaining an understanding of the values, laws and myths that shape the interactions studied on the second level.'[4]

A fundamental aspect of the second level is the analysis of modes of production as ecological phenomena. People have extracted a diverse array of resources from the natural world but the most fundamental resource has been food. All societies in history have had to identify such resources and create modes of production to extract them from the earth. In the process of doing so the natural environment's ecosystem has been affected in some manner. Worster has termed this reorganised ecosystem - an agroecosystem. 'It is a restructuring of the trophic processes in nature, that is, the processes of food and energy flow in the economy of living organisms.'[5]

Worster makes a distinction between subsistence-based and capitalist-based agriculture in his interpretation of agroecosystems. This is an important distinction to make (particularly for this study) as 'capitalism introduced still another innovation, one that would change profoundly the way people related to nature in general: it created for the first time in history a general market in land.'[6] This market in land according to Worster played a pivotal role in the degree to which ecosystems were simplified:

> Despite many variations in time and place, the capitalist agroecosystem shows one clear tendency over the span of modern history: a movement toward the radical simplification of the natural ecological order in the

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[4] G. Thompson, 'The Eastern Shores of St. Lucia: Towards an Environmental History, 1950-1996', (Unpublished M. Env. Dev., Centre for Environment and Development (CEAD), University of Natal, Pietermaritzburg, 1999), p. 3.

[5] D. Worster, 'Transformations of the Earth: Toward an Agroecological Perspective in History', Journal of American History, Vol. 76, No. 4, (March, 1990), p. 1093.

[6] Ibid, p. 1096.

number of species found in an area and the intricacy of their interconnections.[7]

In illustrating an agroecosystem Worster has made reference to the environmental disaster that occurred on the Great Plains of North America. He argues that the process of simplification of the Great Plain's ecosystem began with the arrival of the settlers in the 1870s. With the outbreak of World War One and the boom in the wheat market the agroecosystem was further simplified. The agroecosystem witnessed a simplification in both fauna and flora, making the new environment more susceptible to soil erosion and dust storms experienced in the late 1930s.

Dovers has criticised Worster's definition of environmental history by arguing that this is not an operational definition. Dovers, in contrast, has defined environmental history as an 'investigation and description of previous states of the biophysical environment, and the study of the history of human impacts on and relationships with the non-human setting. Environmental history seeks to explain the landscapes and issues of today and their evolving and dynamic nature, and from this to elucidate the problems and opportunities of tomorrow.'[8] Dovers insists that this discipline should be "pragmatic", so that 'environmental history, which as well as being of interest and furthering the development of the discipline, should make a positive and practicable contribution to environmental management and the quest for ecological sustainability.'[9]

Dovers provides five principles for the study of environmental history. His first principle requires an explanation of our landscape, that is, to 'explain our present landscapes through their history.'[10] In order to successfully explain our landscape

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[7] Ibid, p. 1097.

[8] S. Dovers, 'Sustainability and "Pragmatic" Environmental History: A note from Australia', Environmental History Review, Vol. 18, No. 3, (Fall, 1994), p. 22.

[9] Ibid, p. 21.

[10] Ibid, p. 26.

Dovers says we must see the world as a mosaic of cultural landscapes, an amalgamation of human and natural systems. 'It is at this intersection of natural and human systems that environmental issues arise.'[11] The second principle focuses on explaining the complexity of natural and human systems which together shape the environment.[12]

Methodological impurity is Dovers's third principle. Here, Dovers has asserted that the success of any environmental study is reliant on a multi-disciplinary approach.[13] The fourth principle explains the context in which environmental history occurs, that is, the "when", "what", "how" and "who" of environmental change.[14] And lastly the fifth principle (which is particularly important to this study) focuses on 'what went wrong and is wrong in the environment, and what should be done about it.'[15] Dovers has used these principles in case studies of Australia. He has concluded that environmental history has offered real and practical lessons for modern environmental understanding and management. The primary objective of this study is to make practical suggestions for sustainable future estuarine development in KwaZulu-Natal. If this objective is to be achieved it is essential that Dovers' definition of "pragmatic" environmental history as well as his five principles form important guidelines for this study.

While the principles and levels provided by Dovers and Worster have provided an important framework for this study, they have been modified to incorporate the theories of Andrew Goudie and other authors so as to achieve a better fit with the particular circumstances of the Mgeni River Estuary. The guidelines and theories

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[11] Ibid.

[12] Ibid.

[13] Ibid, p. 27.

[14] Ibid, p. 28.

[15] Ibid, p. 29.

proposed by Goudie have been influenced by the work of Clarence Glacken.[16] Emerging from Glacken's work are three persistent themes. The first theme centres around the idea that the earth was especially designed by a divine force for the purpose of the human species. The second theme is that of environmental influence on culture. This theme attempts to interpret the great array of human cultural and biological differences within humanity. The last theme identified by Glacken sees man as the modifier of nature but nature in turn modifies the perceptions of human societies. This theme is in line with the current western world view that nature is comprised of a set of resources that are there to satisfy human activity. Any problems that arise in the process might possibly be solved with humanity's growing body of scientific knowledge.

Glacken's third theme, which sees man as modifier of nature and nature in turn as modifier of human culture, forms the focus of Goudie's work. Goudie has considered human impacts on the natural environment. To facilitate this study, he has considered all major cultural and technical developments that have taken place over the past 2-3 million years. These developments have been divided into three main phases: 'the phase of hunting and gathering; the phase of plant cultivation, animal keeping and metal working; and the phase of modern urban and industrial society.'[17] (See Fig 1.1, p. 7.)

During the first phase of hunting and gathering a number of cultural developments took place. Humans, however, had neither the numbers nor the technological skills to have any substantial impact on the environment.[18] This changed with the domestication of food plants and animals. During this phase of plant cultivation and animal keeping, humans were able 'to develop a more reliable and readily

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[16] C. J. Glacken, Traces on the Rhodesian Shore; nature and culture on western thought from ancient time to the end of the eighteenth century, (University of California Press, Berkeley, 1967).

[17] A. Goudie, The Human Impact on the Natural Environment, (Blackwell, Oxford, 1981), p. 9.

[18] Ibid, p. 14.

expandable source of food and thereby created a solid and secure basis for cultural advance, an advance which included urbanisation and the "urban revolution".'[19] This phase had significant impact on the natural environment because it involved the simplification of the world's ecosystems.[20]

The final phase of modern urban and industrial society has had the most effect on the natural environment. During this phase there has been a major transformation in both culture and technology. This transformation has reduced the space required to sustain each individual and increased the utilisation of resources.[21] Goudie has explored in great detail the human activities that have taken place during this phase and their resultant impacts on the natural environment. In particular he has considered human impacts on aquatic environments which include damming, channelisation, bridging, groyne construction, urbanisation and agriculture. This phase will therefore provide an important guideline for this study.

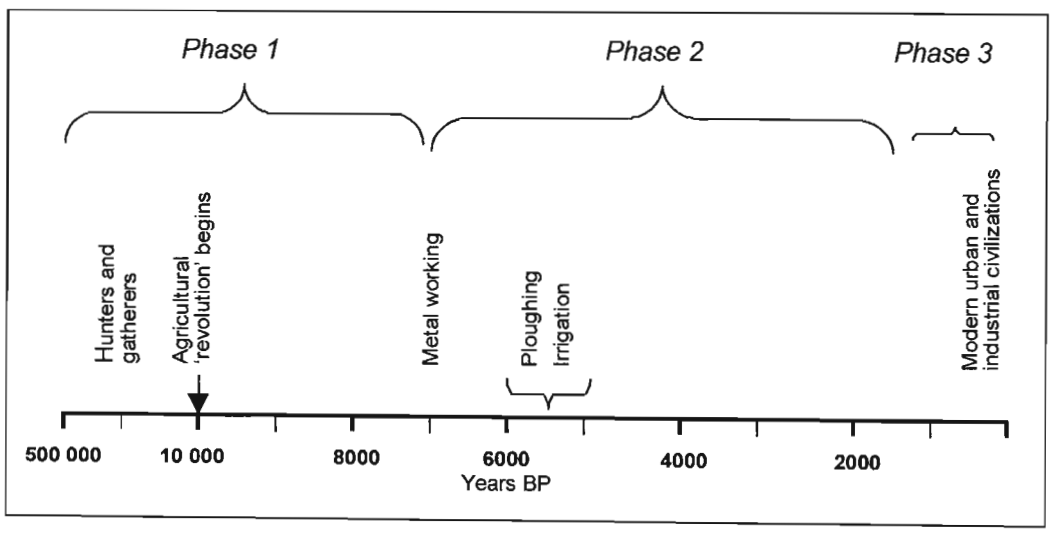

Fig 1.1: Diagrammatic illustration of the three phases of major cultural and technological developments. (Adapted from Goudie, 1981.)

[19] Ibid.

[20] Ibid, p. 21.

[21] Ibid, p. 22.

The framework provided by Goudie has been adapted in this thesis to incorporate some of the theories and methodologies advocated by I.G. Simmons. Of particular importance to this study is Simmons' theory on energy flows. To understand this theory, one must begin by considering Eugene Odum's formal definition of an ecosystem as used by Simmons:

> Any unit that includes all the organisms in a given area interacting with the physical environment so that a flow of energy leads to ... exchange of materials between living and non-living parts within the ecosystem... is an ecosystem.[22]

Working with Odum's definition, Simmons points out firstly that all organisms are included and secondly that flows of energy and materials can often be measured. He claims that by measuring these flows we are able to quantify some of the ecosystem's characteristics. Simmons has also identified phases, or stages, in the history of human impacts on the environment as well as various types of impact. He argues that energy flow has a powerful part to play in all these phases and in characterising the type of impact on, and relationship between, man and his environment. Simmons goes further, suggesting that no organism, ecological system or economic system can exist without an input of free energy.[23] Therefore it is arguable that energy flow patterns are a fundamental determinant of any given society and that one is able to divide human history into cultural periods according to the use of energy. (See Table 1.2, p. 9.) The role of energy flow will be a crucial consideration when identifying human alteration in the Mgeni River Estuary.

To illustrate his argument, Simmons has considered energy use per capita throughout human existence. He explains that an individual needs approximately 10 Megajoules of somatic energy per day to stay alive. Humans, through technological advance, have been able to harness additional somatic energy by using,

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[22] I. G. Simmons, Changing the Face of the Earth: Culture, Environment, History, (Blackwell, Oxford, 1994), p. 10.

[23] Ibid, p. 21.

for example, fire, domestic animals, wind, water, fossil fuels and nuclear power. With the introduction of each new energy source, new types of environmental alteration have occurred, some more radical than others.

Table 1.1: Energy sources available at different economic stages. (Adapted from Simmons, 1989.)

	Primitive man	*Advanced hunter-gatherers*	*Agriculturalist*	*industrialism*	*Nuclear age*
Fire	X	X	X	X	X
Domestic animals			X	X	X
Wind			X	X	X
Water			X	X	X
Fossil fuel				X	X
Nuclear Power					X

Simmons has gone further still and suggests that there are two types of human-directed impacts upon nature which are purposive and accidental. Simmons has termed these impacts "environmental management" and "environmental impact" respectively.[24] These changes do not belong to any specific historical context but occur throughout history. This does not, however, suggest that there are no distinct phases or transitions evident in the history of human environmental alteration. Indeed, Simmons has been able to distinguish three distinct phases or shifts. The first major shift brought about by human societies was their ability to manage fire. This ability had many implications for the environment but the main implication was the permanent alteration of the vegetation. The second major transformation was the domestication of plants and animals which saw transformations in the natural vegetation. The use of fossil fuels is the third and final transformation and has caused

[24] Ibid, p. 378.

by far the greatest changes to the planet's biophysical systems.[25] This phase is most pertinent to this study. During this transformation the Mgeni River Estuary has been subjected to increasing environmental impacts that have been both deliberate and accidental.

Simmons has explored the ways in which human societies have impacted on their surrounding environments. In doing so he has identified that human alteration of natural systems takes on numerous forms at various stages through human development. (See Table 1.3, p. 11.) "Deflection" is one form identified by Simmons. He defines deflection as 'a method of preventing natural succession from going beyond a certain stage because the earlier stage or stages have more value to a human group than any eventual mature ecosystem.'[26] "Simplification" is another form of alteration where human behaviour simplifies ecosystems into sub-natural, semi-natural or even cultural ecosystems. The end result is an ecosystem left with fewer species than existed in its natural state.[27] Simplification in the Mgeni River Estuary will be shown to be the result of many factors such as agricultural practice, forestry and urbanisation. "Obliteration" is the third form of alteration identified by Simmons. Simmons describes this form as taking deflection and simplification to their ultimate stage, in which diversity is entirely removed by diversion. The industrialists have caused the most obliteration to natural systems.[28] This form of human alteration will be shown to be evident in the Mgeni River Estuary.

The fourth identified form is "domestication". This is a process of genetic tailoring of species by humans which means changing genes so that any desirable characteristics are passed on to later generations.[29] "Diversification" comprises the

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[25] Ibid.

[26] I. G. Simmons, Environmental History: A Concise Introduction, (Blackwell, Oxford, 1993), p. 56.

[27] Ibid, p. 59.

[28] Ibid, pp. 62/63.

[29] Ibid, p. 64.

fifth form and is a process of increasing the number of species in any one place. The final form identified by Simmons is "conservation". Conservation is the attempt to exclude from a few areas of the globe a selection of human-induced processes, usually those of "development", which can be seen as pushing a given land use further along the spectrum from natural ecosystems and wilderness to sub-and semi-natural, cultural and built environment.'[30] Attempts have been made in recent years to exclude the Beachwood Mangroves from human impacts. Human alteration of the Mgeni River Estuary will be shown to take on numerous forms as is suggested by Simmons. This study will consider the various forms of human alteration.

Table 1.2: Summary of human actions by cultural ecology stages. (Adapted from Simmons, 1993.)

	Deflection	***Simplification***	***Obliteration***	***Domestication***	***Diversification***	***Conservation***
Hunter-gatherers	Frequent by use of fire	Rare	A few made some spp. extinct	Dog by some	Some	Yes: to avoid overuse of species
Early/ riverine/ agric. & pastoralism	Some permanent	Agric. replacing wild; pastoralism simplifies	Some spp. at permanent settlements	Widespread	Yes domestication added to gene pool	For pleasure
Agric. based empires	Permanent & temporary	Increased efficiency in removing competitors	Spp. extinction start on modern scale	A few added to those already established	Transfer of spp. becomes inter-continental	Pleasure of the rich, some intrinsic value
Industrialism	Much permanent change	Widespread with dev. of cash crops	Through chemical as well as physical means	Science of genetics enhances predictability	More transfers; new varieties	All kinds of conservation; recognition of value of the wild
Global economy	Not different from above	Continues	Extinction rate still high, but attention now paid to it	Genetic manipulation holds much promise and peril	Many organisms transported and capable of mutation	New views with regard to holism of humanity and nature

The last relevant source that will be adopted into the methodology of this study is the work of Gadgil and Guha. Gadgil and Guha have undertaken an ecological history of

[30] Ibid, p. 68.

changing human interaction with living resources, using India to explore four themes. The first theme to be considered by the authors is the conditions under which we may expect human beings to exercise what they have termed "prudence" in their use of natural resources. Secondly, they investigate the forces and relations of production which encompass technological infrastructure and systems of property, together with belief systems that validate human interactions with nature. Thirdly, and this theme has been largely neglected by Worster, Dovers, Simmons and Goudie, they attempt to analyse forms of conflict between the various groups of resource users. Lastly the study considers changing patterns of resource use together with social conflict on the changing status of living resources.[31]

Within the context of the above themes, the authors have identified a linkage between ecology and history which is accomplished by means of a typology that they have termed "modes of resource use".[32] They propose this typology to complement the Marxist concept of modes of production which they believe does not adequately consider the ecological infrastructure of human society.[33] The concept of modes of production focuses on spheres of production such as the field and factory, ignoring 'the natural context in which the field and factory are embedded - the contexts to which they respond, and which they in turn transform.'[34]

Gadgil and Guha's mode of resource use extends the modes of production typology to include flora, fauna and minerals. This concept is intended to ask very similar questions to the mode of production framework. However, it includes two additional dimensions. Firstly, it assesses whether one can identify characteristic ideologies that will govern different modes and, secondly, it identifies the ecological impact of the various modes assessing the consequences for the pattern, distribution and

[31] M. Gadhil & R. Guha, This Fissured Land: An Ecological History of India, (Oxford University Press, Delhi, 1992), p. 4.

[32] Ibid, p. 4.

[33] Ibid, p. 1.

[34] Ibid.

availability of natural resources. Gadgil and Guha have identified one major difference between the Marxian mode of production and their own typology, that is, that the industrial mode as defined by the authors includes both capitalist and socialist societies. Gadgil and Guha recognise that there are vast differences between capitalist and socialist societies but from an ecological point of view the similarities are greater than the differences. Consequently they have treated industrial socialism and industrial capitalism as two variants of one industrial mode of resource use.[35] Gadgil and Guha have made suggestions similar to those advocated by Worster, Dovers, Simmons and Goudie. Indeed they have added a further aspect, they have endeavoured to analyse the forms of social conflict between the different groups of resource users and this social conflict will be followed during this study.

To facilitate their study of India, Gadgil and Guha have divided human history into four distinct modes of resource use: gathering, nomadic pastoralism, settled cultivation and the industrial mode. The authors then go on to identify distinctive characteristics from each of the modes with the aid of the following criteria:

> ... aspects of technology, such as sources of energy, materials used, and the knowledge base relating to resource use; aspects of economy, such as the spatial scale of resource flows and the modes of resource acquisition; aspects of social organisation, such as the size of social group, the division of labour, and mechanisms of control over access to resources; aspects of ideology, including broad perceptions of the man-nature relationship, as well as specific practices promoting resource conservation or destruction; the nature of the ecological impact itself and lastly the characteristic forms of social conflict between as well as within different modes.'[36]

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[35] Ibid, p. 14.

[36] Ibid, pp. 14/15.

The change between modes of resource use can be identified using Goudie's framework for major cultural and technological developments.

In conclusion, this study will accept Dovers' definition of a pragmatic environmental history which advocates that environmental history should explore the previous state of the biophysical environment in conjunction with the history of human impacts on, and relationships with, the non-human setting. In order to adhere to Dovers' definition it is necessary to adopt a hybridised methodology together with Dovers' concept of "methodological impurity". A good example of such an approach has been developed by Thompson in her exploratory study of the Eastern Shores of St. Lucia.[37] Thompson's hybridised methodology has been closely followed throughout this thesis, but modified by incorporating Goudie's theories.

The approach adopted for this study will therefore rely largely on Goudie's three phases of major cultural and technological developments, focusing particularly on the third phase. Gadgil and Guha's proposed typology of methods of resource use will be used to link ecology and history, while Simmons' argument that energy flow largely sets the bounds by which the environment can be altered will be used to identify the numerous forms of environmental alteration. The methodology follows a synthesised version of Dovers' and Worster's principles and levels. In the light of this approach the next chapter deals with the first of Worster's levels which seeks an understanding of nature itself within the biophysical environment.

[37] G. Thompson, 'The Eastern Shores of St. Lucia: Towards an Environmental History, 1950-1996'.

CHAPTER TWO

THE MGENI RIVER MOUTH: TRANSIENT ESTUARINE ECOLOGY

Introduction.

Estuaries occur at the interface between marine and freshwater environments. The meeting of these two aquatic systems renders the estuarine ecosystem inherently variable and transitional. Estuaries do, however, achieve a number of transitionary equilibriums, which support a unique assemblage of birds, fish and invertebrates, as well as distinctive floral communities such as mangrove swamps.[38] Although estuaries comprise only a fractional volume of global waters, they are considered to be one of the most highly productive ecosystems, sustaining a variety of endemic fauna and flora and playing a vital role in the development of numerous aquatic organisms.[39] Many marine fish species are also dependent on estuaries as nursery areas for the development of their juveniles.

Estuaries are also popular recreational venues, catering for a wide variety of activities which include swimming, angling, powerboating, sailing, hiking and bird-watching. Consequently estuaries are an extremely valuable tourist attraction, bringing thousands of holidaymakers and tourists to their beautiful and sheltered waters. Apart from recreational activities, estuaries are also an important resource base, providing both food and employment to numerous local communities. As coastal populations continue to grow, estuaries will be subject to increasing utilisation.[40]

In addition to direct utilisation pressures, estuaries are also subject to human activities originating in their catchment areas. The damming of rivers, changes in land use,

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[38] N. W. Quinn, 'An Integrated Modelling Approach to the Management of Freshwater inflow to South African Estuaries', (Unpublished Ph. D. Thesis, Institute of Natural Resources, University of Natal, Pietermaritzburg, 1998), p. 1.

[39] Ibid.

[40] Ibid, p. 3.

increased abstraction of water, increased soil erosion and the use of rivers for waste disposal all bring about change in estuaries. This change may be evident in a number of forms, including alteration in flow regime, water quality or circulation, or may result more directly in habitat degradation.[41] Changes of this nature will alter the estuaries transitionary equilibruims, upsetting the unique assemblage of fauna and flora that it supports. This in turn will affect humans who utilise the resources provided by estuaries.

It is evident that estuaries by virtue of their location at the interface of ocean, river and land, are both fragile and complex and thus particularly vulnerable to harm through human action. If human beings are to continue to enjoy the benefits derived from estuaries it is imperative that they protect them from ever increasing population and development pressures.

The study area.

The Mgeni River Estuary is a river-dominated estuary[42] and remains open for most of the year. This estuarine system forms part of a much larger ecosystem, extending from the Indian Ocean into the Mgeni catchment. While the focus of this work is on the Mgeni River Estuary, some understanding of the workings of the entire system is necessary in order to realise fully the potential impacts of human activities on it.

The Mgeni River rises in the Dargle Range in KwaZulu-Natal, approximately 230 kilometres from the Indian Ocean. It enters the sea through the northern suburbs of Durban, 5 kilometres north of the city centre. Where the river enters the sea, it is subject to tidal salinity and water level fluctuations in its final 2.5 kilometres stretch.[43] This estuarine reach, which is between the Indian Ocean and Connaught Bridge and includes the Beachwood Creek Channel, will form the area of study. (See Fig 2.1, p. 17.)

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[41] Ibid, p. 4.

[42] A. Cooper, I. Wright & T. Mason, 'Geomorphology and Sedimentology', in B. R. Allanson & D. Baird, eds, Estuaries of South Africa, (Cambridge University Press, Cambridge, 1999), p. 15.

[43] J. A. G. Cooper, 'Sedimentation in the Mgeni Estuary, Natal, South Africa', (Unpublished M. Sc. Thesis, University of Natal, Durban, 1986), p. 1.

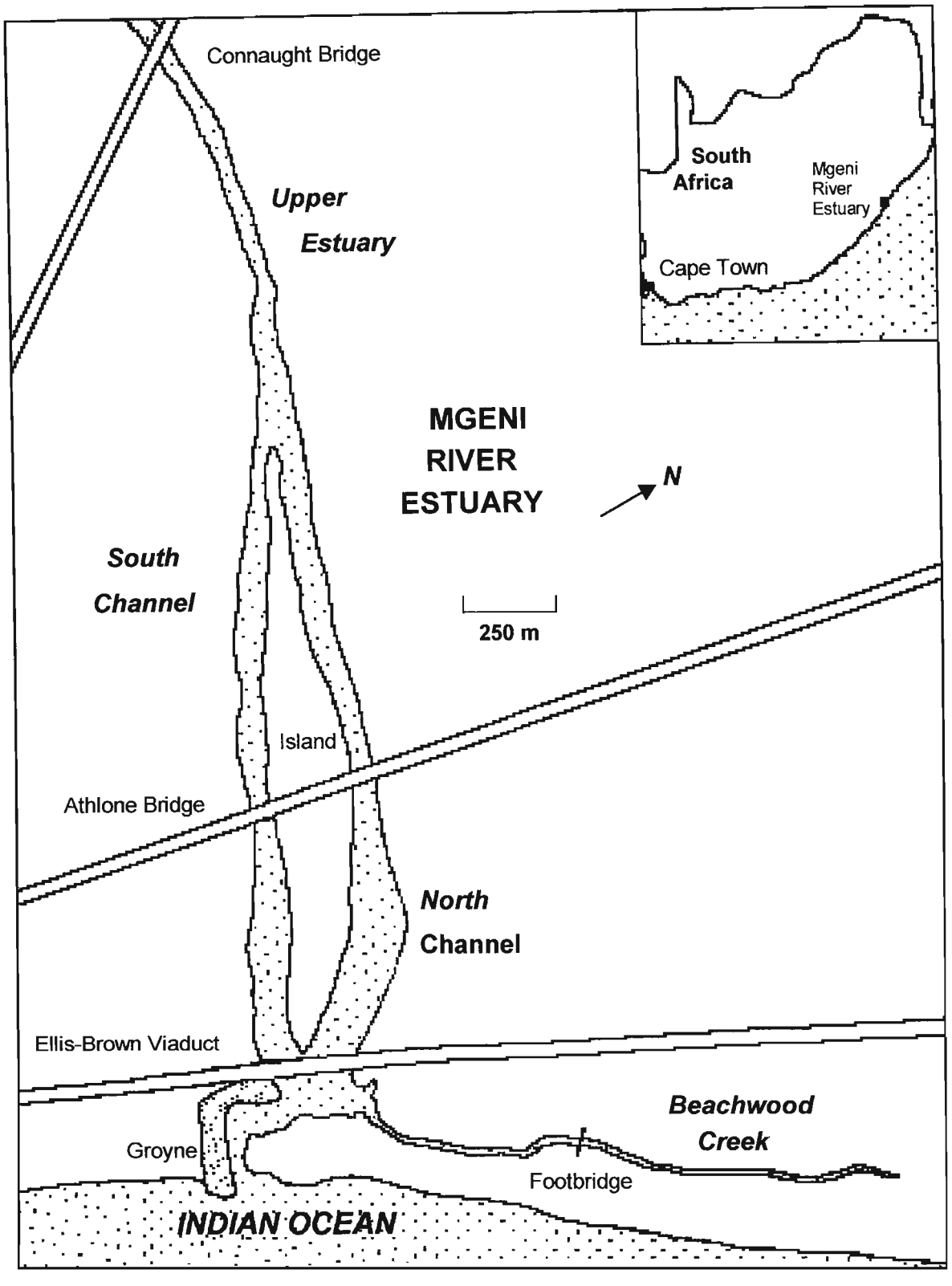

Fig 2.1: Location of the Study Area. (Adapted from Cooper, 1986.)

THE BIOPHYSICAL ENVIRONMENT OF THE MGENI RIVER ESTUARY

The Mgeni River Estuary is a dynamic system that supports a wide diversity of endemic fauna and flora. Its delicate equilibrium is, however, susceptible to harm from human activities. To illustrate this sensitivity, a description will be given of the Mgeni River Estuary's biophysical environment. In doing so it will become apparent why this fragile system is so easily disturbed by man. In the chapters that follow some of the major human activities and their resultant impacts on the Mgeni River Estuary will be discussed.

Geomorphology.

The general landform of the Mgeni River Estuary has, over time, been subject to continual change. The Mgeni River Estuary originated during the Pleistocene epoch (1.75 million - 11000 years ago) when a lowering of the sea level, by as much as 120 metres, caused the Mgeni River channel to become incised through earlier pliocene deposits (5. - 1.8 million years ago) into bedrock of the Ecca and Dwyka groups of the Karoo sequence.[44] (See Fig 2.2, p. 20.) This incised river channel was at its widest in the Springfield Flats area, where it flowed across Ecca rocks and was constricted by outcrops of resistant Dwyka Tillite, at the Connaught Bridge.[45] Subsequent to this period the Mgeni River Estuary experienced further change approximately 13000 years ago when the mean sea level rose 130 metres to within a few metres of the present level which stabilised some 5000-6000 years ago.[46] This Holocene rise in sea levels caused a landward retreat of the shoreline, modifying the lower reaches of the river through an infilling of both fluvial and marine sediment.[47]

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[44] Cooper, 'Sedimentation in the Mgeni Estuary, Natal, South Africa', p. 4.

[45] Ibid.

[46] Cooper, 'Geomorphology and Sedimentology', in B. R. Allanson & D. Baird, eds, Estuaries of South Africa, p. 15.

[47] B. R. Allanson & D. H. Swart, 'Estuaries', in R. J. M. Crawford & I. A. W. Macdonald, eds, Long-term data series relating to southern Africa's renewable natural resources, (Foundation for Research Development, CSIR, Pretoria, 1988), p. 201.

Following this period the sea retreated to its present level.[48] As this stage was reached, the Mgeni River flowed south across the Eastern Vlei where it entered into the Durban Bay. This former river course can be identified by thick estuarine deposits upon which the city of Durban stands today.[49]

Geology and soils.

The unconsolidated sediments of the Mgeni River Estuary lie on bedrock that has been described by Orme as being shale that is 'fractured and weathered towards the surface with dolerite intrusions...'.[50] (See Fig 2.3, p. 22.) At the Athlone Bridge the bedrock lies at a depth of 52 metres below mean sea level, while at the Connaught Bridge the bedrock lies only at a depth of 28 metres below mean sea level.[51]

In the upper reaches of the Mgeni River Estuary the river flows as a single channel that is flanked on its north side by a steep bank in which Dwyka Tillite and Pietermaritzburg Shale are exposed.[52] 'The south bank is a flat, low-lying area formed by alluvium.'[53] Moving down into the lower reaches of the Mgeni River Estuary the channel bifurcates around a large central island forming two channels. These two channels later recombine at the Ellis-Brown Viaduct, where they are deflected to the south behind a sandy spit, forming a small lagoon before entering the sea through a narrow channel.[54]

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[48] Cooper, 'Sedimentation in the Mgeni Estuary, Natal, South Africa', p. 5.

[49] L. C. King & R. M. Maud, The Geology of Durban and Environs, (Geological Survey, Pretoria, 1964), p. 4.

[50] G. W. Begg, The Estuaries of Natal, (Natal Town and Regional Planning Commission, Pietermaritzburg, 1978), p. 236.

[51] Ibid.

[52] Cooper, 'Sedimentation in the Mgeni Estuary, Natal, South Africa', p. 10.

[53] Ibid.

[54] Ibid.

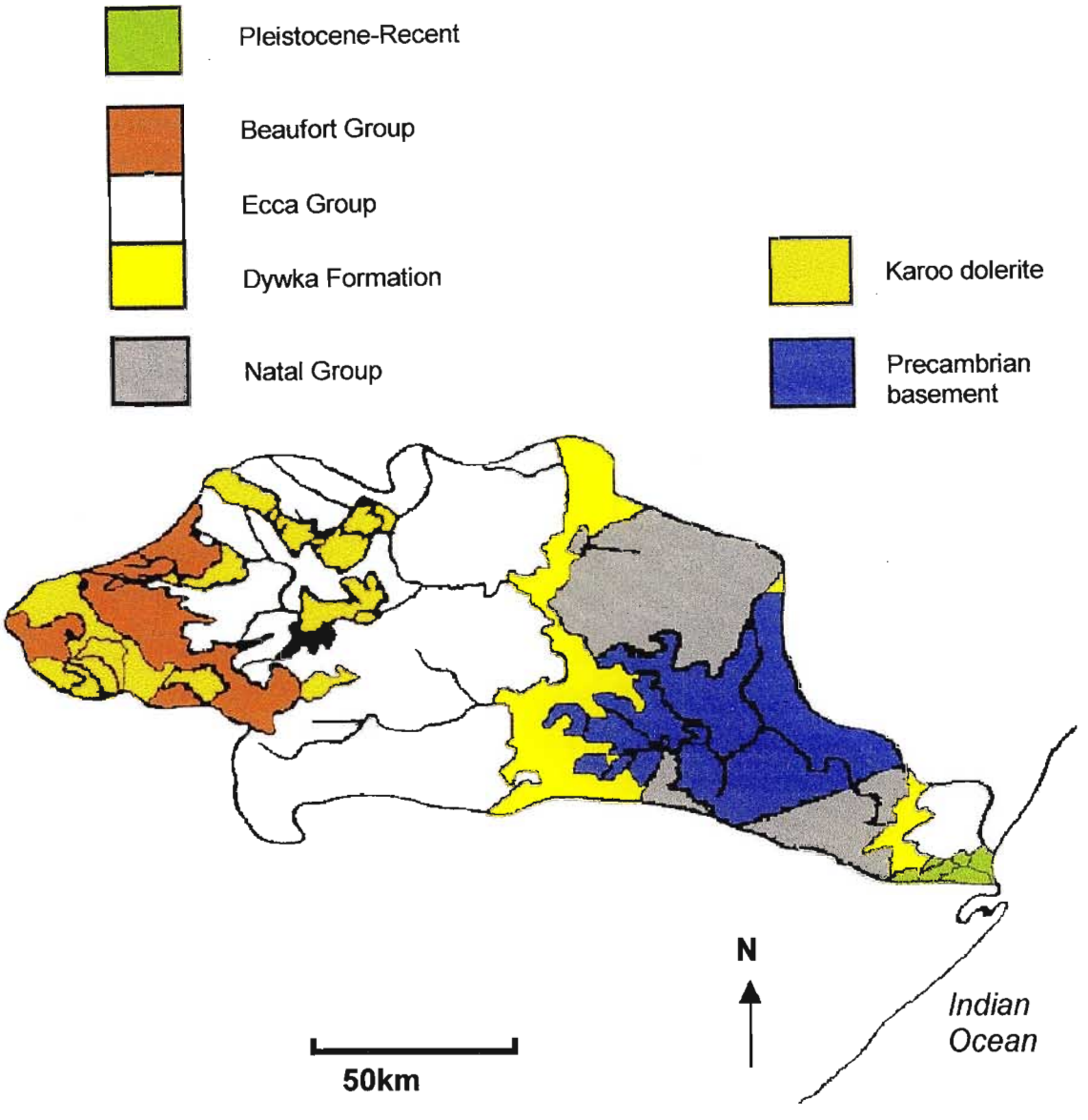

Fig 2.2: Geology of the Mgeni River catchment area. (Cooper, 1986.)

The nature of the sediments found in the Mgeni River Estuary varies considerably at different places. (See Fig 2.3, p. 22.) This is due largely to the wide variety of different rocks through which the river flows in the catchment area. The study area is rich in highly fertile alluvium soil which is said to have its origin in the Valley of a Thousand Hills (Archaean granites).[55] This "Umgeni grit" which is composed of alluvium, quartz sand, grit, clay and mud and is white or red in colour is distributed throughout the Mgeni River Estuary.[56] The nature of the other sediments found on the Mgeni River Estuary bottom have been described as follows:

> near the head of the estuary - fine sands;
> near the middle reaches - sandy to gravelly substrates;
> near the Ellis-Brown Viaduct - black anaerobic silt beneath deposits of sand or silt; and
> in the Beachwood Creek - sand of uniform composition; and
> in the mouth - sand.[57]

The accumulation of these sediments in the Mgeni River Estuary provides ideal habitats for numerous estuarine fauna and flora. A change in composition of the Mgeni River Estuary's sediments will therefore affect a number of estuarine species. While natural occurrences such as droughts and floods will affect the sediment composition, human activities such as damming, bridge construction, channelisation, urbanisation, agriculture and sandwinning will be shown to have a far greater impact on the sediment composition.

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[55] Ibid, p. 236.

[56] C. Mulder, Lower Umgeni River Study, (Mulder Associates Inc, Durban, 1984), p. 7.

[57] Begg, The Estuaries of Natal, p. 237.

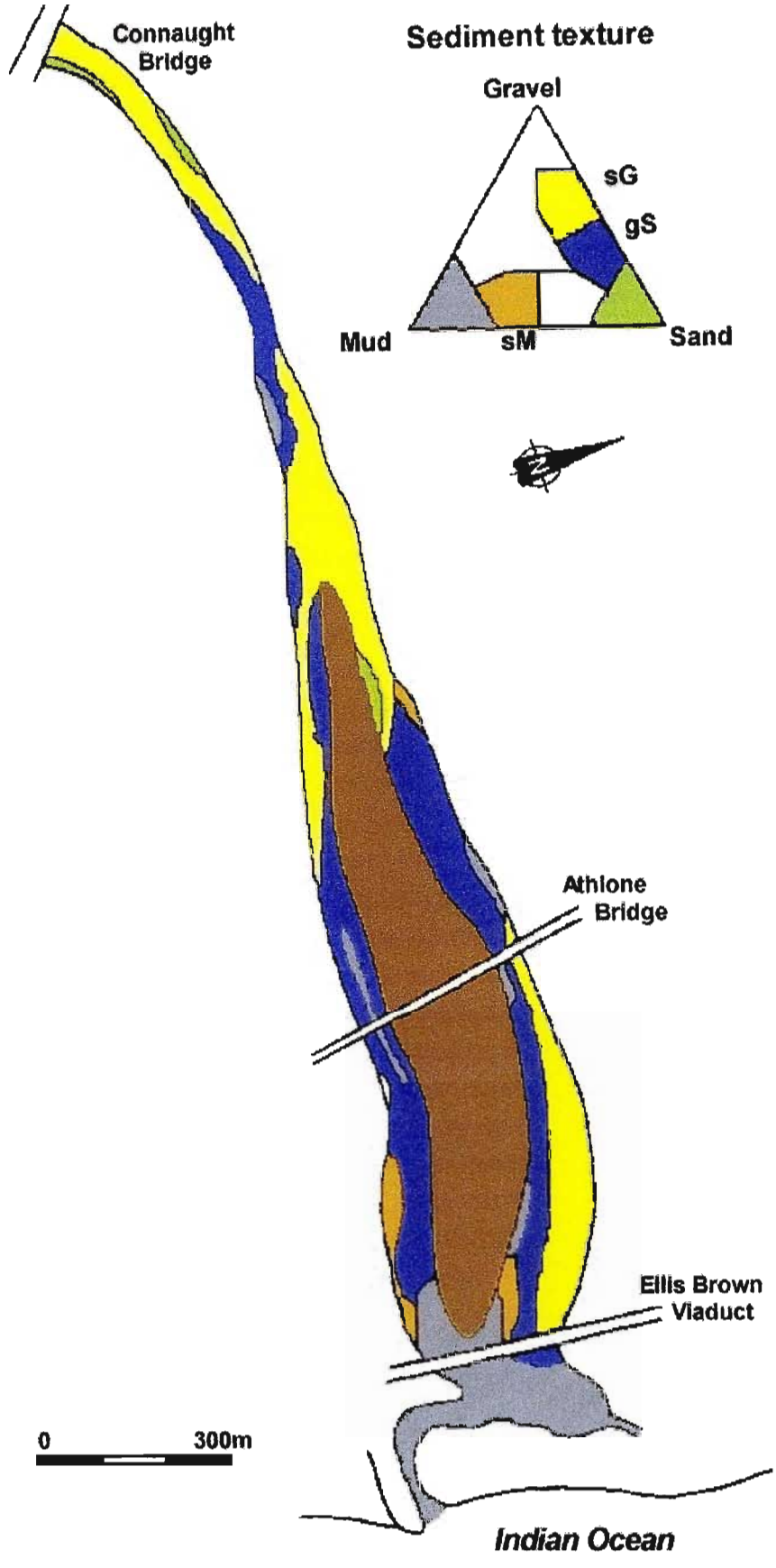
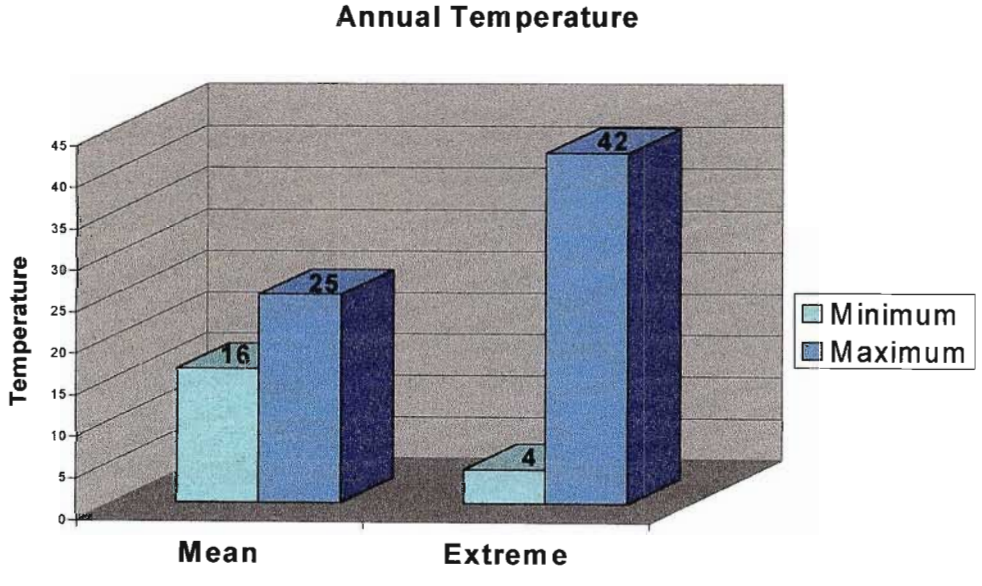


Fig 2.3: The major sediment classes of the Mgeni River Estuary. (Adapted from Estuaries of South Africa, 1998.)

Climate.

The study area lies on the eastern seaboard of South Africa, a sub-tropical climatic zone, which on an annual basis is predominantly warm and humid with few characteristic changes throughout the year. Due to the close proximity of the warm Agulhas current washing along the coast the average annual temperature is mild in winter and warm to hot in summer.[58] The mean daily maximum and minimum temperatures experienced in this region range from 21°C to 28°C in February and from 11°C to 22°C in July while extreme temperatures of above 40°C are also experienced.[59] (See Graph 2.1, below.) In general the temperature is characterised by relatively low seasonal changes due to the moderating effect of the adjacent coast.[60]



min	max		min	max
11	28		4	42

Graph 2.1: Depicting mean minimum and maximum annual temperatures recorded at Durban's old Municipal aerodrome at Stamford Hill.

[58] R. A. Preston-Whyte, Climate of Durban, (Natal Town and Regional Planning Commission, Pietermaritzburg, 1980), p. 15.

[59] E. H. Schumann, ed, Lecture Notes on Coastal and Estuarine Studies, (Springer-Verlag, New York, 1988), p. 86.

[60] Ibid, p. 85.

While rain occurs throughout the year, the "rainy season" is during the summer months (December to February) when sixty per cent of the annual precipitation takes place.[61] Fifteen per cent occurs between May and August.[62] The mean annual rainfall in the Durban region is recorded as being 1013 milimetres with 1305 milimetres and 646 milimetres as extremes.[63]

Coastal winds dominate the study area, especially in summer.[64] The prevailing wind directions, which blow approximately parallel to the coastline and occur with almost equal frequency, are north-north-east to north-east and south-south-west to south-west.[65] The mean wind speeds are lowest during May and June, higher mean wind speeds occur during the months September to March and the highest mean wind speeds occur in September and October. This wind regime influences the high annual rainfall in the study area as well as the waves impinging on the coast. The effect of waves on the Mgeni River Mouth will either erode or return sediment to the estuary mouth. Steep waves such as occur during storms generally remove sediment from the mouth and deposit it offshore while less steep waves, during calmer periods, tend to move the sediment back towards the mouth.

Hydrology.

The hydrology of the Mgeni River Estuary is complex as it is determined by the continual interaction between marine water and freshwater. Consequently the Mgeni River Estuary is extremely variable as each rise and fall of the tide causes change, while seasonal rainfall can bring even greater modifications. These extreme changes in character necessitate special adaptations in organisms that inhabit the Mgeni River Estuary. The hydrological regime of the Mgeni River Estuary needs to be described

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[61] Preston-Whyte, Climate of Durban, p. 15.

[62] Ibid.

[63] Mulder, Lower Umgeni River Study, p. 3.

[64] Schumann, Lecture Notes on Coastal and Estuarine Studies, p. 82.

[65] Preston-Whyte, Climate of Durban, p. 13.

to illustrate how easily this delicate system can be upset by human activities. The freshwater inflow into the study area is determined by the Mgeni River system. (See Fig 2.4, p. 27.) The Mgeni River rises in the Dargle Range at an altitude of about 1830 ma.s.l.[66] and drains the fifth largest catchment in KwaZulu-Natal.[67] The river is approximately 230 kilometres in length and the mean annual runoff has been given as $707 \times 10^6 m^3$.[68] In the upper catchment the major tributary is the Lions River. This area is characterised by numerous vleis, which promote a steady flow of water.[69] Lower down in the catchment the major tributaries are the Karkloof, Mpolweni and Mkabela Rivers. The Mzinduzi River, which rises in the Vulindlela area, is the other main component of the Mgeni River system.

The discharge of this river system is determined by the seasonal rainfall and the subsequent runoff from the catchment area. During the summer months the discharge is on average 18,4 cumecs, while during the winter months the discharge is only 6,5 cumecs.[70] The topography is steep, in that it drops nearly 2000 metres over a distance of 230 kilometres. This phenomenon makes the Mgeni River susceptible to flooding during periods of steady precipitation and heavy rainfall. The frequency and magnitude of flooding events has, however, been reduced in more recent years because of the construction of dams. The implications of damming are twofold. Firstly the sediments in an estuary mouth are not scoured out, and, secondly, the reduced flow may no longer be able to compensate for the evaporation in an estuary and consequently salinity levels may rise.[71]

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[66] G. W. Begg, The location, status, and function of the priority wetlands of Natal, The wetlands of Natal, Part 3, (Natal Town and Regional Planning Commission, Pietermaritzburg, 1989), p. 172.

[67] Mulder, Lower Umgeni River Study, p. 11.

[68] Ibid, p. 11.

[69] G. R. Basson & A. Bath, Water Quality Study. Phase 1, Water quality statement, (Umgeni Water, Pietermaritzburg, 1994), p. 2-1.

[70] Mulder, Lower Umgeni River Study, p. 11.

[71] G. M. Branch & M. Branch, The living shores of Southern Africa, (Struik, Cape Town, 1981), p. 105.

The Mgeni River Estuary is a river-dominated estuary[72] and remains open throughout most of the year. The marine inflow into the Mgeni River Estuary is determined primarily by tidal exchange. However, other factors such as channel structure, sediment movement and human activities also regulate the marine inflow. Sedimentation at the mouth can result in tidal deltas, bars and sandbanks, which can restrict marine exchange. In extreme cases the Mgeni River Mouth can become completely closed by such sedimentation.[73] The damming of the Mgeni River has reduced the scouring of sediments in the Mgeni River Mouth. The construction of roads and bridges, particularly those located in the mouth of the Mgeni River Estuary, has also reduced the marine exchange.

When marine water flows in at the mouth of the Mgeni River and freshwater at the head, a gradient of salinity (salt wedge) is established near the mouth.[74] This wedge is established when the freshwater, moving seaward, floats over heavier saline water entering and leaving the system in response to tidal exchange.[75] This water motion has many implications for the fauna and flora that inhabit the Mgeni River Estuary. Firstly, most estuarine species owe their existence to this water motion because the flow helps retain nutrients and sustains productivity typical of an estuary.[76] On the other hand, the estuarine circulation may bring about fluctuating salinity levels which can cause stressful conditions for many of the Mgeni River Estuary's species. Fortunately, most estuarine fauna have learnt to cope with changing salinity levels. They are, however, under threat when conditions in the Mgeni River Estuary become abnormally saline or fresh. This can occur when the freshwater and marine water flows are severely reduced.

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[72] Cooper, 'Geomorphology and Sedimentology', p. 15.

[73] Ibid.

[74] Branch, Living Shores of Southern Africa, p. 82.

[75] E. Schumann, 'Estuarine hydrodynamics', in B. R. Allanson & D. Baird, eds, Estuaries of South Africa p. 36.

[76] Boicourt, 'Estuaries. Where the River Meets the Sea', Oceanus, Vol. 36, Issue 2, (Summer, 1993), p. 33.

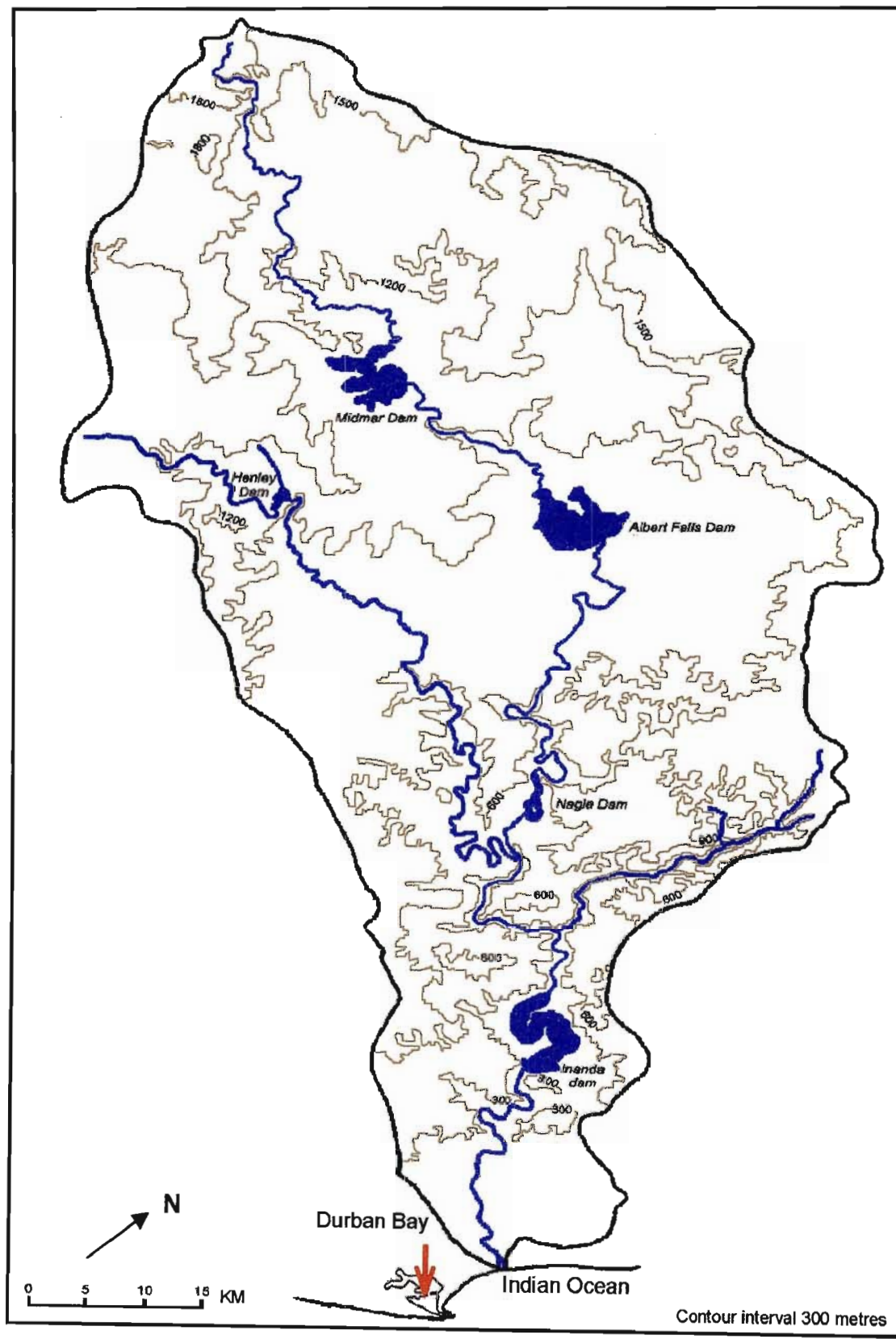

Fig 2.4: The topography of the Mgeni River catchment. (Moleko after Cooper, 1998.)

THE BIOLOGICAL ENVIRONMENT:

Vegetation.

Today the original vegetation is either gone or greatly changed. However, a substantial body of oral and illustrative material exists to support the view that the indigenous vegetation found in this coastal region was originally composed of a number of different plant communities. The formation of these various plant communities was dependent largely on the climatic, geological, hydrological and topographical conditions of this coastal region. Starting from the Mgeni River Mouth and moving progressively inland, the vegetation types were probably the following.

Dune forest lay adjacent to the mangroves in the salt-spray zone of the sea shore.[77] The dune forest was comprised of pioneer species such as Seeplakkie (*Scaevola thunbergii)* and Sandkweek (*Sporobolus virginicus).*[78] These pioneer species served the important function of stabilising the sand dunes which were susceptible to erosion from wind and rain. Once the sand dunes were stabilised, the pioneer community became open to invasion by shrubs and small trees such as Dune myrtle (*Eugenia capensis),* Dune false currant *(Allophylus natalensis),* Coastal red milkwood *Mimusops caffra),* Dune gonna (*Passerina rigida),* Cat-thorn (*Scutia myrtina)* and Veld fig *(Ficus burtt-davyi).*[79]

Located behind the dune forest was coast forest which was protected by the dune forest from the full blast of the salt spray.[80] The average height of the woody canopy in this forest was from 10 to 21 metres.[81] Some of the common tree and shrub species include Natal mahogany *(Trichilia dregeana)*, White stinkwood *(Celtis*

[77] E. J. Moll, The Vegetation of the three Rivers Region, Natal, (Natal Town and Regional Planning Commission, Pietermaritzburg, 1976), Vol. 33, p. 45.

[78] Ibid.

[79] Ibid.

[80] Ibid.

[81] Ibid, p. 46.

africana), White pear *(Apodytes dimidiata)*, Essenwood *(Ekebergia capensis),* White ironwood *(Chionanthus peglerae)*, Black ironwood *(Olea capensis)*, Falcate yellowood *(Podocarpus falcatus)*, Upright yellowwood *(Podocarpus latifolius)* and White milkwood *(Engelerophytum natalense).*[82] The subcanopy layer in the mature coast forest was from 9 to 15 metres in height and included the Natal milkplum *(Englerophytum natalense)* and Bastard ironwood *(Drypetes arguta).*[83] The forest's shrub and herbaceous layer was poorly developed while the forest floor was usually covered with a thick layer of leaf litter.[84]

In the low lying swamp areas halphytic grasses, sedges and reeds occurred. The actual species composition of these areas was dependent largely on the water depth and the frequency with which it dried up. Some of the common species included the Swamp reed (*Phragmites australis)* and Bulrush (*Typha capensis)* and associated sedges (*Cyperace* spp.).[85] The reed and sedge communities provided and continue to provide, habitat for many bird, invertebrate and fish species. In addition to these communities also provide food (detritus) for the detritivores. (See Fig 2.5, p. 31.)

The reed and sedge communities played an important role in the succession of swamp forests as they impeded the flow of flood waters, allowing the deposition of silt. When the deposition was such that the level of ground had risen above the permanent water level, swamp trees were able to invade. Common trees included Umdoni (*Syzygium cordatum),* Quinine tree *(Rauvolfia caffra),* Wild poplar (*Macaranga capensis),* False cabbage tree (*Schefflera umbellifera)* and Wild date palm (*Phoenix reclinata).*[86]

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[82] Ibid.

[83] Ibid.

[84] Ibid.

[85] Ibid.

[86] Ibid.

In areas where the soil was clayey and drainage poor, clumps of palm veld and grassland occurred.[87] The characteristic plant of the palm veld was the Wild date palm *(Phoenix reclinata)*.[88] Other plants that invaded the clumps of palm veld included the Natal fig *(Ficus natalensis)* and the Wild banana *(Strelitzia nicolai)*.[89]

Mangrove swamp occurred throughout the Beachwood Creek and in the lower reaches of the Mgeni River Estuary. The characteristic species of this community consisted exclusively of three mangrove tree species: the White mangrove *(Avicennia marina)*, the Black mangrove *(Bruguiera gymnorrhiza)*, and the Red mangrove *(Rhizophora mucronata)*.[90] These species produced a community structure characterised by a single layer of trees with little or no understorey. The occurrence and abundance of these three species was influenced by the following factors: frequency and flooding of seawater, degree of mixing with freshwater at river mouths and concentration of brackish water, and the consistency of soil.[91] This plant community played and continues to play an important role in providing detritus for the detritivores. (See Fig 2.5, p. 31.)

Suspended within the water column of the Mgeni River Estuary were phytoplankton and microscopic single-celled plants (diatoms). These plant organisms which are classified as primary producers in an estuary food chain, provided an important source of food for filter feeders (e.g. crab species). The distribution of phytoplankton and diatoms depended and still continues to depend on the freshwater and marine input. Both components play a vital role in dispersing the plant material throughout the Mgeni River Estuary, thereby making it available to filter feeders.

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[87] Ibid, p. 48.

[88] Ibid.

[89] Ibid.

[90] D. C. Roberts, 'An Open Space Survey of the Municipal Durban', (Unpublished Ph. D. Thesis, University of Natal, Durban, 1990), p. 239.

[91] Ibid, p. 241.

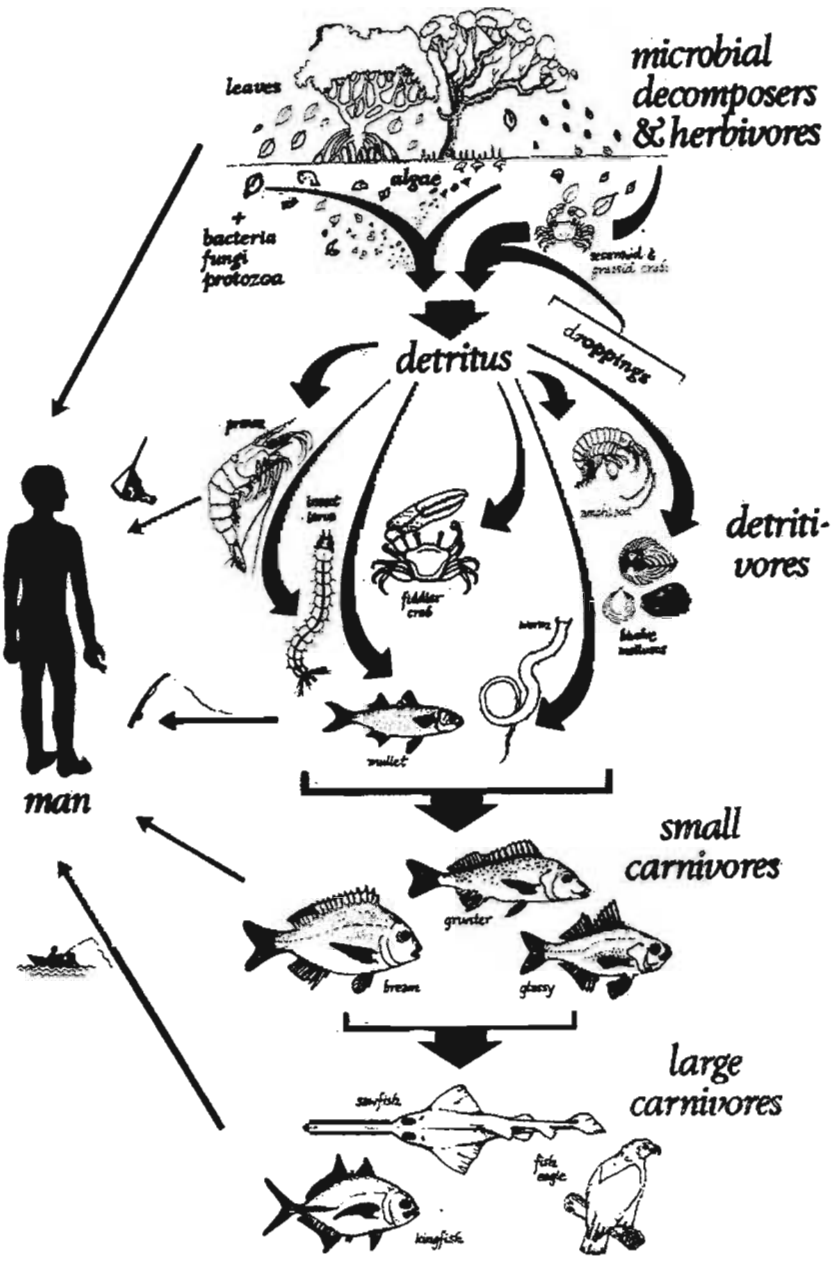

Fig 2.5: Interdependencies within the Mangrove Environment. (Berjak, 1977.)

The present day appearance of the vegetation has changed radically but a number of plant communities still remain. Adjacent to the mangroves at the mouth of the Mgeni River Estuary is an area of sparse dune vegetation that is comprised of species such as Dune myrtle *(Eugenia capensis),* Strandboontjie (*Canavalia maritima),* Hottentot's-fig *(Carpobrotus dimidiatus),* Gonna bush *(Passerina rigida),* Bush tick-berry

(*Chrysanthemoides monilifera)* and Seeplakkie (*Scaevola thungergii).*[92] *(See Plate 2.1, below.)*

Plate 2.1: Seeplakkie (Scaevola thunbergii) binding dune sand. (November, 1999.)

The most common plant community found in the Mgeni River Estuary is still the mangrove swamp. The three mangrove species occur throughout Beachwood Creek but are in far greater abundance towards the creek entrance. (See Fig 2.6 & Fig 2.7, p. 33.) The White mangrove, which is a pioneer specie, is most widely developed along the channel margins where sandy substrates are abundant, while the Black mangrove tends to inhabit areas that contain more clay size particles.[93] The mangrove community acts as an effective sediment trap and it has been argued that the advancing mangrove community is closely associated with the patterns of sedimentation.[94] Growing amongst the mangroves are salt tolerant species of

[92] Ibid, p.15.

[93] Ibid.

[94] Ibid.

grasses such as Coastal buffalo grass (*Stenotaphrum secundatum)* and rushes such as Matting rush *(Funcus krausi)*.[95]

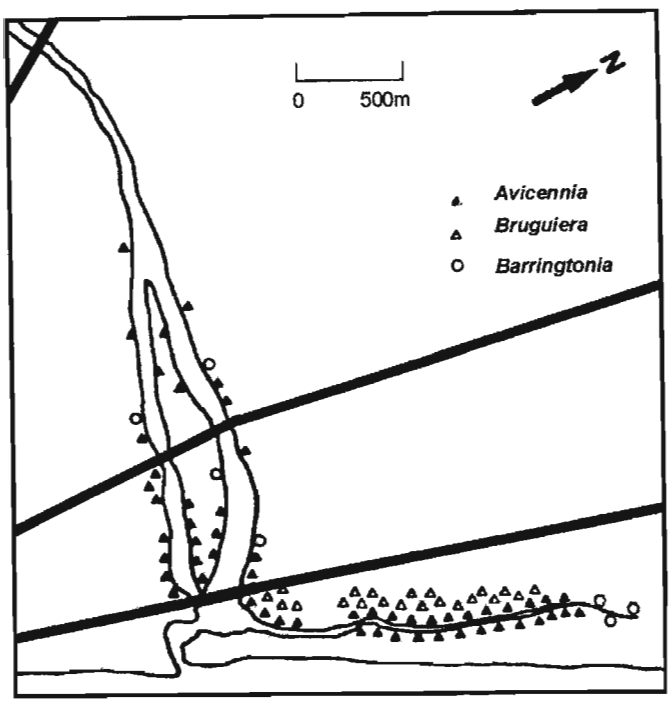

Fig 2.6: Distribution of mangroves in the Mgeni River Estuary. (Cooper, 1986.)

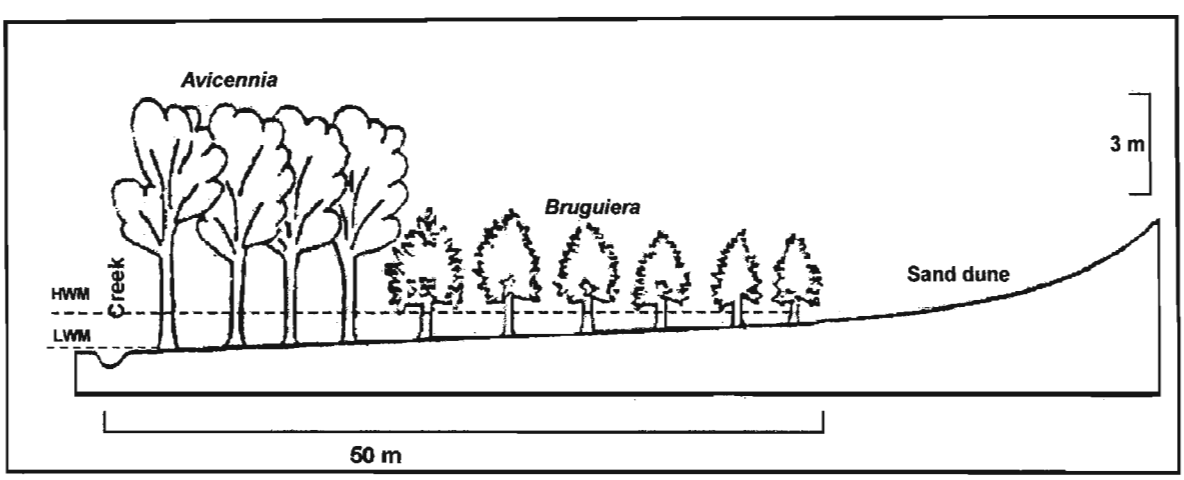

Fig 2.7: Zonation of mangroves in Beachwood area. (Cooper after Brown, 1971.)

[95] Mulder, Lower Umgeni River Study, p. 15.

Coastal woodlands, in the form of various trees and shrubs, occupy the large island which lies between the two arms of the Mgeni River Estuary.[96] In the upper reaches of the Mgeni River Estuary, the banks are dominated by grasses such as Limpopo grass (*Echinochloa pyramidalis)*, Swamp reeds (*Phragmites australis)* and sedges such as Wand sedge *(Scirpus littoralis = Schoenoplectus scirpoides)*. Trees such as the Natal fig (*Ficus natalensis) and* Coast silver oak *(Brachylaena discolor)* also occur.[97] Throughout the Mgeni River Estuary phytoplankton and diatoms are found.

The different types of plant communities found in the Mgeni River Estuary illustrate the uniqueness of this estuarine ecosystem. They reflect the climatic, geological, hydrological and topographical conditions of the region. The described plant communities have, however, been destroyed or changed as a result of human activities encroaching on the Mgeni River Estuary.

Fauna.

Prior to any major environmental alteration, the study area supported a large number of vertebrate and invertebrate species. However, as the white settler population expanded and the City of Durban grew, animal species slowly withdrew from the area.[98] In addition to this withdrawal certain species were preyed upon by the local human population for food, sport, trophies and in the defence of lives and properties.[99]

Carnivores, especially Lion *(Panthera leo)* and Leopard *(Panthera pardus)*, were feared most by the white settlers as they posed a threat to human life and livestock.

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[96] Ibid.

[97] Ibid.

[98] B. Ellis, 'The impact of white settlers on the natural environment of Natal, 1845 - 1870', (Unpublished M. A. Thesis, University of Natal, Pietermaritzburg, 1998), p. 100.

[99] Ibid.

They were therefore eliminated soon after the white settlers had settled in the area.[100] The herbivores on the other hand were eliminated for numerous reasons. Hippopotamus *(Hippopotamus amphibus)* were shot because they destroyed white settler gardens in their nocturnal wanderings,[101] while Buffalo *(Syncerus caffer)* and Elephant *(Loxodonta africana)* were killed for sport by the white settler elite. Other herbivores, such as Antelope *(Hippotragus equinus),* were shot for food.[102] Crocodiles *(Crocodilus niloticus),* which lived in the reeds of the Mgeni River Estuary, were shot because they too threatened human life and livestock.

The activities of the white settlers also played a leading role in the decline of bird life in the region. Originally Pelicans (*Pelecanus* spp.), Flamingoes (*Phoenicopterus* spp.), Cranes (*Balearica* spp.) and Spoonbills (*Platalea* spp.) frequented the area.[103] However, as Durban grew, vleis were drained and forests cleared to accommodate the growing needs of the Durban population as a result of which a large percentage of the bird life was disturbed.[104]

Inhabiting the Mgeni River Estuary were various estuarine invertebrate communities. Invertebrate communities can be broadly categorised into benthos (animals living on the bottom); nekton (animals swimming in the water column) and plankton (animals drifting in the water column).[105] These estuarine invertebrates feed on a variety of matter. Some invertebrates are herbivores, grazing on aquatic macrophytes (e.g. mangroves, reeds and sedges) or phtyoplankton (e.g. seaweed).[106] Other species

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[100] Ibid.

[101] Ibid.

[102] Ibid.

[103] Ibid, p. 103.

[104] Ibid.

[105] L. Beckley, 'Estuarine invertebrates', in Lubke, Gess & Bruton, A Field guide to the Eastern Cape coast, p. 145.

[106] Ibid.

are carnivores, preying on other animals, while yet other species are omnivores, feeding on a mixture of both plant and animal matter.[107]

The benthic invertebrate community is comprised of prawns, bivalves (filter feeders) and meiofauna (organisms less than 0,5 milimetres in length). There are a number of prawn species located throughout the Mgeni River Estuary according to the nature and distribution of the estuarine sediments. For example, the Mud prawn *(Upogebia africana)* prefers substrates of smaller particle size than the Sand prawn *(Callianassa kraussi)*. Consequently Sand prawns *(Callianassa kraussi)* are located in the mouth or head of an estuary where the stronger water flow prevents the displacement of mud. (See Fig 2.3, p. 22.) Competing with the prawns in the muddy sands of the Mgeni River Estuary are numerous bivalve species. Some of these include Pencil bait (*Solen capensis),* Bloodworm *(Arenicola loveni),* and crab species such as the Mangrove swimming crab *(Scylla serrata).*[108] Lastly, there is the meiofauna', these microscopic organisms which live between sand grains and mud particles consist largely of small round worms called nematodes and crustaceans known as copepods.[109]

Nektonic invertebrates in the Mgeni River Estuary are dominated by the Penaeid prawn community. The following species have been identified: Japanese prawn (*Penaeus monodon)*; Green prawn (*Penaeus semisulcatus)*; White prawn (*Penaeus indicus)* and Tiger prawn (*Penaeus monodon).*[110]

The last of the invertebrates is plankton. This type of invertebrate constitutes a major food source in an estuary and fish, especially juveniles, consume large quantities

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[107] Ibid.

[108] Ibid, p. 146.

[109] Ibid. p. 147

[110] G. W. Begg, The Estuaries of Natal, Part 2, (Natal Town and Regional Planning Commission, Pietermaritzburg, 1984), p. 116.

thereof. Planktonic organisms are classified according to their life cycle spent in the planktonic community. Those planktonic organisms that spend their entire lives in the plankton are termed holoplankton and are usually dominated by copepods such as *Acartia natalensis*.[111] Those organisms that are only temporarily planktonic are called meroplankton, examples of meroplankton; include isopods such as *Cirolana fluviatilis* and amphipods such as *Grandidierella* spp. .[112]

The numerous communities found in the Mgeni River Estuary provide a highly nutritious environment for a number of fish. Fish species found within an estuary can be divided into four categories depending on their origin, biological adaptations to the estuarine conditions, and their degree of dependence on the estuary for survival.[113] (See Table 2.1, p. 38.) The following fish species have been recorded in the Mgeni River Estuary: Baldy glassy (*Caffrogobius natalensis),* Estuarine round-herring (*Gilchristella aestuarius),* Knysna sandgoby (*Psammogobius knysnaensis),* River bream (*Acanthopagrus berda),* Natal moony (*Monodactylus argenteus),* Spotted grunter (*Pomadasys commersonni),* Groovy mullet (*Liza dumerili),* Javelin grunter (*Pomadasys hasta),* Blackhand sole (*Solea Bleekeri),* Blackedged blaasop (*Arothron immaculatus),* Belly pipefish (*Syngnathus djarong),* Bluetail mullet (*Valamugil buchanani).*[114]

By the turn of the twentieth century, environmental alteration had drastically diminished the numbers of certain individual species found in the study area. However, in spite of this reduction, the Mgeni River Estuary still provides habitats for a large number of bird, fish, prawn and crab species. This species richness can be attributed to the Mgeni River Estuary's open mouth, the degree of tidal exchange, and the nutrient status of the estuary waters. It is desirable, therefore, that these

[111] T. Wooldridge, 'Estuarine zooplankton community structure and dynamics', in B. R. Allanson & D. Baird, eds, Estuaries of South Africa, pp. 141/ 142.

[112] Ibid.

[113] A. Bok, 'Estuarine Fishes', in Lubke, Gess & Bruton, A Field guide to the Eastern Cape coast, p. 153.

[114] Begg, Estuaries of Natal, Part 2, p. 115.

estuarine functions be maintained if the ecology of the Mgeni River Estuary is to remain diverse.

Table 2.1: The four groups of estuarine fishes. (Adapted from Bok, 1988.)

Group	*Description*	*Examples*
I.	Truly estuarine species which breed and spend their entire life cycle in estuaries.	*Caffrogobius natalensis*; *Gilchristella aestuarius*; *Psammogobius knysnaensis*
II.	Species usually breeding at sea with juveniles showing varying degrees of dependence on estuaries. Adults seasonally enter estuaries.	*Acanthopagrus berda;* *Monodactylus argenteus;* *Pomadasys commersonni*
III.	Marine species which 'stray' into estuaries, usually occurring close to the mouth and not dependent on estuaries	*Liza dumerili*; *Pomadasys hasta*; *Solea Bleekeri*
IV.	Freshwater species for which the degree of penetration into estuaries is determined by salinity tolerance. Includes species which breed in both freshwater and estuaries. This group is not dependent on estuaries.	*Arothron immaculatus*; *Syngnathus djarong*; *Valamugil buchanani.*

Conclusion.

It is apparent that the Mgeni River Estuary is a complex and fragile ecosystem that supports a diversity of organisms. The variable and transitional character of this system is determined by various natural forces that include geology, climate, wave action and the continual interaction of marine and freshwater. This makes the Mgeni

River Estuary particularly vulnerable to a wide range of human activities such as damming, bridge construction, channelisation, urbanisation, industry, poor farming practices and the draining of wetlands, all of which have the potential to upset the intricate balance of this estuarine ecosystem. The following chapter will explore human activities and their resultant impacts on the Mgeni River Estuary.

CHAPTER THREE

HUMAN IMPACTS

Introduction.

Throughout history humanity has developed various modes of resource use in order to survive. This need has led to manipulation of the environment which began with the earliest attempts of societies to obtain food and made considerable advance when humans learned to use fire. Humanity's most significant development, though, has been the advent of agricultural practice. Through the controlled breeding of animals and plants, humans have developed a reliable and readily expandable source of food and have thereby created a solid and secure basis for cultural and technological advance, an advance that has brought about radical changes to the environment.

All major cultural and technological developments can, according to Goudie, be divided into three distinct phases or transitions: the phase of hunting and gathering, the phase of plant cultivation, animal keeping and metal working, and the phase of modern urban and industrial society. This chapter will use the phases provided by Goudie to trace the history of human impacts in KwaZulu-Natal. (See Fig 1.1, p. 7.) The main focus of this chapter is on modern urban and industrial society.

Hunter-Gatherers.

Current archeological evidence suggests that the first humans inhabited the coastal region of Natal some 1,6 million years ago.[115] Research has shown that although the modes of resource of these early nomadic inhabitants (hunter-gatherers) had some impact, the impact appears not to have been damaging until the arrival of colonialism in 1824. The early hunter-gatherers appear to have coexisted in relative harmony

[115] A. Mazel, 'The Stone Age Peoples of Natal', in A. Duminy & B. Guest, eds, Natal and Zululand from earliest times until 1910: A new history, (University of Natal Press, Pietermaritzburg, 1989), p. 3.

with nature, taking only the bare essentials which they needed to survive. Their diet consisted primarily of animals and plants and, with the discovery of fire, there was a small degree of food processing.

More advanced food processing took place during the Middle Stone Age as a result of technological advances which included the use of stone tools detached from the core and grinding stones. These new tools provided the hunter-gatherers with the ability to maintain a more varied diet. The diet was composed of wild fruits, berries, Honey badger *(Mellivora capensis)*, Dassie *(Procavia capensis)* Bushpig, Warthog *(Phacochoerus aethiopicus)*, Hippopotamus *(Hippopotamus amphibius)*, Steenbok *(Raphicerus campestris)*, Oribi *(Ourebia ourebi)*, Mountain reedbuck *(Redunca fulvorufula)*, Roan antelope *(Hippotragus equinus)* Sable *(Hippotragus niger)*, Impala *(Aepyceros melampus)*, Hartebeest *(Sigmoceros lichtensteinii)*, Blue wildebeest *(Connochaetes taurinus)*, Nyala *(Tragelaphus angasii)* and Bushbuck *(Tragelaphus scriptus)*.[116] The transition to the Later Stone Age is characterised by further technological advance. During this period the development of fish hooks allowed the hunter-gatherers to begin exploiting marine resources.

It is evident that while impacting on the environment, the hunter-gatherers' method of resource use would have had relatively small impact on the environment. This impact gradually changed as the hunter-gatherers advanced and technological improvements were made, allowing for greater exploitation of natural resources. This change is supported by Simmons' theory on energy flow where he has argued that 'technology is the strongest cultural determinant of the impact a society can make on the environment'.[117] It is technology that determines what methods of resource use a society will employ and the ability of that society to harness, use and store energy. It will be seen that with the advent of metallurgy, the Iron Age society's technological status improved. This improved status initiated additional changes to the environment.

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[116] Ibid, p. 9.

[117] Simmons, Changing the Face of the Earth, p. 32.

Humans as cultivators, keepers and metal workers.

The advent of the Iron Age saw not only the introduction of metallurgy but, of even greater significance, the introduction of agro-pastoralism necessitating a settled, village way of life instead of the nomadic patterns of the Stone Age. Archaeological evidence suggests that Iron Age farmers moved into the coastal region of Natal in approximately 250 A. D.[118] These early farmers settled within three few kilometers of the shore where the vegetation was most probably coastal forest.[119] It would appear that these early communities lived for limited periods in small villages near which they practiced shifting agriculture. This practice resulted in some replacement of coastal forest by secondary grasslands though the higher woodlands and forests would probably have remained intact throughout the Early Iron Age.[120]

It would appear that while these early settlements did keep cattle, the cultivation of crops dominated the Early Iron Age economy. This is supported by evidence that little grazing would have been available until the practice of shifting agriculture was well underway and secondary grasslands had been established.[121] Furthermore, the combination of a subtropical climate and dense vegetation would have favoured parasites harmful to livestock. As a result of an insufficiency of livestock, the Early Iron Age communities exploited marine resources to supplement their diet. This may explain why these early communities chose to settle on the forest edge where the rich agricultural soil and marine resources were easily accessible.[122]

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[118] M. Hall, Archaeology Africa, (David Phillip, Cape Town, 1987), p. 83.

[119] Ellis, 'The impact of the white settlers on the natural environment of Natal, 1845 - 1870', p. 10.

[120] Thompson, 'The Eastern Shores of St. Lucia: Towards an Environmental History', p. 37.

[121] M. Hall, The Changing Past: Farmers, Traders and Kings, (David Phillip, Cape Town, 1987), p. 37.

[122] Ibid.

The transition from the Early Iron Age to the Late Iron Age took place at around 1000 A. D.[123] It is marked by an extension of settlement patterns into the coastal hinterland and changes in ceramic decorative styles. The spread of secondary grasslands, it is argued, allowed domestic livestock to become more important in the Late Iron Age economy. The increased number of domestic livestock kept by these communities had large impacts on the vegetation of Natal. Most ecologists would argue that the introduction of domesticated animals changed the composition of the veld through a combination of factors.[124] Firstly, the existing ratio of grazers to browsers was upset. Although in the past the ratio of grazers to browsers was not known, it is believed that the grazers would have predominated.[125] The implications of this are that the woody plants would not have been browsed to the same extent than had been the case previously, thus the balance between woody and herbaceous plants would have been upset.[126] Secondly, cattle and sheep graze certain grasses, therefore if they graze continuously in one area those grasses will be reduced and the less palatable grasses will dominate.[127]

It is apparent that technological advance throughout the Iron Age facilitated new environmental change. With the aid of fire and metal axes, large portions of land were converted into cropfields which replaced forests, marshes and natural grasslands. Cultivation as well as cattle keeping also placed increasing demands on the natural vegetation which was used for fuel, fodder, manure, building material and implements. While the Iron Age societies facilitated additional environmental change, far more radical change was to take place, however, with the arrival of the white colonists who brought with them the technology of industrialisation.

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[123] Hall, Archaeology Africa, p. 84.

[124] Ellis, 'The impact of the white settlers on the natural environment of Natal', p. 13.

[125] Ibid.

[126] Ibid.

[127] Ibid.

Modern industrial and urban civilisation.

In 1824 a small group of British hunter-traders arrived in Natal.[128] Although small in number this group of white colonists had a significant impact on the environment. Their arrival saw the rapid depletion of three species of game, these being Elephant *(Loxodonta africana)*, Hippopotamus *(Hippopotamus amphibius)* and Buffalo *(Syncerus caffer)*.[129] This heavy exploitation resulted in a decrease in the population of all three species which impacted on the environment as these species were heavy browsers. Central to understanding the threatening impact that the hunter-traders had on the environment is their improved technological status in that they were equipped with guns and had inherently different aims of production from those of the Iron Age farmers. Where the Iron Age farmers produced subsistence goods, tributes for the Zulu king and possibly a few commodities, the hunter-traders strove to produce commodities purely for economic gain.[130]

In 1837, thirteen years after the arrival of the hunter-traders, 4000 Boers trekked from the Cape to Natal where they chose to settle permanently.[131] These Boers brought with them the system of private land-tenure, which formed the basis for a new relationship between people and natural resources in Natal. Where previously the Iron Age farmers had practiced shifting agriculture, land was now divided into private farms allowing individuals to exploit their land as intensely as they wished.[132] The ability of the Boers to exploit the natural environment was affected by two factors: this was their technology and their use of black labour.[133] With the aid of new farming

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[128] Ellis, 'The impact of the white settlers on the natural environment of Natal, 1845 - 1870', p. 21.

[129] Ibid, p. 25.

[130] Ibid, p. 21.

[131] Ibid, p.29.

[132] B. Ellis, 'The impact of the white settlers on the natural environment of Natal, 1845-1870', in B. Guest & J. Sellers, eds, Enterprise and Exploitation in a Victorian Colony: Aspects of the Economic and Social History of Colonial Natal, (University of Natal Press, Pietermaritzburg, 1985), p. 73.

[133] Ibid.

implements, modes of transport and additional labour, the Boers' exploitation of natural resources was intensified.

During the brief life of the Republic of Natalia (1838 - 1843) a number of activities that impacted on the environment, other than farming, were established. The emergence of a few skilled specialists stimulated a demand for certain raw materials. Wagon-makers and furniture-makers required timber, tile-makers needed clay and masons sought after workable stone, resulting in quarrying and mining activities.[134] Although these activities took place on a small scale, they caused some change to landforms. These and other manufacturing activities, as well as domestic households, all required fuel. This demand resulted in sawyers felling selected species of timber for housing, furniture, wagons and fuel. Consequently the size and composition of forests on the outskirts of Durban were altered.[135]

The Boers' denudation of natural resources was short-lived because the British Government decided to annex the Republic of Natalia in 1843. Annexation sparked a mass exodus of white farmers, so that by 1846 there were only about 60 Boer families left in the region.[136] The implication of this exodus was that the more intensive utilisation of natural resources that had begun with the Boers' arrival in the early 1840s was temporarily halted until 1849 when there was a large influx of British Immigrants.

The British Government's decision to annex Natal did not alter the overriding concern for financial stringency which had dominated imperial administration and defence since the end of the Napoleonic Wars in 1815.[137] After annexation, the British

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[134] Ibid.

[135] Ellis, 'The impact of the white settlers on the natural environment of Natal', p. 110.

[136] Ellis, 'The impact of the white settlers on the natural environment of Natal', in Guest & Sellers, eds, Enterprise and Exploitation in a Victorian Colony, p. 74.

[137] B. Guest and J. M. Sellers, 'Introduction', in Guest & Sellers, eds, Enterprise and Exploitation in a Victorian Colony, p. 3.

continued to practice their policy of economic liberalism which embodied the belief that minimal state intervention would bring the greatest economic benefit to the state. Consequently there was little money made available for the administration of the colony. Therefore colonial settlers were encouraged to settle in the area as a cheap means to entrench colonial institutions.

Between 1849 and the early 1850s, some 5000 British immigrants arrived in Natal. About 2000 of these immigrants were attached to immigration schemes where the promoters provided allotments in the coastlands and midlands.[138] The arrival of these settlers renewed the environmental exploitation begun in the early 1840s by the Boers. This time, though, the exploitation was intensified because the white settlers came from the most highly industrialised nation in the world. They were accustomed to living within a political and administrative structure geared towards producing for both local and international market economies.[139] The British immigrants valued their natural environment for its economic potential, and not as a diverse ecosystem. With the aid of the latest innovative technology from Britain, the white settler exploited every conceivable natural resource for the purpose of making a profit. This facilitated intensified exploitation of natural resources.

The above argument is supported by Gadgil and Guha's typology of 'modes of resource use'. If we consider the distinctive characteristics of this white settler society we see that, in conjunction with technological advance, there was a radical change in the perceptions of the man-nature relationship. The emergence of this society is marked by 'the total rejection of the gatherer view of man as part of a community of beings, or even of the agriculturist view of man as a steward of nature. Instead it is emphatically asserted that man is separate from nature, with every right to exploit natural resources to further his own well being.'[140] This perception is best illustrated in a letter written by Rev. J. Archbell describing the potential of the Mgeni River:

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[138] Ellis. 'The impact of the white settlers on the natural environment of Natal', in Guest & Sellers, eds, Enterprise and Exploitation in a Victorian Colony, p. 75.

[139] Ibid.

[140] Gadhil & Guha, This Fissured Land: An Ecological History of India, p. 45.

> ... The Umgeni, which nature seems to have designed for supplying the town, can be led without difficulty, and, by little more than opening a furrow, will flow through the streets with a current commensurable to the utmost demands that can possibly be made upon it.[141]

This attitude of the white settlers was to have adverse consequences for the Mgeni River and consequently the estuary. The white settlers' first efforts to alter the Mgeni River dates back to 1848 when an attempt was made to modify the river course. A regiment of soldiers was ordered to cut a ditch from the Mgeni River to their camp and then to find an outlet into the Bay. It is argued, by some, that this was done to supply the camp with fresh water. Others have argued that it was a scheme to increase the sand bar at the river mouth by diverting the river into the Bay. This scheme was subsequently destroyed in April 1848 when the first recorded flood of the Mgeni River wiped out the ditch.[142]

The next major flooding event occurred in April 1856. The river was said to have risen eighteen to twenty feet above sea level over a period of four days. This torrential downpour caught the inhabitants of Durban unaware, sweeping animals, machinery, bridges and people into the Bay or out of the Mgeni River Mouth into the ocean. The devastation brought by this flood persuaded the town council to erect an embankment at the head of the eastern vlei above the Umgeni Brickfields to prevent future flooding.[143] This drain, better known as Milne's Drain, flowed out into the Bay. The scheme effectively drained off surface water for years making the Berea more accessible and improving sanitary conditions in the town. The reclaiming of the vlei also made land available for urban development. These developments altered the natural vegetation which was composed of reeds, sedges and grasses and consequently affected a number of fauna inhabiting the Mgeni River Estuary.

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[141] J. Bird, Annals of Natal, (P. Davis and Sons, Pietermaritzburg, 1888), p. 656.

[142] Mulder, Lower Umgeni River Study, p. 25.

[143] Ellis, 'The impact of the white settlers on the natural environment of Natal', in Guest & Sellers, eds, Enterprise and Exploitation in a Victorian Colony, p. 81.

The construction of the eastern vlei embankment and Milne's Drain was effective in mitigating flooding events but did not prevent them. Floods still continued to destroy property. In 1868 flood waters swept away the Victoria Bridge which had been built in 1864. This bridge was replaced by the Umgeni Railway Bridge which was built and completed in 1877. During construction of the Railway Bridge further attempts were made to limit flood damage. In 1875 it was decided that it was necessary to ensure that the Mgeni River Mouth remained permanently open so that water did not accumulate in the river and threaten property. Accordingly two spurs were constructed on the south side of the Mgeni River mouth. However, these spurs were not effective in regulating an open river mouth.

Year by year and throughout each year, the river mouth continued to change. In 1878 the town council received complaints from H. E. Stainbank, a Durban citizen, that the river mouth had shifted up the coast.[144] Stainbank believed that this development posed a health risk to the people of the borough as the migration of the river mouth prevented the tide from effectively flushing out debris from the Sea Cow Lake and the Little Umhlanga River. Instead of flowing out to sea the debris collected between Victoria Bridge and the beach and for a couple of hours every day during low tide it was exposed for some hours, causing a stench. In the light of this phenomenon, Stainbank proposed that he cut through the sand bank, allowing the Mgeni River to flow directly into the Indian Ocean. The town council duly accepted Stainbank's proposal and he was provided with prison labour to carry out the task.

Another area of concern for the town council was the harbour. It was decided that the absence of adequate port facilities was a major obstacle to economic growth. Therefore a commission was appointed in 1849 to report on ways and means of improving the harbour.[145] Initial improvements made in the harbour were the construction of Milne's Pier in the early 1850s and Vetch's Pier, in the 1860s. The

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[144] Pietermaritzburg Archival Repository (PAR), Colonial Secretary's Office (CSO), 643, 1878/1871, H.E. Stainbank brings to notice the state of the Umgeni near its mouth.

[145] L. Heydenrych, 'Port Natal Harbour', in Guest & Sellers, eds, Enterprise and Exploitation in a Victorian Colony, p. 19.

construction of these piers required substantial amounts of building stone, resulting in the opening up of quarries nearby on the Bluff. Within fifteen years these quarries were exhausted and the government had to look elsewhere for stone.[146] A new source of stone was found on the south bank of the Mgeni River, a few metres from the present Connaught Bridge. During 1868 this quarry alone supplied 28,823 tonnes for the northern breakwater in the harbour.[147] This heavy exploitation modified the existing landform.

This situation was exacerbated by the building material requirements of the white settlers who opened up sandstone and shale quarries at Congella and used them into the 1860s and beyond.[148] Besides the Congella quarries there were a number of other deposits on farms outside the borough. Good deposits were found on the Brickfield Farm which lay adjacent to the Mgeni River Estuary. These quarrying activities as well as those at the Mgeni Quarry totally destroyed the natural vegetation of the area and radically modified the landform adjacent to the Mgeni River Estuary.

Destruction of the natural vegetation along the Mgeni River also resulted from demands for fuel. Firewood was collected regularly by Durban citizens for domestic purposes. It was estimated by the Surveyor General in 1874 that an average family of 6 used $1^1/_2$ tonnes of firewood per month.[149] Clearly then the demand for fuel had a substantial impact on the vegetation surrounding the town, which would have been in the vicinity of the Mgeni River Estuary. This impact was exacerbated by the absence of restrictions on the gathering of firewood. Fuel was also needed for industries such as lime-burning and the manufacture of bricks, tiles, candles and soap. These activities, which were centred in the town, would therefore also have impacted on the vegetation in the vicinity of the Mgeni River Estuary.

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[146] Ellis, 'The impact of the white settlers on the natural environment of Natal', in Guest & Sellers, eds, Enterprise and Exploitation in a Victorian Colony, p. 80.

[147] Ellis, 'The impact of the white settlers on the natural environment of Natal', p. 88.

[148] Ibid.

[149] Ibid, p. 82.

The sugar industry had by this time been established some way up the coast. Along the Mgeni River in the Springfield Flats region a sugar mill had been constructed as early as 1848 to service the surrounding sugar plantations.[150] The establishment of the sugar industry and its incumbent activities in the vicinity of the Mgeni River Estuary exacerbated the demand for fuel. Not only did the sugar industry exploit timber resources but it also "simplified" the natural ecosystem. Large wetland areas adjacent to the Mgeni River were destroyed to make way for sugar plantations. In addition to "simplifying" the natural ecosystem the industry also posed a threat to the waters of the Mgeni River Estuary. There is evidence to suggest that in the mid 1870s large quantities of fish were killed in the nearby Umhlanga River as a result of effluent being released from a sugar mill into the river.[151] It is postulated that a similar scenario would also have occurred in the Mgeni River where substantial amounts of effluents were being released.

The Mgeni River Estuary's fish populations were not only threatened by industrial effluent but they were also exploited for food. Initially, in the 1840s and 1850s, white colonists did not establish commercial fisheries because there was no demand for fish. This, however, changed in the 1860s when a new market for fish was opened up for the white settlers with the importation of Indian labourers for the sugar industry.[152] In time this new sector of Natal's settler society would result in escalating pressures on the Mgeni River Estuary.

This was due to the fact that in 1865, when the first indentured labourers were free to return to India, many chose to remain and established themselves as productive market gardeners along the entire coastal belt of Natal. In Durban, numerous Indians, due to their impoverished economic and social circumstances, chose to settle on the Springfield Flats which was an unsafe environment as it was prone to flooding. This

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[150] L. Ramdhani, 'The Springfield Flats Flood Disaster of 1917', (Unpublished M. A. Thesis, University of Natal, Durban, 1989), p. 43.

[151] Ibid, p. 88.

[152] Ibid.

floodplain was rich in alluvial soil, however, and therefore favoured agricultural production. In addition there was a plentiful supply of water and firewood and a nearby market for the produce. Consequently, thousands of Indians leased one-acre plots, at £1 5s a year,[153] on which they intensively cultivated a variety of vegetable species including mealies, tobacco and beans.[154] The establishment of these market gardens had a number of environmental impacts. Firstly, large tracts of indigenous vegetation, which included reeds, sedges, grasses, trees and shrubs, were removed, making the Springfield Flats susceptible to soil erosion and therefore increasing the nett sedimentation in the Mgeni River Estuary. Secondly, the Springfield Flats, which was a wetland, ceased to function efficiently in terms of its ability to manage water. And finally, the destruction of the vegetation destroyed habitats for a number of birds and grazers.

It is clear that with the arrival of the hunter-traders and later, the Boers, exploitative utilisation of natural resources intensified. The overriding factors determining this acceleration were the white colonists' improved technological status and inherently different aims of production. While the white settlers modified and altered their environment it was not until the twentieth century that we saw a rapid acceleration of environmental alteration. By the turn of the twentieth century a more established and sophisticated capitalist/ industrial society had evolved resulting in a far wider range of human activities, all of which impacted in some way on the environment.

The transition from white settler society to a capitalist/ industrial society is evidenced by the development of Durban from an early harbour and trading post into the metropolitan city it is today. With this development the encroachment of human beings on the Mgeni River Estuary has become increasingly apparent. The urban growth of Durban has resulted from several factors. Perhaps one of the most important developments has been the development of modern transport, in particular the private ownership of cars. With this growth there has been enhanced location

[153] Ramdhani, 'The Springfield Flats Flood Disaster of 1917', p. 39.

[154] B. Freund, Insiders and Outsiders: Indian Working Class of Durban, 1911 - 90, (University Of Natal Press, Pietermaritzburg, 1995), p. 17.

opportunities for housing, business and industry. This has led to an increase in construction activity which, in turn, has increased the demand for construction materials. The Mgeni River provides a large source of building sand and consequently sandwinning operations have become a common occurrence at various points along the river.[155] These operations have removed the protective riverine vegetation and severely undercut the river bank.[156] This removal of vegetation has, in turn, increased the amount of fine material in the river and thus contributed to high levels of sediment within the Mgeni River Estuary.[157]

The rapid rate at which the Durban metropolitan and towns upstream have urbanised this last century has also necessitated the construction of a number of dams in the Mgeni River catchment. There are presently five large dams on the Mgeni River and its major tributary the Mzinduzi River, namely: Midmar (1963), Albert Falls (1973), Nagle (1950), Henley (1942) and Inanda Dams (1989). These upstream impoundments together with water extraction for industrial and agricultural usage have altered the hydrology of the Mgeni River Estuary. In addition to these effects damming has also reduced the amount of sand delivered at the coast where it represents an important source of material for beach and dune building processes. This, together with numerous sandwinning operations along the river, has caused sand shortage and ultimately the sand dunes adjacent to the Beachwood Mangrove Reserve have suffered from sand starvation.

The expansion of the Durban Metropolitan Area has also necessitated the construction of a number of bridges over the Mgeni River Estuary. These bridges include the Connaught Bridge (1906), Athlone Bridge (1927), Ellis-Brown Viaduct (1956), a railway bridge and a footbridge across the Beachwood Creek (1970s). The presence of these structures in the Mgeni River Estuary has decreased the tidal exchange between the estuary and the sea. This reduction in tidal exchange has, in

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[155] Mulder, Lower Umgeni River Study, p. 26.

[156] Ibid, p. 19.

[157] Ibid, p. 13.

turn, reduced the Mgeni River Estuary's ability to scour sediments that have settled out and consequently the depth and surface area of water have been decreased.

During the twentieth century the Mgeni River Estuary began to play an increasingly important role in waste disposal. The Mgeni River Estuary, like all estuaries, has a number of built-in features that are essential to maintaining the health and productivity of this estuarine ecosystem.[158] These built-in features also provide goods and services for the surrounding metropolitan area. One such service is the absorption of waste. This service has been utilised by the Durban metropolitan area as a cheap means of effluent and storm water disposal. The bulk of sewage in the Durban area is processed at the Northern Treatment Works at Sea Cow Lake. The processed sewage is then pumped into the Mgeni River Estuary where the estuary assimilates the sewage. The Mgeni River Estuary has been effective in breaking down waste and detoxifying pollution. In many instances, however, sewage and industrial effluents have entered the Mgeni River Estuary unprocessed which has compromised the efficient functioning of the estuary.

With the development of a more sophisticated capitalist/ industrial society significant conflict over resource use has resulted. According to Gadgil and Guha while more than one particular form of resource use can occur within a society the stronger form will always dominate. In South Africa there is an added twist, provided by the racially discriminatory policies implemented during the Apartheid era. These policies favoured the white minority by allowing them to control and monopolise South Africa's resources. This intra-modal conflict and racial discrimination is apparent on the Springfield Flats where Indian market gardeners became victims of the capitalisation of land values and the development of capitalism.[159] In the latter half of the twentieth century the Springfield Flats became very valuable land as it was desired by capitalists for industrial expansion. In order to allow for economic development to take place the Durban Municipality enforced urban design policies

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[158] INR, 'Estuary Services Workshop Documentation', (Unpublished Document, 13 September, 1999), p. 6.

[159] Freund, Insiders and Outsiders, p. 25.

directed from Pretoria which forcibly shifted townships inhabited by people of colour to the south-west and north-west of the city.[160] These racially discriminatory policies ultimately limited Indian market gardeners' access to fertile land on the Springfield Flats, forcing many to shift towards industrial employment.

The decision to develop the Springfield Flats into an industrial complex was motivated by its flat terrain and nearby transport facilities despite the fact that the area is a floodplain and thus prone to flooding. To avoid any possible flooding it was decided to canalise the entire Springfield Flats. The canalisation of the Springfield Flats involved straightening, widening and deepening the Mgeni River so that its ability to transmit flood waters would be improved. Once this activity was completed industrial development could go ahead. The industrialisation of the Springfield Flats resulted in many forms of environmental degradation. It eradicated all the vegetation in the area making the soil susceptible to soil erosion and consequently increased the sediment in the Mgeni River Estuary. The construction of industrial complexes close to the Mgeni River Estuary did not only spoil the aesthetics of the estuary but the incumbent activities also posed a threat to the water quality of the estuary.

While in many instances the aesthetics of the Mgeni River Estuary have been spoiled by industrial and urban development it is still utilised by many people for recreational purposes. The Mgeni River Estuary is used by canoeists on a daily basis for training and for several competitive events. Anglers also make extensive use of the Mgeni River Estuary for fishing and bait collecting while cultural and religious activities are carried out by a number of different communities. As the population has grown so too has the number of recreational activities within the Mgeni River Estuary. This, in turn, has placed increasing pressures on the Mgeni River Estuary.

In the 1970s unregulated public access to the Beachwood Mangroves threatened to destroy this unique plant community. Trees were chopped down, young shoots were trampled on and rubbish, varying from plastic bottles and beer cans to old baths and

[160] Ibid.

refrigerators, was dumped into the creek.[161] In addition a solid footbridge was built in the early 1970s providing fishermen with access to the beach where they tore up and down in beach buggies, destroying the dune vegetation and dune structure.[162] Not only did the footbridge provide public access to the beach but it also prevented tidal flow and impeded drainage. The combination of no sea water and lack of oxygen due to stagnation, killed most of the White mangrove *(Avicennia marina)* trees and mangrove fauna.[163] Reeds then took over the freshwater channel and other plants thrived in amongst the mangroves in the upper reaches of the Beachwood Creek, such as the Bulrush (*Typha capensis)* and Water hyacinth *(Eichorinia crassipes).*[164] In the light of these events, it was decided that it was necessary to declare the Beachwood Mangroves a reserve and limit public access. Currently under the supervision of KwaZulu-Natal Nature Conservation Service (KZNNCS), access to the Beachwood Mangrove Reserve is still restricted. Facilities are, however, available for the reserve to function as an education centre where school children can learn about the animal and plant life of a mangrove community.

In addition to limiting public access, a concerted effort was made, initially by the Wildlife Society and various professional biologists, to rehabilitate the Beachwood Mangroves.[165] Action was taken to allow full tidal access to the Beachwood Creek. This was achieved by removing the footbridge and reopening the channel entrance of Beachwood Creek. These endeavors were subsequently supported by the KZNNCS and have resulted in the successful rehabilitation of the Beachwood Mangroves.[166] It can be argued that this type of human intervention could, according to Simmons, be

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[161] Natal Mercury, 6 Dec, 1979.

[162] Natal Mercury, 3 Dec, 1976.

[163] P. Berjak, G. K. Campbell, B. I. Huckett & N. W. Pammenter, In the Mangroves of Southern Africa, (Wildlife Society, 1977), p. 64

[164] V. A. Wager, Dwindling Forests of the Natal Coast, (Wildlife Society, 1976), p. 28.

[165] Ibid, p. 66.

[166] Ibid.

classified as "Conservation". This type of human alteration is typical of industrial society where people have recently begun to question human attitudes towards the natural world. When the white colonists first arrived in Natal they believed that technological advance could cure all problems. Since the late 1960s there has been a swing away from this unbridled optimism and concern for the protection of unique ecosystems is fast becoming manifest in today's society.

Conclusion.

Human beings have from the outset altered their natural environment. Initially environmental alteration was minimal but as society's perceptions towards the environment changed and technology improved, so came accelerated environmental alteration. It is clear that with the emergence of a more sophisticated capitalist/ industrial society during this century the encroachment of man on the Mgeni River Estuary has become increasingly apparent. This increased environmental degradation has been facilitated by technological advance which has allowed society to harness new sources of energy and this, in turn, has resulted in more radical types of environmental alteration. The following chapter will explore in greater detail the numerous changes brought to the Mgeni River Estuary by the activities of a capitalist/ industrial society.

CHAPTER FOUR

THE TWENTIETH CENTURY

Introduction.

Throughout time the biophysical environments of estuaries have been subject to slow and evolutionary change. This phenomenon was discussed in Chapter Two where it was noted that natural forces such as climate, tides, waves and river outflow affect the estuarine ecosystem. The dynamic nature of this system has therefore made it particularly vulnerable to human activities which have, since their early beginnings, accelerated environmental change in estuarine ecosystems. With human diversification the ability to harness resources has developed, resulting in ever increasing impacts as in the case of the Mgeni River Estuary.

In recent years we have seen an increased human-induced environmental alteration in the Mgeni River Estuary. This chapter will, with the aid of aerial photographs, identify the environmental changes that have taken place in the Mgeni River Estuary during the twentieth century and explain how these changes have affected the functioning of this estuarine ecosystem.

Aerial Photography.

Six aerial photographs of the study area were examined. The photographs were obtained from the Surveyor General, in Mowbray, Cape Town, and were taken in the years 1937,[167] 1959,[168] 1967,[169] 1973,[170] 1989,[171] and 1996.[172] The photographs

[167] Aerial Photograph, Job 117B/37, Strip 53, 54256.

[168] Aerial Photograph, Job 433/59, Strip 14, 6412.

[169] Aerial Photograph, Job 573/67, Strip 13, 6043.

[170] Aerial Photograph, Job, 717/73, Strip 21, 2937.

[171] Aerial Photograph, Job 933/89, strip 12, 2282.

[172] Aerial Photograph, Job 985G/96, strip 32E, 1138.

were chosen according to their availability – the 1937 photograph is the oldest record of the Mgeni River Estuary, while that taken in 1996 is the most recent. Each photograph was compared against the others in chronological order in an attempt to discern changes that had taken place in the Mgeni River Estuary. This comparison illustrated the major changes to the Mgeni River Estuary and made it possible to identify the human activities that have caused these changes. Further, the identified changes have assisted in illustrating how the functioning of the Mgeni River Estuary has been altered.

An exercise of this nature can be very useful for observing change but the limitations of the method need to be noted.[173] Information given by an aerial photograph and the accuracy with which it is interpreted depend on a number of factors such as the angle of the photograph, weather, scale, development and printing. It would have been preferable to have produced maps from the aerial photographs, as maps eliminate distortion, giving a true positional representation of ground features. This, however, was not possible due to the nature of this study. Consequently when interpreting the aerial photographs an attempt was made to establish the following: the time of day, time of year and whether or not there had been any recent flooding events. Factors such as these will cause temporal variations in an estuary, for example, on an ebb tide the water levels in an estuary will fall, exposing intertidal habitat. This intertidal habitat will be covered on the flow tide when the water levels rise again. It is therefore important to identify temporal variations in order to make an accurate assessment of the human-induced change in the Mgeni River Estuary. This unfortunately was only possible to establish in two of the aerial photographs.

AERIAL PHOTOGRAPH OBSERVATIONS:

To assist with observation of the aerial photographs, all the key features have been marked on the respective photographs. Each photograph will be discussed in turn.

Aerial Photograph, 1937. (See Aerial Photograph 4.1, p. 61.)

This photograph was taken during autumn at low tide. Therefore the water level in the estuary is low.

[173] C. Sellick, personal communication, 6 February, 2000.

Mgeni River Mouth (A) – An artificial barrier or groyne has been constructed on the southern side of the estuary mouth. This was constructed in about 1927 to stabilise the river mouth in order to prevent its southward migration.[174] According to Goudie groyne construction will have a significant impact on aquatic environments and this is apparent in the Mgeni River Estuary. (See fig 4.1, below.) It was evident from a chart, dated 1858, that the groyne caused major change in the vicinity of the estuary mouth.[175] The chart shows the river diverted northward at the coast forming an extensive lagoon. This lagoon was separated from the ocean by a spit and a sandy beach. A narrow mouth was present mid-way along the spit. After construction of the groyne it appears that the river channel was diverted from its northward course so that the river flowed directly into the Indian Ocean. The tidal inlet channel is positioned in a north-west position along the spit and a large patch of suspended sediment is clearly seen flowing out of this tidal inlet channel into the Indian Ocean.

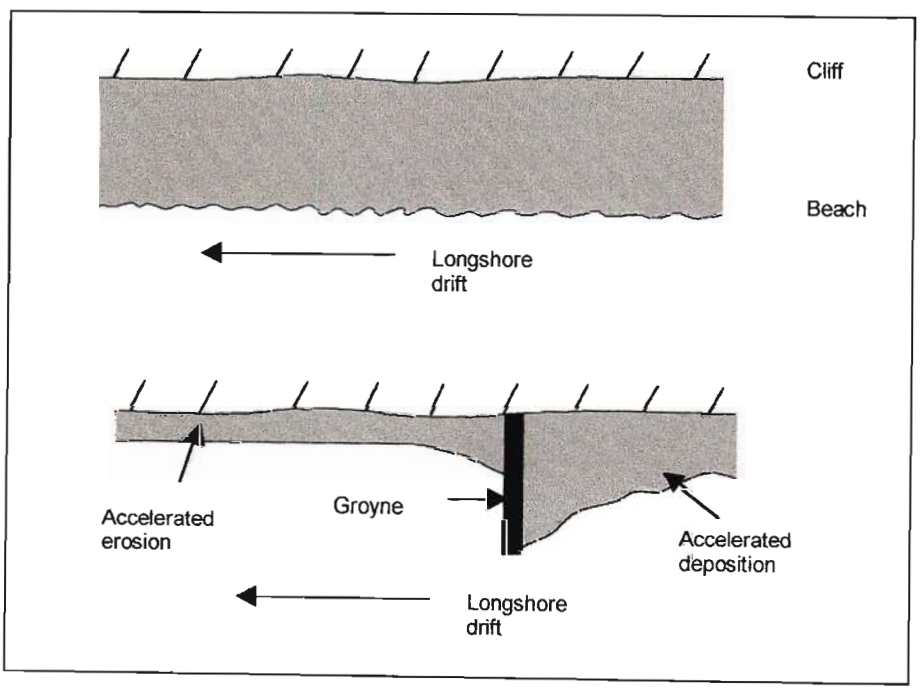


Fig 4.1: Diagrammatic illustration of the effects of groyne construction on sedimentation on a beach. (Goudie, 1981.)

[174] Cooper, 'Sedimentation in the Mgeni Estuary, Natal, South Africa', p. 175.

[175] PAR, Map which accompanied Captain Grantham's report on Port Natal, M3/629.

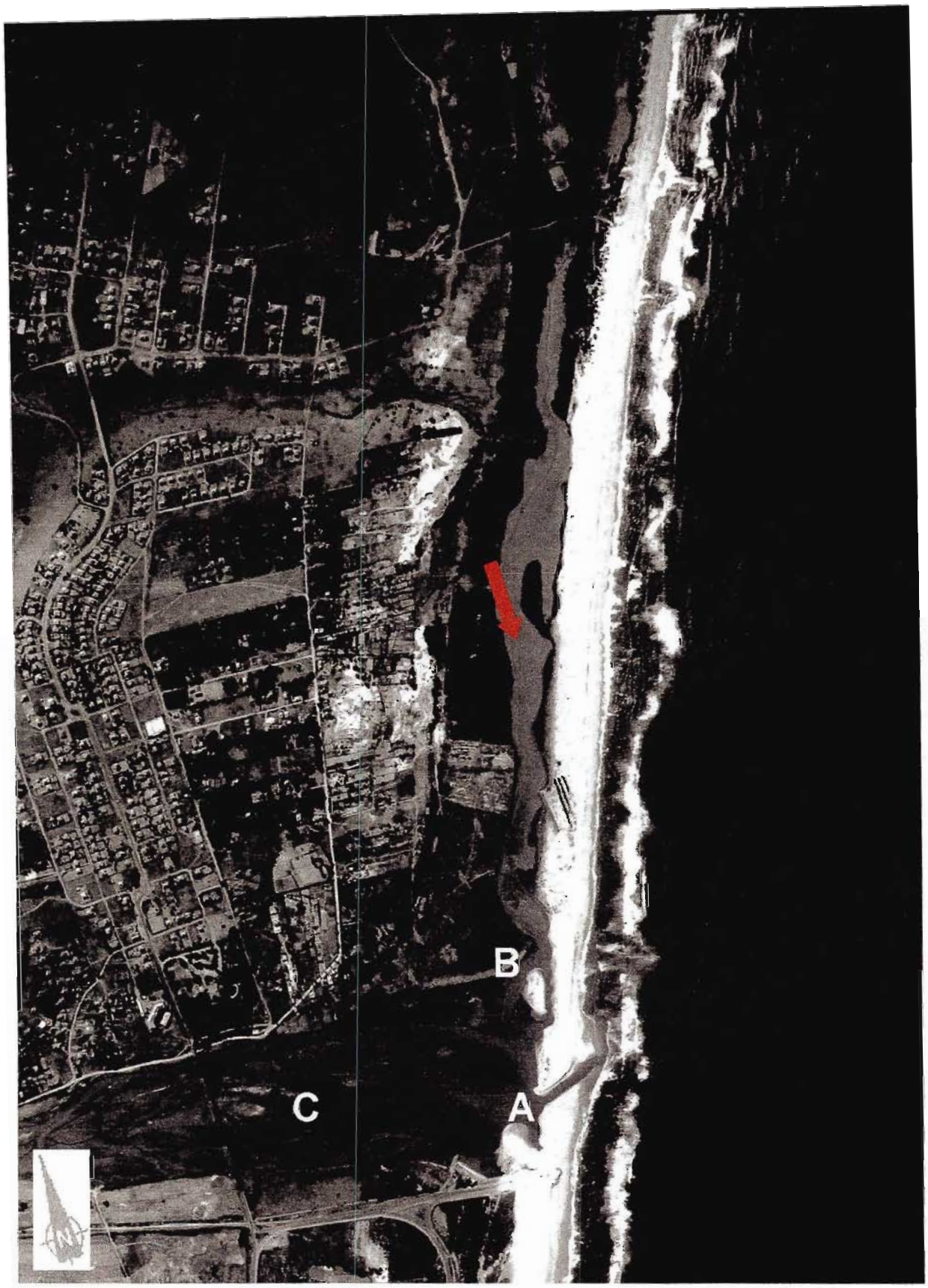
Beachwood Creek (B) – The diversion of the river channel has reduced the former lagoon, evident in the chart of 1858, to a small tidal channel known as Beachwood Creek. In the upper reaches of the creek there is a sparsely vegetated dune barrier. In the lower reaches of the creek a bridge has been constructed providing access to the beach where a shooting range has been established.

Mgeni River Estuary (C) – The vlei that is said to have existed from the estuary to Durban Bay has disappeared.[176] On both the north and south banks of the estuary the indigenous vegetation of the estuary has been disturbed. The vegetation along the south bank has been removed for the construction of the Windsor Golf Course while the vegetation on the north bank has only been partially removed for the construction of Riverside Road. In spite of these disturbances, patches of indigenous vegetation are still evident along both estuary banks.

In the lower reaches of the estuary a few mangroves are still evident. In the estuary itself, there is an obvious braided channel system with a number of sandbars.

Upstream of the Mgeni River Estuary (D) – Unfortunately this photograph does not capture the activities that were taking place further upstream but from historical records we are able to piece together some of these activities. The activities that were underway at this time that would have had a direct impact on the estuary included quarrying, commercial agriculture, and market gardens. These activities will be evident in the subsequent photographs.

[176] Map, PAR, M3/297.



Aerial Photograph 4.1: The Mgeni River Estuary in 1937 (A, B & C). Note the size of the channel in the Beachwood Mangroves.

Aerial Photograph, 1959. (See Aerial Photographs 4.2 & 4.3, pp. 64/65.)

Mgeni River Mouth (A) – The tidal inlet channel is still positioned north-west along the spit and appears not to have migrated southward from its position in 1937. The tidal inlet channel in this photograph is also unusually wide in comparison to 1937. This wide tidal inlet can be attributed to flooding that occurred in June of 1959.[177]

Beachwood Creek (B) – There is a vast reduction in the channel area of the Beachwood Creek. This reduction has occurred as a result of the groyne which diverted the river channel. This diversion contributed to the continued deposition of sediments on both the landward and seaward margin of the creek and the subsequent reduction of the Beachwood Creek.[178] In the mouth of the Creek a number of sandbars have formed which have reduced the size of the mouth. Mangroves have continued to spread throughout the creek.

Mgeni River Estuary (C) – Additional change is evident on the southern bank of the estuary where a model yacht pond has been constructed. Mangroves have continued to spread throughout the lower reaches of the estuary. Moving into the upper reaches of the estuary it is evident that the accretion of sediment on intertidal sandbars has led to their emergence above tidal water. Some of these sandbars have joined together to form a large midstream island that has bisected the estuary into a north and south channel. This newly established midstream island is sparsely vegetated with small trees and shrubs.

Upstream of the Mgeni River Estuary (D) – On the south bank just up from the present day Connaught Bridge there is evidence of extensive quarrying activities and on the opposite bank there is evidence of industrial activity. Moving further up the river, orchards and a number of cultivated fields are evident. On the north bank, further upstream where the Seekoeispruit joins the Mgeni River, it is evident that the

[177] Cooper, 'Sedimentation in the Mgeni Estuary, Natal, South Africa', p. 179.

[178] Ibid, p. 177.

wetland area through which the Seekoeispruit flows has disappeared and market gardens and commercial cane plantations have been established.

Aerial Photograph 4.2: The Mgeni River Estuary in 1959 (A, B & C). Note the reduction of the channel in the Beachwood Mangroves and the formation of the midstream island.

Aerial Photograph 4.3: Upstream of the Mgeni River Estuary in 1959 (D). Note the market gardens and quarrying activities on the south river bank.

Aerial Photograph, 1967. (See Aerial Photographs 4.4 & 4 5, pp. 67/68.)

Mgeni River Mouth (A) – The tidal inlet channel has migrated southward and no longer lies in a north-west position as it did in 1937 and 1959. The width of the tidal inlet channel is extremely narrow in comparison with the channel width in both 1937 and 1959.

Beachwood Creek (B) – There has been an even greater reduction in the channel width of Beachwood Creek. Meanders in the lower reaches of the creek have caused erosion of the landward margin of the spit and have resulted in the spit slumping into the channel.[179] Mangroves have continued to spread throughout the creek.

Mgeni River Estuary (C) – Accretion in the midstream island has resulted in visible growth of the island. The vegetation on the island, which comprises trees and shrubs, has spread substantially in comparison to 1959. Also evident in the region of the midstream island is the construction of the new Athlone Bridge.

Upstream of the Mgeni River Estuary (D) – The quarrying activities on the south bank have increased significantly in comparison with those observed in 1959. Industrial activity on the north bank has also increased. The orchards and cultivated fields identified further upstream have remained much the same with one evident change, that of low cost housing in place of some of the cultivated fields. On the north bank, a few kilometres up from where the Seekoeispruit flows into the Mgeni River, there is evidence that a sewage plant is under construction.

[179] Cooper, 'Sedimentation in the Mgeni Estuary, Natal, South Africa', p. 178.

Aerial Photograph 4.4: The Mgeni River Estuary in 1967 (A, B & C). Note the spread of vegetation on the midstream island as well as construction of the Athlone Bridge.

Aerial Photograph 4.5: Upstream of the Mgeni River Estuary in 1967 (D). Note the low cost housing on the south river bank.

Aerial Photograph, 1973. (See Aerial Photographs 4.6 & 4.7, pp. 70/71.)

Mgeni River Mouth (A) – There is no noticeable change to the estuary mouth. The tidal inlet channel is almost in the identical position and is much the same width as in 1967.

Beachwood Creek (B) – The Beachwood Creek, particularly the channel entrance, has again reduced in size. Washover fans on the seaward side of the creek are responsible for this reduction.[180] The opening to the creek is very difficult to distinguish.

Mgeni River Estuary (C) – In the mid-channel area accretion has caused the midstream island to become linked to a smaller island in the south channel. Where this has occurred mangroves have established themselves thereby further reducing the extent of the south channel. There is also an evident spread of mangroves on the north bank of the estuary. On the midstream island the vegetation has clearly spread.

Upstream of the Mgeni River Estuary (D) – Quarrying activities on the south bank are of a similar size to those identified in 1967. On the north bank industrial activity has grown. This growth has had an influence on the landuse further upstream. Where previously orchards and market gardens were observed it now appears that some of these have been replaced by industrial activities. The low cost housing settlement has increased extensively from 1969. Further upstream on the north bank it is evident that the sewage plant is complete. Market gardens still remain along the banks of the Seekoeispruit and lie in close proximity to the sewage plant. Not evident in this aerial photograph are a number of irrigation furrows which flow into the Seekoeispruit.[181]

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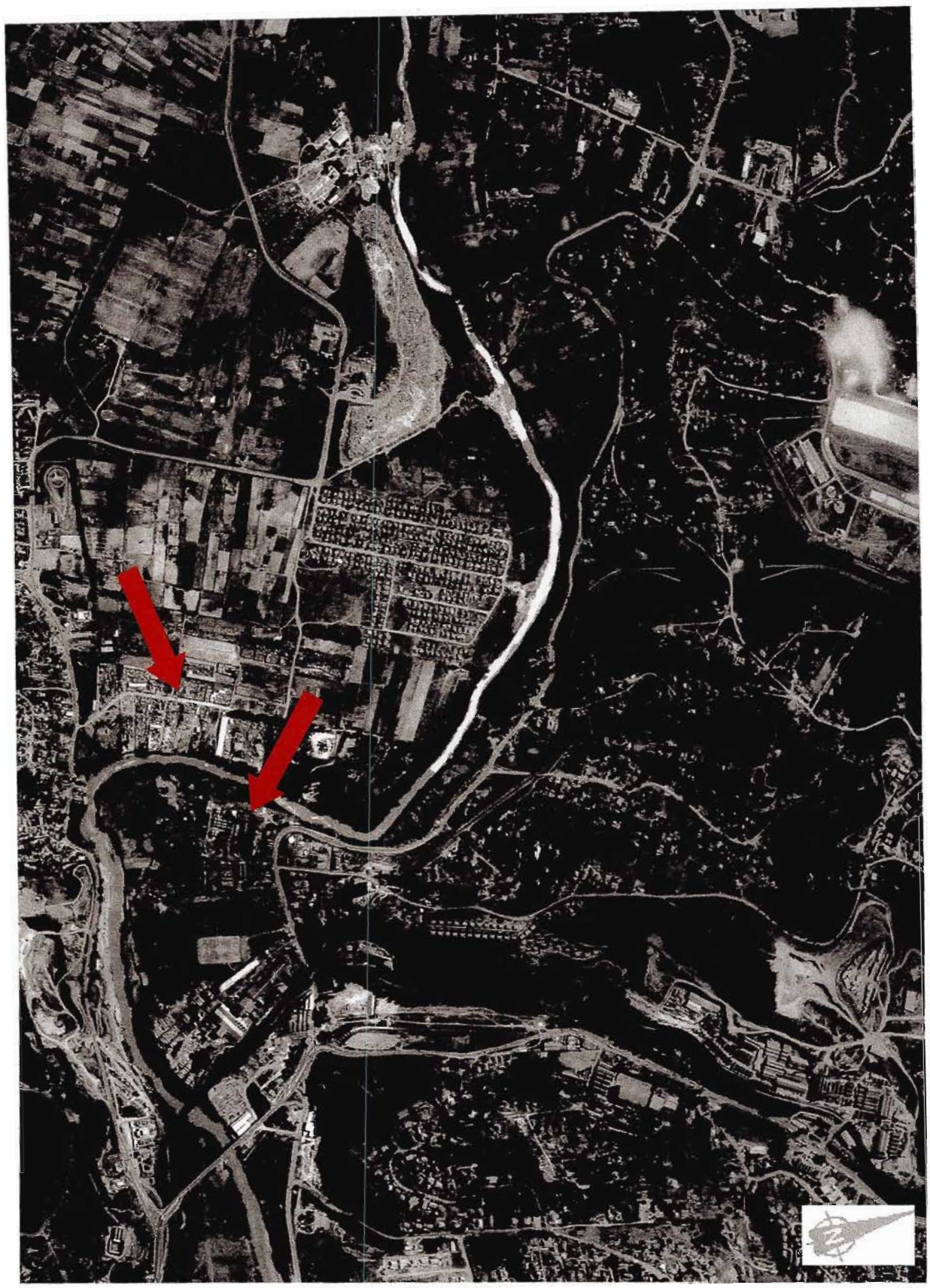
[180] Cooper, 'Sedimentation in the Mgeni Estuary, Natal, South Africa', p. 180.

[181] South Africa, 1:50 000 Sheet, 2930 DD & 2931 CC Durban, 1979.

Aerial Photograph 4.6: The Mgeni River Estuary in 1973 (A, B & C). Note the reduction in Beachwood Creek channel entrance and the growth of vegetation on the midstream island.



Aerial Photograph 4.7: Upstream of the Mgeni River Estuary in 1973 (D). Note the increased industrial activity.

Aerial Photograph, 1989. (See Aerial Photographs 4.8 & 4.9, pp. 74/ 75.)

Mgeni River Mouth (A) – The tidal inlet channel is in a similar position to 1973 and 1967. The width of the tidal inlet channel, however, appears to have been reduced in comparison to the earlier two aerial photographs. The most noticeable difference in this photograph, in comparison with those of the previous years, is that a second tidal inlet channel is trying to form. This tidal inlet channel is positioned in a north-west position along the spit.

Beachwood Creek (B) – There has again been a reduction in the Beachwood Creek. Although it is now very difficult to distinguish where the creek flows it is apparent that the opening of the creek is distinctly wider than it was in 1973. The growth of mangroves throughout the creek is clearly visible. The bridge that once provided access to the beach is no longer visible as it has been removed.

Mgeni River Estuary (C) – In the middle reaches of the estuary the large midstream island and surrounding islands have disappeared. There are, however, signs of a sandbar in the upper reaches of the estuary just below Connaught Bridge. The vegetation on both banks of the estuary has been reduced and the width of the estuary is much wider than in 1973. These marked changes have been attributed to the 1987 floods.[182]

Upstream of the Mgeni River Estuary (D) – The radical change evident upstream is the result of the combined efforts of human activities and natural forces. In the upper reaches of the estuary a new Connaught Bridge has been constructed. Less than a kilometre up-stream on the south bank of the river the former quarry has been replaced by a power station.

Immediately beyond the power station radical change has taken place in the river channel. The river channel has been moved southward and canalised. On the south

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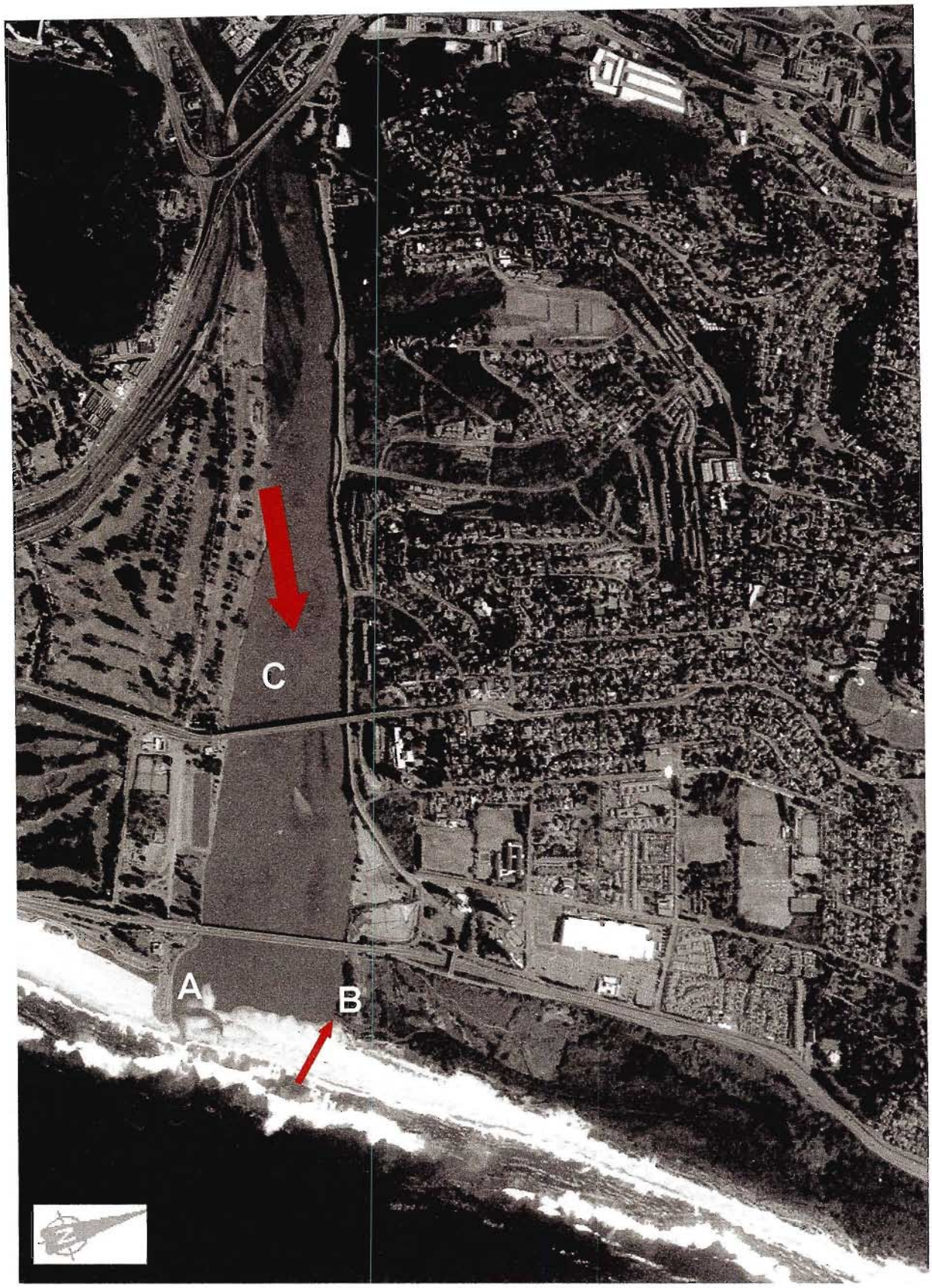
[182] Cooper, Wright & Mason, 'Geomorphology and Sedimentology', in B. R. Allanson & D. Baird, eds, Estuaries of South Africa, p. 16.

Bank, where there were orchards and cultivated fields, there is now a railway complex and on the north bank Springfield Park has been established. Bisecting this new industrial development is the Seekoeispruit. This river, which has been widened, is still a source of irrigation for commercial sugar cane and still flows past the sewage plant. The river, however, no longer has market gardens along its banks, Springfield Park having been established in place of the market gardens.

Moving further upstream the newly constructed north coast highway is evident. In addition it is apparent that the width of the river has been widened and there is increased sedimentation. The substantial widening in the river channel has been attributed to the 1987 floods.[183]

[183] Ibid.



Aerial Photograph 4.8: The Mgeni River Estuary in 1989 (A, B & C). Note the removal of the midstream island and widening of the channel entrance of the Beachwood Creek.

Aerial Photograph 4.9: Upstream of the Mgeni River estuary in 1989 (D). Note the canalisation of the Springfield Flats for industrialisation.

Aerial Photograph, 1996. (See Aerial Photographs 4.10 & 4.11, pp. 77/78.)
This photograph was taken during autumn. Therefore the frequency of rainfall had been declining, resulting in a reduction of the freshwater flow in the estuary.

Mgeni River Mouth (A) – The tidal inlet channel is located in a similar position to that of 1967, 1973, and 1989. The tidal inlet channel is, however, a lot wider than it was in 1967, 1973 and 1989.

Beachwood Creek (B) – It is even more difficult to distinguish where the creek flowed. The opening of the creek is about the same width in comparison to that of 1989. There are, however, a lot more visible intertidal sandbars at the opening than there were in 1989. The mangroves have again spread throughout the creek and on the seaward side of the Beachwood Creek the dune vegetation has developed.

Mgeni River Estuary (C) – In the lower and middle reaches of the estuary, accretion of sediment on sandbars has led to their emergence above tidal water. The large island closest to the north bank of the estuary is very sparsely vegetated with small trees and shrubs. In the upper reaches of the estuary, just below Connaught Bridge, there has also been accretion of sediment on the south sandbar. This too has led to emergence of the sandbars above tidal water and has thus allowed for the spread of vegetation.

Upstream of the Mgeni River Estuary (D) – The activities upstream appear to be much the same as those identified in 1989, the exception being that the scale of the activities has increased. In 1989 it was observed that the width of the river channel had increased extensively from 1973. The width of the river channel has now decreased and is slightly wider than in 1973.

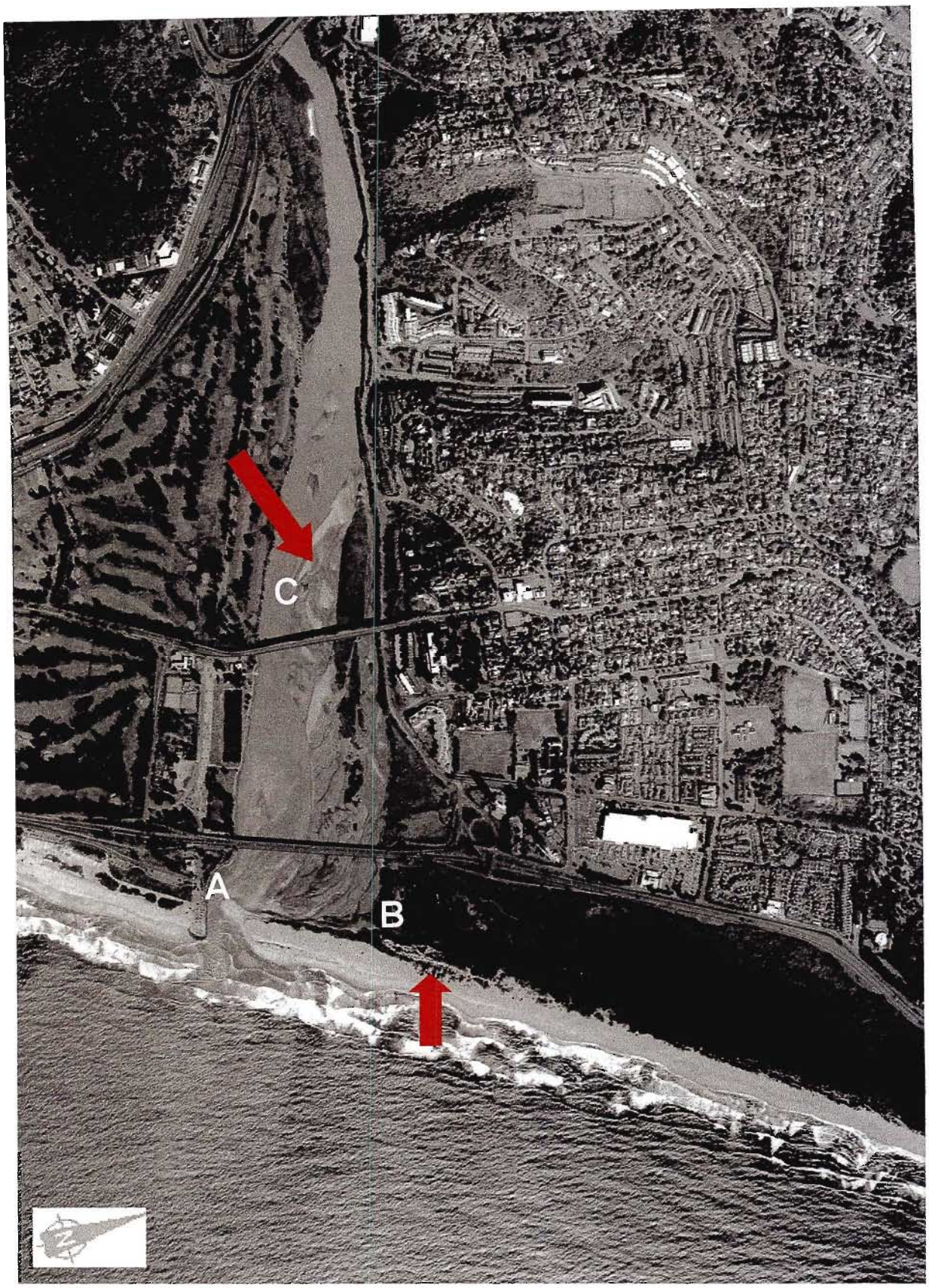


Plate 4.10: The Mgeni River Estuary in 1996 (A, B & C). Note the reemergence of midstream islands and the spread of dune vegetation adjacent to the Beachwood Creek.

Plate 4.11: Upstream from the Mgeni River Estuary in 1996 (D). Note the industrialisation that has taken place, particularly on the Springfield Flats.

Discussion.

The aerial photographs illustrated that the Mgeni River Estuary had increasingly been subjected to environmental alteration. It will be shown that these changes were increasingly due to the consequences of human activities. Furthermore, it will be explained how these changes affected the Mgeni River Estuary's fauna and flora.

It is clear from the photographs that the position and width of the Mgeni River Mouth has changed over the years. These constant changes can be attributed to a combination of both natural and anthropogenic forces. The Mgeni River Mouth, in its natural form, would have regularly changed because of the continual interaction between tides, waves and river flow. Consequently in 1927 when the southward migrating river mouth threatened to erode valuable corporation land a groyne was constructed to stabilise it. (See Plate 4.1, below.) The aerial photographs show that the construction of this groyne diverted the river channel from its northward course so that the river flowed directly into the Indian Ocean.

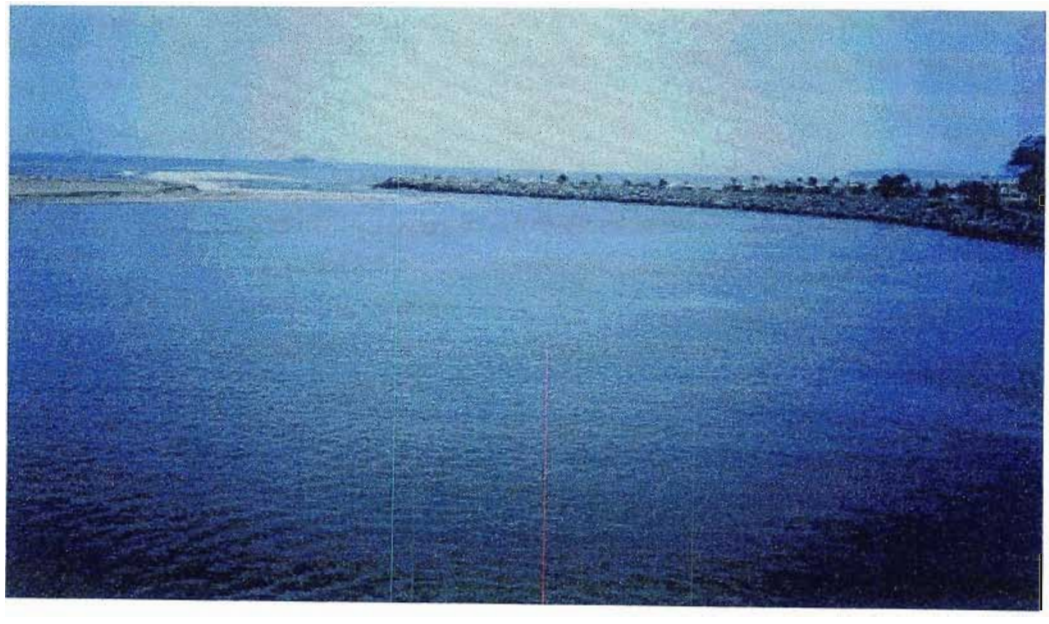


Plate 4.1: Tidal inlet showing the groyne. (November, 1999.)

This change does not appear to have affected the tidal inlet channel. In all the photographs the tidal inlet channels appeared to be open, allowing the freshwater

and saltwater to mix. This estuarine characteristic, as discussed in Chapter Two, determines what fauna and flora inhabit the Mgeni River Estuary. For example, if the Mgeni River Mouth were to close for an extended period the estuary would become hypersaline and therefore those species sensitive to salinity such as Blackedged blaasop (*Arothron immaculatus),* Belly pipefish *(Syngnathus djarong)* and Bluetail mullet *(Valamugil buchanani),* would become distressed or die. Furthermore, juvenile fishes using the Mgeni River Estuary as a nursery would not be able to enter or return to the sea.

While the construction of the groyne has had a minimal impact on the Mgeni River Mouth the same cannot be said of its impact on the Beachwood Creek. The aerial photograph of 1937 shows that after the construction of the groyne the Beachwood Creek was drastically reduced in size. According to Cooper this reduction can be attributed to the diversion of the river channel from its former northward course which effectively reduced current velocities and also the scouring effect of river flow in the former lagoon (Beachwood Creek).[184] Resulting from the increased sedimentation was a visible spread of mangroves from the upper reaches of the creek down to the lower reaches. In Chapter Two it was noted that the mangrove swamps act as sediment traps. Therefore it can be deduced that the reduction in Beachwood Creek was also connected with the spreading mangrove community.

The spread of the mangrove community would have been of great benefit to the many organisms inhabiting the Mgeni River Estuary. Mangroves add large quantities of dead leaf material to an estuary which, when decomposed, provide nutrients to other organisms in the food chain. The increasing number of mangrove species would therefore have increased the specie diversity of the Beachwood Creek resulting in what Simmons classifies as "diversification".

Further human interference in the Beachwood Creek was, however, to have a detrimental effect on the mangroves. The aerial photograph of 1973 shows that there was a severe reduction in the channel entrance. This reduction can be attributed to

[184] Cooper, 'Sedimentation in the Mgeni Estuary, Natal, South Africa', p. 185.

two factors. Firstly, human activities on the seaward side of the Beachwood Creek destroyed the dune vegetation. This destruction resulted in large quantities of sediment from the unprotected dunes being blown or washed over into the Beachwood Creek. Secondly, the construction of a solid footbridge in the Beachwood Creek reduced current velocities and therefore the scouring effect of the river flow in the Beachwood Creek. As a result of the reduction in the Beachwood Creek channel entrance, tidal exchange was prevented and in the absence of sufficient saltwater in the Beachwood Creek most of the White mangrove *(Avicennia marina)* trees and mangrove fauna died.[185]

In the mid 1970s a concerted effort was made by the Wildlife Society and various professional biologists to rehabilitate the dying mangrove community before it was "obliterated". In 1975 sandbaffles and artificial dunes were constructed along the spit to try and prevent further deposition of sand into the Beachwood Creek.[186] In addition the footbridge was removed and the channel entrance was excavated.[187] These efforts were evident in the aerial photographs of 1989 and 1996. The aerial photograph of 1989 shows that the footbridge had been removed and that the channel was wider, while in the aerial photograph of 1996 the dune vegetation had developed. These endeavours resulted in the most successful rehabilitation of the Beachwood Mangroves.[188]

Throughout the years 1937 to 1973, the aerial photographs reveal a reduction in the estuarine channel area. In 1937 it can be noted that there were no midstream islands. This gradually changed with the accelerated accretion of sediment on sandbars. Accretion was accelerated by a number of human activities. In 1956 the Ellis Brown Viaduct was constructed and this caused deposition on the

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[185] P. Berjak, G. K. Campbell, B. I. Huckett & N. W. Pammenter, In the Mangroves of Southern Africa, (Wildlife Society, 1977), p. 64.

[186] Cooper, 'Sedimentation in the Mgeni Estuary, Natal, South Africa', p. 180.

[187] Berjak, In the Mangroves of Southern Africa, pp.64/66.

[188] Ibid, p. 66.

north bank of the Mgeni River Estuary which subsequently became colonised by mangroves. This deposition, according to Cooper, was probably due to a reduction in current velocities near the bank.[189] A similar situation occurred in the south channel during the construction of the second Athlone Bridge in the 1960s. (See Plate 4.2, below.)

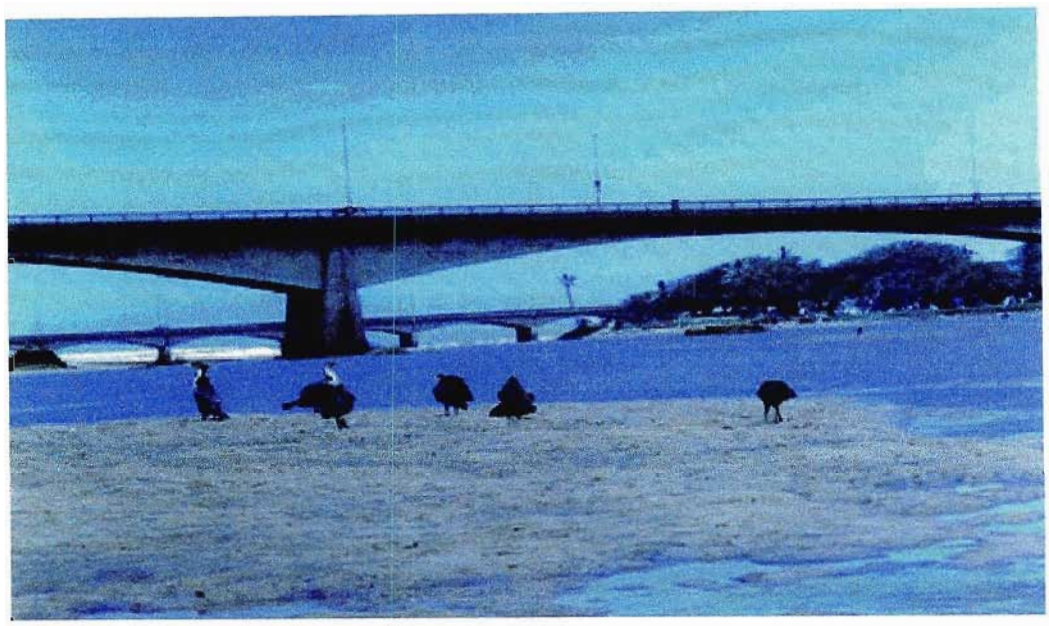


Plate 4.2: View of the Athlone Bridge (foreground) and Ellis Brown Viaduct. (Cohen, December, 1999.)

Bridge construction is not solely responsible for the sedimentation that has taken place. There are a number of other human activities that have contributed to this change. We see evident in the earliest photograph the destruction of a wetland and riverine vegetation. According to Simmons' theory this human induced change would be classified as "simplification". Gone was the once complex biological community of animals and plants, in place of which a monoculture of grass had been established. The drainage of the vlei and the removal of riverine vegetation would have destroyed an important source of detritus for detritivores as well as habitat for bird, invertebrate and fish species. In addition, this environmental alteration would have accelerated soil erosion and thus facilitated the increased sedimentation evident in the Mgeni

[189] Ibid, p. 184.

River Estuary during the years 1959, 1967 and 1973. (See plates 4.3, 4.4, & 4.5, below for examples of "simplification".)

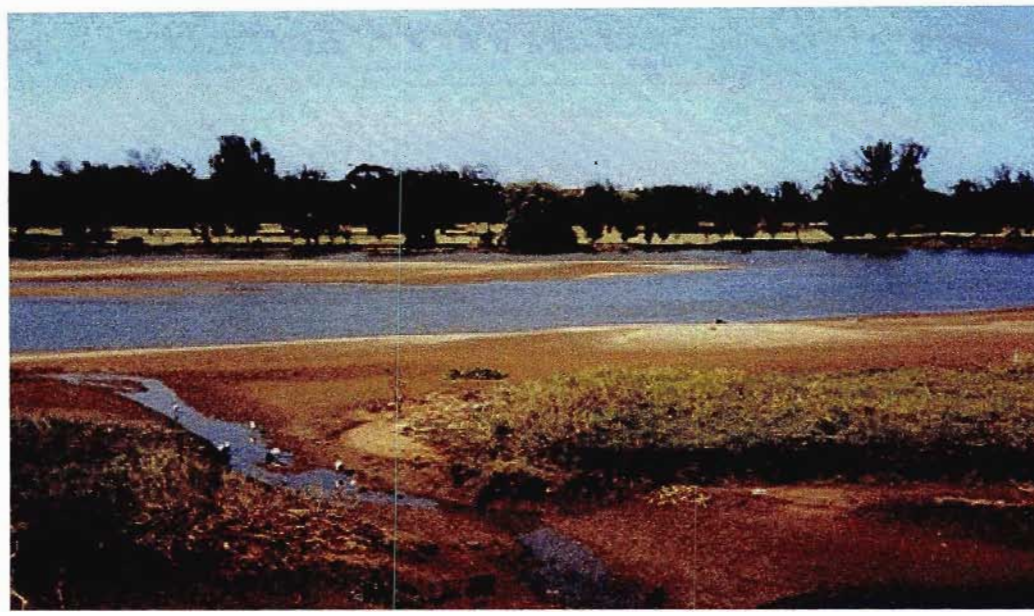


Plate 4.3: Windsor Golf Course showing the "simplification" of the riverine vegetation. (October, 1999.)

Plate 4.4: Riverside Road showing the "simplification" and partial "obliteration" of the riverine vegetation. (November, 1999.)

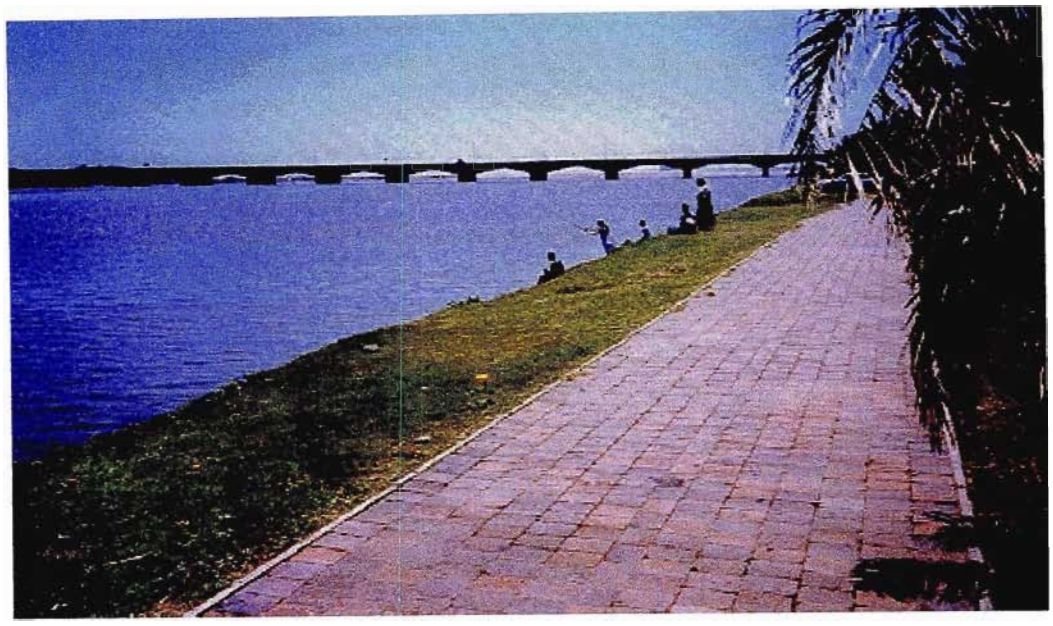


Plate 4.5: In front of the model yacht pond showing the "simplification" of the riverine vegetation. (November, 1999.)

In the aerial photograph of 1959 a number of activities leading to environmental alteration were apparent. Quarrying activities on the south bank just up from Connaught Bridge destroyed the riverine vegetation and exposed the soil to the natural forces. (See Plate 4.6, p. 85.) This human activity caused radical change to the landform which, in turn, made it susceptible to soil erosion, resulting in increased sedimentation in the Mgeni River Estuary. Also evident in the aerial photograph of 1959 was the presence of market gardens, orchards and commercial agriculture. The establishment of these activities would have required the removal of indigenous vegetation and the drainage of wetlands, resulting in "simplification" and an agroecosystem. Worster sees an agroecosystem as capitalist-based agriculture and this, according to Worster, plays a pivotal role in the degree to which ecosystems are simplified. This helps explain the dynamics behind the degree of "simplification" apparent in the aerial photographs.

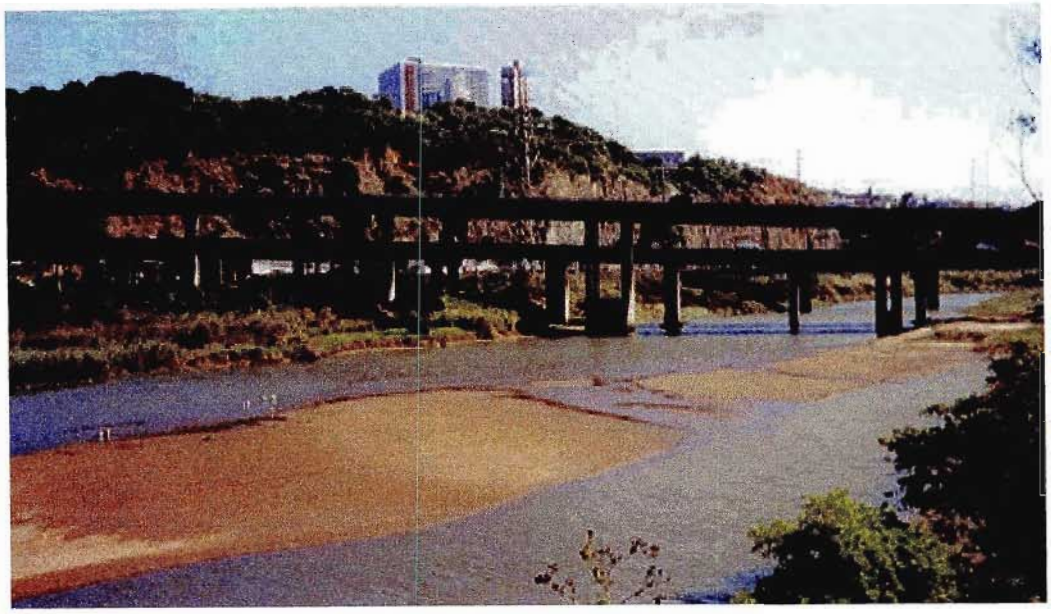


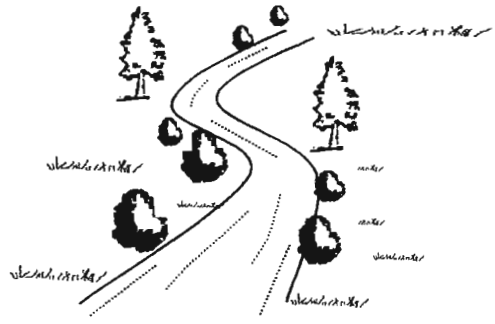
Plate 4.6: Remains of the Mgeni Quarry showing radical alteration to the landform. (October, 1999.)

Another human activity that has facilitated increased sedimentation is canalisation. This was evident in the aerial photograph of 1989. In 1980 the Springfield Flats area was canalised.[190] This project relocated the river to the middle of the Springfield Flats with Springfield Park on the northern bank and a railway yard on the south bank. The construction of the canals, according to Goudie, has many adverse affects on the environment. In the Mgeni River, for example, canalisation led to large quantities of riverine vegetation being "obliterated", making the soil susceptible to erosion and thus facilitating the increased sedimentation. This environmental alteration also had implications for the fauna which were affected by the reduction of shelter in the channel bed and the reduced nutrient inputs due to the destruction of overhanging vegetation.[191] (See Fig 4.2, p. 86.)

[190] Mulder, Lower Umgeni River Study, p. 25.

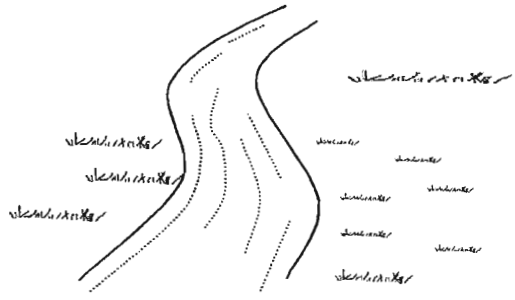
[191] Goudie, The Human Impact on the Natural Environment, p. 154.

Natural Channel

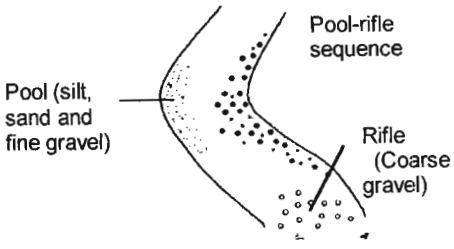


Suitable water temperatures:
adequate shading; good cover for fish life; minimal variation in temperatures; abundant leaf material input

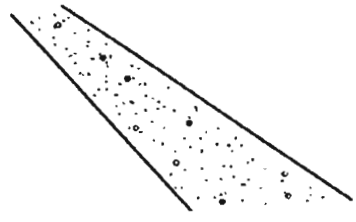
Artificial Channel



Increased water temperatures:
no shading; no cover for fish life; rapid daily and seasonal fluctuations in temperatures; reduced leaf material input

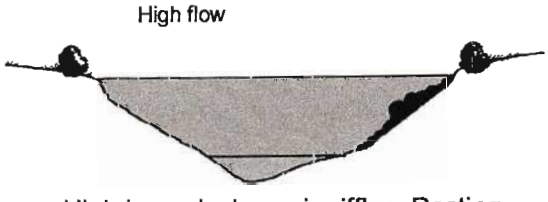


Sorted gravels provide diversified habitats for many stream organisms

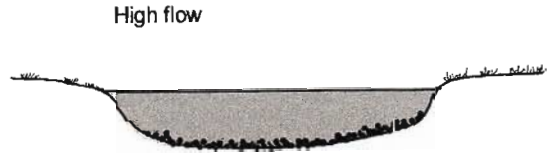


Unsorted gravels:
reduction in habitats; few organisms

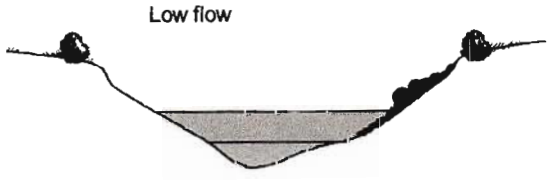
POOL ENVIRONMENT



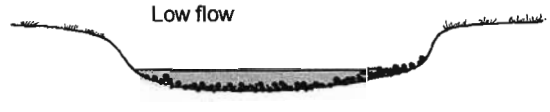
High in pools, lower in riffles. Resting areas abundant beneath undercut banks or behind large rocks, etc.



May have stream velocity higher than some aquatic life can withstand. Few or no resting places



Sufficient water depth to support fish and other aquatic life during the dry season



Insufficient depth of flow during the dry seasons to support diversity of fish and aquatic life. Few if any pools (all riffle)

Fig 4.2: Comparison of the natural channel morphology and hydrology with that of a channelised stream, suggesting possible ecological consequences. (Goudie after Keller, 1976.)

The scouring action of periodic floods would have removed large quantities of sediment that had accreted in the estuarine channel area but, due to dam construction, flood events have become smaller and less frequent which in turn has facilitated sedimentation of the Mgeni River Estuary. The numerous dams which have been constructed on the Mgeni River include: Henley Dam in 1942; Nagle Dam in 1950; Midmar Dam in 1963, Albert Falls Dam in 1975 and Inanda Dam in 1989. These dams have all contributed to the increased sedimentation evident in photographs of the years 1959, 1967, and 1973. In 1987 raging flood waters removed large quantities of sediment that had built up in the Mgeni River Estuary over the years. The effects of this flood are apparent in the aerial photograph of 1989. It can be seen that the midstream island was removed and that the estuarine channel area was of a similar size to that of 1937. Despite major flooding events in the 1980s, the sediment appeared to have been replaced relatively quickly. This was evident in the 1996 aerial photograph which showed the emergence of vegetated islands near the north bank of the Mgeni River Estuary and on the south bank just below Connaught Bridge.

The accretion of sediments in the estuarine channel area has had some positive implications for the fauna and flora inhabiting the Mgeni River Estuary. In Chapter Two it was noted that halphytic grasses, sedges, reeds, swamp trees and mangroves occur in low lying areas. This is evident in the aerial photographs from the years 1959, 1967, 1973 and 1996 where vegetation on the midstream islands was identified. The vegetated islands noted in these years would have attracted a large amount of birdlife.

It would appear that the above human activities have in some instances been environmentally beneficial to the Mgeni River Estuary. However, more often than not, these activities have had adverse environmental effects. The increased deposition of sediment has reduced the water volume in the Mgeni River Estuary which, in turn, will have reduced the Mgeni River Estuary's storage capacity, resulting in a loss of aquatic habitat. Furthermore, it will be recalled in Chapter Two that certain

invertebrate species inhabit estuarine sediment. Therefore the nature of the benthic communities will have changed from those that favour a sandy substratum to those more at home in mud. The construction of dams on the Mgeni River has reduced the frequency and size of flooding events and this has in turn limited the periodic scouring of sediment. Damming and the abstraction of water for agricultural purposes has also reduced the river flow and this reduction has at times resulted in the Mgeni River Estuary becoming isolated from the sea by the formation of a sand bar at the mouth. While this is not apparent in any of the aerial photographs, historical records indicate that the Mgeni River Mouth has at times been closed.

It is evident from the aerial photographs that there has been an increasing number of changes to the Mgeni River Estuary which resulted from a combination of both anthropogenic and natural forces. Unfortunately, it was not possible to identify all the environmental impacts from the aerial photographs, some of which are of great detriment to the waters of the Mgeni River Estuary. These impacts will now be discussed.

In the aerial photographs of 1959,1967 and 1973 there was evidence of extensive agricultural production. This activity, according to Goudie, is one of if not the most important sources of water pollution and leads to the deterioration of water quality. This deterioration of water quality in the Mgeni River can, in part, be attributed to the fertilisers and pesticides that have leached into the river from the cultivated fields which first appeared in the early nineteenth century with the establishment of the sugar industry. Over the next century the sugar industry was to develop substantially, resulting in increasingly adverse environmental impacts on the Mgeni River Estuary. Although cultivated fields no longer appear in the study area today, the extensive cultivation of land continues to have a very real impact on the waters of the Mgeni River Estuary. Fertilisers that leach into the Mgeni River have increased the nutrient content of the river resulting in the growth of pest species such as Water hyacinth

(Eichornia crassipes). (See Plate 4.7, p. 89.) The excessive growth of this species commonly leads to water deoxygenation, which can result in the death of fish.[192]

Plate 4.7: An example of Water hyacinth (Eichornia crassipes) (November, 1999.)

Pesticides, which are highly persistent and toxic, have also targeted the Mgeni River Estuary's fauna and flora. This pollution has, in turn, affected human beings who utilise the Mgeni River Estuary's resources; for example, in 1979 people were warned not to eat the fish as thousands had died from a suspected insecticide.[193] (See Fig 4.3, p. 90.)

[192] J. B. Adams, G. C. Bate & M. O'Callaghan 'Primary producers', in B. R. Allanson & D. Baird, eds, Estuaries of South Africa, p. 107.

[193] Begg, The Estuaries of Natal, Part 2, p.112.

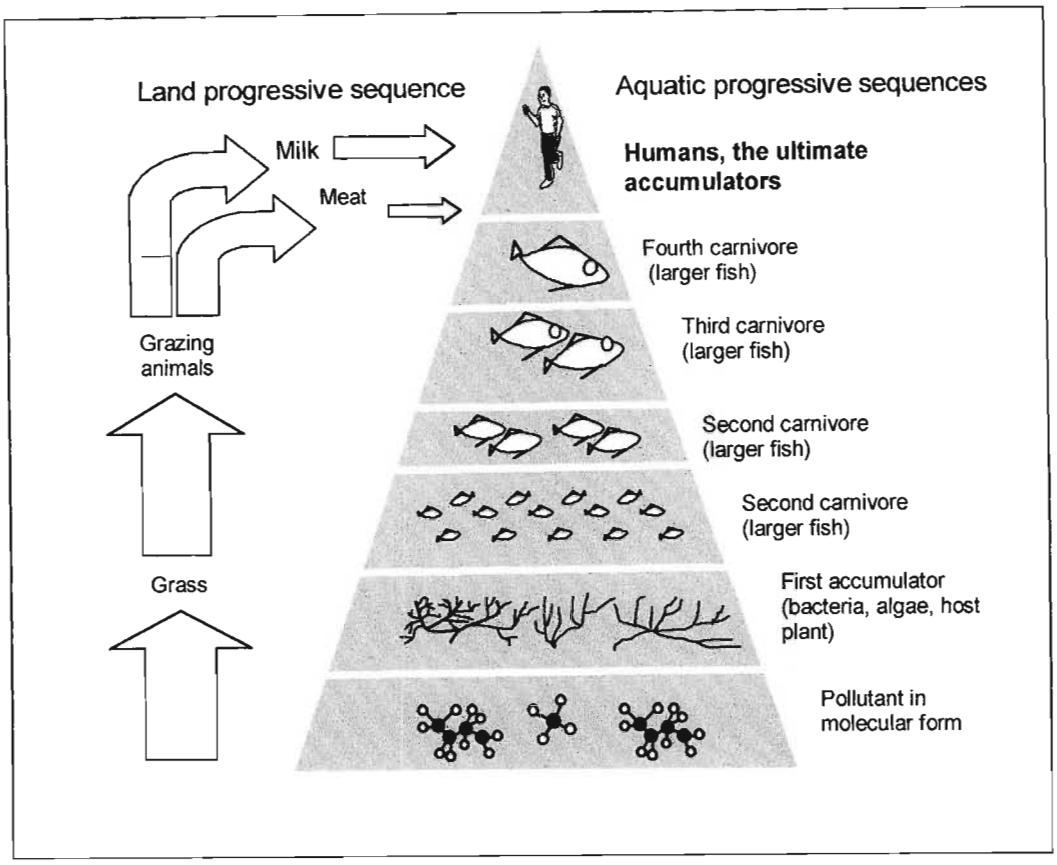
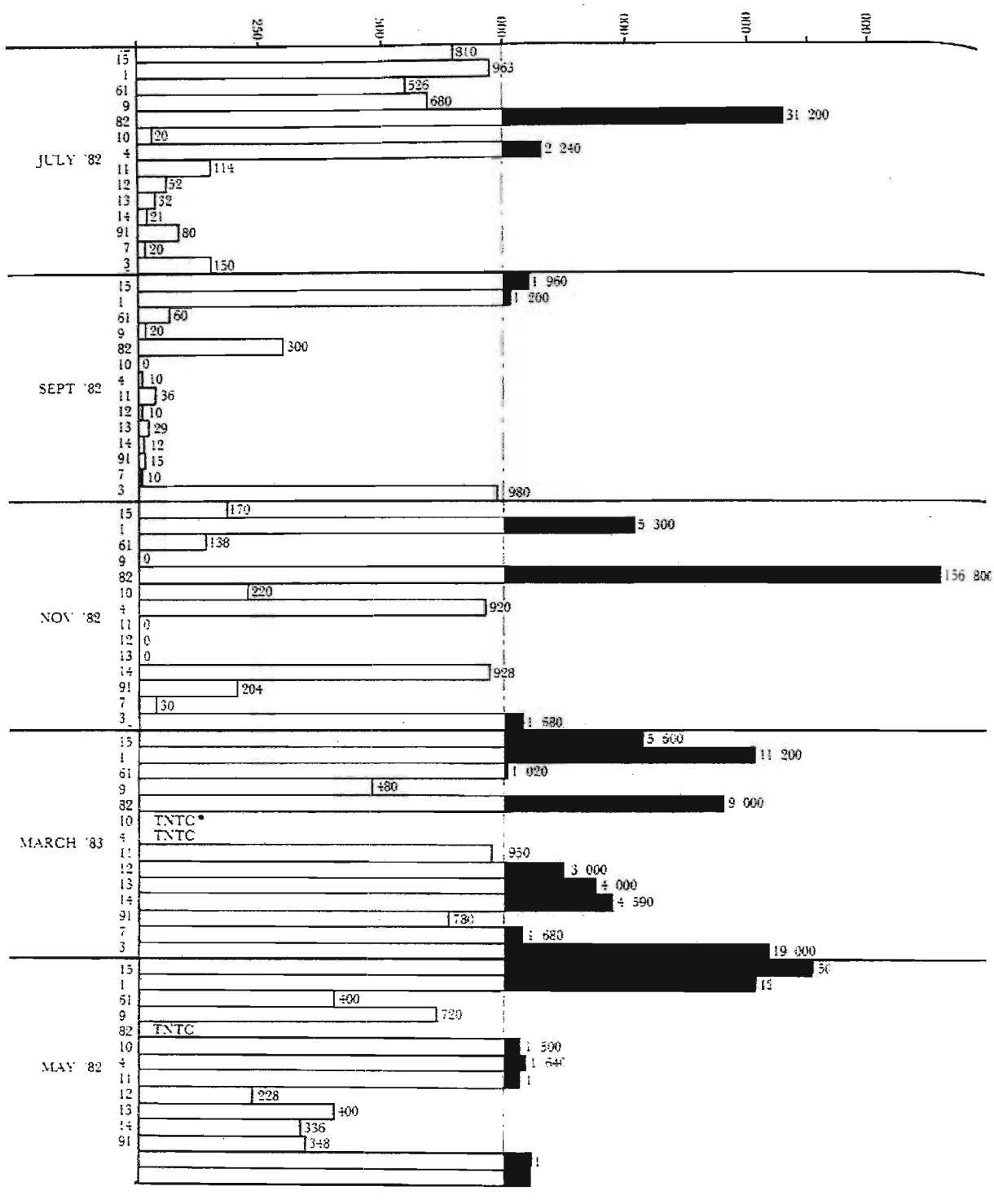


Fig 4.3: Effects of chemical sprays on the biological food chain. (Goudie, 1981.)

Water deterioration in the Mgeni River also occurs due to the sewage effluents released into the Mgeni River. Sources of this effluent are from the Pietermaritzburg outfall into the Mzinduzi, Abattoir outfall from Cato Ridge, Kwadebeka outfall from Clermont, New Germany plant, KwaMashu plant and the Durban Northern works (which was evident in the aerial photographs of 1967, 1973, 1989 and 1996).[194] In addition to sewage effluent, raw sewage is also leached into the Mgeni River from informal settlements along the river banks. (See Plate 4.8, p. 92.) According to Durban Corporation records, there are areas in the river where the presence of *E.coli* has greatly exceeded the recommended limits of 1000 organisms per 100 ml for recreational purposes.[195] (See Graph 4.1, p. 91.)

[194] Mulder, Lower Umgeni River Study, p.18.

[195] Ibid.



*Graph 4.1: Depicting **E.coli** readings taken from various tributaries flowing into the Lower Mgeni River. The black bars indicate readings in excess of 1000/100m.l. (City Engineers, Mulder, 1984.)*

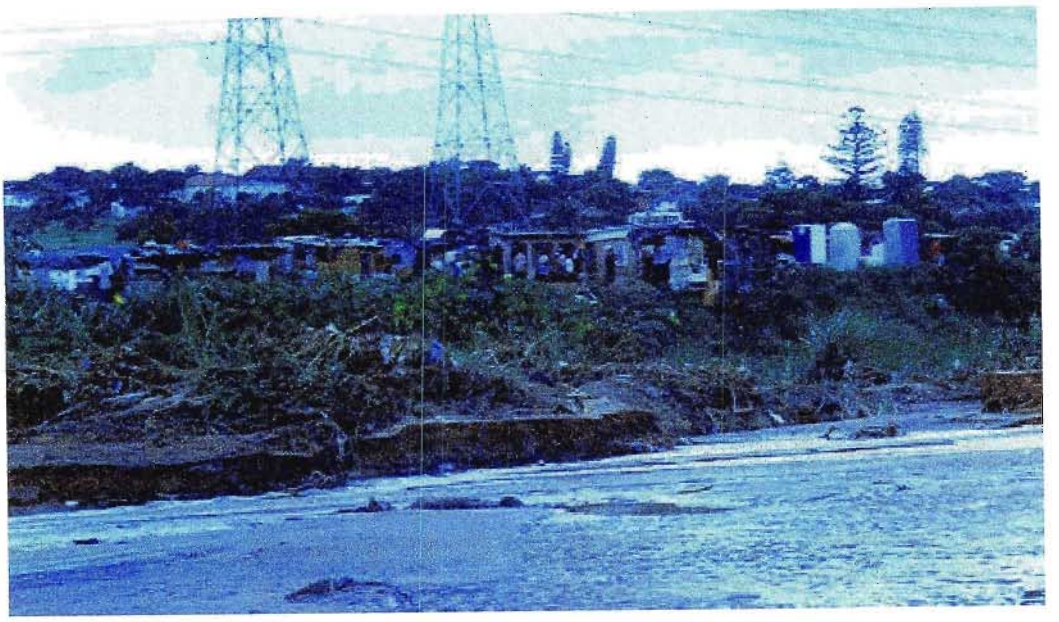


Plate 4.8: Informal settlement, upstream from the Northern Freeway. (Cohen, December, 1999.)

Another form of water contamination in the Mgeni River Estuary is thermal pollution. This has occurred as a result of the power station pumping large quantities of coolant water into the river. The increase in water temperature causes a decrease in the solubility of oxygen and thereby depletes the oxygen content in the water.[196] The outflow of coolant water also increases the water temperature and so affects those estuarine fauna and flora that are sensitive to temperature change.

A further source of water pollution stems from industrial effluents discharged into the Mgeni River. In 1960 the Centre for Scientific and Industrial Research (CSIR) carried out a pollution study in the lower Mgeni River and identified industry as one of the major polluters of the Mgeni River Estuary. In particular, it identified a distillery factory, a board mill factory, a steam laundry and a dry cleaning operation as having the greatest impact on the fauna and flora inhabiting the Mgeni River Estuary. The report found at one of the sampling stations that a deterioration in water quality had resulted in a considerable change in the fauna composition. Species known to be sensitive to pollution, such as nematodes, showed a decline in numbers while species such as copepods, which were

[196] Goudie, The Human Impacts on the Natural Environment, p. 188

more tolerant of pollution, increased.[197] Since this report was undertaken there has been a substantial amount of industrial development adjacent to the river. This is particularly evident in the aerial photograph from 1989 where the industrialisation of the Springfield Flats can be seen. The effect of this growth would have accelerated the degree of pollution in the Mgeni River Estuary. (See Plate 4.9, below.)

Plate 4.9: Industry along the Mgeni River. Note the close proximity to the river (Cohen, December, 1999.)

The presence of industrial, cropland and sewage effluents in the Mgeni River Estuary may not necessarily be detrimental as the estuary has an ecological capacity to absorb and assimilate waste. Damage has, however, occurred because the rate of waste inflow has been greater than the ecological capacity of the Mgeni River Estuary to absorb it. Pollution in the Mgeni River Estuary has led to deterioration in water quality, unpleasant odours and aesthetic offences. These changes have, in turn, affected the abundance and composition of fauna and flora species in the Mgeni

[197] H. J. Schoonbee, Pollution Studies in the Umgeni Basin. Part 1: The Lower Umgeni at Durban - a Report on Estuarine Pollution, (CSIR, Pretoria, South Africa, 1963), p. 19.

River Estuary. Furthermore, they have also affected the numerous resource users of the Mgeni River Estuary such as fishermen and canoeists.

Conclusion.

The aerial photographs show that there have been substantial changes to the Mgeni River Estuary during the twentieth century. These changes can be attributed to the establishment of a more sophisticated capitalist/ industrial society. With this transition, an increasing number of human activities emerged and this has in turn led to an acceleration in environmental alteration in the Mgeni River Estuary. The key to understanding this alteration are the dynamics and characteristics that underlie capitalist/ industrial society. This chapter has identified some of these dynamics but more intangible dynamics and motivations will be explored in the following chapter.

CHAPTER FIVE

THE DYNAMICS OF CHANGE

Introduction.

Estuaries are inherently dynamic and have from their formation been subject to change. In the case of the Mgeni River Estuary this change took place in the Pleistocene period. The Mgeni River Estuary has been subject to forces of natural change ever since. These changes are evident in the Mgeni River Estuary today but more important to this study is the rate at which these natural processes have been accelerated by human activities.

In order to make a meaningful assessment of the human impacts on the Mgeni River Estuary it is necessary to understand the dynamics behind natural change as well as the dynamics behind human-induced change and the merging of the two. This is a relatively new concept which was successfully adapted by Thompson in her exploratory study of the Eastern Shores of St. Lucia. In her study Thompson points out that, in the past, the term "ecosystem" has not been directly associated with the study of human beings and that commonly studies of ecosystems have been studies of natural ecosystems only. She has stressed that in reality there are few, if any, ecosystems in the world today that have not been influenced by humans.[198] Clearly then if, as Dovers suggests, environmental history should be relevant and should inform the contemporary challenge of ecological sustainability,[199] it is necessary to analyse both the natural and human dynamics behind the formation of what can be termed "human ecosystems".

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[198] Thompson, 'The Eastern Shores of St. Lucia: Towards an Environmental History', pp. 35/36.

[199] Dovers, 'Sustainability and "Pragmatic" Environmental History', p. 21.

For ease of reading, the dynamics behind the formation of " human ecosystems" will be broken down and discussed separately. The dynamics of natural change is discussed first, followed by the dynamics of human change.

The dynamics of natural change in estuarine systems.

Estuaries are dynamic systems that have from their formation been subject to change and the Mgeni River Estuary is no exception. The formation of estuaries began, in part, with the drowning of river valleys due to eustatic changes in sea levels.[200] This change occurred during the Pleistocence period when one third of the land surface was covered in ice and the sea surface was 100-150 metres below present sea levels.[201] Following this period the climate became warmer and as the ice melted the sea level rose, drowning the river valleys to form the majority of estuaries along the KwaZulu-Natal coast, including the Mgeni River Estuary.

In KwaZulu-Natal, estuaries have been and continue to be subjected throughout the year to strong winds and a powerful wave system. These prevailing environmental factors render estuaries, in particular the Mgeni River Estuary, vulnerable to temporal variations in both chemical and physical conditions. The most notable physical variation in an estuary is the mouth. In KwaZulu-Natal, estuary mouths, unless pinned by a rocky feature, have a tendency to meander under the influence of currents, wind and wave action and sediment movement.

The freshwater flow in the Mgeni River Estuary is, as in all estuaries, a further factor that will govern the configuration of the estuary mouth. In times of drought, the flow in an estuarine system can cease or dwindle to an extent where the mouth of the estuary will become closed off from the sea.[202] When flooding occurs, the raging waters reopen the estuary mouth. Flood waters will not only reopen the estuary

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[200] J .H. Day, The nature, origin and classification of estuaries', in J. H. Day, ed, Estuarine Ecology with Special Reference to Southern Africa', (A. A. Balkema, Cape Town, 1981), p. 2.

[201] Ibid.

[202] Begg, The Estuaries of Natal, p. 601.

mouth but will, depending on the magnitude of the flood, alter the shape and depth of the estuary.[203] This phenomenon has both advantages and disadvantages. In some estuaries the scouring by floods assists in maintaining the storage capacity, while in others scouring has an adverse effect in that it removes fine, nutritive materials from the floor of the estuary.[204]

The freshwater flow of an estuary, as in the case of the Mgeni River Estuary, will also govern many of the estuary's chemical characteristics. The chemistry of an estuary, however, depends not only upon the freshwater flow but also upon tidal exchange. Together these two factors determine the chemical characteristics of an estuarine system. The chemical conditions of an estuary are continually changing. The source of much of this variation, which is a common characteristic of "open mouth" estuarine systems, such as the Mgeni River Estuary, lies in the daily rise and fall of the tides, currents set up by these tides and fluctuating freshwater flow.[205]

The fauna and flora of an estuary, including the Mgeni River Estuary, are typically capable of tolerating chemical variations. Those that can tolerate an estuarine environment are able to thrive in its sheltered, nutrient rich waters. Estuaries are rich in organic detritus which forms the basic ingredient upon which energy flow through the food web depends.[206] An important source of detritus is from the decomposition of leaf material shed from macrophytes, such as mangrove trees. Nutrients are also provided from leaves and other plant litter brought in from the catchment as well as seaweeds washed in by tidal currents.[207] These organic materials are broken down

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[203] Ibid.

[204] Ibid, p. 603.

[205] P. Badenhorst & T. Heinecken, Coastal Management. Notes on Basic Processes and some Management Principles, p. 38.

[206] Begg, The Estuaries of Natal, p. 604.

[207] Badenhorst, Coastal Management. Notes on Basic Processes and some Management Principles, p. 40.

by bacteria and fungi into more easily digestible carbohydrates and proteins providing the major source of food for fauna and flora in an estuary.

Water levels also play an important role in an estuary's productivity. Rising water levels submerge peripheral plant communities, providing organisms with maximum opportunity to seek shelter and food, while falling water levels have the important effect of moving detritus from the periphery of the estuary to the centre.[208] For the estuary to be functional, however, it is essential that there is sufficient depth to ensure that the storage capacity allows adequate retention of nutrients, detritus and microbiota.[209] It is important too that there is contact with the sea for most parts of the year to allow the estuary to function as a nursery. Most estuarine species will spawn at sea because of the more stable environment here. After hatching the juveniles will, however, enter into the sheltered and nutritious estuarine environment where they will develop into adults.

It is clear that although estuaries are by nature extremely variable and transitional, they are able to achieve a characteristic mix of physical, chemical and biological processes. This complex interaction underpins the ecological functioning and uniqueness of estuaries.[210] Human activities in estuaries, such as the Mgeni River Estuary, have unfortunately upset many of these natural processes resulting in estuarine degradation.

The dynamics of human change.

The above is a description of how the majority of estuaries, including the Mgeni River Estuary, would have typically functioned prior to the advent of human settlement in KwaZulu-Natal. From the advent of human settlement the natural dynamics behind the changes of estuarine systems have been directly impacted upon by human activities and indirectly impacted on by the goals, beliefs and aspirations which drive

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[208] Begg, The Estuaries of Natal, p. 603.

[209] Ibid.

[210] Ibid, p. 604.

the relevant societies' activities. What is required now is an analysis of the dynamics behind the change in the way different societies interact and relate with their environment, as this is what causes change in human impacts. It is necessary to acknowledge that when studying ecosystems, one needs to look at human activity within the systems. Because human activity is based on social systems we also need to look at the social systems that govern and give meaning to those activities and interactions.[211]

Prior to the arrival of white colonists in Port Natal, it was the indigenous communities living in the area who had provided the dynamics for environmental alteration. The impacts from these communities have been noted, as has the change to the environment which was generally slow and evolutionary in nature. This slow and evolutionary change can be directly attributed to the simple methods of resource use employed by these societies. It will be recalled that the technological state of a society is a major determinant of the methods of resource use employed and therefore it is directly related to the type of environmental alteration that takes place. Laws, customs and beliefs which are shaped by the modes of resource use of any given society also influence environmental alteration. All these factors will ultimately determine how a society will exploit technology and therefore the society's interaction with the environment. It is thus necessary to analyse the goals and capabilities of the relevant society and its aspirations and motivations, if we are to fully understand the dynamics behind the change in the way in which different societies interact and relate with their environment.

The focus of this study has been on a capitalist/ industrial society because of its escalating impact on the Mgeni River Estuary. However, to understand the full implications of this society's goals, motivations and aspirations, it is necessary to briefly contrast a capitalist/ industrial society with earlier societies. It will then become apparent how a change in goals, values and aspirations has directly affected the type of environmental alteration that has taken place. The goals and aspirations of the

[211] Thompson, 'The Eastern Shores of St. Lucia: Towards an Environmental History', pp. 35/36.

hunter-gatherer society need to be considered first. Their basic goal was to meet their needs of survival and as hunter-gatherers survival was totally dependent on the environment. This dependency resulted in a very close and intricate relationship with the environment. The hunter-gatherers' reverence for the environment was reflected in their rock art as well as their tribal customs. For example, during tribal dances 'shamans ' would enter into trances and perform certain tasks such as the promotion of economic activity by, for instance, guiding antelope into bushes and controlling rain.[212] Thereafter thanks would be given for the gifts received from the environment. This practice is consistent with Gadgil and Guha's contention that a society's relationship with the environment is built up and reinforced by their traditions, customs and beliefs.

The transition from hunter-gatherer to Iron Age society was marked, in addition to technological advance, by a change in beliefs and aspirations. This society no longer saw themselves as much a part of nature, instead they saw themselves more as custodians of nature, with nature providing for them. As custodians of the environment the Iron Age society established a number of beneficial customs and practices which were regulated by an *inkosi* (chief) or *induna* (headman). Of particular importance was the *inkosi's* responsibility for the allocation of land on which to build, land to cultivate and to graze. There was therefore no private land tenure. Land was gratuitously assigned to all members of the community but nobody could hold land as his own.[213] In addition to allocating land, the *inkosi* also defined areas for cultivation and grazing and closed and opened seasons for cultivation. This duty was particularly important as far as the allocation of natural resources from the area were concerned.[214] Besides this practice there were a number of other beliefs customs and values which reflected the importance that this society attached to their natural surroundings. For example, the opening of various seasons often involved ceremonies such as the *uNomdede* feast. This feast, which was held in honour of

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[212] Bowden, 'An Environmental History of Keate's Drift', p. 31/32.

[213] Thompson, 'The Eastern Shores of St. Lucia', pp. 76/77.

[214] Ibid, pp.77/78.

iNkosazane yase zulwini (Princess of Heaven), usually took place before harvesting as it was believed that the princess had the power to enhance the harvest.[215]

The belief system was not the only practice that reflected the importance of nature to this society. It had over the decades acquired a substantial knowledge of the environment which was practically applied. The people relied on various natural signs such as the position of stars in the sky and the arrival of certain bird species as an indication of the right time for sowing. Until these necessary signs had been received planting would be held over.[216] They also held a comprehensive knowledge of the indigenous plant species of the region and used many of the species medicinally for both humans and animals.[217] It is obvious that the natural environment provided them with their means of survival and therefore they developed a deep respect for and knowledge of it. As custodians of the environment their customs and beliefs reflected the importance, intricate knowledge of and respect for the environment. This relationship provides important dynamics behind the type of impact that this society had on its environment. Impact was at times intrusive and altered ecosystems but in general did not result in degradation of the environment.

With the arrival of white colonists in the nineteenth century more severe environmental alteration was set in motion. The changes in the landscapes and ecosystems resulting from this society's activities have been discussed in previous chapters. What needs to be analysed now are the social dynamics behind these changes. One of the most notable changes in this society was the manner in which it valued its environment. The capitalist/ industrial society no longer thought of humanity as the custodian of nature. Instead this society believed humans were separate from nature with the perception that they had a right to exploit natural resources to further their own well being. In addition the capitalist/ industrial society no longer believed the environment was a key to its survival and therefore lost

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[215] Ibid.

[216] Ibid, pp. 78/79.

[217] Ibid.

the deep respect for and knowledge of the environment that pre-industrial societies had acquired. This change in values and beliefs introduced to the study area a new and very distinctive relationship between humans and the environment.

A powerful motive behind the establishment and perpetuation of the capitalist system is the pursuit of profit.[218] Consequently we see, in the study area, exploitation of natural resources for this purpose. This goal is first apparent in the Natal region with the arrival of white hunter-traders in 1824. The hunter-traders, unlike pre-industrial society, heavily exploited large mammals such as Elephant *(Loxodonta africana)*, Hippopotamus *(Hippopotamus amphibius)* and Buffalo *(Syncerus caffer)* in order to obtain skins and ivory to trade for profit. This resulted in obliteration of these species from the region. With the development of a more sophisticated capitalist/ industrial society the goal of profit intensified, resulting in obliteration and simplification of the environment by the establishment of commercial sugar plantations, market gardens and industrial developments.

The quest for profit has also, according to Worster, commodified land and, although not a commodity in the sense that it had been produced by human labour, it was regarded as such and used and traded accordingly.[219] This is evident in the private real estate and commercial developments in the vicinity of the Mgeni River Estuary. The drainage of wetlands adjacent to the Mgeni River Estuary is a further example of this attitude. The capitalist/ industrial society has ignored the ecological value of huge wetlands and instead regarded these areas as prime sites for industrial, urban, recreational and agricultural development. The commodification of land and the desire for profit has had severe implications for the relationship that a capitalist society has with its natural environment and therefore explains the impact this society has had on the environment. These capitalist objectives have driven society to utilise all its available technology and in so doing have intensified environmental alteration in the Mgeni River Estuary.

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[218] Ibid, p. 81.

[219] Worster, 'Transformations of the Earth', p. 1101.

The continued growth of the capitalist system, then, is due both to the fact that humans designed superior technology and because in the process of doing this they changed their values, their perceptions and outlooks, especially as far as what is believed to be important and what constitutes a "need".[220] According to Richard Lichtman, every society, in order merely to survive, must satisfy the basic subsistence needs of its members for food, shelter, clothing and human recognition. For these needs to be achieved a level of productivity must be attained. Human needs are satisfied through this means of production. In the process of doing so, however, the original needs are altered giving rise to new needs, satisfaction of which depends upon new forms of social organisation and technical instruments.[221] Humans, by way of technological progress, have been able to harness additional energy which has been necessary to satisfy their growing needs. As human energy consumption has increased so too has, Simmons argued, the manipulation of the environment.

In a capitalist/ industrial society the many perceived needs are established by one of capitalism's most deeply rooted characteristics, viz., consumerism. 'Consumerism derives from the fundamental tenet of capitalist ideology: the assertion that the primary requirement for individual self-fulfillment and happiness is the possession and consumption of material goods.'[222] Therefore when we consider the dynamics of change it is important to realise that the environmental alteration that has taken place during this phase in history can be attributed to more than just technological advance and consumption of energy. It is sustained by the values and perceived needs of a society which rationalises the continued exploitation of natural resources.

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[220] Thompson, 'The Eastern Shores of St. Lucia', p. 82.

[221] R. C. Edwards, M. Reich & T. E. Weisskopf, eds, The Capitalist System: A Radical Analysis of American Society, (Prentice Hall, INC, New Jersey, 1978), p. 392.

[222] Ibid, p. 401.

As early as the mid nineteenth century the capitalist "need" to consume faced limitations due to the availability of productive natural resources. This limitation led to the establishment of various methods of preservation of valuable resources, such as "vermin" control. In 1866 concerned authorities in Natal passed the Noxious Animals Law, giving magistrates the right to reward individuals who destroyed animals belonging to species listed in Schedule A: Leopard *(Panthera pardus)*, Hyaena *(Hyaena brunnea/ Crocuta crocuta)*, Crocodile *(Crocodilus niloticus)*, Jackal *(Canis* spp.*)* and Wild cat *(Felis* spp.*)*.[223] These species were all predators which destroyed settler property, especially domestic stock. It was believed that predators and prey were directly related, and therefore, if the number of prey were to be increased, it was necessary to decrease the number of predators. While this law emphasises the value that capitalist society placed on natural resources, it also illustrates how the quest for profit warped an understanding of the workings of ecosystems and the importance of bio-diversity. Society failed to appreciate that in order to conserve wildlife resources it was necessary to conserve the ecosystems and processes upon which they depended.

Complex as the capitalist system was in KwaZulu-Natal and South Africa it had an added complexity leading to accelerating environmental impact. This added complexity was as a result of the racial policies and laws which gave rise to an additional goal of racial segregation. This goal of racial segregation had its own set of environmental impacts in KwaZulu-Natal. During the Apartheid era the "needs" of the white minority were met through the practice of racially discriminatory policies. In the study area, as late as the 1980s, large tracts of market gardens leased by Indians were uprooted on the Springfield Flats for the "needs" of white industrialists. While this action met the needs of white industrialists, it also assisted in meeting the aims of the then government to ensure and consolidate their policy of racial segregation. The conversion of the Springfield Flats into a railway and industrial complex effectively created a buffer zone between white communities and communities of colour, which had its own impact on the workings of the Mgeni River Estuary.

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[223] B. Ellis, 'The impact of white settlers on the natural environment of Natal', p. 72.

Early conservation policies were also affected by the racial prejudices of the then government. During the nineteenth century the rapid depletion of large species of game was met with concern, and consequently, legislation was passed in 1866 to regulate hunting. The legislation established open and closed seasons for hunting and allocated animals to different schedules.[224] To shoot any animals in schedule C, permission was needed from the Lieutenant-Governor. This provision effectively excluded the indigenous population from the privilege of hunting as it is unlikely that they would have been able to obtain the consent of the Lieutenant-Governor. What appeared to be conservationist legislation was therefore used to restrict the hunting of sought-after animals to the ruling class, a phenomenon observed elsewhere in Africa.[225] It is not surprising, then, that South Africa's history of conservation has been described as being 'apartheid-based authoritarian conservation'. Clearly, authoritarian conservation excluded the indigenous population from access to natural resources, for example, people of colour were denied access to the Beachwood Creek and as a result many indigenous people now view contemporary conservation efforts in the study area with understandable scepticism.

The goals and aspirations of conservation and conservationists have, however, changed over the years. This change is particularly apparent from the 1970s when the viability of the capitalist economic order began to be threatened by its economic activities, resulting in the need to bring these activities into line with the sustainable limits governing the natural environment.[226] The technology and needs of global society will change once again as human values change in relation to the environment. The intensive utilisation of natural resources resulting in, for instance, the extinction of species and global warming has made global society increasingly aware that natural resources are not infinite and therefore effective management of

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[224] B. Ellis, 'The impact of white settlers on the natural environment of Natal', p. 74.

[225] Ibid, p. 75.

[226] R.C. Edwards, The Capitalist System, p. 407.

resources and the environment is of the utmost importance. In South Africa similar changes in values are evident. There is an added dimension with the dismantling of the apartheid system in the early 1990s. In the context of these social and political changes, conservationists have adopted concepts such as the following: 'to conserve the wildlife resources of KwaZulu-Natal and the ecosystems and processes upon which they depend and to assist all other public and private groups in ensuring the wise use of the biosphere.'[227] 'Conserve' in this instance is defined as the 'means to ensure the survival of indigenous fauna, flora and natural ecosystems, the promotion of public environmental awareness and the provision of nature-orientated outdoor recreation' and 'wise use' signifies use 'that will maintain biological diversity and ensure sustainable utilisation of all resources.'[228] Some of these ideals have been implemented by conservationists in the Beachwood Creek.

In the initial discussion about conservation policies it was suggested that early policies were structured simply to protect those resources which were profitable. Conservation today has an element of profit in it, in the form of tourism and recreation. In addition to recreation and tourism, Simmons has provided a table of reasons for establishing conservation areas. (See Table: 5.1, p. 107.) In this table he provides six economic reasons, of which only two (tourism and recreation) appear to be beneficial to the capitalist system. If one is to cost the destruction of the environment into the cost of production, as appears to be the growing trend, then all reasons will, in turn, appear to be beneficial and relevant to the capitalist system.

[227] www.wildnetafrica.com/kwazulunatalparks/hpage.html#define

[228] www.wildnetafrica.com/kwazulunatalparks/define.html

Table 5.1: Reasons for establishing conservation areas. (Adapted from Simmons, Environmental History, 1993.)

REASONS FOR ESTABLISHING CONSERVATION AREAS			
Utilitarian values		**Non-utilitarian values**	
Scientific	*Economic*	*cultural*	*Ethical*
Preserving a sample of ecosystems to ensure biotic diversity	providing a particular form of recreation	Conserving a cultural heritage	rights of non-human entities
Conserving genepools and potentially useful organisms	Conserving wildlife	Preserving aesthetic values	scope for individuality
Protecting natural areas for research and monitoring	Protecting watersheds and water quality	Providing educational opportunities	social value of exercising restraint and transformation
	Conserving scenery for tourism		
	avoiding diseconomies of development		
	promoting a "balanced" land use pattern		

During the last decade the importance of conservation ideals have been increasingly realised in the study area. For example, the Durban Metropolitan, in its search for a sustainable future, has identified the need to make market economies pay for environmental costs. If these ideals are implemented they will have a

positive impact on the workings of the Mgeni River Estuary because, at present, negative environmental impacts are not costed into prices and are thus 'external to the market.'[229] The operation of market economies encourages industry to cut prices so that they remain competitive and to cut prices they off-load environmental cost on the external environment, for example, the Mgeni River Estuary. 'There is little incentive for an industry to invest in pollution control technology if its competitors can produce at a lower cost by discharging more pollutants.'[230] Recent legislation which reflects the changing values of society towards the environment has tried to make provision to protect the environment from significant pollution or degradation. The National Environmental Management Act No 107 of 1998 (NEMA) has given individuals, among other things, the right to take action to prevent environmental harm. The National Water Act No 36 of 1998 has adopted the 'polluter pays' principle. If current legislation is effectively implemented it will have direct benefits for the efficient functioning of the Mgeni River Estuary.

Another important initiative undertaken by the Durban Metropolitan Council is the Durban Metropolitan Open Space System (D'MOSS). This initiative aims to create a network of open spaces linking important conservation and recreational areas.[231] Open spaces, which include the Mgeni River Estuary, have been identified as an important resource of the Durban Metropolitan area which provide a number of services. In KwaZulu-Natal 'open spaces underpin our tourist industry, protect our commercial areas and infrastructure from flood damage, provide recreational opportunities and feed our growing population.'[232] Poorly planned and ad hoc development is, however, threatening this resource. Without this resource the Durban Metropolitan Council is faced with enormous environmental costs for those

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[229] D. Hindson, N. King & R. Peart, Durban's Tomorrow Today. Sustainable development in the Durban Metropolitan Area, (Durban Metro, 1996), p. 61.

[230] Ibid.

[231] Durban Metro, The Durban Metropolitan Open Space Framework Plan, An Information Booklet, Environmental Branch Development and Planning Service Unit, p. 1.

[232] Ibid, foreword.

services that are provided by the environment, such as storm water control and the production of food and traditional medicines. While the successful implementation of D'MOSS will save the Durban Metropolitan Council enormous environmental costs it will also have a very positive impact on the workings of the Mgeni River Estuary.

Conclusion.

Within the study area there are already indications of changes in the values, beliefs and laws governing the resident societies' relationship with the environment, resulting in positive impacts on the Mgeni River Estuary. These changes further illustrate that in order to understand environmental change it is necessary to assess both the dynamics behind natural change as well as the dynamics behind human-induced change and the merging of the two. Environmental alteration in the Mgeni River Estuary has been directly related to the changing goals, beliefs and aspirations of the different societies. Therefore, if sustainable estuarine development is to take place in the future it is necessary for both policy makers and managers to acquire an understanding of how natural and human dynamics within the natural environment affect plans for such development.

CONCLUSION

This thesis has attempted to illustrate that environmental history is a necessary tool for providing positive and practical contributions to environmental management and the pursuit for ecological sustainability. Environmental historians, in their search for sustainability, construct histories and identify important long-term trends which provide the necessary baselines to assist policy makers and environmental managers in solving pressing environmental concerns.

Although some of the environmental changes in the Mgeni River Estuary have been brought about by natural changes, much of the environmental alteration is directly related to the way in which different societies have interacted with their environment. Pre-industrial societies depended on the environment for survival rather than for profit. Their simple methods of resource use ensured that they developed a deep respect for and knowledge of the environment, while the capitalist/ industrial society by contrast became divorced from the natural environment. This changed relationship with the environment was supported by a change in goals, beliefs and aspirations which affected the impact that the capitalist/ industrial society had on the environment.

Capitalist/ industrial society, unlike early societies, is driven primarily by the goal to make profit and consequently, through technological advance, has exploited all conceivable natural resources for this purpose. This goal has been reinforced by the perception that man is separate from nature and that he has a right to exploit natural resources to further his own well being. The continued exploitation of natural resources has been further entrenched by the capitalist "need" to consume in order to satisfy the fundamental requirement for individual self-fulfillment and happiness. However, it is important that humanity understands one of the most basic laws of ecology, namely that 'everything is connected to everything else, and that you cannot remove one piece of the jigsaw without repercussions - new, unforeseen problems - elsewhere.'[233]

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[233] G. Park, The Groves of Life. Ecology and History in a New Zealand Landscape, (Victorian University Press, Wellington, 1995), p. 317.

If human society is to continue into the next millenium, we need to revisit our past to consider the beliefs and aspirations of early societies. Our history has an important story to tell; it is here that the key to our survival lies. We can no longer think like conquerors and stay bound to the dogma that nature has no place in land that can produce profit. We need to acquire, like our ancestors, a deep respect for and knowledge of the natural environment. In doing so we will realise that it is not only technological innovation that sustains us but that we are also dependent upon conservation of the resources and the processes and ecosystems upon which they depend. Clearly, if sustainable development is to take place in the future, it is important to understand how our goals, beliefs and aspirations impact on the environment so that our destructive patterns of living can be altered.

This is an important lesson, especially when considering that there will be further development on the KwaZulu-Natal coast. From the outset estuarine development will need to consider the negative environmental impacts that this study has identified. For example, in the Mgeni River Estuary we have seen that wetlands play a very important role in managing water. They hold water back during floods and release it during dry periods. By regulating water flow during floods they prevent flood damage and soil erosion. In addition to flood attenuation they also remove pollutants and serve as breeding grounds. Wetlands provide important services that are beneficial to both estuarine ecosystems and human society and yet they were eradicated. Environmental managers will need to identify areas such as wetlands and plan in a manner that will allow them to function. This might appear in the short term to be costly but history has shown that managers must cost in the destruction of environmental services or they will be faced with great expenses in the future.

Sustainable estuarine development will, however, only be attainable if policy makers and environmental managers look further than the physical impacts on an estuarine system to the attitudes and beliefs that underlie human activity and if the goals which drive society are modified to include a new concept of survival: 'that we must live with the rest of nature or die with the rest of nature.'[234]

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[234] Ibid, p. 332.

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