PARTICIPATORY MONITORING AND EVALUATION OF MARINE WATER QUALITY. A CASE STUDY OF SAPPI SAICCOR, UMKOMAAS.

By

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Coursework Masters Degree in Environmental Sciences,
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March, 2002

ABSTRACT

Previously, issues concerning the use and conservation of the natural resources were restricted to certain groups of individuals, normally those considered to be scientific experts. However with the emergence of sustainable development and the adoption of its principles therein, there has been increased community concern over environmental quality issues resulting in pressure for transparency in environmental decision-making processes. The result has been a dramatic expansion in the number of organisations at the local, national and global scales committed to environmental improvement. This in turn has let to dramatic changes in the role of the public in decisions relating to natural resource management. Participatory development is now acknowledged as critical in achieving sound environmental management.

The initiation of community-based environmental decision-making has led to the formation of new and interesting partnerships. Environmentalists, communities, policy makers and business people have begun to work together in an attempt to find consensus concerning environmental problems and related socio-economic inequalities. This has resulted in the development of new ways of integrating local and scientific knowledge systems.

This thesis illustrates community-based environmental decision-making in the management of the use of the south coast of Durban. It outlines a partnership, through the formation of the Permit Advisory Panel (PAP), comprising industry (Sappi Saiccor), government, through its Department of Water Affairs and Forestry, environmental organisations, and the local people in the monitoring of the impacts of effluent produced by the industry and disposed of into the sea. The aim of this thesis is to develop an alternative methodology that will be acceptable to all stakeholders, for the collection and analysis of data in the monitoring of the Sappi Saiccor effluent. This was achieved through the following objectives: to develop a methodology for the collection and analysis of data, to assess the performance of the new pipeline in terms of reduced aesthetic impacts of the effluent, to assess the role of local knowledge in the monitoring process, and finally to assess the role of this study in the functioning of the PAP.

This thesis attempts to integrate qualitative and quantitative methodologies. The subjective local data collected by the divers is analysed using statistical methods to assess the impacts of the effluent on marine water quality and the effect the new pipeline has had in reducing these impacts. Qualitative surveys such as questionnaires and interviews were administered to assess the role of local knowledge in the monitoring process and also to assess the role this study has had in the functioning of the PAP.

The statistical analysis did not reveal any major improvement in underwater visibility since the pipeline was extended. There is a 6% and 4% improvement in the number of effluent days and visibility respectively. This however is due to some limitations inherent in the data collection process, and as a result the improvement brought about by the pipeline extension has been toned down. An effluent and visibility index is therefore recommended as an alternative method of data collection and analysis to reduce the level of inaccuracy. The role of local knowledge is perceived by many of the PAP members as vital in the monitoring process. This study was therefore thought of as an important step in validating this local knowledge such that it can be a reliable data source to be used in the monitoring process. It also played an important role in resolving the conflict between the PAP members. It is therefore recommended that the divers data should be continually used in the monitoring process, though the divers have to be more actively involved. The PAP is therefore tasked with liasing with the community members, especially the divers such that they can assume a more active and responsible role within the PAP. They should be involved in the development of the methods of data collection and analysis.

PREFACE

The work described in this thesis was carried out in the School of Life and Environmental Sciences, Geography Department, University of Natal, Durban, from January 2000 to February 2002 under the supervision of Ms. Catherine Oelofse, and Dr. Dianne Scott from August 2001 to February 2002.

This study presents original work by the author and has not been submitted in any other form, in part or in whole, to any other University. Where use has been made of the work of others, it has been duly acknowledged in the text.

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ACKNOWLEDGEMENTS

This thesis has been a real challenge to me, through which I have grown and matured both professionally and personally. It has been a rewarding experience and hence I would like to thank all the people who made it possible for me.

My greatest gratitude goes to my supervisors, Ms. Catherine Oelofse and Dr. Dianne Scott for the guidance, support, patience and compassion that they have shown me, not only for this thesis, but throughout my whole study period in this university. Cathy and Di, I am truly grateful for all the opportunities that you made possible for me. I would also like to thank all members of staff, especially Frank and Isaac, for their help and assistance.

Furthermore I would like to thank the Sappi Saiccor PAP for letting me do this project and for all the valuable input they made. I would also like to thank all the people who willingly assisted me by giving me information or advise. Dr. Immo Kleinschmidt from the Medical Research Council, Ms. Glenda Mathews from the statistics department, University of Natal, for all their help. Furthermore I would also like to thank my friends and colleagues whom we travelled this route together for their support, encouragement and constructive criticism.

I would also like to extend my deepest gratitude to my family. This is for the love and support you have all shown me throughout my life. You've seen me through the worst... I know I was not always an easy person ... but you never gave up on me. Thank you for putting up with me and believing in me. This is for us....... We've made it together.

Last but not least, I thank the Almighty for always looking over me and giving me the courage and the strength to always do my best.......

CHAPTER ONE

INTRODUCTION

The emergence of sustainable development in the mid 1980s was one of the highlights of change within environmental management. Essentially sustainable development advocates for economic development, ecological sustainability and social equity. It is within this call for social equity that sentiments of transparency, democracy and participation are echoed (Scott, 1999c).

Scott (1999c) further argues that the challenges facing those who have the responsibility of making sound environmental decisions have thus multiplied over the past decade due to these changing perspectives on environmental problems. There has been increased pressure for governments to move away from centralised governance to more horizontal approaches. Participatory approaches have evolved due to pressure from donors, governments, and primary stakeholders for increased accountability and transparency. In the South African context, the pressure for participatory approaches was further compounded by the need to redress social inequalities, which were caused by the apartheid era.

In all government sectors, including the management of natural resources, countries such as South Africa, have thus drafted new policies and legislation to ensure the implementation of these sustainability principles. The South African Constitution, Act 108 of 1996, embraces the key principles of equitable access to natural resources, access to information and involvement of the public in decision-making and management. Furthermore the White Paper on Sustainable Coastal Development for South Africa, released in June 2000, highlights the importance of improved access to coastal resources and community involvement in the management of local coastal resources. The key goal here is to develop partnerships between state, the private sector and the civil society in order to foster co-responsibility for coastal resources and areas (Hauck and Sowman, 2001). This implies therefore that knowledge construction concerning the links between natural resource management, social realities and ecological dynamics should be a co-operative venture between research scientists, communities and all other stakeholders involved.

This process of democratisation of environmental decision-making has implications for the kind of knowledge used as the basis for decision-making processes. It comes with the realisation that the different stakeholders come with differing knowledge systems and perceptions of the world around them. There is therefore a need for acceptance and tolerance of these different knowledge systems between the stakeholders, accepting that the community have their own knowledge system based on their everyday experiences. There is therefore a need for environmental decision-making processes that are participatory, using frameworks that encourage the integration of local (community) and expert (scientific) knowledge systems. The struggle therefore is to find ways of integrating these different schools of thought since it has been realised that they are in fact complimentary and enhancing rather that conflicting as was previously thought. The quest therefore is for a "zone of in-betweenness" (Sibley, 2001).

Chechile and Carlisle (1991), suggest three ways of ensuring a successful integration of local and expert knowledge. Firstly, they suggest full participation of the community in all stages of environmental decision-making, i.e. from planning to decision-making and implementation. Secondly they suggest good communication practices such that both participants can develop a better understanding and appreciation of each other's concerns and value systems. Finally, negotiation and mediation are said to be vital in order to find common ground in cases where there is a difference of opinion. Given the complexity and differences in social perceptions within societies, it is critical to involve all those who might be affected by the outcome (Bosch *et al.*, 1996). This multi-vocal approach highlights the importance of listening and appreciating different perspectives and ideologies in the construction of knowledge and of negotiating the integrated 'middle-ground' with its changes and creative possibilities (Sibley, 2001).

This study outlines a case study of an attempt to integrate local and scientific knowledge systems in the management of marine water quality along the upper south coast of KwaZulu-Natal. Local knowledge, documented by the local divers in the area, has been accepted by the Sappi Saiccor Permitting Advisory Panel (PAP) as a reliable data source that can be used in assessing the extent of Sappi Saiccor's marine pollution. This local subjective data is analysed in this study using scientific statistical techniques. Based on this analysis, an alternative method of data collection and analysis to those presently adopted will be developed. This form of participatory monitoring will also be assessed in terms of its ability to diffuse hostility and rebuild trust between the stakeholders.

1.2 CONTEXTUAL SITUATION

This thesis presents a case study of an attempt to integrate local and scientific knowledge systems in the management of natural resources. In this case, local knowledge is being contested as a reliable data source that can be used in assessing the impact of Sappi Saiccor's marine effluent.

The south coast of KwaZulu-Natal is known for its warm sandy beaches and its fishing and diving opportunities, hence tourism is considered to be a key economic activity in the area. The local economy of this area relies on this tourist industry as the local people have established businesses offering services, accommodation and leisure activities (Scott, 1999c). Of major importance however are the dive operators who conduct dive tours off the coast especially at the Aliwal shoal, which is ranked as one of the best diving spots in the world. Currently there are five dive operators in this area who use the Aliwal Shoal.

The Sappi Saiccor mill, which produces cellulose from wood pulp is also situated along this coast, and is one of the biggest operations of its kind in the world. In the manufacturing process effluent consisting of calcium lignosulphonate and various other sugars is produced and disposed of into the sea. Because of its tendency to stabilise natural foam in the surf zone and its ability to discolour seawater with its distinct dark colour, this disposal has raised a number of concerns pertaining to its physical and social impacts (Oelofse, 1999).

In response to these problems and as a result of public pressure Sappi Saiccor extended the length of the pipeline from 3 km to 6.5 km in 1999. This was undertaken in an effort to disperse the effluent further out into the sea such that the impact on the shore, where usage of marine resources is greatest, can be reduced. This extension has however resulted in the transferral of the problem of effluent, particularly in its impact of reducing visibility at the diving zone on the Aliwal Shoal. Although the impacts have been greatly reduced along the shore, they are still persistent at the Aliwal Shoal. The opposition against the disposal of effluent into the sea therefore still persists, especially from the divers.

It is due to these concerns and others arising from the disposal of effluent from other industries along the south coast that the divers, through their involvement in the Permitting Advisory Panel (PAP), have become involved in the monitoring of the impact of the effluent on the environment. The formation of this panel in 1997 was a recommendation of the South Coast Marine Pipeline Forum (SCPMF) as a provision for public participation in the monitoring process, comprising of the public (represented by the dive operators and other concerned members of the public), the permitting body (DWAF), also acting as mediators, industry (Sappi Saiccor), and environmental organisations. The panel is responsible for assisting in the monitoring of the effluent to ensure compliance with the permit conditions and also makes recommendations regarding the permit itself such that a continual improvement in the effluent impacts can be attained.

The PAP recognises that the divers' observation constitute the only available data on visibility on the Aliwal Shoal. However, due to the 'subjectivity' and 'qualitative' nature of this data, the regulators have requested that the divers' data be subject to rigorous statistical analysis, hence the commissioning of this study. This thesis focuses on developing a methodology that integrates local and scientific knowledge in order to provide analysed data and knowledge that is acceptable to all stakeholders and which can be used to monitor visibility. The PAP commissioned this study to provide a monitoring system for assessing the impact of effluent on the Aliwal shoal and also to foster transparency and consequently built trust between the local people and industry. This study is also a response to the global call for more participatory, transparent and holistic approaches in development and monitoring systems, such that development initiatives can be more sustainable. This study is a sustainability driven initiative, advocating for equity, accountability, transparency and community involvement in environmental decision-making processes.

The local knowledge of the divers is being analysed using scientific methods. Two different knowledge systems are being used in a complimentary and integrated manner, such that consensus can be reached regarding the level of visibility before and after extending the pipeline to its present length. In this way, it is proposed that a way forward for improved marine water quality can be found. A case is made that the integration of local (qualitative) and scientific (quantitative) knowledge systems lends credibility to the data being used and ultimately to the monitoring process itself (Abbot and Guijt, 1998).

It is envisaged that the inclusion of the local people in the monitoring process will have the following advantages:

- Improved performance of the monitoring process itself
- A clear sense of ownership of the monitoring process by the participants
- A greater degree of consensus amongst stakeholders
- Enhanced skills and confidence
- Increase cost-effectiveness in data collection and its quality
- The provision of opportunities for empowerment and development for the participants
- Effective use of local knowledge (Bosch *et al.*, 1996; Allen, 1996).

1.3 AIM AND OBJECTIVES

The aim of this study is to develop a methodology that will be acceptable to all stakeholders of the PAP for the collection and analysis of data in the monitoring of Sappi Saiccor's marine pollution. This aim will be achieved through the following objectives listed in their order of importance and consequently the depth they will be dealt with, starting with the most important:

- To develop a methodology for the collection and analysis of visibility and effluent data;
- To assess the performance of the new pipeline in terms of reduced aesthetic impacts of the effluent;
- To assess the role of local knowledge in the monitoring process and how it can successfully be integrated with scientific theories to achieve a more holistic and inclusive process.
- To assess a change in attitude over time amongst the PAP members, i.e. assess the contribution of this study towards resolving the conflict within the PAP.

The analysis that has been adopted in this study has two objectives. The first is to compare the data collected by the different dive companies, looking for consistency in individual records and variability between the different dive charters, such that the data can be validated. This was done through the use of descriptive statistical methods, which are normally used to examine the spread of values in a dataset (Robinson, 1991). Further tests of variance were used to validate this data. The second objective is to examine visibility trends such that the performance of the pipeline extension can be evaluated. Parametric and non-parametric hypothesis tests were adopted in this case to test the significance of the differences in the data. Based on these two objectives the alternative methods of data collection and analysis are developed.

1.4 STRUCTURE OF THE THESIS

This thesis consists of six chapters. The next chapter presents the theoretical framework, which provides the conceptual framework for the analysis of the results. It covers issues relating to community participation in planning, implementation, monitoring and evaluation stages of all development projects, and also reviews literature relating to the integration of different knowledge systems for more holistic approaches in these initiatives. Background information relating to the case study and events that led to the commissioning of this research are presented in chapter three.

Chapter four is the methodology chapter, which outlines the methods that were applied in both the data collection and analysis stages of this study. Primary data was principally verbal, observatory and documentary. Data was gathered through observation through the attendance of the PAP monthly meetings, open-ended interviews and questionnaires, and documentary sources consisting of correspondences between the PAP members, newspaper cuttings and the PAP minutes. Furthermore, the effluent and visibility data analysed in this study was collected by the divers, and analysed using statistical techniques.

The fifth chapter presents the analysis and discussion section. This section will present the alternative methodology developed for the collection and analysis of data. A discussion of these findings in relation to the theoretical framework is also outlined in this section. The divers' data is validated and used to assess the present data collection and analysis methods as adopted by Sappi Saiccor's environmental team, such that alternatives can be developed. It is further used to assess the performance of the present pipeline in reducing the impacts of the effluent on marine water quality. The role of local knowledge in the monitoring process is also assessed together with the role of this study in the functioning of the PAP.

The last chapter contains the conclusions and recommendations. This covers all the conclusions that can be drawn from this study based on the literature and make appropriate suggestions pertaining the next steps that could be undertaken in the monitoring of marine effluent on the Aliwal shoal.

CHAPTER TWO

THEORETICAL FRAMEWORK

2.1 INTRODUCTION

This chapter will review the theoretical literature that will provide a framework within which the research questions as stated in the previous chapter can be answered. This research is framed by the overarching paradigm of sustainable development, but is more specifically informed by participatory approaches in environmental decision-making processes. In order to understand the present decision-making frameworks within the environmental arena, it commences with background information on the mainstream approach to environmental decision-making and its limitations. The resultant shifts in thinking towards more integrated approaches will be explored with more focus on the tools that can be adopted to ensure effective integration of local and expert knowledge systems. This literature review will inform this research study in terms of the formation and functioning of the PAP as a mechanism for participatory monitoring.

2.2 SHIFTS FROM MAINSTREAM APPROACHES IN ENVIRONMENTAL MANAGEMENT

From the 1960s and 70s, at the start of the modern environmental movement, there was rising concern about environmental problems such as pollution and global warming, resulting from the complex interrelationship between humankind, the global resource base and the social and physical environments (Huber, 2000). Everett and Neu (1999) state that this concern consequently triggered the development of theories from academics, especially those within the disciplines of politics and sociology, in a quest to understand this relationship and solve the prevalent environmental problems. They argue that the concept of ecological modernisation was thus developed, and it has since become a mainstream framework of analysis. They further suggest that ecological modernisation identifies modern science and technology as central institutions for ecological reform. It is viewed as an environmentally sensitive technological change and a style of policy discourse that serves to foster better environmental management (Everett and Neu, 1999).

Furthermore, Everett and Neu (1999) propose three characteristics that they claim are central to this discourse. The first is the notion that economic activity systematically results in environmental harm; second is the idea that economic growth and development can be reconciled with the resolution of ecological problems and finally, ecological modernisation advocates for the management of the world's global resources through proactive strategies, preventative practices, rigid and systematic politics, institutional arrangements and regulatory practices.

Essentially, ecological modernisation supports the belief that environmental degradation is the inevitable ultimate result of economic activity and that society should therefore adopt proactive measures to regulate and control their actions (Dryzek, 1997). Based on this argument this discourse subscribes to the notions of win–win solutions, support the need for universal regulation and appeals to science to solve problems. Ecological modernisation has therefore had an appeal to a variety of groups and institutions who have manipulated it to suit their differing interests and objectives and to justify or rationalise their actions therein as being in the global interest (Everett and Neu, 1999; Hajer, 1995).

Ecological modernisation presumes that most if not all environmental problems can be overcome through scientific innovations and rationality. It is seen as an alternative to the more radical environmental movements of the time, since it acknowledges modern science and technology as central institutions in addressing environmental problems, and it assigns a new role for science in environmental policy-making (Hajer, 1995). Everett and Neu (1999) echo this notion and furthermore highlight that this scientific epistemology excludes the social realm:

> *"...the intersection of ecological and social realms are ignored and issues of social justice are effectively erased"* (Everett and Neu, 1999).

Harvey (1998) as quoted in Everett and Neu (1999), states that science and scientific rationality are central to this discourse, both in terms of knowledge construction and problem solving. Due to this dominance of science, equally important issues such as social justice, economic redistribution and democracy are excluded. This discourse is therefore clearly driven by the positivist philosophy to knowledge construction, which is based on the following assumptions.

The first is the claim that the scientific method is the only true method of obtaining knowledge, hence discarding all non-scientific methods as meaningless. Second, is the argument that science is the ultimate provider of answers or solutions to all problems. The last assumption is that scientific judgement is objective. Essentially, positivism rejects metaphysics, i.e. people's experiences and beliefs and the meanings they attach to them (Johnson, 1983).

Johnston (1983) argues that positivism therefore claims that the only acceptable knowledge is 'real' or 'certain' knowledge, and that any other knowledge claims that are less certain are to be rejected. It further claims that the only domain through which one can get this 'certain' knowledge is the domain of natural science. Since emotions, thoughts, values, attitudes and perceptions cannot be directly observed and measured, they are not considered to be legitimate topics within scientific discourse and so cannot be considered as 'certain' knowledge (Everett and Neu, 1999; Scott 1999a). It is not surprising therefore, that other forms of knowledge such as local knowledge are rejected on the basis of claims of lack of absolute certainty.

Proctor (1991) claims that politics and values (social issues) are external to the practice of science. He argues that these two do not influence the origins of scientific knowledge and its successes in solving world problems. As he puts it, these two are

> *"... inherent in the uses of science not its origins, in its failures but not in its successes or triumphs, in the exceptional or the peripheral, but not in the everyday and fundamental"* (Proctor, 1991).

This thinking is based on the ideology that science is pure or value free and that values and politics enter only as contamination. Webster (1991) however argues that the social and material interests of capitalism influence the practice and claims of science. Furthermore, Hadley (1993), Bosch (1989), Behnke and Scoones (1991), and O'Connor (1986), have all noted that the majority of natural resource management research and development projects based on purely scientific methodologies only were unsuccessful. This high level of failure supported the search for alternative approaches based on the concepts of openness and evolving systems. This resulted in new approaches, that are participatory in nature and which build upon the principles of experiential learning and synthesis thinking, being developed (Allen *et al.*, 1998).

The epistemology and culture of the scientific discourse has become a matter of serious concern to social scientists resulting in initiatives towards a science that is more in tune with human needs, hence the birth of 'civic science'. This is a form of science that is deliberate, inclusive, participatory, revelatory and designed to minimise losers (O'Riordan, 1995). O'Riordan (1995) states that this new form of science ensures that all stakeholder groups within society are identified so as to ensure fair and more comprehensive decision-making processes.

Civic science acknowledges the limitations, in terms of uncertainty, inherent in knowledge construction discourses, including the scientific epistemology; hence it acknowledges a more widely based validation arrangement through multiple stakeholder review as opposed to the traditional peer review procedures (O'Riordan, 2000). Many commentators have documented the origins of this new science, and essentially it can be traced back to philosophical shifts within knowledge construction discourses and shifts within the political arena for more transparent and democratic decision-making.

The most marked philosophical shift for the birth of this new science is the shift from positivist thinking to a more liberal philosophy of post-positivism. This philosophy acknowledges that knowledge is fallible and has error, and that all theory is revisable (Garner, 1996). Post-positivism is critical of objectivity and certainty of knowing reality. While a positivist believes that the goal of science is to uncover the truth, a post-positivist critical realist acknowledges science as just one of the many ways of struggling to get closer to reality, though we can never really get there. Post-positivist thinking therefore emphasizes the need for multiple measures and observation each of which are different and can criticize each other (Martin and Richards, 1995; Barnes and Duncan, 1992).

2.3 PARTICIPATORY APPROACHES

The challenges facing those who have the responsibility of making sound environmental decisions have multiplied over the past decade due to changing perspectives on environmental problems and the notion of what constitutes the environment itself. This is a direct result of the new global wave towards a more holistic, multi-use and multi-value view of the environment (Hauck and Sowman, 2001). Within this context science is seen as a means of achieving ends that are continually being redefined by social concerns. Despite the fact that positivism has resulted in considerable improvements in understanding the world around us, it has failed to incorporate differences of opinion in its objective analysis, or even solve the conflicts resulting therein. There is therefore a need for development policies to take cognisance of these imperfections. Common recommendations to address these issues are the use of local and community-based approaches, and increased transparency in planning, management and decision-making processes.

The new broader definition of the environment, which now encompasses both the social and economic components, has also changed the perspective of environmental management and decision-making structures and processes as opposed to the previous definition, which only focused on the physical or natural environment (Rajasekaran, 1993). Furthermore, there has also been increased community concern over environmental quality issues resulting in pressure for transparency in environmental decision-making processes. The result has been a dramatic expansion in the number of organisations at the local, national and global scale committed to environmental improvement (Hauck and Sowman, 2001). Participatory approaches have also evolved due to pressure from donors, governments, and primary stakeholders for increased accountability and transparency. Furthermore, the mainstream approach to environmental decision-making, i.e. ecological modernisation, was accused of being politically and economically biased hence there was a need to resort to more inclusive and participative approaches so that this bias can be reduced (Rouse, 1992).

Scott (1999c), argue that in the South African context, the pressure for participatory initiatives was further compounded by the need to redress social inequalities, which were caused by the apartheid era. In its quest to address issues of inequality the new democratic government promulgated a number of policy documents advocating for equitable access to natural resources and information, involvement of the public, transparency and accountability. The Constitution, Act 108 of 1996, embraces the key principles of equitable access to natural resources, access to information and involvement of the public in decision-making and management (Hauck and Sowman, 2001). Furthermore, the White Paper on Sustainable Coastal Development for South Africa (2000) highlights the importance of improved access to coastal resources and community involvement in the management of local coastal resources. The key goal here is to develop partnerships between state, the private sector and the civil society in order to foster co-responsibility for coastal resources and areas (Hauck and Sowman, 2001). The call for transparent, inclusive and democratic approaches were however essentially prompted and driven by two factors, namely sustainable development and the rise of the so-called social movements.

The emergence of sustainable development in the mid 1980s was one of the highlights of change within environmental management. Sustainable development was first explicitly proposed and documented at the World Commission on Environment and Development in 1987 by the Brundtland Report. This has been followed by a number of other international initiatives elaborating and endorsing the same sustainability principles within different contexts. Essentially sustainable development advocates for economic development, ecological sustainability and social equity (Huber, 2000). It is within this call for social equity that sentiments of transparency, democracy and participation are echoed. There was therefore a demand for the devolution of power to the local level in decision-making processes (Scott, 1999c). This resulted in a move away from centralised decision-making structures inherent to the mainstream approach to environmental decision-making.

These processes were accompanied by the rise of the so-called 'new social movements' (Scott and Oelofse, 1999). These movements were focused on uplifting and empowering the previously disadvantaged groups of society hence these movements advocate gender, race, ethnicity, multiculturalism, community and environmental issues, demanding procedural equity in decision-making processes (Scott and Oelofse 1999). They advocate the recognition and inclusion of these diverse groups in decision-making, calling for a science that is more in tune with the needs of the people, hence the birth of civic science (O'Riordan, 1995).

It is within this broader context that a call for more inclusive participatory, multi-vocal and interactive approaches in environmental decision-making processes is made (Scott, 1999c). The research and development projects undertaken should therefore begin with the search for solutions to the problems of the community. For this reason and others, such as the need to incorporate social issues in decision-making process such that different opinions may be incorporated and conflict resulting from conflicting perceptions and ideologies resolved, science is being asked to collaborate with communities to develop a new understanding among all participants. In this regard science assumes the role of empowering the communities such that they can deal with their own needs (Martin and Richards, 1995).

Participatory approaches primarily seek to be practical, useful, formative and empowering. Their practicality is seen in the fact that they respond to the needs, interests and concerns of their primary users; useful because findings are disseminated in ways that primary users can use them and formative because they seek to improve program outcomes (Allen, 1999). Ultimately the involvement of the participants in the development process will empower them.

Ongoing community dialogue helps develop a shared understanding, reduces unnecessary conflict and clarifies issues by continually defining the context within which any piece of information is provided. This also in turn encourages a learning environment that is conducive and facilitates constructive and voluntary behavioural change (Bosch, 1996).

Good communication can also help generate useful ideas that are more likely to be adopted and applied and also identify relevant research opportunities. Participatory research provides all interested parties with the opportunity to learn from the experiences gained within natural systems. Among other things, this allows scientists to realise how their contributions fit in the whole process. Close collaboration and understanding of different perspectives can only be achieved if a common language is developed. Essentially, this participatory approaches, advocate for the inclusion of the public in environmental planning management and decision-making processes (Allen, *et al.*, 1995). This has therefore challenged conventional monitoring systems, due to lack of participation. The result has been a move to more community-based approaches to monitoring. The following two sections will therefore be dedicated to community participation and participatory monitoring respectively. These two will be defined and their roles in sustainable development outlined.

2.3.1 Community Participation

Due to increased public interest in the management of natural resources and the global shifts in perceptions of environmental problems and their consequent management, there has been a shift to more participatory approaches in environmental management practices. New policies and legislation have been promulgated globally and in South Africa, and new approaches to governance sought, so as to ensure the involvement of local communities in environmental decision-making. A convention on access to information, public participation in decision-making and access to justice in environmental matters was passed in Aarhus, Denmark in 1998 (http://www.unece.org/env/pp/documents/cep43e.pdf).

In most cases all the initial information needed about the relationship between social and physical environmental systems is held within local contexts (Allen *et al.*, 1995). Involving local people in programme design and implementation is essential if we are to achieve sustainable systems or programmes in a constantly changing environment. Greenwood and Levin (1998) define participation as a process of democratising the knowledge generation process. They further make the point that the inclusion of all stakeholders enables communities to take responsibility and control of their own life situations.

An essential pre-requisite to accessing local knowledge is to ensure equal participation in decision-making processes. The success of this can only be attained through community involvement in all aspects of the development or research process. This will ensure that research efforts are more closely linked with the needs of the community, management and policy (Allen, 1999). Edgerton *et al.* (2000) define participation as a process of inquiry and dialogue through which stakeholders can influence and share control over development initiatives and decisions affecting them. It ensures that stakeholders feel a sense of ownership and commitment to the whole process.

Edgerton *et al.*, (2000) argue that participation is not uniform, rather it involves a continuum of approaches ranging from information dissemination, collaboration, consultation and political representation to participatory research. It can occur in four distinct ways; first, information sharing, which is a one-way flow of information to the public; second, consultation, which is a two-way flow of information between co-ordinators; third, collaboration, which refers to shared control over decision-making and finally, empowerment, which is the transfer of control over decision-making and resources to all (Edgerton *et al.*, 2000).

Table 2.1 below outlines the different types of community participation that can be adopted (Catley, 1999). The specific approach used is determined by area specific conditions such as governance, political and social structure, but the goal is always to reach the maximum level of participation feasible within a particular context. This classification system is used in this thesis to assess the type of participation within the Sappi Saiccor PAP.

While the process of participation may seem attractive and simple, putting it into practice may not be that easy. It is important therefore to be aware of possible constraints that can be anticipated. Table 2.2 outlines some of the most common constraints. These constraints can however be avoided or solved, hence should not be used as an excuse to avoid community involvement. Knowing these constraints can only help improve the process since all the possible hindrances can be avoided or dealt with accordingly. Many commentators have thus derived frameworks and models that can be adopted to ensure the success of these participatory processes. One such framework is the Integrated System for Knowledge Management, which has been developed based on a case study done in the agricultural lands of New Zealand's South island high country (Allen *et al.*, 1998). This framework essentially focuses on bringing scientific and local knowledge systems together into a single, accessible and structured focal point, to support the identification and adoption of more sustainable resource management practices (Allen *et al.* 1995; Bosch *et al.*, 1996).

The adoption of participatory approaches also has implications for the type of monitoring processes in place. It advocates for more participatory and inclusive processes hence the move to more community-base monitoring processes. The next section will deal with this concept further, highlighting its advantages and how best to implement it.

Table 2.1: Types of community participation (Catley, 1999)

1. Manipulative Participation: community (Co-option)	Community participation is just a pretence since the representatives are not elected by the community and have no power.
2. Passive Participation: (Compliance)	Communities participate by being told what has been decided. Involves unilateral announcements by an administration or project management without listening to people's responses. The information belongs only to the external professionals.
3. Participation by consultation:	Communities participate by being consulted or by answering questions. External agents define problems and information gathering processes, and so control analysis. Limited, if any, local decision-making, and professionals are under no obligation to take on board people's views.
4. Participation for material incentive	Communities participate by contributing resources such as labour in return for material incentives (e.g. food, cash). Local people have no stake in prolonging practices when the incentives end.
5. Functional participation: (Cooperation)	Community participation is seen by external agencies a means to achieve project goals. People participate by forming groups to meet predetermined project objectives; they may be involved in decision-making, but only after external agents have already made major decisions.
6. Interactive participation: (Co-learning)	People participate in joint analysis, development of action plans and formation or strengthening of local institutions. Participation is seen as a right not just the means to achieve project goals. The process involves interdisciplinary methodologies that seek multiple perspectives and make use of systemic and structured learning processes. As groups take control over local decisions and determine how available resources are used, so they have a stake in maintaining structures or practices.
7. Self-mobilisation: (Collective action)	People participate by taking initiatives independently of external institutions to change systems. They develop contacts with external institutions for resources and technical advice they need, but retain control over how resources are used. Self-mobilisation can spread if governments and NGOs provide an enabling framework of support. Such self-initiated mobilisation may or may not challenge existing distributions of wealth and power.

Table 2.2: Constraints inherent to the participation process (Edgerton *et al.*, 2000)

- Creation of parallel participatory processes that are not integrated with existing social and political structures.
- Limited trust, conflicting interests and differing bargaining power between stakeholder groups that result in disorganisation of the process and abuse of confidences.
- Diverse perceptions by different stakeholders concerning the participation process and the issues of concern or the problems.
- Exaggerated expectations of the participation process by some of the stakeholders.
- Insufficient information sharing.
- Poorly planned participation processes that are open ended and not realistically budgeted for, or processes that are just token efforts.
- Lack of political will among government agents to allow wide participation because of fear of loss of power or influence.
- Limited time
- Consultation fatigue.

2.3.2 Participatory Monitoring

Due to increased pressure for countries to include the public in environmental planning, management and decision-making processes, new challenges that questioned the validity of the centralised approach emerged. This shift from centralised to horizontal approaches in the decision-making process has placed challenges on conventional monitoring due to its lack of participation, leading to more community based approaches to monitoring. The conventional monitoring and evaluation processes have been challenged by the need for monitoring processes with improved learning about changes occurring locally. Participatory monitoring encourages more community involvement at all the stages of the monitoring process, hence an enhancement of local capacity in collecting or recording, and analysing change using locally defined indicators and methods (Estrella *et al.*, 2000). It entails the recording of data and its periodic analysis by the people directly involved / affected by the project with the help of outside expertise.

Participatory monitoring recognises the central role that local people can play in planning and managing their use of the environment. It moves away from the externally defined and driven programmes and stresses the importance of locally acceptable processes for gathering, analysing and interpreting data (Estrella *et al.*, 2000). The implication of participatory monitoring is that local people will have an influence and control over the social, economic and political dynamics of the project. But in order for this process to be effective and successful, there is need for empowerment of local people. This empowerment entails changing people's knowledge, skills, attitudes and practices and also broadens the knowledge of local people so that they can participate as equals (Guijt and Gaventa, 1998).

Another important factor that can determine the success of these participatory approaches is capacity building. This capacity building however is not only targeted at local people to enable them to understand the external systems of environmental monitoring, but also to external people such that they can understand local systems. This monitoring system moves away from a situation whereby the whole process is centred on the outsiders to one that embraces local systems already in place and builds on them through capacity building in recording and analysing data. In addition to its "watch dog" function, this process should continually improve the learning of those involved and the actions taken (Abbot and Guijt, 1998).

Participatory monitoring offers the opportunity for participants to generate, collect and analyse data as a group. Although some of the information may be lost, as all control over data collection is handed over to participants, equally important information may also be found. Although quantitative data has always been highly prized, qualitative accounts offer striking images that cannot be represented in numeric summaries (forms). The blending of quantitative and qualitative data through participatory monitoring and evaluation strategies therefore lends credibility to the data being collected. The participatory monitoring and evaluation process generates information on socio-cultural issues that are valued by participants and also provide opportunities for empowerment and development (PACT Publishing, 1989). All the stakeholders, especially the community, should have a clear understanding of their involvement and the objectives of the project. Everyone should be kept informed of progress or lack of it towards the planned objectives.

Participation is a process of inquiry and dialogue through which stakeholders share ideas in ways that help them to have a multidimensional perception of their needs. The importance of effective participation in building a monitoring and evaluation system is that it ensures a sense of ownership and commitment by the stakeholders. Other basic functions of participatory monitoring are listed in Table 2.3 below.

Table 2.3: The basic functions of a participatory process (Estrella *et al.*, 2000; Guijt and Gaventa, 1998).

i. *Progress measurement*: This process provides information during the life of the project such that possible flaws can be detected hence alterations/modifications/ alternatives can be sought. ii. *Information provision for the decision makers*: The recording of information and its analysis during the life of a project can provide important feedback that can influence the decision-making process. iii. *Examination of progress towards objectives*: This process enables the assessment of the process itself to determine whether the set procedure is being followed and whether it is going towards the desired goals.

Participatory monitoring has some basic steps that are recommended to ensure the desired outputs from the process. These steps serve as guidelines that can be used as a counter-check tool to ensure the inclusion of all stakeholders at all levels of the decision-making process. It also serves to ensure that the process is transparent, fair and that all the voices are given a hearing such that all the stakeholders can influence the decision-making process. These basic steps proposed by Guijt and Gaventa, 1998; Abbot and Guijt, 1998; and PACT Publishing, 1989 are;

i. Discuss reasons for monitoring: Both the insiders and the outsiders have to review the benefits and purposes of monitoring and decide whether it is the answer for them.
ii. Review objectives and activities: The objectives and activities have to be reviewed by all involved such that the community can accept or change them to fit their situations.
iii. Develop monitoring questions: Make sure that the questions being set for the monitoring process to address are clearly stated and agreed upon.

iv. Establish direct and indirect indicators: Establish direct and indirect indicators that can be used to answer the monitoring questions.

v. Decide which information gathering tools are needed: Decide on the most appropriate method of collecting the data for each indicator.

vi. Decide who will do the monitoring: Monitoring may require people with certain skills and who have the time to do it; hence people doing monitoring should be selected on this basis.

vii. Analyse and present the data: It is important to analyse the information being monitored at specified times throughout the project. The results of this analysis have to be presented to the public either through a public meeting or through the media (community newsletter, radio, etc.).

Participatory monitoring provides an on-going picture of the project and how far it has gone such that progress of activities planned can be assessed. It may also show whether the planned activities can be made timeously. This process is therefore an 'early warning' system which identifies problems or obstacles early such that solutions can be sought before its too late. It also ensures maintenance of good standards through continuous feedback on whether activities are in line with the set objectives and also whether the data collected is of good quality. It provides the chance for self-evaluation, improvement and growth. Furthermore, this will ensure effective use of resources. Continuous feedback ensures that resources are channelled in the right direction where they are needed the most, and where they can yield the most effects, i.e. the proper distribution of resources to ensure a better effect. Participatory monitoring also has the advantage of providing a holistic view, through its ability to combine, qualitative, descriptive local information with numerical expert data. This process can therefore provide useful information base for both the insiders and the outsiders (Estrella *et al.*, 2000).

It is further argued that participatory monitoring improves monitoring efficiency through the harnessing of multiple perspectives from a wide range of stakeholders. A case is made that through the integration of different perspectives, a better understanding of the 'connectedness' within the environment is achieved (Abbot and Guijt, 1998). This participatory approach can also ensure improved programme performance, clear ownership of the programme and consensus. The participants can also develop their skills and enhance their abilities and confidence, hence providing opportunities for empowerment and development. Including the public in the monitoring process can also increase cost-effectiveness in data collection and its quality. Finally this monitoring approach can successfully achieve the integration of local and expert knowledge systems. The use of both qualitative and quantitative methods lends credibility to the data (PACT Publishing, 1989).

This call for adopting more participatory approaches comes with a realisation of the need for new sources of knowledge and databases such that persistent resources management practices can be identified and improved and the bad or unproductive discarded. Local communities can be one source of information about the past and present status of natural resources, and the relationships between social and environmental systems in an area. This implies therefore that knowledge construction concerning the links between natural resource management, social realities and ecological dynamics should be a co-operative venture between research scientists, communities, and all other stakeholders involved e.g. policy agencies (Allen, 2000a). Allen further argues that there is a need therefore for science programmes to be more participatory, using frameworks that encourage the integration of local and expert knowledge systems. This will ultimately ensure relevance and ownership by the local community. This next section will therefore focus on local knowledge, outlining its importance and relevance in environmental management processes.

2.4 INTEGRATION OF LOCAL AND EXPERT KNOWLEDGE

Scientists, local people, policy makers and other interested parties need to learn together how to manage their natural resources in a sustainable fashion. Scientific or western knowledge needs to be integrated with local knowledge systems. In order to fully appreciate this amalgamation of knowledge systems, it is important to define them so that their strengths and weaknesses can be identified (Allen, 1996).

Local knowledge, is the knowledge that people in a given community have and continue to develop over time, hence it is unique to a given culture or social group. This body of knowledge is acquired by local people through their experiences, informal experiments often tested over centuries of use, and the intimate understanding of the environment within their given contexts. It reflects people's experiences based on tradition and culture with a blend of more recent experiences with modern technologies. Local knowledge is therefore dynamic and changing (Rajasekaran 1993).

Local people are well informed about their surroundings, and are aware of how elements of the environment are related to one another and ultimately how a change in one can affect the rest. Local knowledge is therefore tuned to address these local contexts such that the needs of local people can be addressed and the quality and quantity of the available resources improved or maintained. It is normally developed around issues such as adaptation, natural resource management, coping strategies or mechanisms, experimentation and innovation, trial and error problem solving and decision – making skills (Norgaad, 1984).

Local knowledge can play a vital role in providing an essential information base for local resource management and also for directing scientific research by pinpointing areas of need for further information. In order to play this role, however, it has to be systematically collected and scientifically verified, before being complemented with information derived through western-based sciences (IIRR, 1996; Norgaad, 1984).

Local knowledge systems have some limitations inherent within them that strengthen the attitudes of outsiders who claim that local knowledge is primitive, unproductive, irrelevant and messy. The first limitation is the fact that it is often given in oral accounts, which are, in some cases, not precise or specific; the second is that there are no formal written records and documentation. Furthermore, each individual possesses only a part of the community's local knowledge, and even then they rarely recall quantitative data. Local knowledge systems may also be implicit within local people's practices, actions and reactions, rather than a conscious resource (Rajasekaran, 1993).

Rajasekaran (1993), however further argues that undermining communities' confidence in their local knowledge can result in them being increasingly dependent on outside expertise. It can also lead to the communication gap between promoters, practitioners and the community widening, giving rise to myths, lack of trust and eventually resulting in conflict. Disregarding local knowledge also results in the inefficient allocation of resources and manpower to inappropriate planning strategies.

Local knowledge involves both empirical and practical components that are fundamental to sustainable development resource management. It is however imperative to look beyond these two and recognise the fundamental socio-cultural importance of local knowledge. It is through the transmission of this knowledge within different societies/ communities, that worldviews are constructed, social institutions perpetuated, customary practices established and social roles defined. In this manner local knowledge shapes society and culture which in turn shape knowledge itself (IIRR, 1996).

Local knowledge is not as abstract as scientific knowledge; it is rather concrete and dynamic. It relies strongly on intuition, directly perceived evidence and an accumulation of historical experiences. Local knowledge reflects the dignity of the local community, and so places its members on equal footing with outsiders (experts). Local knowledge can also act as a mechanism for facilitating understanding and communication between outsiders and insiders, which will eventually enhance community participation (Norgaad, 1984; Rajasekaran, 1993).

Given the complexity of the systems under stress, it is evident that there is need to have as many different perspectives as possible. The new approach to be adopted therefore requires a greater emphasis on linking scientific research and current knowledge in the community. The implication here is a participatory research whereby the community becomes directly involved as "researchers". A major component of this participatory research is the communication of knowledge. This two-way communication acts to reduce conflict, encourage participation and provide a co-learning environment (Rahman, 1998; Allen, 2000a).

Allen (2000a) suggests that if these two knowledge systems could be successfully integrated, both the local people and the scientists could be provided with more opportunities to inform and stimulate each other. This would also help develop a reliable and comprehensive decision support system to be used in environmental decision-making process. Sharing understanding and knowledge between scientists and local people allows both to gain a better understanding and appreciation of the opportunities and problems facing each other. This will therefore lead to the development of structured and comprehensive database relevant to community needs. Given the complexity and differences in social perceptions within societies, it is critical to involve all those who might be affected by the outcome (Bosch *et al.*, 1996). The case study of this thesis outlines the integration of local and scientific knowledge, where local knowledge, in the form of visibility and effluent data, collected by the divers in the area is analysed statistically in the monitoring of the Sappi Saiccor effluent.

Although the integration of local and expert knowledge is desired in environmental decision-making, it is not always an easy process. The knowledge local people have gained about their local systems over the years is unfortunately not available to the community at large in any organised collective mode and is often represented in a subjective or qualitative form. Similarly, much of the information scientists have accumulated over the years is fragmented and is presented in a highly scientific or technical format. It is therefore increasingly difficult to integrate these two schools of though into a single accessible and structured database, hence the struggle to find ways of integrating these two still persists (Allen *et al.*, 1995).

Chechile and Carlisle (1991), suggest three ways of ensuring a successful integration of local and expert knowledge. Firstly, they suggest full participation of the community in all stages of environmental decision-making, i.e. from planning to decision-making and implementation. Secondly they suggest good communication practices such that both participants can develop a better understanding and appreciation of each other's concerns and value systems. Finally, negotiation and mediation are said to be vital in order to find common ground in cases where there is a difference of opinion. Given the complexity and differences in social perceptions within societies, it is critical to involve all those who might be affected by the outcome (Bosch *et al.*, 1996). This multi-vocal approach highlights the importance of listening and appreciating different perspectives and ideologies in the construction of knowledge and of negotiating the integrated 'middle-ground' with its changes and creative possibilities (Sibley, 2001).

This process of democratisation of environmental decision-making has implications for the kind of knowledge used as the basis for decision-making processes. It comes with the realisation that the different stakeholders come with differing knowledge systems and perceptions of the world around them. This realises a need for acceptance and tolerance of these different knowledge systems between the stakeholders, realising that the community have their own knowledge system based on their daily encounters. There is therefore a need for environmental decision-making processes that are participatory, using framework that encourage the integration of local (community) and expert (scientific) knowledge systems, such as the Integrated Systems for Knowledge Management developed by Allen *et al.*, (1995). The struggle therefore is to find ways of integrating these different schools of thought since it has been realised that they are in fact complimentary and enhancing rather that conflicting as was previously thought. The quest therefore is for a "zone of in-betweenness" (Silbey, 2001).

This approach serves to strengthen and enhance the application of methods to promote participation and information sharing in natural resource management projects. The framework is viewed as a 'social system' since it allows for the interaction of people to create new knowledge and also broaden their perspectives of the world. This is a very important process since it outlines a situation whereby information technology (scientific systems) and end users (local systems) form elements of a larger knowledge system. Allen (2000a) state that this concept is synonymous with the idea that learning through the process is socially constructed. Through the interactions between these two systems, learning occurs as a shared language is developed. The 'scientists' acquire the subjective viewpoint of the community, while in turn the community acquires some skills and enhance their capacity.

Given the complexity and differing social perceptions of the different stakeholders the process actively supports continued communication and dialogue. This will help the different participants to develop a shared understanding of how others view the world and how that shapes the way they act. The communication and dialogue can be in the form of facilitated workshops; hence this process also ensures capacity building and empowerment of the participants. The challenge in this process of information sharing is creating a supportive atmosphere for all stakeholders who hold conflicting social perspectives. Dialogue, which has proved to be an effective constructive conflict management tool, is therefore key to helping stakeholders change their views and ultimately reach a mutual understanding where there was previously conflict of perspectives or contrast of new and traditional perceptions (Allen, 2000a).

Allen *et al.*, (1995) propose that in order for the Integrated System for Knowledge Management to be a success, it has to be undertaken in an environment with strong social capital. This is an all encompassing term for all the networks, norms and trust needed to facilitate co-operation for mutual benefit in development and organisational learning processes (Allen *et al.*, 1995). The nature and outcome of the relationships forged between different stakeholders is influenced by the quality of the social capital within the process. Social capital therefore plays an important role in influencing change and sustaining a social and institutional environment that is conducive for learning and ready to adapt and change (Allen, 2000a).

Effective interactive learning is often not easy to achieve due to conflicting social perspectives between stakeholders, hence it is important to have an open dialogue. Allen *et al.* (1995) proposes that this dialogue should be characterised by constructive debate or negotiations of the merits of alternative goals, technologies and reflections on the interpretation of underlying evidence and beliefs, which are normally diverse. These negotiations, referred to by Lubell (2000) as constructive conflict management, are what help stakeholders to change their views and find a mutually understood and supportable position. Tensions normally arise due to differences in perception and/or the contrast between new ideas and traditional perceptions (Allen, 2000a; Scherbele, 2000).

Much of the conflict surrounding many projects or programme initiatives relates to the fact that different interest groups fail to appreciate the perspectives and value systems inherent in the actions of others. It is therefore important for the stakeholders to share their experiences and viewpoints such that an understanding of why these differences exist can be achieved. The issue of conflict comes out as one of the important factors affecting the functioning of the Sappi Saiccor PAP, hence it will be addressed in this thesis.

In most cases however, there is lack of the participative culture within multi-stakeholder processes. Capacity building should therefore always be seen as the first step in this process. Capacity building involves gaining access to resources, engaging non-participant decision-makers, and creating mechanisms or institutional abilities to sustain the accomplishments attained. Capacity building should however not only be viewed as a function of science. There is a need for a two dimensional capacity building process, i.e. a process where all the stakeholders appreciate each other's knowledge systems and are willing to learn from them, hence every sector or group involved has to contribute to the development of social capital (Cheema, 1997). Within this broader picture, science is viewed as a tool being used to achieve ends that are continually being redefined by social concerns. This therefore provides the basis for this new wave in research and development, whereby scientists, local people, policy makers and other interested parties can learn together how to manage their resources in a sustainable fashion (Borrini-Feyerabend, 2000). This is reflected in the quest in this study to integrate local and scientific knowledge systems through the formation of partnerships between this different sectors.

The challenge is for science to build strong social capital and to promote a more multi-disciplinary approach. This requires building closer partnerships between communities and technical experts in change management, relationship building and conflict resolution (Allen, 2000a).

2.5 ENVIRONMENTAL PARTNERSHIPS

In accordance with the above-mentioned shifts in thinking, all sectors of government in South Africa, including those responsible for the management of natural resources, have introduced new policy and legislation. These policies include new approaches to governance. This in turn has lead to dramatic changes in the role of the public in decisions relating to natural resource management. Participatory approaches are now acknowledged as critical in achieving sound environmental management. This initiation of community involvement in environmental decision-making has lead to the development of panels, forums and partnerships between the state, civil society and the developers or industry, such that a more accountable and transparent decision-making process can be achieved (Hauck and Sowman, 2001).

Environmentalists, communities, policy makers and business and industry have begun to work together in an attempt to find consensus concerning environmental problems and related socio-economic inequalities, resulting in the development of new ways of integrating local and scientific knowledge systems. The partnerships that have developed through these processes can be defined in different ways for different collaborations. They can refer to any voluntary collaboration among organisations working toward a common objective. Figure 2.1 outlines how environmental partnerships differ from regulatory activities that tend to be more mandatory and direct. Environmental partnerships are voluntary, collaborative initiatives as opposed to other arrangements that might be legal requirements that are guided by policies, principle or guidelines. Any set rules in environmental partnerships are those set by the partners themselves (Long and Arnold, 1995).

The most important aspects of partnerships include the provision of equal standing for all the parties involved and their willingness to openly consider the ideas and concerns of others within the partnership. In a partnership everyone should feel rewarded. Partnerships have become a very popular component of decision-making in issues relating to environmental quality, resource conservation and sustainable development (Long and Arnold, 1995). This is evident in the Sappi Saiccor case study where partnerships have been forged between the different stakeholder groups in the monitoring of the impacts of industrial effluent on both the ecological and social environments.

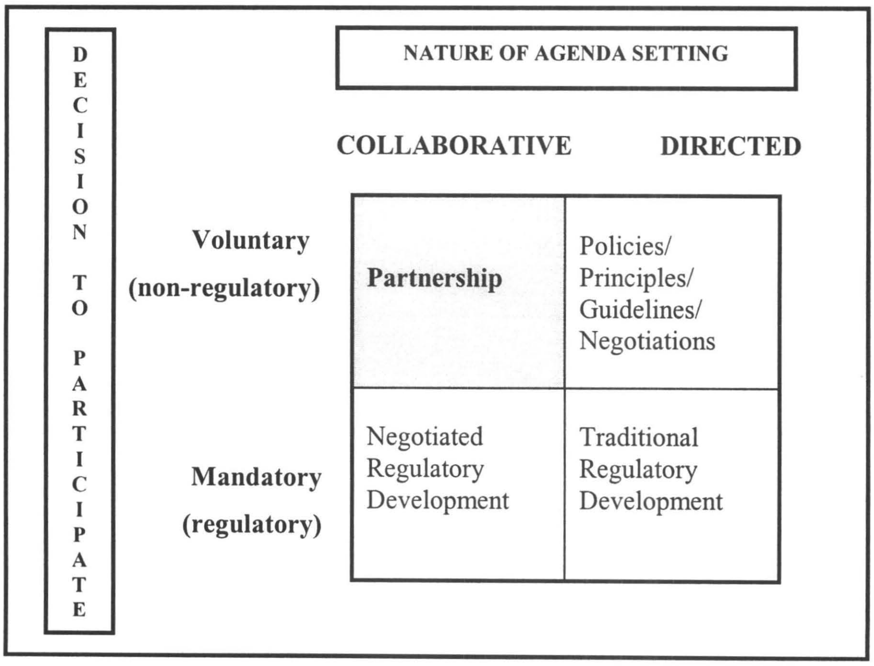

Figure 2.1 Nature of environmental partnerships (Long and Arnold, 1995, p. 6).

Although there are different definitions of partnerships, most of them have four common key elements. Firstly partnerships are characterised by common objectives and goals among the partners. Secondly, the partners should share the risks and benefits associated with the partnership, though they may not necessarily be the same nor experienced at the same time for all the partners. All partners should contribute to the partnership. Lastly, there has to be a shared authority, responsibility and accountability of the whole process and its outcomes. This implies that there should be procedural equity between the different stakeholders. An overarching notion inherent to a partnership is that the partnership should be the best strategy for all involved in solving the problem or tackling the issue of concern.

Partnerships have been distinguished into different types by different authors. Tojman (1998) makes a distinction based on the main methods of change, hence distinguishes between public education partnerships, social marketing partnerships, community investment partnerships and social change partnerships. Rodal and Mulder (1993) however developed another criteria based on the extent to which power is shared. This criterion resulted in partnerships such as consultative, contributory, operational and collaborative. For the purpose of this study however the typology as outlined by Long and Arnold (1995), which is based on the purpose of having the partnership and the level of conflict between the stakeholders will be adopted. Because of the similarities between this case study and this typology, most of the literature on partnerships in this study will draw from the work of Long and Arnold.

Long and Arnold (1995) argue that partnerships cannot be separated from the people who initiate, implement and champion them. Their success is influenced and dependent on the people or individuals within the partnership. Individuals within a partnership should therefore possess a combination of the following characteristics in order to make the partnership successful. They should possess some expertise and knowledge of the issue to be addressed so that their input can be credible. They should have the ability to listen and learn from others. They should also be committed to making the partnership succeed by willing to adopt unconventional solutions and be willing to take risks. They should be innovative and also have strong teamwork skills (Long and Arnold, 1995).

Commitment and creativity of participants are not the only factors that can guarantee a successful partnership. Other conditions, such as pre-existing conflict and the degree to which each party considered the partnership's outcome critical or important, are important factors that can determine the success or sustainability of a partnership (Long and Arnold, 1995). These two factors can be mapped together on what is referred to as the Environmental Partnership Map and depending on the degree of overlap between these two the type of partnership adopted can be determined (Fig. 2.2). Since the Sappi Saiccor PAP is characterised by pre-existing conflict, this Environmental Partnership Map will be adopted in this study to assess the type or types of partnerships that exist within it.

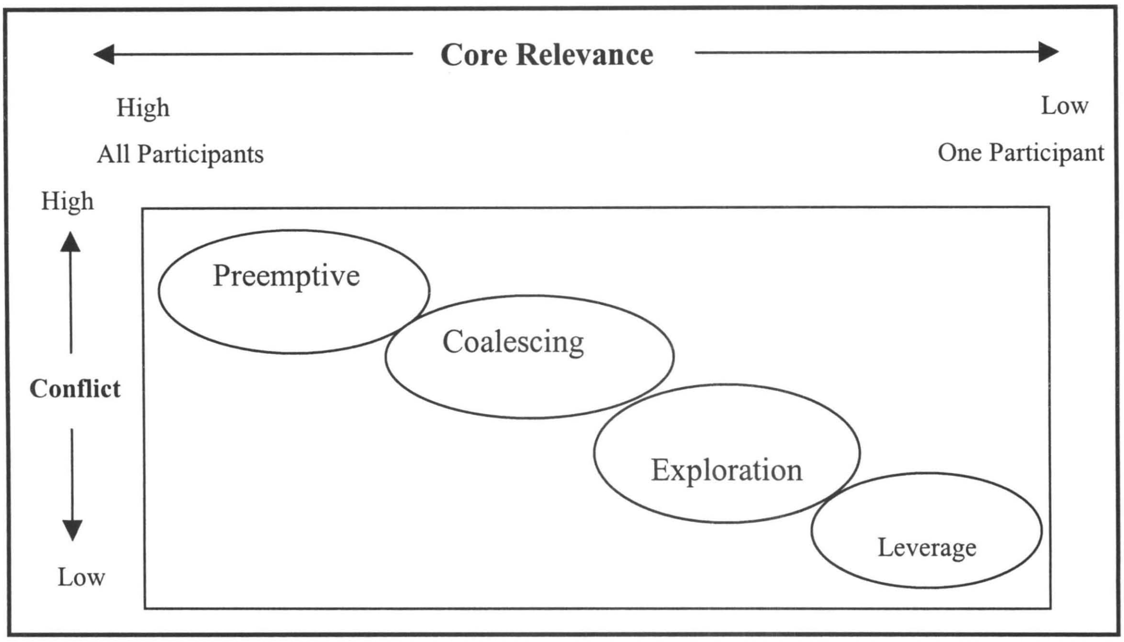

Figure 2.2: Environmental Partnerships Map (Long and Arnold, 1995, P. 61).

The degree of conflict between some or all of the partnerships is an important aspect, as it will determine the levels of social capital (open and transparent dialogue, trust and equity) invested in the process. The dimension of conflict is a continuum that ranges from high to low, where high conflict is normally a result of a mature environmental issue. The longer the parties have been fighting each other, the deeper the conflict. The opposite is true for low conflict. High conflict is characterised by public confrontations either through litigation or public protests. On the contrary if parties have known each other and have had arguments, but have not gone public with their disputes, then this is referred to as moderate conflict. Low conflict is characterised by parties that do not know each other though they are competing in some contexts, excluding the environmental arena (Long and Arnold, 1995).

The level of commitment by participants is also a direct function of how they perceive the partnership in terms of what they will get out of it, hence core relevance also plays an important role in assuring the success of a partnership. The relevance scale also has a continuum that ranges from high to low. High relevance is when all participants view the partnership as a 'life or death situation'. At this stage it is normally too late for a partnership to be effective since there is little or no compromise from any of the parties. All the parties involved are set to get what is best for them (Ekos Research Associates, 1998; Long and Arnold, 1995).

Moderate relevance is when all participants realise that the issue is important, but not critical. In this case people show commitment though they realise that no drastic measures can be taken. Low relevance on the other hand is when one party believes an issue to be important but realises that the others see it as relatively unimportant. In this case the parties that do not consider this project as important may be willing to participate as long as they are not required to take on a great deal of responsibility or when it is not inconvenient in terms of time and resources. When the two parameters of 'conflict level' and 'relevance' are mapped out on two axes, an Environmental Partnership Map as shown in Figure 2.6 is created, outlining the four basic types of partnerships, which are further explained in Table 2.4 below (Long and Arnold, 1995).

Table 2.4: Four basic types of partnerships (Long and Arnold, 1995)

Preemptive:	This is an attempt to defuse a situation that is already hostile or to preempt one that has the potential of being hostile.
***Coalescing*:**	This is a partnership that sees competing parties that depend on each other to reach their respective goals. Due to the competitiveness, there is a potential for hostility or disagreements, hence the challenge is to find a common vision, which they can share and mutually support.
***Exploration*:**	This is an opportunistic partnership attempting to research or investigate environmental issues of joint concern.
***Leverage*:**	This is the most opportunistic partnership where all the involved parties make a modest investment in environmental improvements with the hope of getting high social, political or financial returns.

People are the most important determinants of the success of partnerships, while a vision for environmental quality or resource conservation is the driving force. Capacity building is therefore an important tool for people to give effect to their visions. People, goals and capacity building are therefore considered to be important factors of successful partnerships.

The development of partnerships for dealing with decision-making around the use of natural resources is not a new phenomenon. Partnerships have always been there, though informal. What has changed is the fact that they are now forged between traditional adversaries, not necessarily between accomplices (Tojman, 1998). For example, in the past, environmental partnerships were more focused on the implementation of clearly defined solutions rather than venturing into finding solutions where there was uncertainty. In cases of uncertainty, the courts were seen as the ultimate solution. Lately, environmental partnerships venture into areas of uncertainty involving parties who might not even know each other. There also seems to be a cross-sectoral broadening in participation in the new form of environmental partnerships. Previous partnerships were proactive rather than reactive (Long and Arnold, 2000). They were only formed during a crisis situation, but lately partnerships are formed right at the onset of projects even before any problems are experienced.

The legitimacy and sustainability of these partnerships depend to a large extent on how representative the structures are, or are perceived to be and how appropriate the participatory methods and techniques are. Historical conflict due to political agendas is also an important factor in determining the type and sustainability of partnerships. Greater attention will therefore need to be given to these processes of partnership formation within the South African context. Forty-five years of apartheid, preceded by more than 300 years of colonial rule have resulted in an uneven distribution of power in resource use. Black people and the poor were marginalized in the decision-making process, even where they were directly affected. The tensions which resulted from this type of governance between the government through their conservation officials, traditional authorities, funders and the community still persist to this day, hence the conflict within most of these newly formed organisations or partnerships (Hauck and Sowman, 2001).

2.5.1 Constraints to the formation of environmental partnerships

A partnership can flounder due to structural flaws or process breakdowns. Structural flaws are inherent in partnerships that fail to satisfy all the social capital requirements that influence the success of partnerships. This can be a result of partnership co-ordinators failing to incorporate appropriate mixes of people, goals and capacity building. Common indications of structural flaws include the failure to participate of a critical stakeholder, mismatch of participants' timeframes or objectives with the overarching body that they are trying to inform, and also lack of commitment from participants (Ekos Research Associates, 1998).

Process breakdowns on the other hand are inherent in partnerships that are conceptually and structurally effective but flawed in their management and orchestration of the different aspects of the partnership. Process breakdowns are normally a result of acute problems left unattended and ultimately exhibiting chronic consequences. Symptoms of a process breakdown include demonstrations of anger and/or frustrations with the process as a whole or any other proposal being put forward by other participants. Individuals rehashing issues that were apparently resolved at earlier stages could be another indication of a process breakdown. Furthermore, another indication could be individuals seeking changes in the agenda or process as a whole that seem irrational to the other participants. Finally the demonstration by parties of their view that the partnership is declining in importance by attending meetings less frequently or by sending new people to replace them is another sign of a process breakdown (Long and Arnold, 1995).

The first step in the process of developing sustainable partnerships between local people and experts is identifying the problem together. Most problems would have a scientific and a socio-cultural dimension hence these two are equally vital in trying to solve the problem at hand. The locals' perceptions of the problem should be taken into account. They should be viewed as co-researchers who can provide some crucial input in determining the problems and how best to deal with them. When dealing with local people however, one needs to identify different groups within the community and deal with them separately since they may perceive the same problem differently. A clearly defined problem is one that encompasses a good understanding of the situational context in terms of the ecosystem, an appreciation of resources, perceptions and priorities. A continual dialogue between those stakeholders is pertinent throughout this whole process (Rodal and Mulder, 1993).

In order for partnerships to be sustainable, they have to be completely voluntary. They should be allowed ample time for mutual trust and understanding to develop. There also has to be a continuity of key partners who demonstrate willingness to compromise and respect for the commitment and contribution of others. There also has to be a balance of power within the partners. Tojman (1998) argues that in order for a partnership to be successful, more emphasis should be placed on having strong beginnings. Paying attention to the upfront work in the formation of partnerships can pay significant future dividends. Interpersonal aspects such as skills and approaches are also important aspects to be considered when forging sustainable relationships.

Though environmental partnerships have to be completely voluntary, a more formal agreement can help to clarify goals, roles and responsibilities of the partners. It can also act as a binding tool to ensure the commitment of partners to the process, and consequently help sustain the partnership through hard times. Future plans should also address eventualities of termination or extension of the partnership, together with the possibility of one or more of the partners withdrawing. They should also address the maintenance of the partnership in the longer term, i.e. ongoing responsibilities of the partners to support the activities or products of the process.

2.6 CONCLUSION

This chapter has provided the theoretical background upon which this study will be based and the research questions answered. It started off with discussions around mainstream thinking in environmental management, i.e. ecological modernisation. Until recently, the positivist ideology was the most dominant worldview. In this discourse, science was seen as the only way to the truth and understanding the world such that predictions about the future could be made and possibly controlled. Deductive reasoning was used to formulate theories, which were then tested. Observation and measurement were thought of as the core of this scientific endeavour. Recently, there has been a shift from this positivism to what is referred to as post-positivism. The major improvement that has resulted from this shift is that the post-positivist discourse realizes that observation is fallible and has error, The first partnership is characterised by highly strained relationships due to the high levels of pre-existing conflict and core relevance. As both the levels of conflict and the core relevance decrease, the partnerships tend to be more opportunistic and less hostile, with leverage partnerships being the most opportunistic. In this case all the parties involved make a modest investment in environmental improvements with the hope of getting high social, political or financial returns.

CHAPTER THREE

CONTEXT

3.1 INTRODUCTION

This chapter provides the background to this case study to enable the reader to understand and appreciate the methodology developed to integrate local and scientific knowledge in the monitoring of the impacts of marine effluent on underwater visibility. It further discusses the events that lead to the commissioning of this study.

3.2 THE UPPER SOUTH COAST OF KWAZULU-NATAL

3.2.1 Sea and weather conditions

The upper South Coast of KwaZulu-Natal is characterised by very dynamic sea and weather conditions. It is predominantly influenced by the strong south-flowing warm Agulhas current running parallel to the shore. Reversals in the direction of this current flow are regular occurrences and velocities may exceed 1 ms^{-1}. High seasonal rainfall (> 1000 mm per annum) results in substantial discharges of freshwater and associated sediments into the sea. This coastline is also characterised by dynamic sediment movement patterns with the seabed consequently displaying natural spatial and temporal patchiness. This is further compounded by the presence of mud patches drawn from the Umkomaas River (http://www.kwazulu-natal.co.za).

This coastline is famed for its mild, sunny winters, with average daily temperatures ranging from 16°C to 25°C. Summer temperatures can be as high as 32°C, with seawater temperatures comparing with those of the Mediterranean (24°C). In winter however, the seawater temperature seldom falls below 10°C (http://www.kwazulu-natal.co.za).

3.2.2 Tourism

It is due to these conditions that this coastline is one of the major tourist destinations in South Africa. People from all over the world come to enjoy a range of activities including walking on the warm sandy beaches, swimming, surfing, surf skiing and paddle skiing, angling, boating and diving at the Aliwal Shoal. The local economy of this area therefore relies on this tourist industry where the local people have established businesses offering services, accommodation and leisure activities (Scott, 1999c). Of major importance however are the dive tours off the coast especially at the Aliwal shoal, which ranks as one of the world's best diving spots. It is the second best known and most popular dive destination in South Africa after Sodwana Bay (http://www.seafever.co.za). It is located approximately 5km offshore, south of Umkomaas, which is south of Durban (See Fig. 3.1).

The Shoal runs in a north to south direction and is a little less than 5 kilometers long and about 300m wide. It is home to a large variety of fish, coral, and mammalian life forms. The reef's location is on the inner edge of the warm Mozambique current which allows for excellent visibility (http://www.scuba.lia.net/scuba/html/aliwal_shoal.htm). Furthermore the Aliwal shoal is also popular for the 'Produce and Nebo shipwrecks', and its ragged tooth sharks. The 'Produce' was a Norwegian bulk carrier that struck the north-east pinnacle of the Aliwal Shoal on 11 August 1974 and then drifted off to her present resting place where she lies on her side, while the Nebo carrying railway sleepers sank in stormy weather. The Aliwal Shoal depth ranges from 9m to a maximum depth of 27m, with a visibility of anything between 2m to 30m (http://www.seafever.co.za/page8.htm).

3.2.3 Sappi Saiccor mill

The Sappi Saiccor mill, which is the world's largest producer of chemical cellulose pulp and possibly the largest source of lignosulphonate raw material in the world (http://www.nu.ac.za/focus/text/vol12no2/industry.txt), is located on the upper south coast of KwaZulu-Natal, on the riverbanks of the Umkomaas River (refer to the Figure 3.3 and Plate 1). This mill was established in 1954 (Crowther Campbell & Associates, 1997). The location of this industry was influenced by its need for abundant water supply and the need to dispose of its effluent. The Umkomaas River is hence the ideal supplier of water while the sea is the ideal sink for the industry's effluent. Sappi Saiccor produces chemical cellulose from wood pulp, all of which is exported and ultimately converted to products such as viscose, rayon and cellophane, thereby earning foreign currency (McClurg, 1997). The mill also provides valuable and much needed employment in the area. In 1999 1232 people were employed, earning R84, 47 million per annum (Scott, 1999a).

In the manufacturing process, effluent constituting of 98% water and only 2% dissolved solids consisting of calcium lignosulphonate and various other sugars is produced. The effluent is emitted at an average flow rate of 4 200 m^3 per hour with a disposal limit of 45 million m^3 per annum allowed (Scott, 1999c). Initially the effluent was discharged directly into the surf at the river mouth. In 1967 however, a 2.3 km pipeline was commissioned. This was subsequently replaced by with a 3 km offshore stainless steel pipeline in 1987 (Crowther Campbell & Associates, 1997).

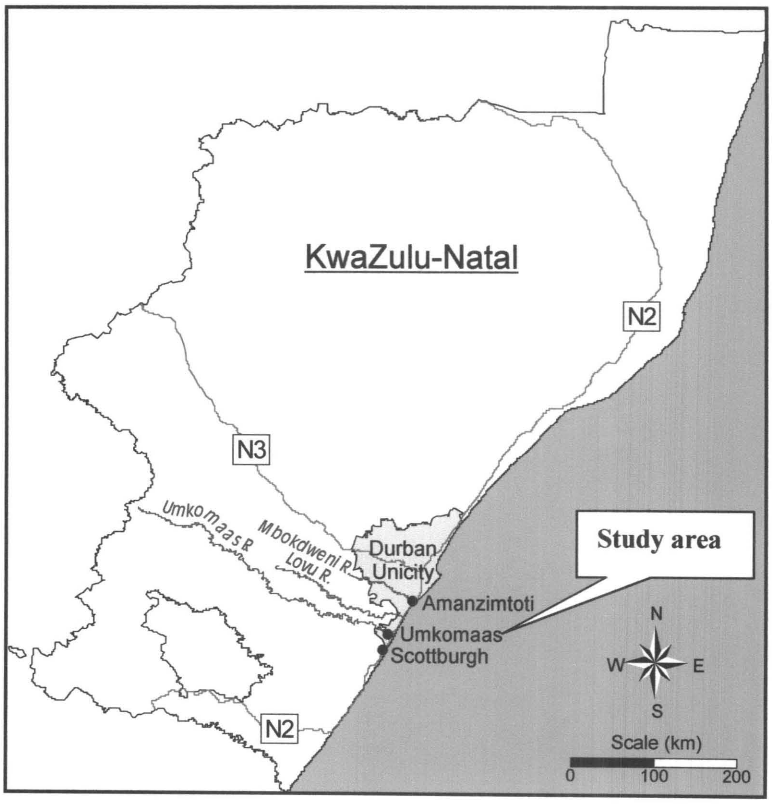

Figure 3.1: Location of Study Area

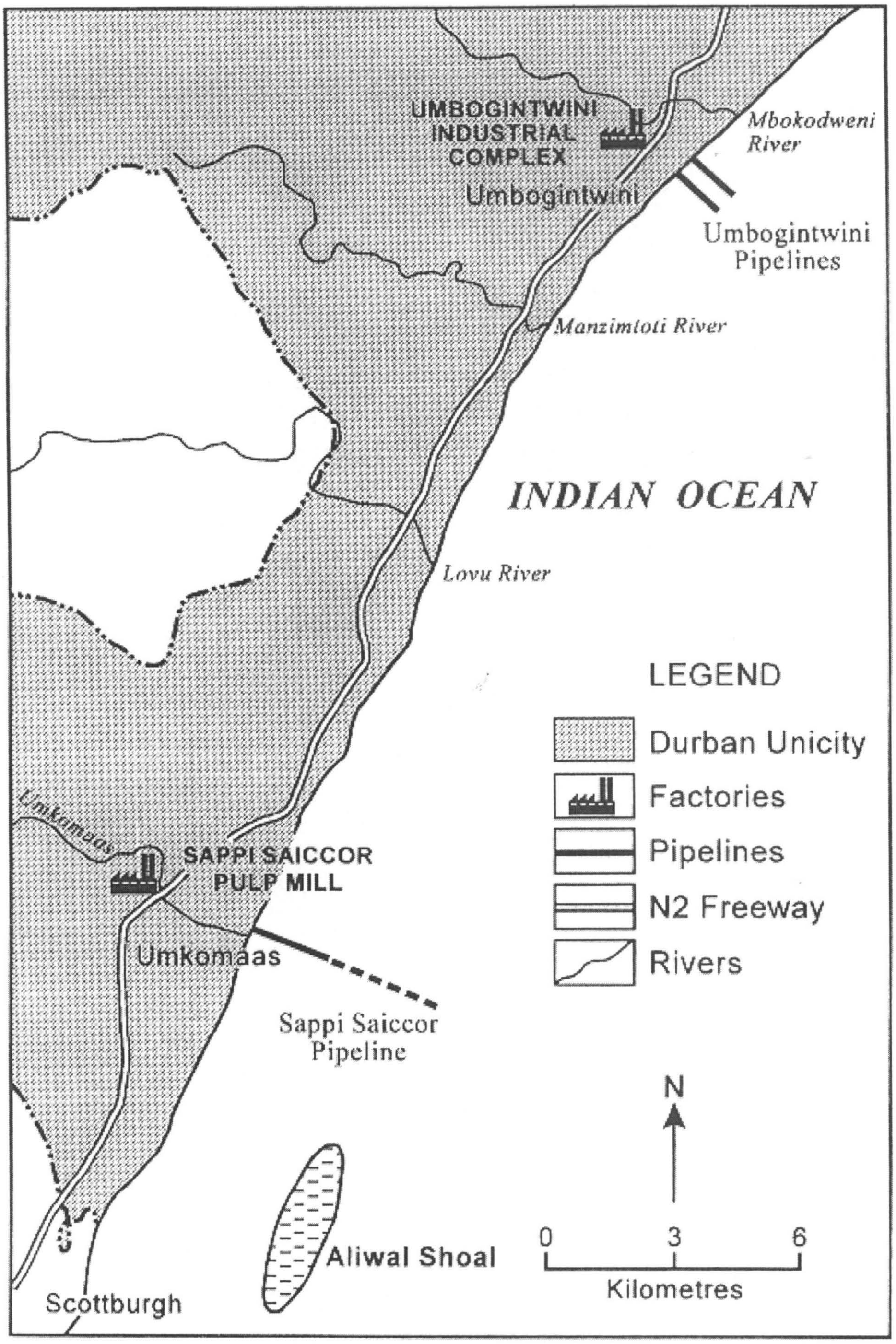

Figure 3.2: Location of the Sappi Saiccor Mill and the Umbongitwini Industrial Complex (Source: Scott, 1999c).

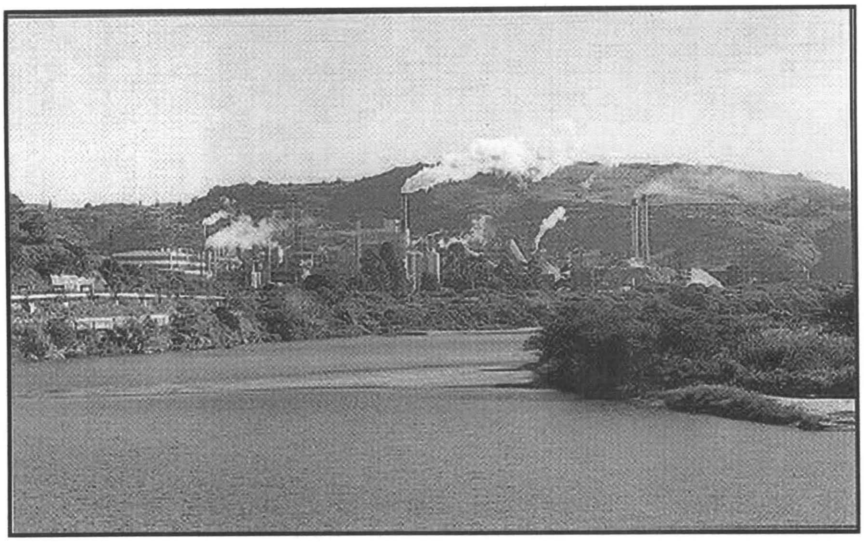

Plate 1: Sappi Saiccor mill situated on the banks of the Umkomaas River.

The effluent has a tendency to stabilise naturally forming foam in the surf zone (McClurg, 1997). It is buoyant, has a characteristic odour, and discolours seawater with its distinct dark colour. Situated further north of the Sappi Saiccor mill is the Umbongitwini industrial complex with two more industries, AECI and Tioxide SA, which also dispose their effluent into the sea via pipelines (see Fig.3.2). This disposal of effluent into the sea has raised a number of concerns pertaining to its impacts on, the marine environment; the intrinsic value of the ocean (i.e. the aesthetic and ethical value); diving conditions at the Aliwal shoal (reputed as one of the foremost diving sites in the world) and its human health risk (Oelofse, 1999).

Durban's growing population calls for an increasing need for more waste disposal sites. The ocean is therefore used as a sink for most of this waste. There are eighteen point sources discharging effluent into the sea, including marine pipelines from the Sappi Saiccor Mill and the Umbongitwini Industrial Complex. Figure 3.3 shows all the point sources, their types and relative quantities. It can be deduced from this map that Sappi Saiccor disposes more industrial effluent into the sea than any of the other industries.

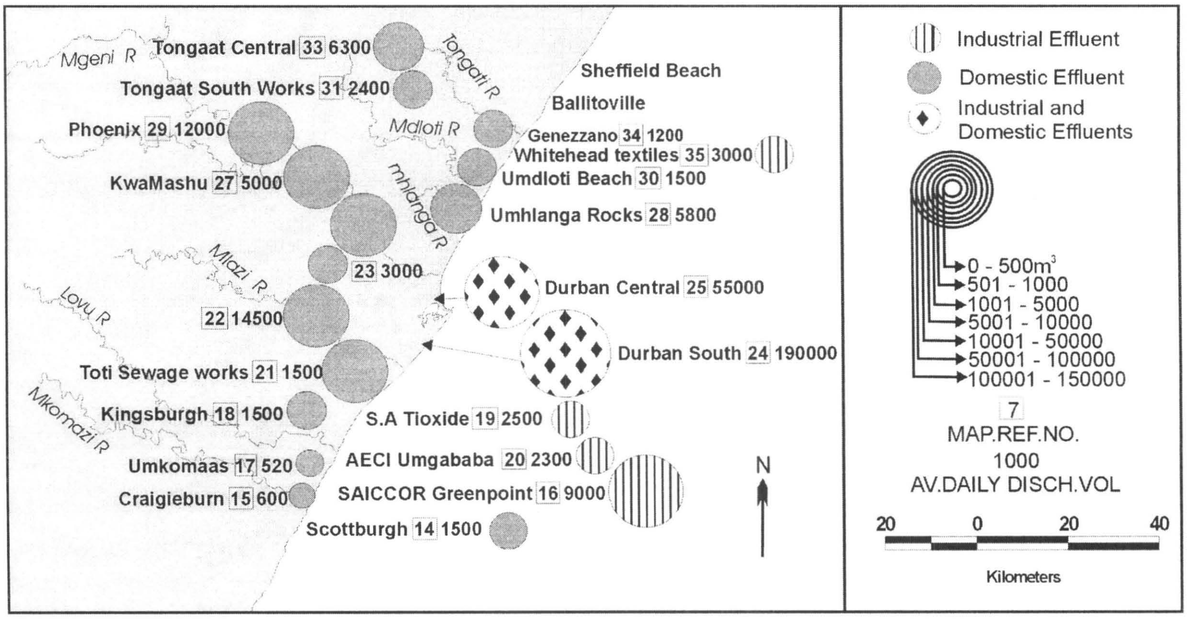

Figure 3.3: Coastal effluent discharges along Durban's Coast

(http://www.ceroi.net/reports/durban/issues/marine/pressure.htm)

3.3 STAKEHOLDERS IN THE MONITORING OF THE MARINE WATER QUALITY OF THE SOUTH COAST

It is due to these concerns and others arising from the disposal of effluent from other industries along the south coast that there has been considerable and increasing opposition from the public to effluent disposal into the sea. Local residents and sea users have voiced their concerns pertaining to the impacts of effluent, which ultimately infringe on their use of the sea. In the mid 1990s, a bumper sticker campaign was launched by local residents, declaring that Saiccor was polluting their ocean (Scott, pers. comm., 15/ 06/ 2000). This opposition resulted in growing conflict between the community, Sappi Saiccor and the Department of Water Affairs and Forestry (DWAF), who act as regulators.

It is this escalation in conflict that ultimately led to the formation of the South Coast Marine Pipeline Forum (SCMPF) in August 1995. This is a voluntary forum comprising of all stakeholders involved with both the Sappi Saiccor and the Umbongitwini pipelines. The major objective of this forum was to resolve the conflict. A charter was therefore signed committing everyone to working jointly towards the resolution of the conflict that arose due to these concerns (Scott, 1999b).

Due to the pending application of the Sappi Saiccor permit renewal in 1996, the SCMPF recommended the formation of participatory Permit Advisory Panels (PAPs) for the different pipelines to provide for public participation in the permitting process. This was a result of a realization of the need for a strategic approach in resolving this issue in a case specific manner. These panels comprise of a range of stakeholders and their task is to ensure compliance of permit conditions. They also make recommendations concerning the permit conditions themselves to ensure a dynamic system that can keep abreast with changing ideas and objectives in the monitoring process. The Minister of the Department of Water Affairs and Forestry (DWAF) approved the proposal for the formation of these PAPs, and they started operating in January 1997 (Scott, 1999c).

Although the PAPs started operating in 1997, it was acknowledged in one of the Saiccor PAP meetings that this particular PAP only began functioning properly and started showing some progress in 1998, a year after its establishment (Scott, 1999c). This can be attributed to the high levels of conflict and mistrust that prevailed between the stakeholders. This still remains the major stumbling block in the smooth running and operation of the PAP even to date. The PAP committee is however committed to resolving this conflict and ultimately stakeholders are working together to promote sustainable economic development. A group dynamics specialist was appointed in August 2000 to resolve issues within the PAP as a result of the high degree of conflict in this panel.

The task of the PAP is to make recommendations to the regional Director of DWAF regarding conditions to which Sappi's exemption could be subject to, as well as monitoring their compliance with the conditions of the exemption (see Appendix II). The PAP comprises of a range of stakeholders based on the recommendations made in the Social Impact Assessment (SIA) of 1996, which was undertaken by Dr. Scott from the University of Natal (Appendix I).

3.5 MANAGEMENT OF THE IMPACTS OF EFFLUENT ON THE MARINE WATER QUALITY

Due to the rising concern over the impacts of the effluent on the marine environment, Sappi Saiccor was pressurized into cleaning up their act. There were several options that Sappi Saiccor had that could decrease the impact of the effluent. They could convert from calcium to magnesium, use biological treatment, membrane technologies, pyrolysis, extract lignosulphonate or extend the marine pipeline. The first four options were technically feasible, though high on capital cost, hence commercially unacceptable. The lignosulphonate extraction option was the most attractive, but was market dependent while the extension of the pipeline was lower on capital cost (Sappi Saiccor presentation to DWAF, 25/09/97).

Sappi Saiccor needed to reduce the impact of the effluent by at least 70%, both on the beaches and the shoal, as stated in the permit. Of all these options, the extension of the marine pipeline was the only one that it was felt could achieve this in a relatively short time and was not prohibitively expensive. It was however acknowledged in a letter from Sappi Saiccor to DWAF that extending the pipeline is only an interim solution, and the problem should be fully solved when the lignosuphonate plant is running.

Sappi Saiccor has since implemented a number of strategies and actions to reduce the impacts of the effluent. These include the conversion of part of the mill process to a magnesium based recovery as opposed to the calcium based process that is the main contributor to Sappi Saiccor's effluent load (Crowther Campbell & Associates, 1997). Another initiative was to extend of the 3.5 km pipeline. This was undertaken in response to public pressure to reduce the impact of the effluent along the beaches. DWAF requested Sappi to undertake an Environmental Impact Assessment (EIA) in response to their application for this extension, and this was subsequently undertaken from January to September 1997.

As part of the EIA, CSIR in Stellenbosch was commissioned to do an ocean current study based on a computer model to predict the appropriate pipeline length that would yield optimal dispersion and dilution of the effluent, so that its impacts would be reduced. The model indicated that a 6.5 km length would be the best option; hence construction of this pipeline commenced in January 1998 and was declared operational on the 20th April 1999 (See Plate 2). The pipeline extension was predicted to reduce the occurrence of the then old effluent and foam levels of 18% to less than 4%. According to this model, any extension beyond 6.5 km would not be suitable due to the fact that stratification and the temperature of the water at that depth would prevent the effluent from rising through the water column to the surface; hence it would be trapped and the dilution decreased (Crowther Campbell and Associates, 1997).

In addition to the pipeline extension, a lignosulphonate plant, LignoTech SA, was constructed and started production in December 1999. This was a joint venture between Borregaad Industries of Norway and Sappi Saiccor. This plant extracts excess lignin, which is the major component of the effluent contributing to its distinct dark colour, which softens the effluent's environmental footprint. This by-product is then exported and can be used for a variety of commercial applications and also as a dispersing agent in concrete, textile dyes, pesticides, ceramics and as binding agents in briquetting, animal feed and dust suppression. The production of this plant fluctuates depending on the market for lignin and also on the operational or maintenance problems of the plant itself. It started off with a production capacity of 100 tons per month in 1999 when the plant began production and has increased to 55, 000 tons. Borregaad and Sappi Saiccor announced on the 9th May 2001 that they plan to expand the capacity of the plant through the introduction of a new production line. It is envisaged that the new plant will commence production by mid 2002 and that production will be boosted from a current 55, 000 tons to 150 – 200, 000 tons per month (htpp://www.mbendi.co.za).

Sappi Saiccor had their permit renewed in October 1997 based on the findings of the EIA. The new permit stipulated that the extended pipeline should reach a minimum reduction of 70% of the present aesthetic impact of discoloration and foaming on the beach and the shoal (Sappi Saiccor Permit, 1997; Appendix II), though it does not stipulate how this 70% should be measured. The measurement of the required 70% reduction has been the focus of debate within the PAP and is considered in this research. A workshop was eventually held in December 2000 to clarify what the 70% clause implied and how it was supposed to be measured. The permit could only be renewed to 2002 if the 70% improvement had been achieved; otherwise the permit was liable for termination with immediate effect. DWAF has since stated that this clause will have to be revisited as they are now in a process of restructuring their permitting system in order to issue licenses in the future (PAP Minutes, Feb 2001).

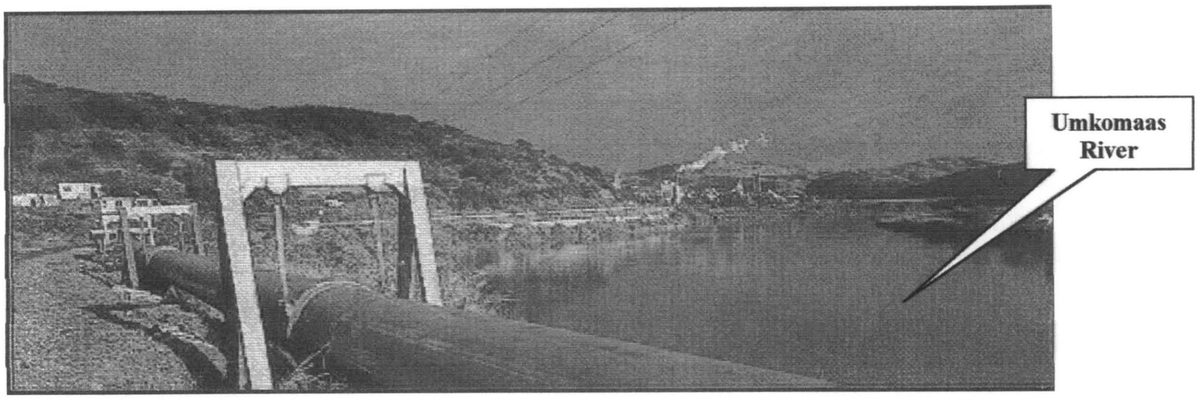

Plate 2: The Sappi Saiccor pipeline running on the banks of the Umkomaas River out to sea.

3.5 MONITORING OF THE SAPPI SAICCOR EFFLUENT

As a way of monitoring its compliance with the permit conditions, Sappi Saiccor has historically and continue to undertake routine sampling and analysis of the effluent as it leaves the pipeline. This data is used for reporting to DWAF. In addition to this, four 'trained effluent officers' record and monitor the presence of effluent. This is done twice daily and has been going on for the past 26 years (M. Bentley, pers. Comm., 07/12/2001). The officers visually assess the impacts of the effluent from strategically selected points along the shore where they can see the effluent in the ocean. They record their observations in the following categories:

- *Plume visibility*: referring to the presence of the dark purple colour in the water, normally closer to the pipeline.
- *Suds*: the presence of foaming in the long shore trough and on the back line
- *Lace*: streaks of lightly foaming effluent which occur when the suds are pulled out to sea due to wind, and hence are usually in long parallel lines.
- *Old effluent*: a result of decaying or oxidized foam. It is usually darker in colour and causes blackening or greying on the surf.
- *Foam*: referring to the presence of effluent on the beach (Oelofse, 1999).

Sappi's Environmental Manager has reported the data from both of these forms of monitoring to the PAP every month since 1997. The PAP normally discusses this information, noting any exceedences and requesting their verifications, and ultimately suggests possible solutions to the problems. Sappi Saiccor is also expected to hand in monthly reports to DWAF and give feedback to the SCMPF every three months. DWAF also undertakes independent monitoring to monitor compliance and as a check against the results obtained through industry's monitoring. The analysis done by Sappi Saiccor's Environmental Manager, Mike Bentley comprises of two sets of calculations namely, the determination of the Aliwal diving incidence and the Aliwal diving severity. Both of these applications have been used to assess the effectiveness of the pipeline extension.

The Aliwal diving incidence: This is the percentage of days when effluent was present within a month, recorded over a year. The Environmental Manager decided an effluent day was recorded as such when 50% or more of the dive operators recorded the presence of effluent. The divers record the presence of effluent as either E, implying there was effluent present or LE, implying there was little effluent. Mike Bentley does not consider LE records as effluent days. This implies that if all the dive operators record LE, that day will not be regarded as an effluent day. Figure 3.4 shows a graphical presentation of the data representing percentage of effluent days.

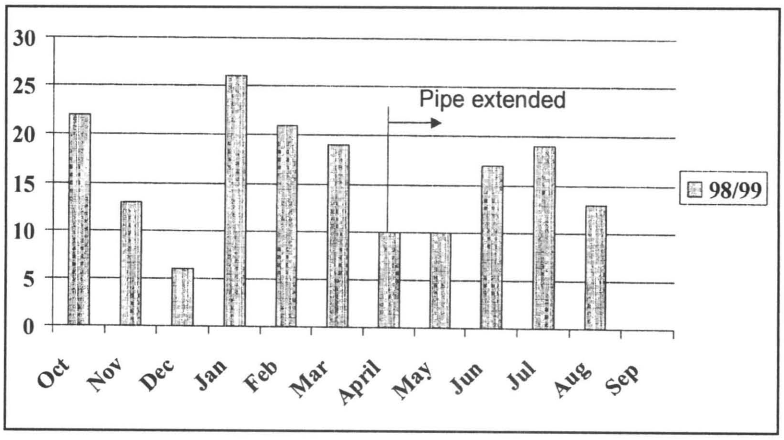

Figure 3.4: Aliwal Diving Incidence

The Aliwal diving severity (ADS): This is a figure that reflects the severity of obscured visibility within a month recorded over a year. The method for determining this was developed by Mike Bentley, the environmental officer for Sappi Saiccor. It is the summation of the difference between the monthly average visibility and the daily average visibility on effluent days. It is calculated using Equation 1. The bigger the ADS value, the worse the visibility. Figure 3.5 shows a graphical presentation of the ADS from October 1998 to February 1999.

$$ADS = \sum (X - XE_i)$$

Where X = the monthly average visibility

XE_i = Daily average visibility on effluent days

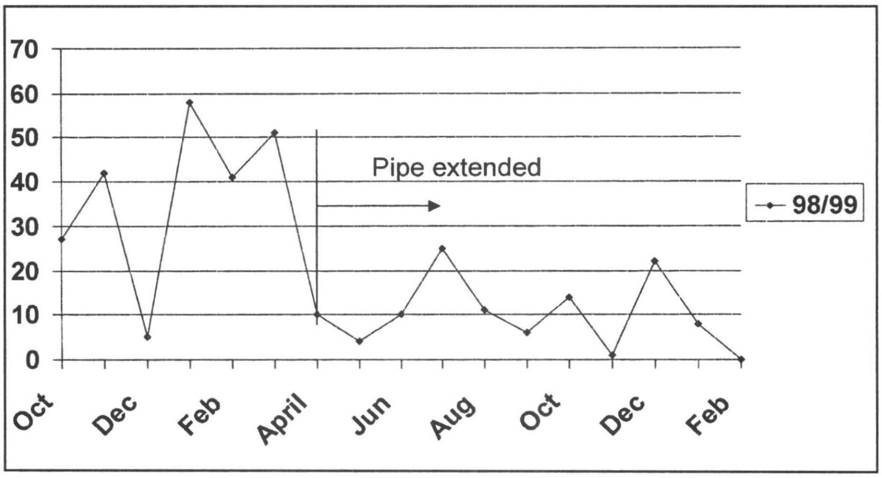

Figure 3.5: Aliwal Diving Severity

Throughout all these monitoring systems Sappi Saiccor has always complied with the permit regulations with regard to the constituents of the effluent. The issue of colour, which potentially leads to the loss of underwater visibility, has however remained the major issue of concern and has resulted in hot debate, charged with emotions between the different stakeholders within the PAP. This issue raised a great deal of debate pertaining to what knowledge is considered appropriate or valid enough to assess this impact. Different ways of measuring this impact, such as satellite imaging were proposed, but all were found not to be viable due to costs.

The recording of the effluent and visibility conditions through observation was eventually accepted as the only way of assessing this impact at this time. However the Dive charter groups challenged the objectivity of Sappi Saiccor's Effluent Officers. Due to the history of conflict between the residents and sea users, and the industry, there has been mistrust and discontentment with the methods that were adopted by Sappi Saiccor in the data collection and analysis processes. One of the dive operators, Mr. Swinford-Meyer, stated that they were dissatisfied with being referred to as mere observers (PAP minutes, 26/10/99). They wanted to be involved in the monitoring process in a more participative manner. The concern was that Sappi was not transparent in their monitoring, and that the sea users should be involved in a more active and participatory sense. The dive operators and sea users argued that they are in a better position to collect reliable data pertaining to the presence of effluent and its impacts on visibility since they use the sea almost daily and so have a better understanding of the sea conditions. However, Sappi Saiccor maintained that such 'subjective' data was not an appropriate measure of visibility conditions.

The historical monitoring process as adopted by Sappi Saiccor is typical of earlier approaches to environmental management in the sense that the public was not involved in either the collection or analysis of data. Scientific approaches used in collecting data, that are difficult for the local people to understand and review have been used. For example, Sappi Saiccor uses Hazen units as a measure of colour in seawater. Although this is a scientifically accepted measure, the local dive operators challenged the reliability and objectivity of this method. They claim that due to their extensive experience in and under the water, they are the ones who can reliably assess the presence of effluent in the sea (Scott, 1999c). The sea users have a very good understanding of the ocean currents, wind systems, sea conditions and the likely set of conditions within which effluent is likely to occur. The proposal that the dive operators could collect data that would be considered as a valid source of data for monitoring the underwater visibility was met with a great deal of resistance and lead to much heated debate within the PAP. In the same way, as the divers questioned the credibility of the effluent officers' judgement so did Sappi Saiccor and DWAF question the validity of the divers' data. It was eventually accepted by the PAP, after much debate that this 'subjective' data collected by the divers would be regarded as valid data to be used in the monitoring process (PAP Minutes, 08/04/1999).

This acceptance was mostly motivated by the notion that the monitoring process would be more transparent and inclusive of the affected stakeholders. It was emphasized that having a range of data is good for the monitoring process and for checking the legitimacy of the various sources (PAP minutes, 18/05/1999). Both Sappi Saiccor and DWAF were requested to pledge their support in writing for the divers' data as valid data to be used in the monitoring system. Sappi Saiccor wrote a letter stating that if and when other information come to light, it would be used as a separate set of data to improve the data input given by the dive operators (PAP minutes, 28/ 09/ 1999). DWAF also drew up a protocol for plume visibility monitoring, which was to be accepted by the regulators as a legitimate means of measuring compliance and would be legally binding. The initial drafts of the statements given by both Sappi Saiccor and DWAF reflected some reservations about the divers' data being accepted as valid data. These were then amended by the PAP to reflect full acceptance of the divers' data. Furthermore a provision was made that a statistician be appointed to analyse and assess the validity of this data (PAP minutes, 28/09/1999).

The DWAF protocol was drafted as a watch dog document outlining a monitoring process to be followed in order to determine the extent of change that will result from the new 6.5 km pipeline, in accordance with condition 2.3 of Sappi Saiccor's permit, which states that there has to be 70% improvement in aesthetics. In essence the protocol suggested three monitoring periods, before and after commissioning the pipeline and also on-going monitoring. This was deemed the only possible way of validating this data since there were no other possible validity indicators, such as other independently obtained data sets, which could be used for comparison. The researcher did try to get other data sets from other independent organisations known to do regular monitoring along the south coast such as the Sharks' board. Their records however, were not useful since they had a different focus.

This protocol was requested after long intense debates as to what the best way of assessing this 70% improvement was and which knowledge system was legitimate. Once it was agreed that the divers' data would be accepted as another source of data, five charter groups were issued with log sheets on which records of visibility, presence of effluent, ocean currents and prevailing wind conditions, and general ocean and weather conditions were recorded (Appendix III). Initially, Sappi Saiccor undertook the task of analysing this data, the results of which were reported to the PAP on a monthly basis together with Sappi Saiccor's monthly emission report. It was however argued that the protocol calls for an independent statistician to carry out this analysis. Researchers from the School of Life and Environmental Sciences of the University of Natal offered their services to do this analysis. The PAP agreed that a Masters student from the School of Life and Environmental Sciences, with the help of a statistician, would do the analysis and ultimately derive alternative methodologies of data collection and analysis such that the divers' data could be verified and analysed and that the 70% improvement could be assessed. This study was commissioned, and commenced in March 2000. The terms of reference for this study were made based on the requirements of the protocol and are shown in Table 3.1 below.

Table 3.1: Terms of Reference for this study (PAP minutes, 14/03/2000)

▪ Assess the present monitoring system, in terms of the collection and analysis of data as currently done by Sappi Saiccor 's environmental manager, and recommend alternatives. ▪ Assess the validity of the divers' data ▪ Develop a method to quantify the improvement in water quality as a result of the extension of the pipeline.

As stated in the protocol, as the designated student to carry out the analysis, the researcher was required to attend the monthly PAP meetings (Plate 3 and 4) where I was expected to report back on progress made. Dr. Immo Kleinschmidt, a bio statistician from the Medical Research Council and Ms. Glenda Mathews, a statistician from the statistics department at the University of Natal, were consulted for review of the analysis already done and advised on further possible analysis. A meeting was also held with Dr. Allan Connell from the CSIR for more suggestions.

Plate 3: One of the Sappi Saiccor PAP meetings (29/01/02)

Plate 4: Presentation of the monitoring results (29/01/02)

3.6 CONCLUSION

The KwaZulu-Natal South Coast has weather conditions that are closely comparable to a Mediterranean climate. These conditions, compounded with its proximity to one of the world's best diving spots, the Aliwal Shoal, makes it a popular tourist destination. Small businesses have in turn also flourished due to this high tourism market, with diving at the Aliwal Shoal being the most important. This business industry was however threatened as the marine environment deteriorated due to the disposal of industrial effluent into the sea. The effluent was from the Sappi Saiccor mill, which is situated along this coastline, on the banks of the Umkomaas River, and to a lesser extend from the Umbongitwini Industrial complex. The effluent decolourises the water and distabilises foaming along the beaches, thereby compromising the aesthetic or intrinsic value of the area. The discolouration also impacted negatively on the underwater visibility, which is an important aspect when diving. A lot of concern was also raised pertaining the impacts of this effluent on the health of both the marine environment and the people using and living around the area. Scientific research carried out by the CSIR however showed that the effluent did not pose any human or marine health risk. Consequently, the aesthetic impacts and the impacts on the underwater visibility became the only issues of concern.

Due to these concerns, the community in the area and the sea users made public statements voicing their concerns and demanding the government to resolve the matter. The result was the formation of a Permit Advisory Panel (PAP), which comprised of the community, industry, government and NGOs, to provide for public participation in the monitoring of the impacts of the effluent on the marine environment. This panel serves to monitor Sappi Saiccor's permit compliance and also to advice DWAF on permit conditions. In an attempt to comply with its permit requirements Sappi Saiccor extended their pipeline from 3 km to 6.5 km and also built a lignosulphonate plant to extract excess lignin, which is the major constituent of the effluent which causes the discolouration, from the effluent.

Although Sappi Saiccor had been solely responsible for the monitoring process for a long time, the divers were eventually accepted as alternative data sources, and they became involved in the data collection process. Due to pre-existing conflict between the stakeholders, there was a great deal of conflict and mistrust within the PAP. There were heated debates about which data sources were most valid and reliable. It is due to these concerns that this study was commissioned such that the levels of transparency could be increased, and also contribute towards the conflict resolution process. The local knowledge of the divers is being analysed using scientific methods. Two different knowledge systems are being used in a complimentary and integrated manner, such that consensus can be reached regarding the level of visibility before and after the building of the extended pipeline. In this way, a way forward for improved marine water quality could be found.

CHAPTER FOUR

METHODOLOGY

4.1 INTRODUCTION

Since this study attempts to integrate subjective local knowledge and 'objective' scientific knowledge, both quantitative and qualitative research methods were adopted. Qualitative techniques were used to analyse the subjective qualitative data collected by the divers. Furthermore, qualitative methods were used to assess the role of this study in the functioning of the PAP and the role of local knowledge in environmental decision-making. This chapter outlines these data collection and analysis methods. In order to ensure an understanding and appreciation of the type of data used in this study, the first section of this chapter will outline the data sources.

4.2 DATA SOURCES

Data is available in many different forms, obtainable from different sources and generated in a variety of ways. All this information can however be differentiated as being either qualitative or quantitative. It is also common to differentiate between pre-constructed data already available from official sources and data constructed by the researcher from interviews and participant observations. These distinctions are important when detailing certain techniques that make use of particular data types (Hammond and McCullagh, 1998). Robinson (1998) however argues that a good research combines both qualitative and quantitative methods. He further argues that different data sources can also be used together provided there is a sound theoretical basis on which it is based and the data limitations fully acknowledged (Robinson, 1998).

This study is an example of a study that integrates qualitative and quantitative knowledge systems, where quantitative methods are used to analyse qualitative data. Since the major impact of the effluent is its ability to reduce underwater visibility, the presence of effluent in water and underwater visibility are the obvious indicators used to monitor the performance of the Sappi Saiccor pipeline in terms of the level of pollution in the water.

The divers make daily records of the presence of effluent and the consequent underwater visibility, based on visual assessments. Records of prevailing ocean currents and weather conditions are also made, since they too affect visibility, to ensure an accurate correlation of the presence of effluent and under water visibility (Appendix III). Though qualitative in nature, the visibility data is recorded numerically as a range (in metres) since it is an approximation. Presence of effluent is however recorded as a binary measure, where a record only specifies whether there is effluent or not. These records are forwarded to Sappi Saiccor's Environmental Manager, Mike Bentley daily, who in turn would forward them to the researcher for analysis. These records were analysed statistically to assess validity of the data, the extent of the Sappi Saiccor effluent in the water and its consequent effects on the diving conditions, and hence the performance of the pipeline. Monthly reports from this analysis were then presented to the PAP.

Data relating to the functioning of the PAP and the stakeholders' perceptions of the role of this study was collected through semi-structured interviews and a questionnaire (See Appendix IV), and also through available documentation, such as the minutes of the meetings. Furthermore, information was collected through observation in the PAP monthly meetings, since this study is an action research project. The researcher was actively involved in the PAP as a participant observer and in presenting Monthly feed back in the PAP meetings on the analysis of the divers' data. The next section will therefore provide a detailed account on action research.

4.2.1 Action research

Greenwood and Levin (1998), define action research as social research carried out by a team encompassing an action researcher and members of the organisation or community seeking to improve their situation. They argue that it advocates for broad participation and supports action such that a more holistic and transparent approach, where all stakeholders have a voice, can be achieved. Furthermore they state that the action research process is a joint venture between the researcher and the stakeholders starting from the identification of the problem, generating or constructing relevant knowledge, moving on to learning and eventually executing their actions based on what they have learned. Action research is based on the belief and experience that all people accumulate, organise and use complex knowledge systems every day of their lives. During this time new knowledge is constructed as people learn through their experiences and attempt to tackle the problems they encounter (Greenwood and Levin, 1998).

Kork *et* al. (2000), state that action research is a research practice with a social change agenda. It critiques the conventional academic practice that studies social problems without providing solutions to them. This however does not imply that action researchers reject formal research methods nor undermine the necessity of valid social knowledge. Action research acknowledges that there is need to take research a step further by attempting to find solutions to problems being investigated within a local setting (Greenwood and Levin, 1998).

Action research encompasses three elements namely: research, action and participation. Research is considered an important element in action research since it is considered to be one of the most important and powerful ways of generating knowledge. The process of participation is also deemed important as it democratises the knowledge generation process (Kork *et al.*, 1997). It advocates for the inclusion of all stakeholders such that they take responsibility and control of their own life situations. The last element, action, in a way makes the action research process participatory in a second sense. The community organisation or group takes action in alleviating their problems. Action research is the effective application of research where it is not only used to learn about problems, but is also reactive towards them (Allen, 2000b).

Unless all three are present, the process cannot be referred to as action research. Action research can thus be defined as a form of research that generates knowledge that can be used to take action that can ultimately promote social change and analysis. Social change in this regard is centred on empowerment and capacity building where the community or organisation or group of people are in charge of their own destinies and can continue growing long after the research itself is over (Greenwood and Levin, 1998).

Zuber-Skerrit's (1992) as quoted by Allen (2000b), summarises the characteristics of action research in what he refers to as the CRASP definition. It is defined as a **C**ritical collaborative inquiry by **R**eflective practitioners who are **A**ccountable and **S**elf-evaluative in their practice and findings, and engage in **P**articipative problem solving.

AR can contribute to people recognising their values. It helps people envisage a desired future and enables them to plan and organise effectively so that they can achieve their goals. It is change oriented and seeks to bring about change that has a positive social value. "Learning by doing is therefore fundamental to action research (Allen, 2000b). The basic underlying assumption that underpins this concept is the realisation that people can learn and create knowledge on the basis of their concrete experiences, through observing and reflecting on that experience and by forming abstract concepts and generalisations about what to do next, and eventually testing the implications of these concepts in new situations.

Action research aims to contribute to the practical improvement of problem situations while developing the public's knowledge. It also aims to develop the self-help competencies of people facing problems (McNiff, 1988). The aim is to build the capacity of the participants to act and also to support them such that they can improve their problem situations in a self-reliant and empowering manner (Kork *et al,* 1997). If people are not provided with the capacity to participate, successful change is unlikely to occur. Given these aims Allen (2000b) derived four basic themes to guide AR.

- Collaboration through participation
- Capacity building
- Social change
- Empowerment of the participants.

In this study collaboration has been fostered between the community, industry, and the authorities through the establishment of the PAP. Each of these stakeholders is represented and participates in the monitoring of the impacts of the Sappi Saiccor effluent on the marine environment and the livelihoods of the sea users. The divers collect the data, which is then analysed by both the researcher and Sappi Saiccor's environmental team. The results of both forms of analysis are then presented in the PAP monthly meetings, where the other PAP members then comment on the results themselves as well as on the methods of analysis and also make suggestions. This is an interactive learning process for all participants, thus building the capacity of all those involved. The community learn about scientific methods of analysis while the outsiders learn about the local conditions as perceived by the local people and their problem solving or coping strategies. The process of capacity building is normally accompanied by that of empowerment. Helping people develop knowledge about how best to deal with their situation is the best empowerment tool. When sharing information with the community you are empowering them to take control of their situation and improve their quality of life.

Action research does not only benefit the participants. Action researchers also stand to gain in this process. They acquire facilitation and managerial skills such as the ability to build a shared vision between all stakeholders such that they can work successfully together. This process can also expose and challenge their mental models and ultimately foster more systematic patterns of thinking (Allen, 2000b). In conjunction with the aims of the AR process itself, the action researcher has a vital role to play in order for this process to be a success. Firstly, the action researcher has to ascertain the involvement of the wider community. He or she also has an obligation to develop participatory attitudes, excitement and commitment and also bring about improvements and innovation for individual and community benefit. The other key role for the action researcher is to develop frameworks and networks through which people can continually expand their capabilities to shape their future. He or she also has to develop a learning environment that challenges the status quo and ultimately fosters the generation of liberating alternatives (Greenwood and Levin, 1998).

Action research was primarily introduced as an alternative to overcome the limitations of the positivist discourse, giving the impression that AR and positivism are contrary to each other. This view has led to researchers believing that they have to choose between these two. Ultimately this led to conflictual debates between qualitative and quantitative researchers who were made to feel that they are on opposite sides and hence have to defend themselves (Kork *et al*., 1997).

The information generated from an action research process is often criticised since it is not obtained through 'rigorous' methods, and it lacks scientific discipline. This is thought of as a major weakness that will supposedly lower its academic value due to its informal and unplanned structure. Furthermore action research is often criticised for its inability to produce models that are externally valid. i.e. models that are valid outside the context of their particular setting or situation for which the action research was developed. This is attributed to the fact that action research processes concentrate on a small group of people, and represent the dynamics of that particular group situation. This is seen as a weakness since different cases apply to different groups, unless there are a reasonable number of similar cases to base any conclusive statements (Kork *et al.*, 1997).

The low level or lack of control is seen as one of the limiting factors of the action research process. This is believed to hamper the critical examination of the influence of a set of independent variables on one dependent variable. It is also argued that personal over-involvement of researchers in action research could hinder good research as they might impose personal biases. Action research is also alleged to be weak with regard to the lengthy period required to conduct a quality action research. This often causes problems with sponsors or clients (Greenwood and Levin, 1998; Kork *et al.*, 1997).

Action research practitioners however argue that the very criticisms of action research could actually be turned around and when looked from another angle are its very strong points. The in-depth nature of action researches is believed to increase the confidence level of its findings (Kork *et al.*, 1997).

McNiff (1988) argues that the cyclic nature of the action research process is believed to go a long way towards adding rigour to the whole process, and hence lending credibility to its findings. While personal over-involvement is seen to hinder the production of value free, objective information, it is argued that it is impossible for a practitioner to inject positive intervention, which is one of the characteristics of action research that make it so unique, without being involved. In traditional research, the researcher always strives to be as objective as possible, and separation from the system being studied is thought to achieve this. The system is also reduced a few variables, with the rest of the system assumed to be constant. This has proven to be appropriate in many circumstances, particularly in the biophysical sciences. It is however argued that since social systems are complex and dynamic, the researcher must be actively involved in order to understand the dynamics and complexities of the relationships between individuals, groups, and their physical environments (Allen, 2000b).

Due to the complexity and sensitivity of the Sappi Saiccor issue, getting individual opinions in a group situation was difficult, hence interviews and questionnaires were also administered to the PAP members. Semi-structured interviews were conducted with all the dive charter operators in Umkomaas, and some of the PAP members. The choice of the interviewed PAP members was based on the term of service within the PAP, where members who had been actively involved in the events that led to the inception of the PAP were considered to be more knowledgeable about the dynamics of the PAP. Questionnaires were also administered to all the PAP members at one of the PAP meetings, and a follow-up was also done via e-mail. This next section will justify the choice of these two methods.

4.2.2 Social survey questionnaires and interviews

Questionnaires and interviews were specifically selected due to their complementary nature. The weaker points of one method seem to be the very strengths of the other. This study therefore adopted both these methodologies so that they could complement each other and consequently optimise the data collection process.

Semi structured interviews were undertaken due to their flexible nature. Interviews have the advantage of enabling the researcher to clarify and probe further so as gain an in depth understanding of the issues under discussion. The response rate also tends to be higher for interviews since even the illiterate groups that would otherwise have been excluded by mailed questionnaires can be included. It also minimises the responses of 'I don't knows' and 'no answers'. There is also no risk of not getting back all the questionnaires. Another advantage is the level of detail that talking promotes as opposed to writing, hence more detail and explanations can be captured from interviews (Babbie, 2001; Denzin and Lincoln, 1994).

Furthermore the interviewer has the advantage of observing non-verbal behaviour to assess the validity of the respondents' answers. Emotions and attitudes are conveyed through bodily expressions. Another added advantage is the control the interviewer has over the situation. An interviewer can standardise the interview environment by ensuring things like privacy, and that the respondent does not 'cheat' by getting answers from others or by having others complete the entire questionnaire for him or her. The interviewer also has the advantage of asking the questions in any desired order. The interviewer can record spontaneous answers. This enables important issues that may have been overlooked in the questionnaire to be included. Lastly, the interviewer can record the exact date, time and place of the interview so that if anything happens during the study that may result in the interviewee changing his statements, the researcher can compare the before and after answers (Denzin and Lincoln, 1994).

Interviews are costly both in terms of time and money. Questionnaires were therefore used to gain information from those people who could not be interviewed. Interviews are also prone to a certain level of bias. It can happen that the interviewer can misunderstand an interviewee. It is also true that the respondent's answers can be affected by his or her reaction to the interviewer's sex, race, social class, age, dress, physical appearance or accent. Since questionnaires limit respondent-researcher interaction, any influence the researcher may pose is curbed.

Furthermore, it has been shown repeatedly that a person's reasoning ability is adversely affected by such factors as fatigue, stress illness and heat (Bailey, 1978). The mailed questionnaires provide the best opportunity for the respondent to answer when the adverse factors are at a minimum as opposed to interviews, which may be at a very inconvenient time for the respondent. Questionnaires also provide more privacy and anonymity for the respondents. Less assurance of anonymity may result in the respondents being reluctant to be honest about their feelings especially on sensitive issues. While the flexibility of probing and rephrasing questions for the different respondents may be an advantage, it may pose problems if it causes difficulty. The next section will discuss how the data was analysed in this study.

4.3 DATA ANALYSIS

In geographical data analysis, it is the norm to apply certain specific analytical techniques to the data assembled by the researcher. This ideology implies that the link between data and technique is central to this whole process of investigation. The linkages between theory, data construction, analysis and interpretation are however neither simple nor static (Cloke *et al.*, 1991). There is a considerable amount of interpretation within the process of data construction when a researcher is both a participant and observer of a social group. It is therefore of importance to note the ways in which interpretation draws upon and in turn modifies theoretical and philosophical positions within a research programme (Robinson, 1998).

This study adopted both qualitative and quantitative methods of analysis. Qualitative methods were used to assess the role of local knowledge in the monitoring process based on a participatory framework that facilitates the identification and introduction of more sustainable land management practices developed by Allen *et al.,* (1995), as well as the role of this study in the functioning of the PAP. Community participation and partnership types as proposed by Catley (1999) and Long and Arnold (1995) respectively were also used to assess the participation and partnership types within the PAP. Since the qualitative analysis adopted statistical methods, these methods will be further discussed in the following section.

4.3.1 Statistics in geographical analysis

In the early 18th century, geography was largely centred on compiling and revising maps. During the late 1950s and early 1960s, the geography discipline underwent great changes that reflected in part a change in thinking about the philosophy of the subject, although primarily they involved a methodological revitalisation (Clark and Hosking, 1986). Mowforth (1979), states that it was not until the 1950s that geographers recognised the advantages of using statistical techniques. The ensuing quantitative revolution is believed to have initiated a new way of thinking. This change involved a move to a more 'scientific' approach, where geographers became increasingly dependent on mathematical and statistical methods in their descriptions and testing of concepts, which were previously subjectively formulated. Silk (1979), however argues that geography was an empirical subject even well before the quantitative revolution of the 1960s; hence statistics can be regarded as essential to geographic enquiry.

This shift in thinking and the consequent change in methodology did however have its problems. Clark and Hoskings (1986) state that problems of ill-conceived analyses, over exuberance in the use of the methods and gross errors were most common. The beginning of this change was clouded with uncertainty and there was a great deal of debate about the implications of adopting mathematical methods. By the 1970s however things were more settled, as debates were not as emotional as they were in the beginning of this revolution. The debate had now shifted to issues relating to the philosophy of the discipline and mathematics, especially statistics had been accepted as a useful and important tool in geographic research. Hypothesis testing and verification thus became essential elements within geographic investigations (Clark and Hosking, 1986).

The basic aim of statistics in geography is to provide methods of organising and simplifying data so that their significance can be understood. Statistics also enhances and simplifies the representation of data and so ultimately aids interpretation. The methods of simplifying data and representing it in a more digestible form are commonly called descriptive statistics. Geographers use statistical methods to make conclusive statements based on empirical data, i.e. measurements derived from observation or experimentation.

A further aim of statistical analysis is to provide methods for drawing valid inferences from samples. Of major importance in modern statistics is to determine the degree of reliance that can be reasonably placed on particular samples. This branch of statistics is commonly referred to as inferential statistics (Mowforth, 1979). Statistical inference is a form of inductive inference that allows the researcher to be relatively precise about her/his degree of uncertainty. Inferential statistics provide formal procedures for calculating limits and probabilities for hypothesis testing and thereby drawing statistical inferences.

The statistical analysis in this study was guided by two objectives. The first was to assess the performance of the recently extended Sappi Saiccor pipeline. The second task was to assess the present data collection and analysis methodologies as adopted by Sappi Saiccor's environmental team, so that alternatives could be developed. Data has to be validated before it can be used in any analysis. The divers' data was therefore validated using statistical methods, such as the ANOVA test and simple graphical presentations.

4.4 SIMPLE STATISTICAL DESCRIPTIONS

This study adopted the use of simple statistical descriptions such as averages, percentages and/or counts, standard deviation, the median and graphical presentations to summarise and extrapolate the data. Four statistical moments namely, the arithmetic mean, the standard deviation, skewness and kurtosis provide tools for representing data (Williams, 1984). In this study however only the arithmetic mean and the standard deviation were used.

The arithmetic mean: This is one of the measures of central tendency together with the median and the mode. The mean is defined as:

$$\overline{X} = \frac{\sum x_i}{n}$$

Where $\sum x_i$ = the sum of all values of variable X, and

n = the number of observations (Robinson, 1998).

The mean was used to summarise the divers' data such that daily and monthly estimates of underwater visibility both for individual dive charter groups and collectively can be made. This allowed further analysis to assess validity and consistency between the different dive charter groups and trends over time such that the reduction in the effluent impacts can be quantified.

Measures of central tendency on their own, without using measures of dispersion to describe the level of dispersion in the distribution can be very misleading. A small deviation implies that all responses are clustered around the measure of central tendency, while a large deviation implies that the mean is a poor representation of the distribution. Summary statistics can therefore be adopted to provide for the incorporation of this dispersion (Clark and Hosking, 1986 and Robinson, 1998).

The arithmetic mean can easily be influenced or deviated by extreme values in the data set, hence in cases where the data is widely distributed, it can either give an under or overestimation of the real situation. In such cases, letter values, commonly referred to as 'resistant' due to the fact that they are not easily affected by extreme values, can be a more precise measure to use.

Letter values can be graphically displayed as box plots, displaying a summary of a frequency distribution. They feature characteristics such as the median (M), lower and upper quartiles (QI and QU) and also the lower and upper extremes (EI and EU respectively), as shown in Figure 4.1 below. The median is resistant, as it is not affected by extreme values unlike the arithmetic mean, which is easily influenced by extreme values (Williams, 1984). In simple terms, the median is defined as a central value in a series of ordered values (Robinson, 1998, King, 1969 and Williams, 1984). If the number of cases

(n) is an odd number, the central number is the median. If however the number of cases is an even number, then the median is the average of the two numbers at the centre of the observations. For example, if n = 59, the median is the 30^{th} in the series, leaving 29 values before and after. If however n = 60, the median will be $\frac{30+31}{2} = 30.5$.

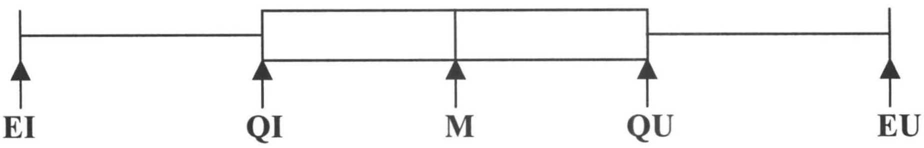

Figure 4.1: Summary of a Frequency Distribution.

Letter values are used in this study to supplement the mean, which fails to show the data distribution (variation), both within the different dive charter groups and also within different time periods. They are used to assess the dispersion of the data both within the different dive charter groups and also over time. The significance of these values was to assess if there is any one particular dive charter who is significantly different in his/ her records from the others (outliers). This also enabled a periodic comparison between the periods before and after the extension of the pipeline to its present length.

Standard deviation: More frequently, geographers use measures of variability around some measure of central tendency. These are the quartile deviation (qd), the mean deviation around the arithmetic mean (v_x), the mean deviation around the median (v_{md}), variance (s^2) and standard deviation (s). The standard deviation is most commonly used due to its practical advantages. It is defined as;

$$S(or\sigma) = \sqrt{\left(\frac{\sum (xi-\bar{x})^2}{n-1}\right)}$$

The standard deviation is the square root of the variance (s^2). It measures the deviation of a set of data about its mean. This is the preferred measure of deviation over the variance since it is an absolute measure of dispersion as opposed to the variance, which expresses this variation in terms of units of squared deviation (Robinson, 1998 and Mowforth, 1979).

These statistical descriptions that have been described above have been used to summarise and analyse the divers' data.

4.5 INFERENTIAL STATISTICS

The divers' data was further analysed using inferential statistics. After the collection and examination of data using descriptive statistics, the data was be used to infer characteristics of the population from which the sample was taken. This is part of what is referred to as inferential statistics. The basis of this analysis is probability theory, hence any results from this analysis are probabilistic in nature. Geographers have used probability theory in many ways. In inferential statistics, however, it has been used to model behaviour of the unpredictable events in real life through the use of theoretical probability distributions. Real events can be approximated through models using different types of probability distributions. The three commonly used distributions are the binomial, normal and poisson (Ebdon, 1985, Mowforth, 1979 and Robinson, 1998). The data in this study was found to be normally distributed, hence the normal probability distribution was used.

4.5.1 Normal distribution

The frequency curve of the distribution of any data set can be described in terms of its arithmetic mean and its standard deviation. If these two are known, the probability of occurrences at any given value or between any two values can be determined.

Ebdon (1985) perceives the normal distribution as the most important probability distribution in statistics, as it forms the basis for most of the statistical tests within the parametric techniques. It is symmetrical with a convex central peak at $\bar{x} = \mu$ where μ is the mean of the data, and concave tails stretching away on either side. The horizontal scale represents values of a variable with the mean being the mid-point. The total area under the curve represents a probability of 1.0. The area under the curve between any two points is proportional to the probability of occurrences of a value in between those two points (Ebdon, 1985 and Mowforth, 1979). The values of a normally distributed variate, X, are expressed in terms of deviations from the mean. The newly created values are standardised, and are termed z values. Positive z values imply that the values are greater than the mean while the negative ones represent values less than the mean (Robinson, 1998).

$$Z = \frac{x - \mu}{\sigma}$$

It is from these z values that probabilities can be calculated. The area under the curve between any two points can be calculated and is readily available from pre-prepared tables referred to as z tables. Figure 3.2 (a) below shows an example of calculating the area between the mean, where z = 0.0 and z = 0.5. This value can be read directly from the table, and is 0.19146. The implication here is that the probability of getting:

- A value between *0.0* and *0.5* is *0.19146*, i.e. *P = 0.19146.*
- A value greater than *+0.5* is *0.30854*, i.e. *0.5 – 0.19146*

The area under a frequency curve can be used as an estimate of the probability of having a value between the two points defining the area. The following probabilities, shown in Figure 4.2 below, are mostly used in statistical analysis.

i. Approximately 68% of the area under the curve lies within ± standard deviation (δ) of the mean, hence the probability of getting a value that lies within this range is 68%.
ii. Approximately 95% of the area under the curve lies within ± 2 δ of the mean, hence the probability of getting of value that lies within this range is 95%.
iii. Approximately 99% of the area under the curve lies within ± 3 δ of the mean, hence the probability of getting a value that lies within this range is 99%.

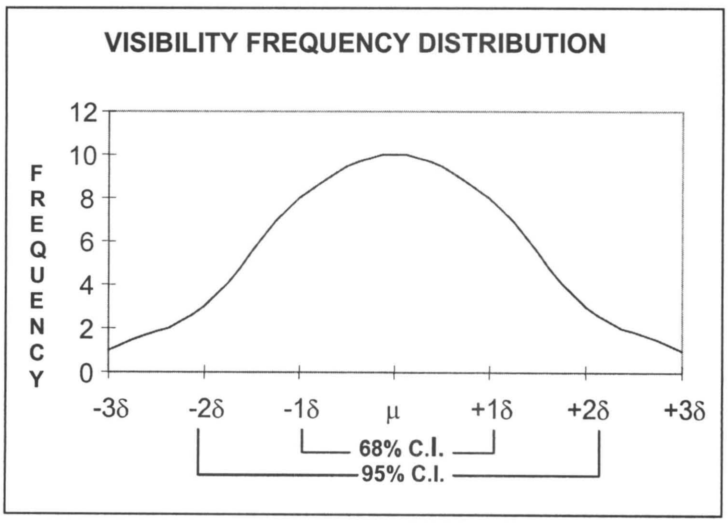

Figure 4.2: Frequency distributions at 68% and 95% confidence intervals

Figure 4.3 shows the z values associated with one, two and three standard deviations on either side of the mean. For convenience, these are normally given as $P = 0.68$, $P = 0.95$, and $P = 0.99$ respectively, and can be converted to percentages such that ultimately they are referred to as 68%, 95% and 99% confidence intervals as shown in Figure 4.3. The confidence interval provides a range that is highly likely to contain the true population quantity, or parameter that is being estimated. The narrower the interval, the more informative is the result.

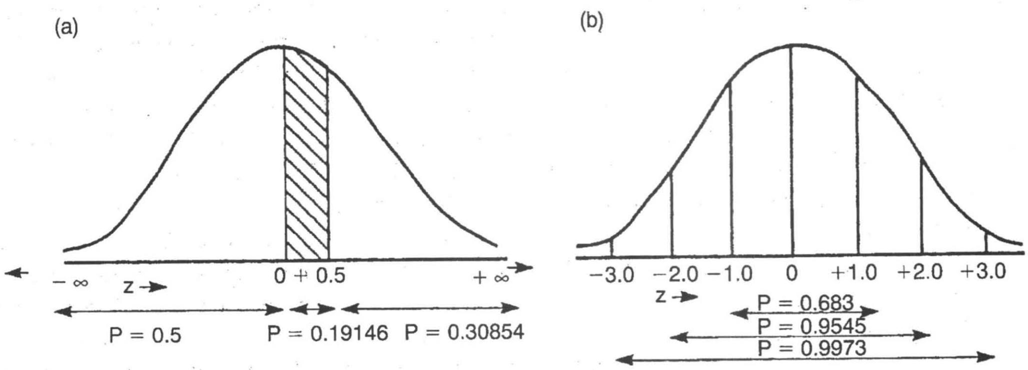

Figure 4.3: The Normal Distribution

a) *P (z = 0 to 0.5),* b) Probabilities and z values (Robinson, 1998).

This normal distribution theory was applied to calculate the monthly average underwater visibility at certain confidence limits, such as a 95% confidence interval. This theory also provided the visibility variations within months, making it possible to compare the different months and also the Pre and Post-pipeline extension periods.

4.6 HYPOTHESES TESTING

Geographers also use statistics for significance testing. This may be done using many different techniques. Hypothesis testing was applied in this study. A chi-squared test (X^2), and a t-test were used to assess the significance of the difference in the number of effluent days and underwater visibility respectively for the periods before and after the pipeline was extended to its present length of 6.5 km. The analysis of variance (ANOVA) was also used to assess the significance of the difference in the records of the five dive charter groups.

Hypothesis testing is normally done when there is an apparent relationship between variables in the data. In terms of statistical techniques, however, this term will be defined as "a general proposition about all the things of a certain sort." (Robinson, 1998). It is defined as a statement in the form of an unproven theory.

In geographical analysis, there might be an apparent relationship from which the researcher can make predictions about possible explanations or conclusive statements. In order for these statements to withstand scrutiny however, they have to be put under 'rigorous' testing, hence they are stated as hypotheses, which can then be tested. The stated hypothesis to be tested is referred to as the null hypothesis (H_o). It states that the apparent relationship within the sample data is not representative of the relationship in the population from which the sample was taken. The null hypothesis is therefore stated as the opposite of the conclusive statement made by the researcher. An alternative hypothesis (H_1), which states that the apparent relationship as seen from the sample data accurately represents the relationship as it is in the population, is also set up (Robinson, 1998; Ebdon, 1985).

The process of hypothesis testing follows the following procedure;

- Statement of the null hypothesis (Ho) and its alternative (H_1): If the null hypothesis does not state the direction in which the data differs, i.e. if it takes the form "there is no difference between A and B", then this is termed a two-tailed test. If however it states that "A is not greater or less than B", a one-tailed test is used.
- Selection of the rejection level or level of significance (α). Once the hypotheses have been stated, an appropriate test has to be applied, the selection of which depends on the type of data. Table 4.1 below outlines the different types and conditions under which they may be applied.
- Interpretation of results: The different tests give results, which determine whether the null hypothesis is accepted or rejected.
- If the calculated value is smaller than the value from the appropriate tables, i.e. ($t_{cal} < t_{crit}$), then the null hypothesis (H_o) is accepted. In case of the ANOVA test the null hypothesis (H_o) is accepted if the probability value is bigger than the level of significance ($P > 0.05$).
- If the calculated value however is greater than the value from the appropriate Table, i.e. ($T_{cal} > t_{crit}$), then the null hypothesis (Ho) is rejected and the alternative hypothesis (H1)

is accepted. For the ANOVA test if the probability value is smaller than the level of significance, then the null hypothesis (Ho) is rejected ($P < 0.05$).

Table 4.1: Parametric and Non-Parametric Hypothesis Testing

Parametric Hypothesis tests	Non-Parametric hypothesis tests
▸ Data on the interval or ratio scale. ▸ Assumes a normal distribution. ▸ Random sampling. ▸ Small size.	▸ Data on the ordinal scale. ▸ Does not assume any distribution (Free distribution).

4.6.1 Chi-squared (X^2) test

This is normally used to find the significance of the difference between one or more frequency distributions and a hypothesised or ideal/expected distribution. The test can be applied to one, two or more independent samples to establish whether one dataset corresponds to a particular distribution as well as comparing two datasets. The test however can only be applied when the data is in the nominal scale in the form of classes, groups or frequencies (Robinson, 1998).

This test can only be applied if

- The data is nominal. Percentages or relative frequencies are not suitable.
- The total number of observed cases is more than 20.
- In the case of two categories, the frequency in each is not less than 5.
- The observations are independent.
- Two-tailed tests are to be used.

A Chi Squared test can be applied to compare a distribution actually observed in the field against expected distribution decided on by the researcher. The formulae for this test is

$$X^2 = \sum \frac{(O-E)^2}{E}$$

Where O = Observed frequencies, and E = Expected frequencies

And the degrees of freedom, df = n – 1

In a case where the test is used to determine the significance between two independent groups, the degrees of freedom, df = (r – 1) (c – 1) (Robinson, 1998).

4.6.2 Simple Student t-test

This is one of the most powerful parametric tests. It compares the means of two sample datasets or with that of a set distribution. It is defines as;

$$t = \frac{\left|\bar{x}_a - \bar{x}_b\right|}{SE(x_a - x_b)}$$

Where $\bar{x}$ and $\bar{y}$ are the sample means of the two datasets being compared

$SE_{(\bar{x}-\bar{y})}$ is the standard error of the difference between the sample means.

Similar to the X^2 test, the distribution of the t-test is dependent upon the sample size, hence the number of degrees of freedom, df = $n_x + n_y - 2$ (Robinson, 1998).

The test can only be applied if;

- The data is normally distributed
- Random sampling methods were used
- Data are measured on the interval or ratio scale.

4.6.3 One-Way ANOVA

An ANOVA test is a parametric test that assesses whether the difference between several samples of data is significant or not (Robison, 1998). Simply put, it is an extension of the logic of t-tests to those situations where we wish to compare the means of three or more samples concurrently, unlike the t-test, which can test the differences between two means only. It tests differences between means though it is based on a comparison of variances (Lutz, 1983). Essentially a One-Way ANOVA is used to assess whether any apparent difference between the results of a succession of similar experiments is due to real differences of a substantive nature or merely through data collection imperfections (Robinson, 1998).

The ANOVA test is based on the assumptions that;

- the populations from which the samples were taken are normally distributed.
- the samples must be randomly assigned to one of the n groups, i.e. they must be independent.
- the variances of the populations have to be equal, otherwise the outcome of the multiple comparisons may be affected.

An ANOVA test is based on a comparison of two independent estimates of the variance in the population. The first estimate is on the differences between the samples, while the second one is within the samples.

The results of the ANOVA are more conveniently viewed in a summary table as shown below.

Table 4.2: Summary table for a test of variance

	SS	**df**	**MS**	**F**	**P/ Sig.**
Between Groups	SS (B)	K – 1	$\frac{SS\ (B)}{K-1}$	$\frac{MS\ (B)}{MS\ (W)}$	Probability value
Within Groups	SS (W)	N – K	$\frac{SS\ (W)}{N-K}$		
Total	SS (W) + SS (B)	N - 1			

The first column in the table above contains the source of variation. There are two sources of variation: differences among groups and within groups. The second column contains the sum of squares, while the third contains the degrees of freedom (df). The df between groups is always equal to the number of groups minus one. The df for within groups is equal to the number of subjects minus the number of groups. The fourth column contains the mean of squares, which are estimates of variance and are computed by dividing the sum of squares for groups by the degree of freedom for between groups. The fifth column contains the F ratio, which is computed by dividing the mean square for between groups by the mean square for within groups. The last column contains the probability value. This is the probability of obtaining an F value as large or larger than the one computed in the data. The decision will be to reject the null hypothesis if this value is smaller than the test statistic from the table.

4.7 CONCLUSION

The methods discussed in this chapter indicate that both qualitative and quantitative methods were used. Qualitative methods were adopted in the data collection process while quantitative methods were applied in the analysis. The divers' data collection process is qualitative since no instrumentation is used and depends on individual perception. Further collection of data by the researcher is also qualitative, making use of tools such as interviews and questionnaires. Other additional information was collected through participant observation since this study is an action research. Action research primarily contributes to the practical improvement of a problem situation while building the capacity of the people involved, hence it embraces the concept of "learning by doing" which is the buzz phrase in environmental management lately.

Quantitative methods were then applied to verify this data to ensure reliability and validity, after which they were further used to analyse the data such that the effluent impacts and the performance of the new pipeline can be assessed. Furthermore, this study displays an integration of subjective and objective knowledge systems, where the local subjective knowledge documented by the divers is being analysed using scientific statistical methods. Probability theory is also used to determine the confidence level of the results such that they can be appropriately inferred to the real life situation from which the sample was taken. Hypothesis tests are also applied such that the significance of the difference in both the effluent and visibility records before and after the pipeline extension can be determined.

CHAPTER FIVE

DATA ANALYSIS

5.1 INTRODUCTION

This chapter analyses the subjective local data collected by the divers to assess the impacts of the effluent on marine water quality, specifically its impacts on underwater visibility. The performance of the new pipeline in decreasing the impacts of the effluent on marine water quality is also assessed. Furthermore the role of this research in providing input into the functioning of the Permit Advisory Panel (PAP) in terms of resolving the conflict between its members is explored.

The chapter is divided into five sections. The first section describes the data collection methodology so that a thorough understanding of the nature of the data can be achieved, and a better understanding and appreciation of the methods of analysis adopted is generated. The second section concentrates on the methods that were adopted to validate the data. The third section is dedicated to the analysis of the data. It considers visibility fluctuations over time and how this correlates with the presence of effluent. This section also presents the newly proposed methods of data collection and analysis. The fourth section is dedicated to assessing the performance of the new pipeline in terms of improvements in underwater visibility, and the last section assesses the relevance of this study to the PAP.

5.2 DATA COLLECTION

The divers only began collecting data for the monitoring of the impacts of the effluent on the marine environment in September 1998, prior to which Sappi Saiccor has been solely responsible for this. Since the pipeline was extended to the present 6.5 km in 1999, foaming along the beaches has been greatly reduced and hence concern over Sappi`s effluent disposal into the sea has subsided. The divers are however still concerned as the problem still persists at the Aliwal Shoal. The major impact of the effluent is its distinct dark colour, which significantly reduces the quality of the water in terms of reduced underwater visibility, which directly affects diving conditions. Due to these concerns, the divers have advocated for their direct involvement in the data collection process for the monitoring of the effluent, arguing that they are in a good position to assess these impacts in conjunction with the Sappi Saiccor "effluent officers". They argue that they should play a key role in monitoring since the impacts affect them directly and also because of their good knowledge of sea conditions. The PAP members therefore reached a decision in 1999 that the divers' data would be analysed by an independent statistician and used as an independent monitoring system alongside that of Sappi Saiccor.

The divers are issued with log sheets (Appendix III) that they fill out every time they go diving. Records of the time, location, current direction and speed, approximation of visibility in metres, the presence of effluent and any general comments are entered into these log sheets. No instrumentation is used to measure these variables. They are based on individual experiences and knowledge of the sea conditions gained over years of working in this environment. The records are also entirely up to the individual's discretion since no form of standardisation has been done to ensure uniformity in the way the data was being recorded by the different dive charter groups. The information from these log sheets is then summarised using simple statistical methods such as averages and entered into a database as shown in Appendix V, from which statistical methods are used to assess the effluent occurrence and its impacts on the under water visibility.

5.2.1 Data limitations

As Robinson (1998) argues, a good research process is one that integrates both qualitative and quantitative methods and also acknowledges limitations in data collection and analysis. The limitations are mostly those inherent within the data itself and also those imposed by the researcher, hence it is important to outline the level of interaction between the researcher and the data. Since human geography is an interactive and creative process, the process of data construction can never be entirely neutral or objective. Data is a reflection of the particular circumstances that prevailed during data collection, analysis and presentation. The struggle is always to make research as objective as possible, but researchers do bring their own preconceptions and predilections that will ultimately affect the data construction and interpretation processes. It is therefore important to understand the extent to which the researcher has extended his/her own prejudices and preconceptions as well as the circumstances that could have influenced the outcome of the research (Robinson, 1998). The major limitations in this study are as follows:

i There are only seven months of divers' data available (September 1998 to March 1999) before the pipeline was extended. This is limited and is therefore not truly representative of the whole period before the pipeline was extended. Any comparative analysis between the period before and after the pipeline extension therefore is conducted using similar months (September to March). This attempts to counter seasonal variations that might influence the outcome of this analysis. The following grouping is adopted throughout this study. Trend assessments will still however include all the available data.

Table 5.1: Temporal grouping adopted in this study

PERIOD		MONTHS COVERED
PRE-PIPELINE (Before the pipeline extension)		Sept-98 – Mar-99
POST-PIPELINE (After the pipeline extension)	Post 1	Sep-99 – Mar-00
	Post 2	Sep-00 – Mar-01

ii Another limitation is in the data collection process itself. The data is collected by different people without the use of any instrument or any other tool to standardise the data hence discrepancies arise. The first step in this analysis was therefore to validate the data, before any analysis could be made. This was done by considering consistencies in the data collection process and variations in the records between the different dive charter groups collecting the data.

5.3 DATA VALIDATION

Apart from the influence of the researcher and the obvious data limitations, data should be tested for validity in its construction. Though there is a general belief that the positivist approach is infallible and its results objective and reliable due to its subjection to rigorous analysis, it is argued that all data will have a certain level of subjectivity due to human influence (Robinson, 1998). The positivist approach is assumed to be objective. An oversight in this thinking is the impact humans have during the analysis and interpretation. One way of validating the data is therefore to acknowledge this influence and any limitations inherent to the data itself.

In quantitative research, the instruments or tools used are calibrated and tested before being used. In qualitative research however, where data is constructed subjectively i.e. from other people's perceptions and experiences, the data should be tested for outliers. This refers to any respondent who is significantly different from others within the same situational context. It was therefore important to determine the level of variation within the different dive charter groups recording the data. In this study this was done through a graphical presentation showing their consistency in their data collection and also through significance testing, using the one-way ANOVA to assess the significance of the variation in visibility records collected by the divers.

5.3.1 Consistency in data collection

This section assesses how consistent individual divers are in collecting data, i.e., how regularly do they make their records on a monthly basis. This is important since the summarised data for the daily and monthly records are made through averaging. As Robinson (1998) states, the arithmetic mean can easily be influenced or deviated by extreme values or missing values in a data set, resulting in under or over estimations of the real situation. Consistency of the Dive Charters in the data collection will therefore serve to ensure that any general statements made are truly representative of the time period they represent. This may also reflect on the commitment of the divers to the monitoring process. Simple graphical presentations as shown in Figure 5.1 are made to assess this consistency.

There are five dive charter groups involved in the data collection process. These are Aliwal Dive Charters (ADC), Sea Fever Lodge, Whaler, Umkomaas Lodge and Blue Wilderness Dive Expeditions. Three of these dive groups, Sea Fever Lodge, Whaler and Umkomaas, are reasonably consistent in their data collection, with ADC and Blue Wilderness Dive Expeditions being rather inconsistent. There are some months when ADC and Blue Wilderness Dive Expeditions have not handed in their log sheets (Figure 5.1). Blue Wilderness Dive Expeditions is the least consistent dive charter group with an average of eight days per month, followed by ADC with an average of eleven days. Sea Fever lodge and Whaler both have an average of twenty days while Umkomaas lodge has an average of twenty-two days per month.

Consistency of three out of five dive charter groups constitutes for valid reliable data, and also reflects the commitment of these dive operators. The inconsistency of the other two dive operators is problematic. These two dive operators are involved in the PAP, Blue Wilderness Dive Expeditions as a representative of the other dive operators and ADC as an interested and affected party. Their inconsistency was mainly due to busy business schedules. Compounded to this is the problem of trust, where one operator did not want to hand in his log sheets to Sappi Saiccor, claiming that Sappi Saiccor would manipulate the data. In some cases such as June 1999, a common trend can be identified in the individual records, suggesting a possible common reason for a decline in the number of dives for that month. Some of the reasons for cancellation of dives are bad weather conditions, off seasons in the industry, or the presence of unfavourable quantities of effluent for diving.

Although ADC and Blue Wilderness Dive Expeditions have a lot of missing values in their data sets, they were included in the analysis, to allow for a broader range of available data sets, such that a more holistic approach can be maintained in identifying alternative methods of data collection. It was also important to include all the data sets for the sake of transparency and rebuilding trust between the different stakeholders, since excluding certain data sets could have been interpreted as being biased. It should however be noted that their inclusion might result in the results of this study being an under or over estimation of the real situation in terms of assessing the effectiveness of the pipeline extension.

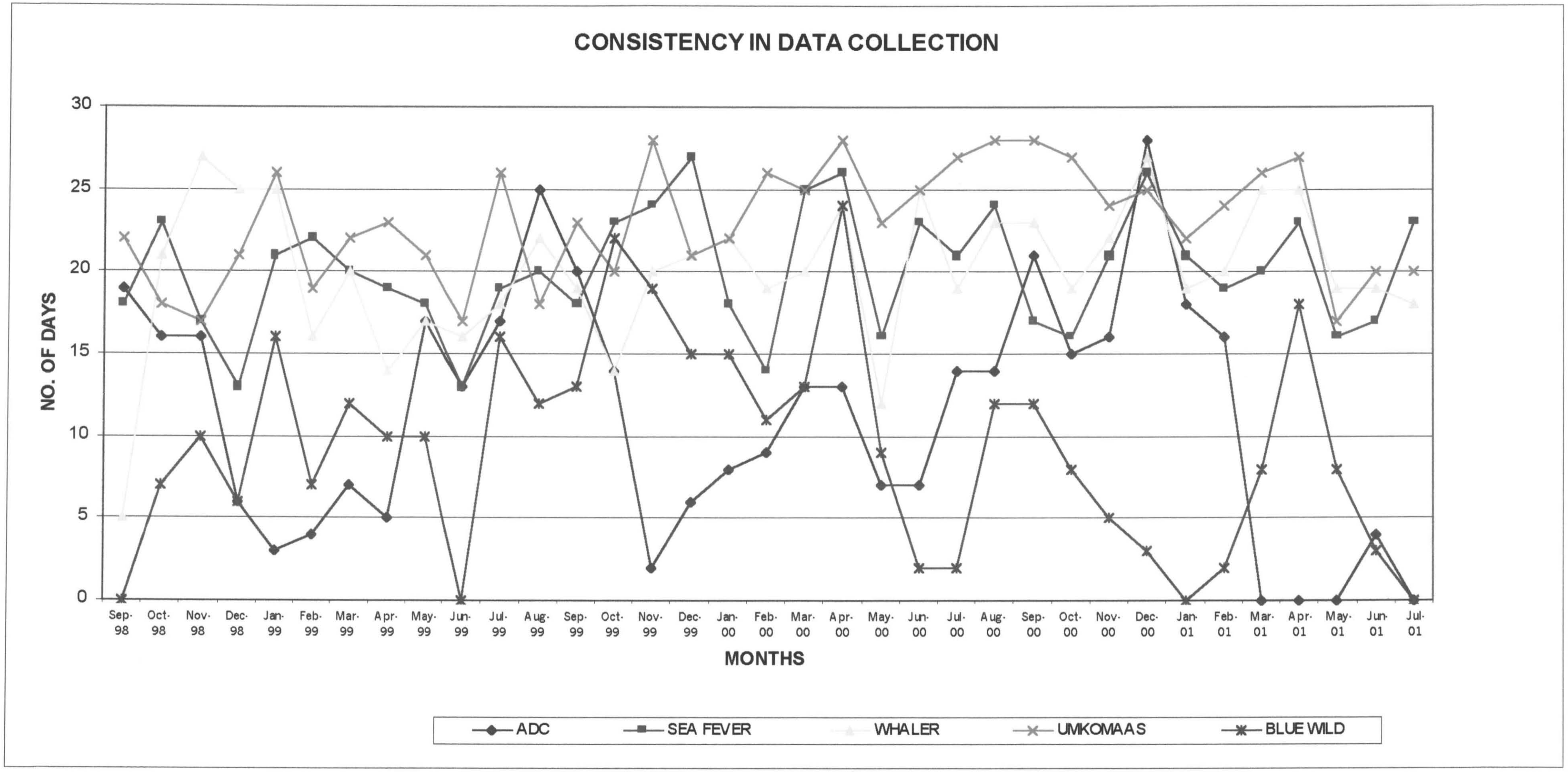

Figure 5.1: Consistency of the dive charter groups in data collection

5.3.2 One-way ANOVA

Apart from the consistency in the data collection process, the data needs to be validated in terms of the data distribution between the individual dive operators collecting the data. There are two parameters that are used to assess the impact of the effluent on the marine water quality. These are the presence of a visible effluent plume and underwater visibility. Simple graphical presentations were done for both in order to assess the variability in the manner these two were recorded by the different dive charter groups (see Figures 5.4 and 5.5). Furthermore, the one-way ANOVA was done to assess the significance of these variations.

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Visibility validation

Figure 5.2 shows the visibility distribution as collected by the different dive operators. From this graph all the dive operators seem to have similar ranges, with the medians for all charters lying between 11.4m and 13.2m. BlueWilderness has the most widely distributed records with a range of 15.33 (Appendix VI). Umkomaas and BlueWilderness have outliers (extreme values) of 19.79 and 22.5 respectively. These extreme values could have influenced the mean for these two; hence the median is the most reliable measure to use. However the box plot shows graphically that there is not a great deal of variation in the data collected. It can therefore be concluded that all the data sets from the different dive Charter groups is valid enough to be used in the analysis since there is no one group that deviates a lot from the others. Their visibility records are within the same range of values. This is further endorsed by Figure 5.3, which compares the monthly records of the different dive charters. In all the months, all the visibility records from the different dive charters are within a reasonable range of each other, hence the visibility data sets from the different Dive Charter groups are consistent with each other, and hence can be deemed accurate.

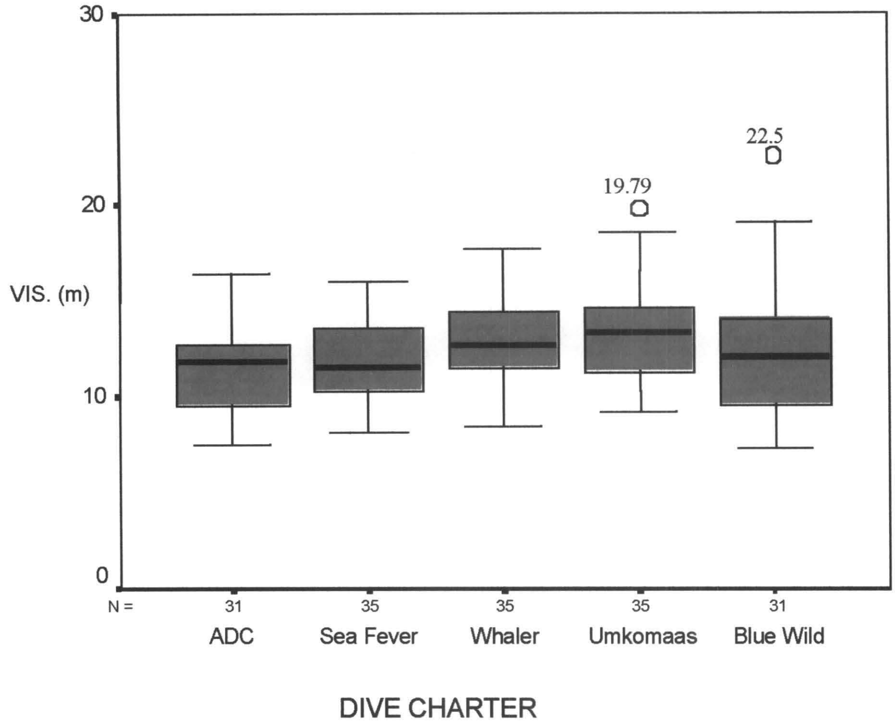

Figure 5.2: Visibility data variations between the different dive charter groups.

A hypothesis test was also applied to assess whether there is a significant difference between the different divers' records. The following two hypotheses, the null hypothesis (H_o) and the alternative hypothesis (H_1) were stated, and the one-way ANOVA was run using the SPSS package, the results of which are shown in Table 5.2.

H_o: There is no significant difference between the different dive charter's visibility records.

H_1: There is a significant difference between the different dive charter's visibility records.

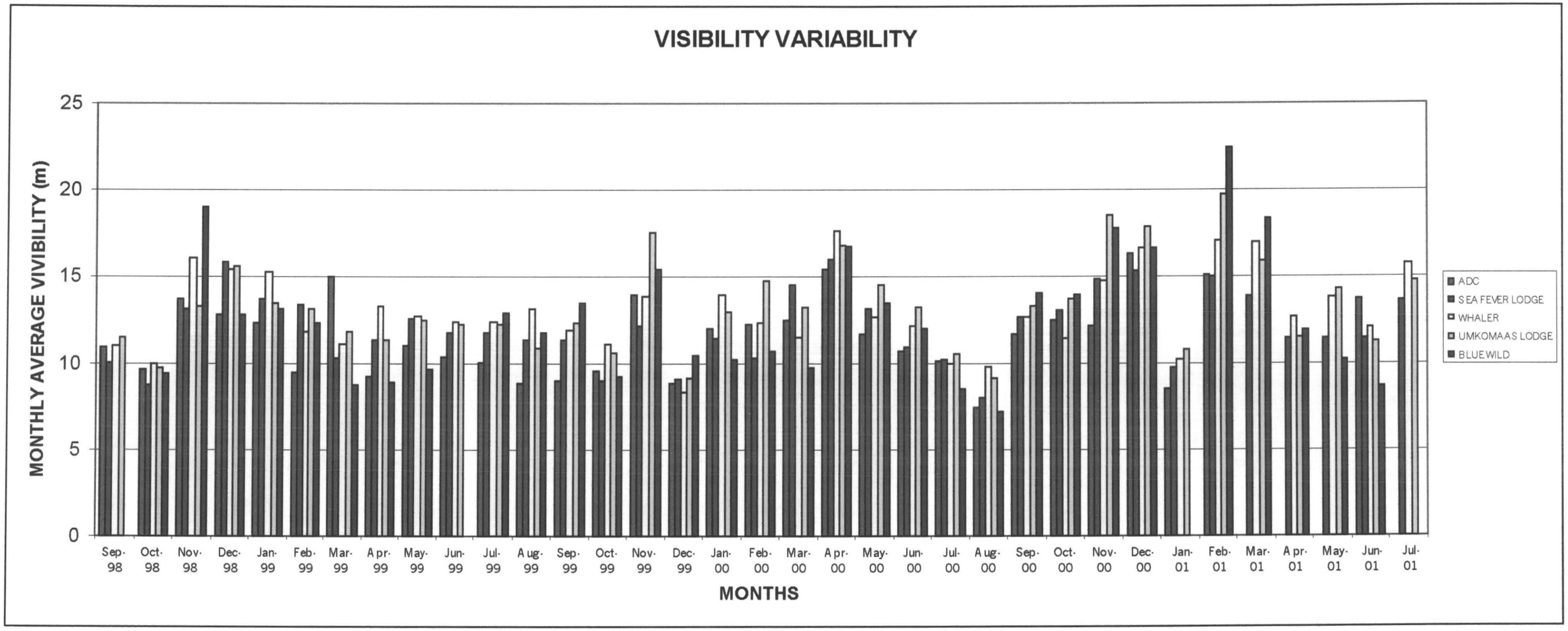

Figure 5.3: Monthly visibility data variations between the different dive charters

Table 5.2: Visibility results of the One-Way ANOVA test

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	66.309	4	16.577	2.386	.053
Within Groups	1125.650	162	6.948		
Total	1191.959	166			

The above analysis shows that P (0.053) > 0.05, therefore H_0 is accepted. There is no significant difference between the different dive charter group's visibility records. This implies that the differences in the visibility records between the different dive charter groups are coincidental. There are several possible explanations that can be attributed to the differences that appear in the daily and monthly records. The subjective nature of the data could result in the differences since subjective data is not precise although similar trends can be derived. Since the data is collected by different people, using their own discretion to make visibility estimates, differences in the records are to be expected, however these are shown above as not significantly different. Another possible explanation is that the divers take their records at different times of the day, and since weather conditions and currents are also important factors that can influence underwater visibility, changes in these conditions can result in some changes in the underwater visibility. This could therefore account for the different records made at different times in one day. Unless there was a drastic change in these conditions, the differences are not expected to be too significant.

Table 5.3 below shows the descriptive results of the ANOVA test, outlining the records for the different charters in more detail. From this table ADC has the lowest monthly mean visibility of 11.52m, for the period September 1998 to July 2001, while Umkomaas has the highest of 13.24m, with the rest of the groups clustering around 12m. This is however not a big discrepancy and the ANOVA test has also shown that the difference in the visibility records between the groups is not significant enough to invalidate anyone's records. This implies that there is no fear of any one particular group having an influence on the data in such a way that the results are biased towards a certain desired outcome; hence this data can be used to make valid conclusive statements about the impacts of effluent on the marine water quality.

Table 5.3: Descriptive visibility results of the One-Way ANOVA test

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
ADC	31	11.5187	2.2807	.4096	10.6822	12.3553	7.43	16.36
Sea Fever	35	12.0091	2.0942	.3540	11.2898	12.7285	8.04	16.04
Whaler	35	12.9831	2.3146	.3912	12.1881	13.7782	8.36	17.67
Umkomaas	35	13.2446	2.6605	.4497	12.3306	14.1585	9.14	19.79
Blue Wilderness	31	12.6213	3.6409	.6539	11.2858	13.9568	7.17	22.50
Total	167	12.4948	2.6796	.2074	12.0854	12.9042	7.17	22.50

Presence of effluent

Another important parameter that the divers record for assessing the marine water quality in terms of underwater visibility is the presence of a visible effluent plume. The number of days in a month that are recorded as effluent days can be used to determine how good or bad a month was and ultimately it can be used to assess the performance of the pipeline. Figure 5.4 below shows the variability between the different dive charter groups in their records of the presence of effluent.

The graph shows that the effluent records for the different dive charter groups are within a similar range, with BlueWilderness having the lowest average. This could however be attributed to the fact that BlueWilderness is not consistent in its data collection. From the graph above, ADC, Sea Fever and Umkomaas average around five effluent days per month, while Whaler and Blue Wilderness Dive Expeditions have an average of around two effluent days. This graph would suggest that the effluent records between the different dive charters are consistent. However a closer examination of the data, as shown in Figure 5.5, reveals a great deal of variability in these records. For example, in August 1999, ADC has a record of 16 days, while Sea Fever and Whaler have records of four and three days respectively, and Umkomaas and Blue Wilderness have no records of effluent, although all were consistent in collecting data for this month. In April 2000, only Umkomaas had a record of effluent days with the others having no effluent recorded at all.

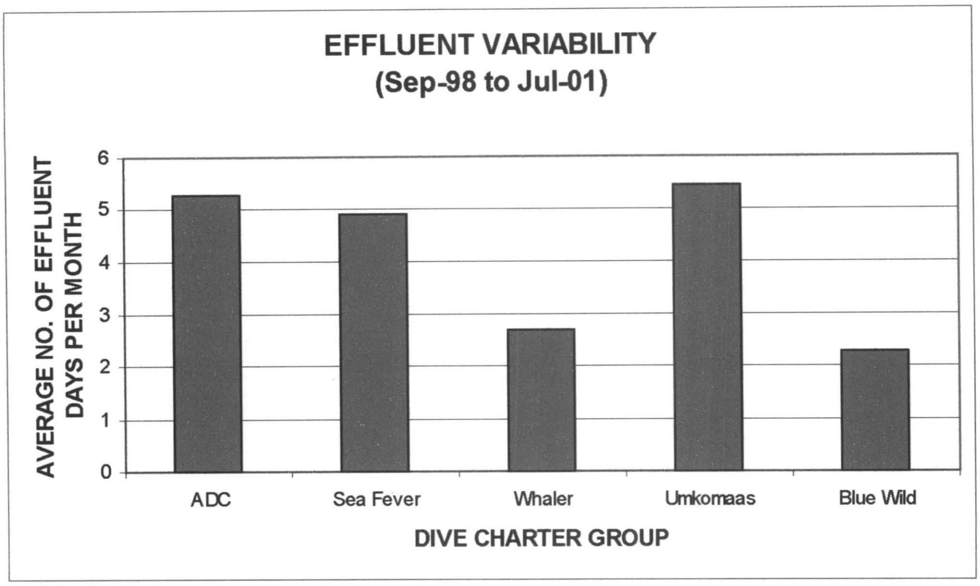

Figure 5.4: Effluent data variations between different charters

Although similar trends do surface in the visibility records, the effluent records still remain a problem, since there is a great deal of variation in the records from the different dive charter groups. There are discrepancies in the way the presence of effluent is recorded, resulting in cases where one person would record the presence of effluent (E) while the rest of the divers would not. There is also no consistency in the manner in which it is recorded. It is normally recorded as either E or LE implying effluent present and little effluent present respectively. This raises a question of whether these two descriptions mean the same for each person. Since the effluent can manifest itself in many different forms in the water, it is important that all the people collecting the data agree on how to categorise these different forms so that the records can be consistent.

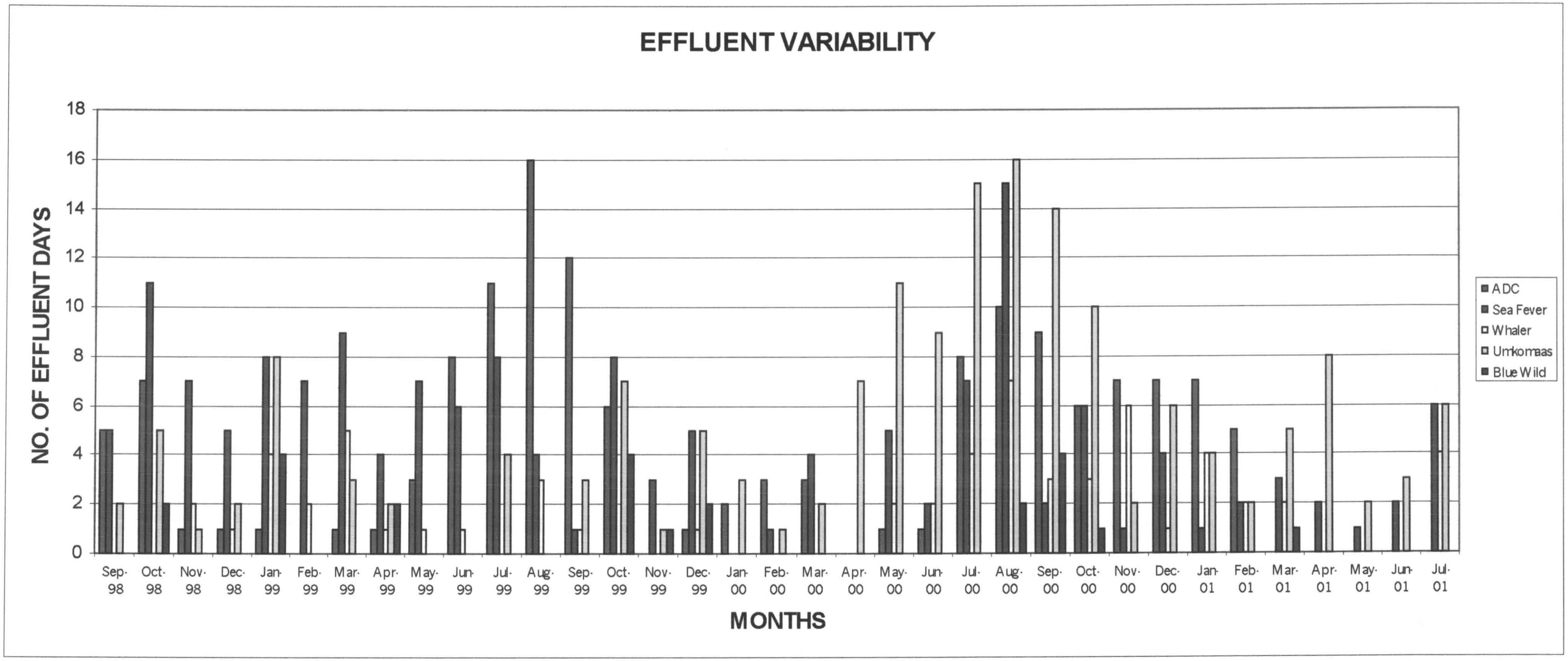

Figure 5.5: Monthly effluent data variations between the different dive charters.

A One-Way ANOVA test was also done to assess the significance of this variation in the records of the presence of effluent between the different dive charter groups. The following hypotheses were stated:

H_o: There is no significant difference between the different dive charters' effluent records.

H_1: There is a significant difference between the different dive charters' effluent records.

In this case the test results, as shown in Table 5.4 below, revealed that there is a significant difference in the effluent records between the different dive charter groups.

Since P (0.004) < 0.05; hence H_o is rejected and H_1 accepted.

Table 5.4: Effluent results of the One-Way ANOVA test for the effluent Days

	Sum of Squares	df	Mean Squares	F	Sig.
Between Groups	183.441	4	45.860	4.000	0.004
Within Groups	1375.759	120	11.465		
Total	1559.200	124			

The error in the effluent records could be inherent to the construction and interpretation of the data. The issue of effluent presence is slightly more complex than that of visibility since it can manifest itself in different quantities and forms. Unless these differences are taken into account and a standard protocol is set for all the divers to follow when they do their records, it will be hard to find any consistency in these records. Although the ANOVA test has shown that the effluent records are not very valid and hence imply that they cannot be used to make any conclusive statements, for the purpose of this study, further statistical analysis is undertaken, such that alternative methodologies for the construction and interpretation of these data can be developed.

5.4 UNDERWATER VISIBILITY AND EFFLUENT TRENDS AND FREQUENCIES

Data is collected on a daily basis on all the dive trips that the divers take in a day. Divers estimate underwater visibility in meters, normally given as a range. These figures are averaged out for every day so that single visibility figures for each dive charter group for that particular day can be entered into the database. These figures are also averaged out over a month such that monthly averages can be attained. These are the figures that have been used to identify general trends in the underwater visibility. Furthermore, records of the presence of a visible effluent plume are also made. Usually this is recorded as either E (visible effluent plume) or LE (little effluent). Comparative graphs were also used to establish whether there was a clear causal relationship between underwater visibility and the presence of effluent.

5.4.1 Underwater Visibility trends

Underwater visibility refers to the estimated distance a person can see under water. This distance is rated in terms of whether it is good for diving or not. Sappi Saiccor's Environmental Manager, Mike Bentley, has always calculated monthly averages in his analysis, which he then uses to calculate what he refers to as the Diving Severity Index (See section 3.5). The Severity Index is a number, not based on any scale, which is interpreted as implicying good diving conditions if it is small, and bad conditions if it is large. However this is not very easy to use, as there are no benchmarks to interpret this index against. Without these benchmarks, through which the diving severity index can be evaluated, its hard to have a clear conception of how good or bad the situation is.

Given the above-mentioned concerns, the researcher realised that there was a need to set some benchmarks that can be used to assess the implications of the effluent on the diving conditions, which is of major importance to the divers. The PAP members, specifically the divers, were therefore asked to identify these benchmarks depending on what they consider as bad and good visibility for diving (PAP minutes, 18/07/00). The following categories were developed, and they will be used throughout this study to assess the diving conditions in relation to the underwater visibility. It was agreed that

- A distance of less than 8m is bad for diving
- 8m – 10m is acceptable
- 11m – 15m is preferable
- 15m and above is excellent (See section 3.5.1).

For each day, all the records from the different dive groups are analysed and summarised using averages. The average underwater visibility for every day is calculated. Given the above ranking, a day can then be ranked as excellent, bad or acceptable (moderate conditions). Figure 5.6 shows the visibility trends (monthly averages) starting from before the pipeline was extended to the present. From this graph no apparent improvement can be noted after the pipeline was extended in April 1999. The visibility seems to fluctuate a great deal throughout both periods, with the monthly average visibility ranging from 9.51m to 15.40m before the pipeline was extended, and from 8.38m to 17.31m after the extension.

Judging from Figure 5.6, no month can be classified as bad for diving since there is no month with an average visibility of less than 8m. The assumption could therefore be that the diving conditions have improved, and that the visibility is never below 8m. This however is not a true representation of the daily realities, which are most important to the divers, since the daily conditions are the ones determining the quality of the dives, if any can be made.

Monthly averages are therefore not appropriate in determining the trends of visibility in terms of its impacts on local diving businesses. Figure 5.7 shows this disparity by comparing the monthly averages with the minimum values for the months. This graph shows that the underwater visibility can be as low as 2m (March 1999, October 1999, December 1999 – February 2000, and November 2000), which is in contrast with the mean monthly reading of 8m or above for the same month. The mean can easily be influenced by extreme values; hence the mean is not truly representative of the real situation. There is therefore a need to consider the daily averages in order to get a clearer picture.

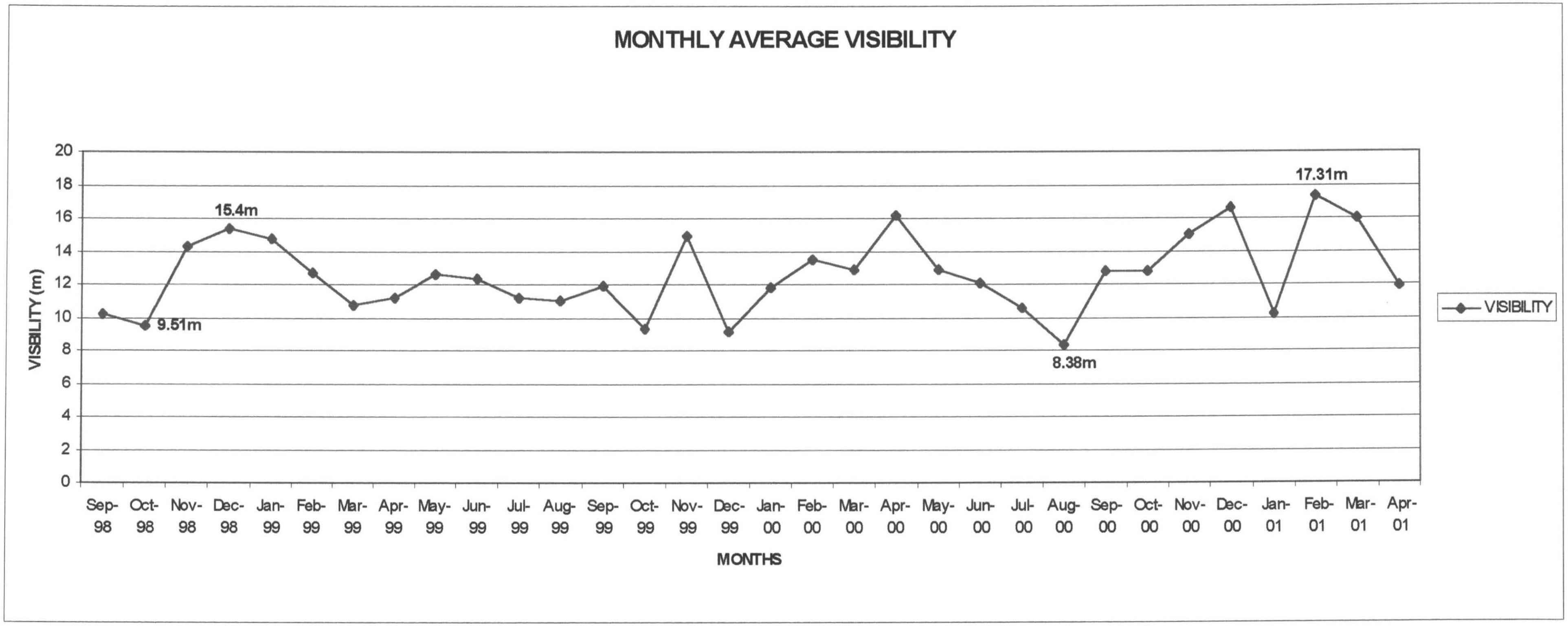

Figure 5.6: Monthly Average Visibility Trends Over Time

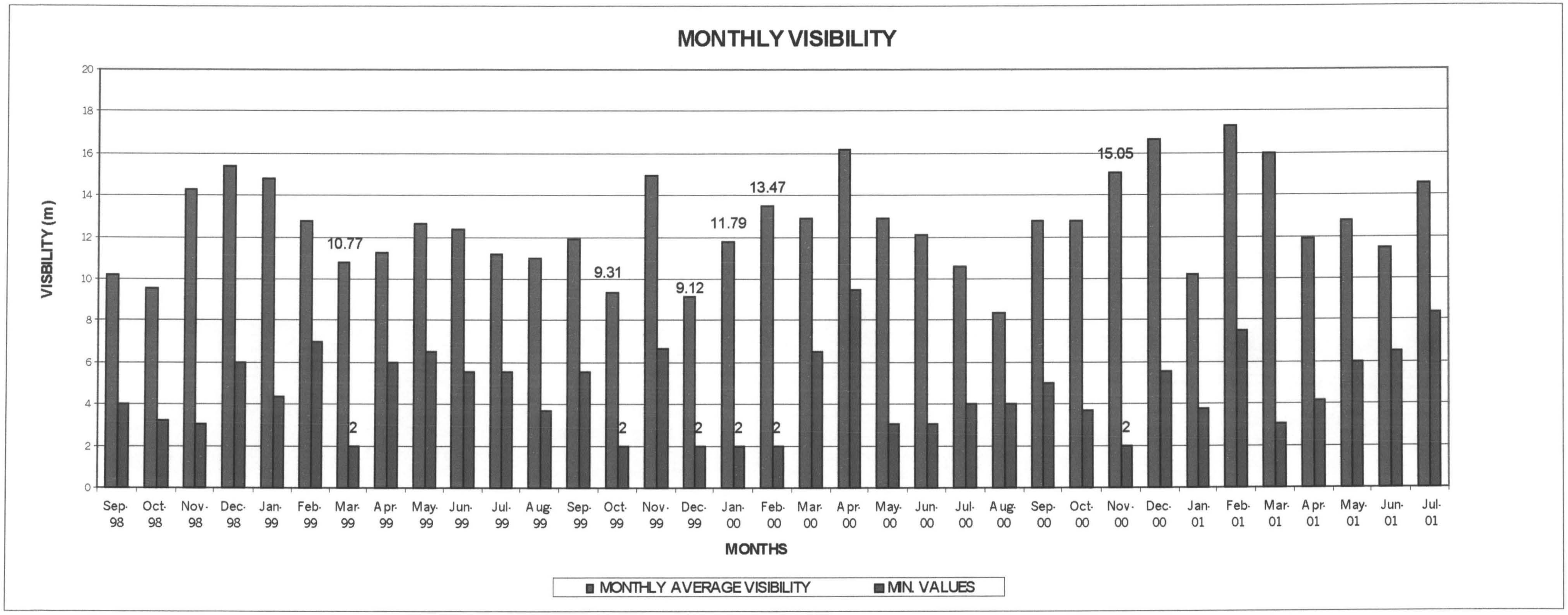

Figure 5.7: Average Monthly Visibility and Monthly Minimum Visibility records Over Time

The daily visibility averages were also assessed more closely and categorised according to whether they were good or bad days, based on the benchmarks as set by the PAP. Figure 5.9 shows how visibility was distributed from September 1998 to July 2001. Throughout this period, the diving conditions were mostly within the preferred diving range (11–15m visibility), with a frequency of 37%. In addition, 24% of the time the diving conditions were within the acceptable range (8 – 10m visibility) or excellent (above 15m visibility), and only 14% of the time were the diving conditions bad (visibility of below 8m). This indicates that the underwater visibility is acceptable for diving most of the time

Since the daily records are the most important to the divers, frequency distributions of the visibility records were carried out for all the months, and this revealed that the data is normally distributed. Figure 5.8 shows examples of how data is distributed in the various months. (The frequency distributions for the other months are shown in Appendix VII). The frequency distribution curves below all have their peaks around the 11 – 15m range. This implies that the visibility is most frequently ranging between 11m and 15m throughout the months, with a few high and low values.

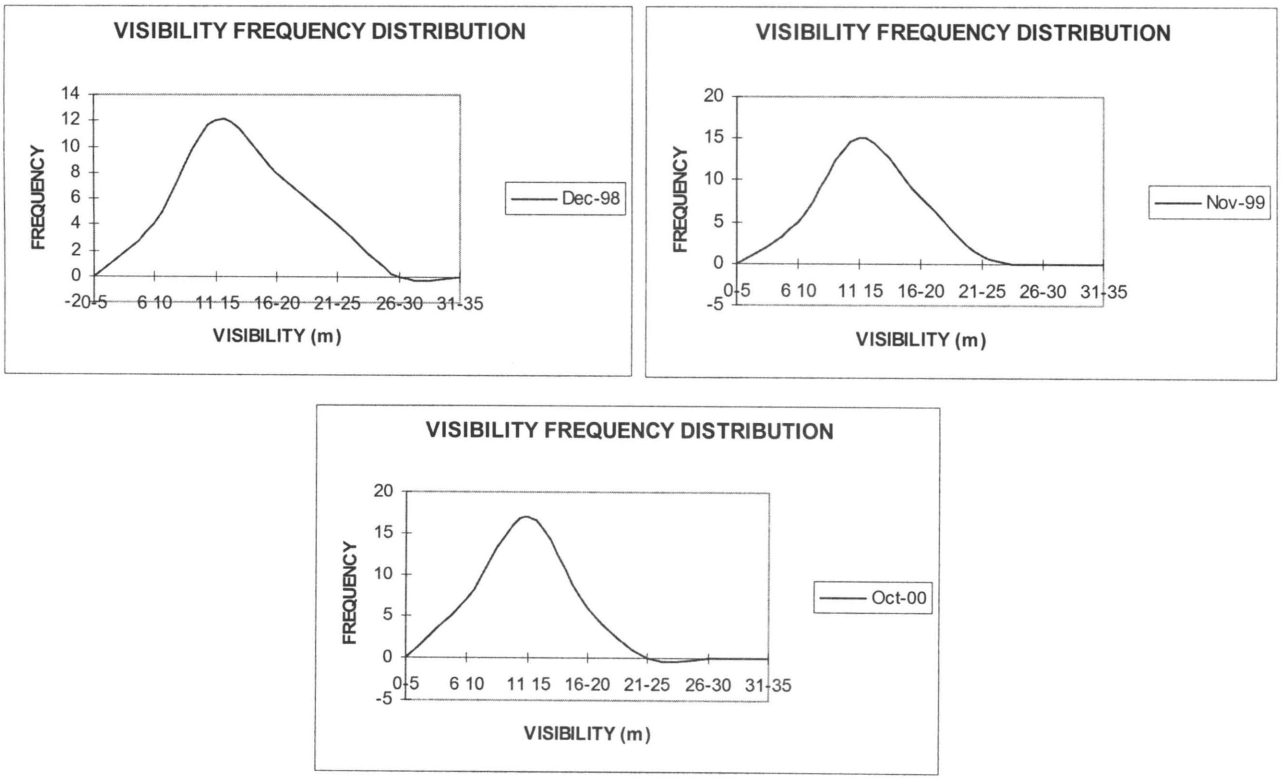

Figure 5.8: Monthly visibility frequency distributions, showing that the visibility data is normally distributed.

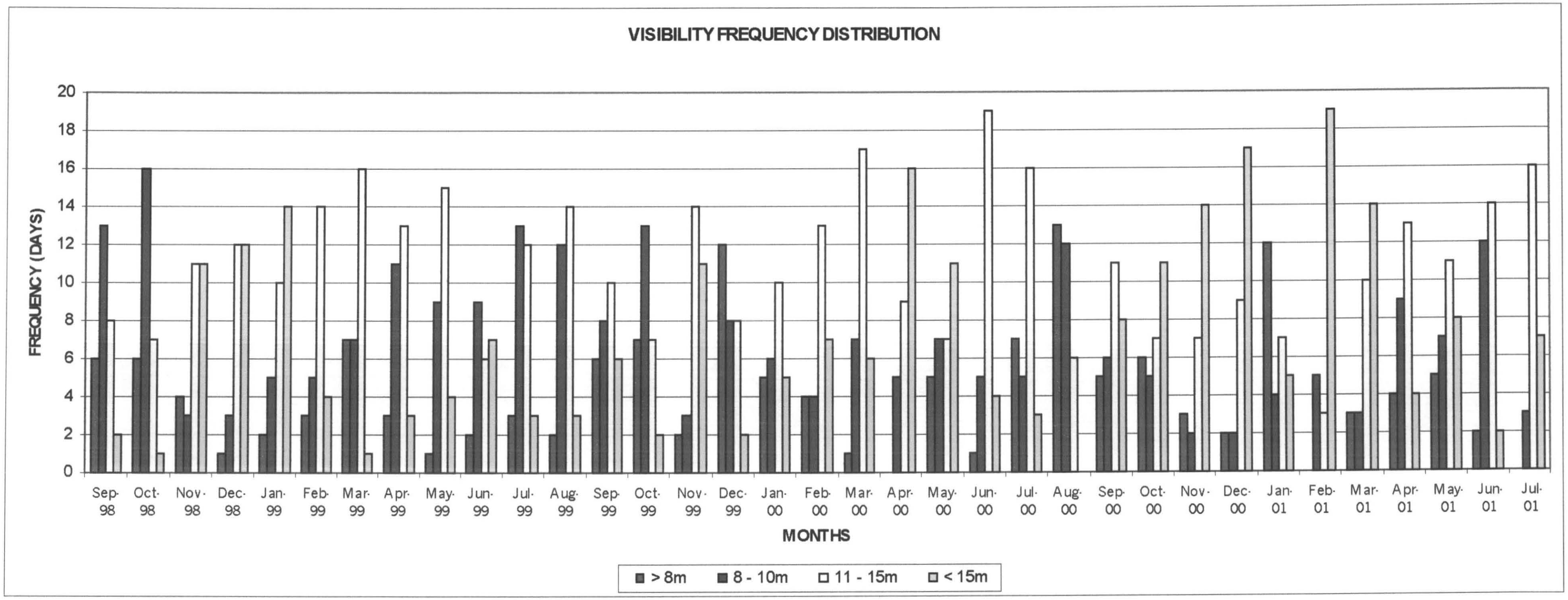

Figure 5.9: Visibility Trends in Relation to Diving Conditions.

Since the data is subjective due to the unsystematic data collection methods and the unpredictability of the diving conditions and the fact that the data is only representative of a certain time period (data is limited, since the time prior to September 1998 does not have any data) probability theory was used in order to infer the results of this analysis to the real situation. The Normal distribution theory was adopted and 95% confidence intervals were developed to approximate real events. This theory plays a central role in statistical theory in that the means of samples taken from the same population tend to plot as an approximately normal distribution, even if the measurements comprising the population are not normally distributed. This ability of the normal curve to describe the distribution of means, regardless of the way the individual measurements are distributed is of fundamental importance in this study. The adoption of this theory enabled the distribution of the data to be described with a certain confidence interval. It also enabled the assessment of how visibility varied over time as well as between the different dive charter groups.

This study adopted the 95% confidence interval. The table below shows the 95% confidence intervals for the different months. The confidence interval reflects consistency in the data collection process and the visibility variations at the Aliwal Shoal. A high confidence interval could mean that there is a high variability in the visibility records between the different dive charter groups or it could imply that the visibility is varying a lot within a month. The opposite could be true when the confidence interval is small. The variability between different dive charter groups however has been proven to be insignificant by the one-way ANOVA; hence this variability most likely reflects visibility trends.

The confidence intervals in the table below show that visibility varies a great deal within a month. At a 95% confidence interval visibility can range from very low visibility to very good conditions. An example is in January 2000, when the range is from 5.09m to 18.57m. The use of the normal distribution theory in this case counters the disadvantage of using monthly averages, which do not reflect daily situations. This concept of confidence intervals gives insight into the possible range of visibility conditions that can be expected within a month within a given probability.

Table 5.5 shows the visibility data distribution from September 1998 to July 2001 at a 95% confidence interval. The table does not show any significant difference in the visibility since the pipeline was extended to its present length. In almost all the months, the visibility could have ranged from being bad (below 8m) to excellent conditions (15m and above). Only eight of the months since the pipeline was extended had a minimum visibility record that is above 8m. The higher the range value, the more varied is the data. This could have two implications. Either the visibility varies a lot, probably due to the fact that there are so many other factors that can influence it, or the divers vary a lot in their data collection process. The opposite applies when this value is small.

5.42 Presence of Effluent

A count of the number of days that were recorded as effluent days, i.e. the days on which effluent was present, is another way of assessing the marine water quality. Sappi Saiccor's Environmental Manager decided an effluent day on the basis of majority rule. He stated that a day was decided to be an effluent day when 50% or more of the dive charter groups recorded the presence of effluent (E) for that particular day (the majority rule). This study adopted the precautionary principle, which advocates for being cautious whenever there is some uncertainty of any kind at any stage of the process, so as to ensure environmental protection when there is scientific uncertainty.

The precautionary principle is a culturally framed concept based on changing social conceptions about the roles of science, economics, ethics, politics and law in pro-active environmental protection and management (O'Riordan, 1994). Based on this principle a day was decided as an effluent day even when only one dive charter group recorded the presence of effluent (E). This principle was used to show the worst-case scenario. An effluent day was recorded if at least one operator recorded it as such, thereby allowing trends to be analysed on a worst-case basis, and ensuring representation of all the dive operators' data.

Table 5.5: Monthly Average Frequency Distributions of Visibility at a 95% Confidence Interval

MONTH	MONTHLY AVE. VIS. (m)	STD. DEV.	-2δ	-1δ	+1δ	+2δ	CI RANGE	95% CI
SEP-98	10.23	2.69	4.85	7.54	13.38	16.07	4.85 – 16.07	11.22
OCT-98	9.51	1.89	5.73	7.62	11.4	13.29	5.73 – 13.29	7.56
NOV-98	14.27	2.68	8.91	11.59	16.95	19.63	8.91 – 19.63	10.72
DEC-98	15.4	3.48	8.44	11.92	18.88	22.36	8.44 – 22.36	13.92
JAN-99	14.78	3.28	8.22	11.5	18.06	21.34	8.22 – 21.34	13.12
FEB-99	12.75	2.49	7.77	10.26	15.24	17.73	7.77 – 17.73	9.96
MAR-99	10.77	1.67	7.43	9.1	12.44	14.11	7.43 – 14.11	6.63
APR-99	11.23	1.48	8.27	9.75	12.71	14.19	8.27 – 14.19	5.92
MAY-99	12.6	2.35	7.90	10.25	14.95	17.3	7.90 – 17.30	9.4
JUN-99	12.4	2.53	7.34	9.87	14.93	17.46	7.34 – 17.46	10.12
JUL-99	11.2	2.22	6.76	8.98	13.42	15.64	6.76 – 15.64	8.88
AUG-99	10.99	2.57	5.85	8.42	13.56	16.13	5.85 – 16.13	10.28
SEP-99	11.89	3.33	5.23	8.56	15.22	18.55	5.23 – 18.55	13.32
OCT-99	9.31	2.49	4.33	6.82	11.8	14.29	4.33 – 14.29	9.96
NOV-99	14.95	3.3	8.35	11.65	18.25	21.55	8.35 – 21.55	13.2
DEC-99	9.12	2.15	4.82	6.97	11.27	13.42	4.82 – 13.42	8.6
JAN-00	11.79	3.35	5.09	8.44	15.14	18.57	5.09 – 18.57	13.4
FEB-00	13.47	2.55	8.37	10.92	16.02	18.57	8.37 – 18.57	10.2
MAR-00	12.89	2.79	7.31	10.1	15.68	18.47	7.31 – 18.47	11.16
APR-00	16.19	3.35	9.49	12.84	19.54	22.89	9.49 – 22.89	13.4
MAY-00	12.92	3.27	6.38	9.65	16.19	19.46	6.38 – 19.46	13.08
JUN-00	12.12	2.79	6.54	9.33	14.91	17.7	6.54 – 17.70	11.16
JUL-00	10.62	2.19	6.24	8.43	12.81	15	6.24 – 15.00	8.76
AUG-00	8.38	2.21	3.96	6.17	10.59	12.8	3.96 – 12.8	8.84
SEP-00	12.74	2.75	7.24	9.99	15.49	18.24	7.24 – 18.24	11
OCT-00	12.77	2.5	7.77	1027	15.27	17.77	7.77 – 17.77	10
NOV-00	15.05	4.22	6.61	10.83	19.27	23.49	6.61 – 23.49	16.88
DEC-00	16.64	3.16	10.32	13.48	19.8	22.96	10.32 – 22.96	12.64
JAN-01	10.21	2.11	5.99	8.1	12.32	14.43	5.99 – 14.43	8.44
FEB-01	17.31	4.49	8.33	12.82	21.8	26.29	8.33 – 26.29	17.96
MAR-01	16	3.83	8.34	12.17	19.83	23.66	8.34 – 23.66	15.32
APR-01	11.93	2.33	7.27	9.6	14.26	16.59	7.27 – 16.59	9.32
MAY-01	12.79	1.93	8.93	10.86	14.72	16.65	8.93 – 16.65	7.72
JUN-01	11.45	2.06	7.33	9.39	13.51	15.57	7.33 – 15.57	8.24
JUL-01	14.57	2.53	9.51	12.04	17.1	19.63	9.51 – 19.63	10.12

Legend
- (dark shading) Months in which the visibility ranged from bad (< 8m) to excellent conditions (>15m).
- (light shading) Months in which the lowest visibility records were below 8m
- (line) April 1999, the month in which the new pipeline was commissioned.

Figure 5.10 shows the number of effluent days as determined by Sappi Saiccor's environmental team and as decided in this study based on this principle. The graph shows that the precautionary principle resulted in higher values for the number of days that were recorded as effluent days as opposed to the ones that were decided based on the majority rule principle. Another interesting point to note is that when adopting the precautionary principle, all the months had effluent days whereas the alternative method shows months such as January 2000 and February 2000 as not having any effluent days.

The distinct dark colour of the effluent is the most important factor that led to the demonstrations of concern from the public about the disposal of effluent into the sea. This was because of its unsightliness, its perceived human health impact, and its impacts on the marine environment and most importantly its impacts on the underwater visibility. A simple comparative graph shown below (Figure 5.11) was therefore done to assess whether there is a relationship between the presence of effluent and visibility.

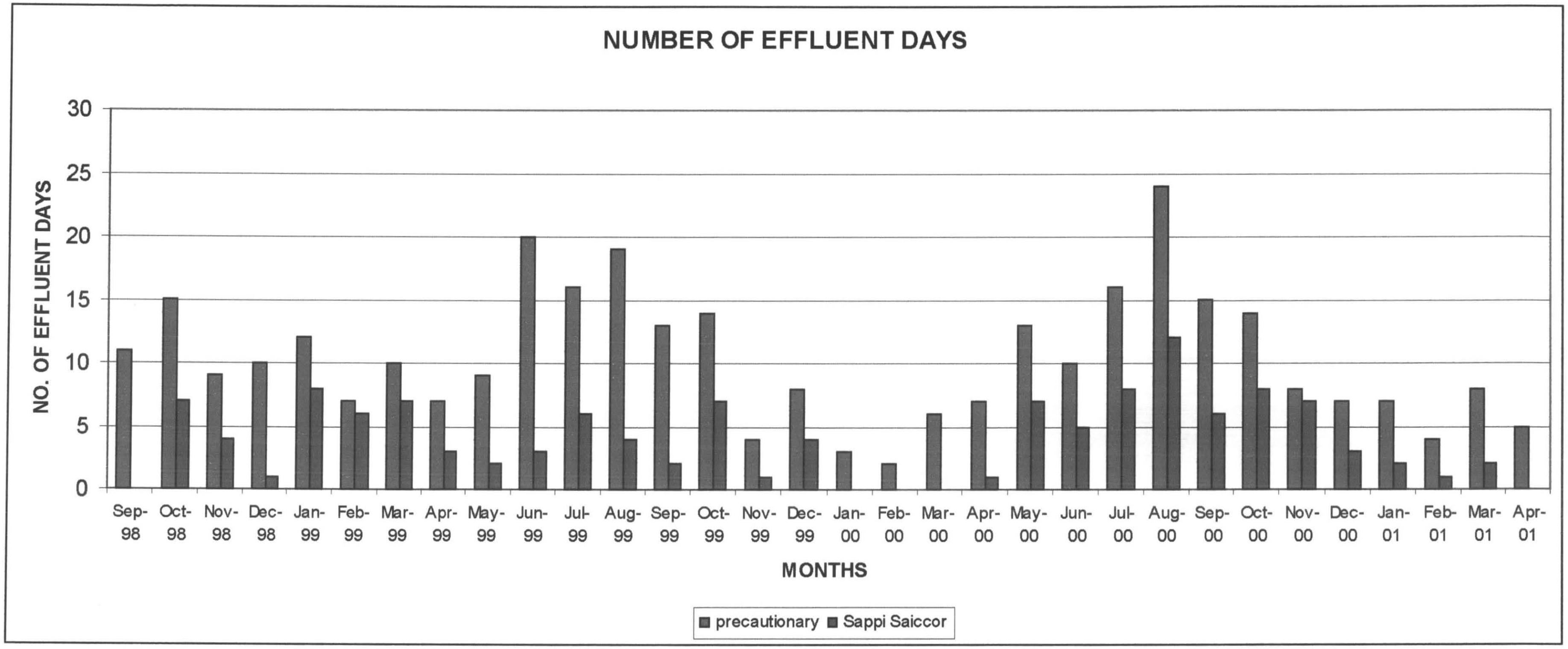

Figure 5.10: Number of effluent days as decided by Sappi Saiccor and through the adoption of the precautionary principle.

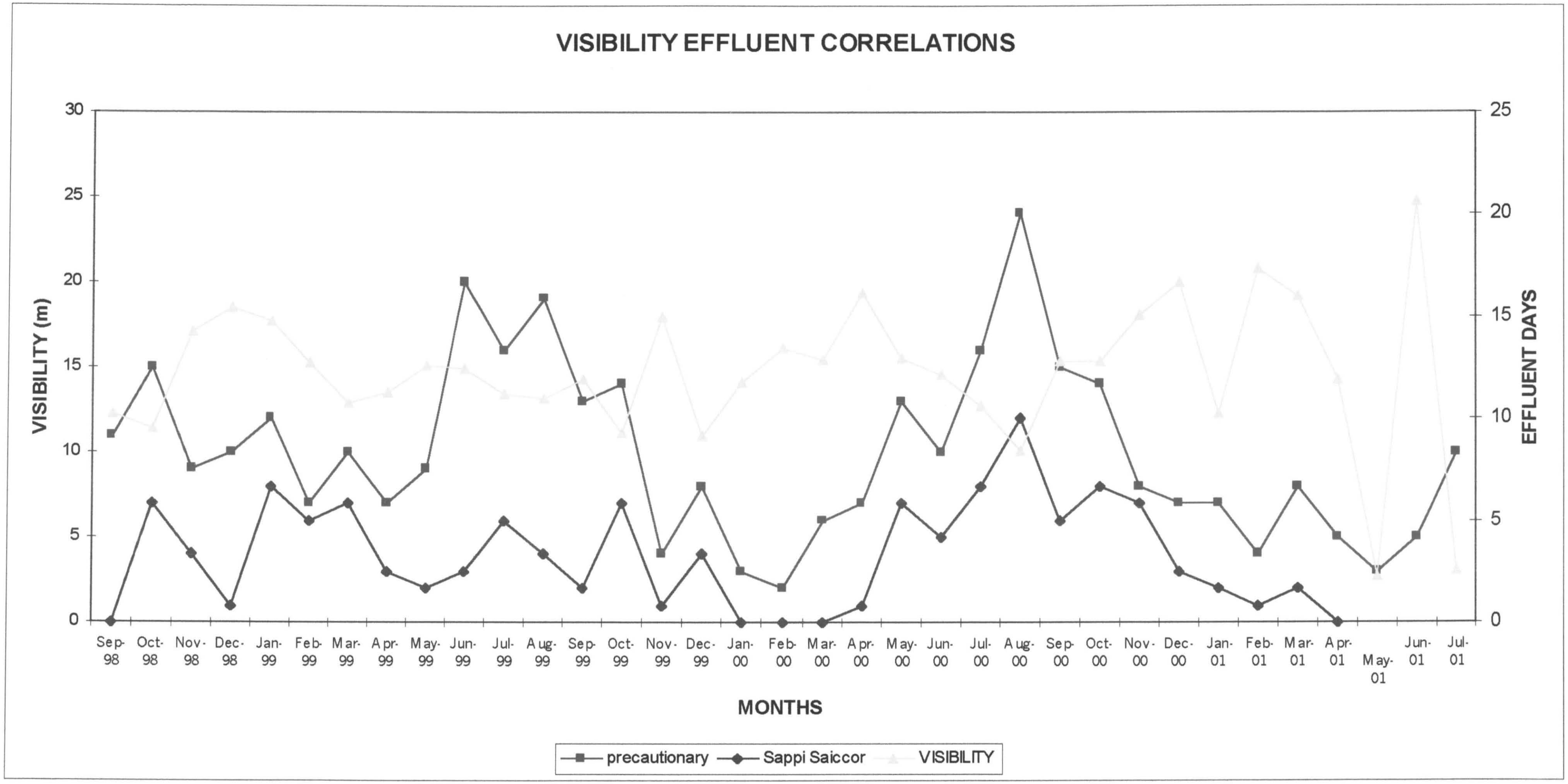

Figure 5.11: Visibility effluent comparisons

Figure 5.11 shows a correlation between the presence of effluent and underwater visibility. When the number of effluent days increases, visibility tends to decrease, and the opposite happens when the number of effluent days decreases. This can be seen for the months October 2000 to April 2001, where as the effluent days decreased, the visibility improved. Within the same period however there were some dips in the visibility trend although there was no major increase in the effluent days. Another contrasting outcome is seen in May 2001, where the number of effluent days are decreasing but at the same time the visibility decreases from the previous month record of around 12m to 2m.

The smaller dips within a generally good visibility trend and decreased effluent days could be a result of other factors such as weather conditions, currents and river influence, which also impact on the underwater visibility. Drastic declines such as in May 2001 (From 12m to 2m) however can be compounded by technical problems, either with the pipeline itself or with the lignosulphonate plant. A leak in the pipeline or a shut down of the plant could result in more effluent being pumped to sea, hence effluent plumes can easily be seen. Around this period, a leak was detected in the pipeline itself. This could have resulted in a few days of really bad visibility. This again clearly outlines how the mean is influenced by extreme values.

Although a relationship can be seen between the presence of effluent and visibility, the relationship cannot be quantified. This is mainly due to the fact that there are other outside factors that affect underwater visibility apart from the presence of effluent such as weather conditions. The other factor is lack of consistency between different dive charters in the recording of the presence of effluent. The standardisation of this process would therefore go a long way to validating the effluent records and adding more credibility to the whole process.

Figure 5.11 also shows the seasonal variation in the presence of effluent, where the winter months seem to have higher numbers of effluent days, than the summer months. Although the new pipeline started operating in April 1999, immediately after that there was a sharp increase in the number of effluent days. From June to August 1999, about 50% of the days were recorded as effluent days, after which there was a gradual decrease until February 2000, with a record of only 2 days. After this there was another gradual increase until August 2000, which recorded the highest number of effluent days, namely 24 days. This is followed by a decline up to May 2001 after which the number of days rose. Although the amount of effluent that can be seen in the water is dependent on many factors such as production process and technical problems of the lignosulphonate plant and possible leaks, this trend can also be influenced by seasonal changes, since the sea conditions themselves play a vital role. A possible explanation could therefore be that during this time the water temperature was low resulting in less mixing, hence reduced dispersion and dilution of the effluent.

5.4.3 Effluent index

Compounded to the complexity of the problem of reaching consensus on how to decide an effluent day when interpreting the divers' data, is the fact that in the methods adopted by the Environmental Manager for Sappi Saiccor and the one adopted in this study, the records of little effluent (LE) were not given any weighting in deciding an effluent day, as they were not included. There is therefore a need to find a way of including all these different forms of the presence of effluent in a more significant way in the analysis process. It is evident that the effluent can manifest itself in different forms and quantities. It is important to note all these different forms and quantities so that the results can be as representative as possible to the real situation. This study therefore seeks to develop an index that will be inclusive of all these forms in proportion to their impacts on visibility.

The Sappi Saiccor Effluent Officers who are involved in monitoring the presence of effluent visually assess conditions along the coast and inshore distinguishing between the different forms that the effluent can manifest itself in the water. These categories (Table 5.6) are adopted in this study to develop the effluent index, since they are common terminologies that are used by the sea users to describe the presence of the effluent, to differentiate between the different forms and quantities of the effluent. An alternative method of recording the data is therefore suggested as shown in Appendix VIII.

Table 5.6: Descriptions of effluent in water in relation to its quantity, source and form (Oelofse, 2000).

- Plume visibility, denoted as **E** – a very distinct dark purple colour, which can clearly and easily be seen in the water.
- Lace, denoted as **LE** – streaks of lightly foaming effluent that can be clearly seen in the water.
- Suds, denoted as **SE** – This are the traces or trails of effluent that can be seen along the trail of a boat.
- Old effluent, denoted as **OE** – This is old effluent that has been swept from somewhere else by currents or which has been brought up due to up welling.

Based on the above-mentioned descriptions of the presence of effluent, the rating as shown in Table 5.7 below was developed, and an effluent index ultimately devised from these ratings. This is an alternative method to Sappi Saiccor's index, of assessing the presence of effluent in a meaningful and fair manner. It recognises the presence of effluent in its different forms but also acknowledges that these have different impacts on the visibility under the water by assigning them different weightings.

Table 5.7: Effluent forms and their Ratings

EFFLUENT FORM	RATE (R)
E	4
LE	3
SE	2
OE	1
No Effluent	0

The rates are allocated on the basis of the impacts of the effluent form on visibility, where the worst is given the highest score. When there is no effluent a score of zero is given. The daily effluent index is then calculated as discussed in section 3.5.2.

Daily effluent index = $\sum R_{DC1} + R_{DC2} + R_{DC3} + R_{DC4} + R_{DC5}$

$$= \sum R_{DCn}$$

Where R_{DCn}, is the rate for every dive charter group.

The indices are then categorised, such that a meaningful interpretation can be made. That is, the effluent index should reflect whether the conditions are bad or good for diving. The ratings, which are shown in Table 5.9, were made based on the assumptions as shown in Table 5.8. This effluent index can therefore be used to translate the presence of effluent in its different forms and quantities into its implications for diving conditions. This index can facilitate easier assessment of the performance of the pipeline, since it weighs the different quantities of effluent depending on their corresponding impacts.

Table 5.8: Ratings of the Effluent Indices

Excellent:	This ranges from when there is no effluent to when at the most, all the dive charters have recorded 'Old effluent' (OE). No effluent – Old effluent
Preferable:	This ranges from when at least one dive charter group has recorded 'suds' (SE) while the other four have recorded 'OE' to when all have recorded 'SE'.
Acceptable:	This ranges from when one dive charter group has recorded 'LE' and the other four have recorded 'SE' to when all have recorded 'LE'.
Bad:	This is when one of the diver charter groups has recorded plume visibility (E), and the rest have at least recorded 'LE' to when all have recorded 'E'.

Table 5.9: Classes of the Daily and the Monthly Effluent Indices

DAILY	RATING	MONTHLY
0 – 5	Excellent	0 – 155
6 – 10	Preferable	156 – 310
11 – 15	Acceptable	311 – 465
16 - 20	Bad	466 - 620

5.5 PIPELINE PERFORMANCE

One of the objectives of this research was to assess the performance of the present pipeline. This is also one of the requirements of the Sappi Saiccor permit, which stipulates under Section 2.3.1 that the extended pipeline should reach a minimum reduction of 70% of the aesthetic impacts of discoloration and foaming on the beach (Sappi Saiccor Permit, 1997; Appendix II), though it does not stipulate how this 70% should be measured. This section will therefore concentrate on assessing the performance of the pipeline against the effluent and visibility conditions before the pipeline was extended. Simple graphical presentations were done to show the conditions before and after the pipeline was extended. As already shown in Figure 5.6, there is no significant improvement in the monthly average visibility after the pipeline was extended. However to have a more accurate comparison, the same months before and after the pipeline extension were used for analysis (Refer to Table 5.1) where:

- Pre is from September 1998 to March 1999
- Post 1 is from September 1999 to March 2000
- Post 2 is from September 2000 to March 2001

Hypothesis tests were also done to assess the significance of the differences in the marine water quality before and after the pipeline was extended. A Chi Squared test and a T-test were done to assess the significance of the differences in the number of effluent days and visibility conditions respectively. A variance test (ANOVA) was also done to assess the significance of the differences between the records of the different dive charter groups.

5.5.1 Pre and Post-pipeline extension effluent comparisons

Apart from determining the effluent index, the number of days recorded as effluent days in a month could be another useful indicator to be used to assess the impact of Sappi Saiccor on diving. Although there is inconsistency in the effluent records, there is a correlation between the presence of effluent and a decline in underwater visibility, hence the effluent data can be used as one way of assessing the performance of the pipeline. Figure 5.12 below shows the comparison of effluent days before and after the pipeline extension.

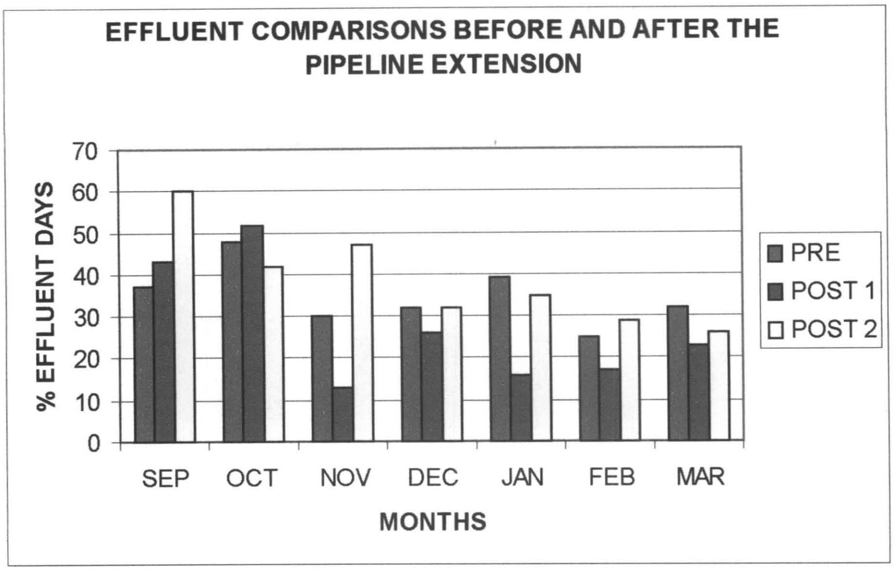

Figure 5.12: Monthly effluent comparisons before and after the pipeline extension

As already discussed in section 5.4.2, there is no clear pattern that can be derived from the effluent presence over time. There is no apparent improvement in the number of effluent days after the new pipeline was commissioned in April 1999. However this is based on the worst-case scenario. Figure 5.12 above does not reflect any indication of improvement. Rather, it shows most months (September, October, November and February) having an increased number of recorded effluent days after the pipeline extension, especially in Post 2. A clear picture can be seen when looking at the cumulative results of these months as shown in Figure 5.13 below. This graph shows a 14% reduction in recorded effluent days in Post 1, which however is followed by a 15% increase in Post 2. Overall there is a 6% decrease in the number of recorded effluent days after the pipeline was extended (37% effluent days before the pipeline was extended and an average of 31% after the pipeline extension). A chi-squared was therefore conducted to determine the significance of this difference.

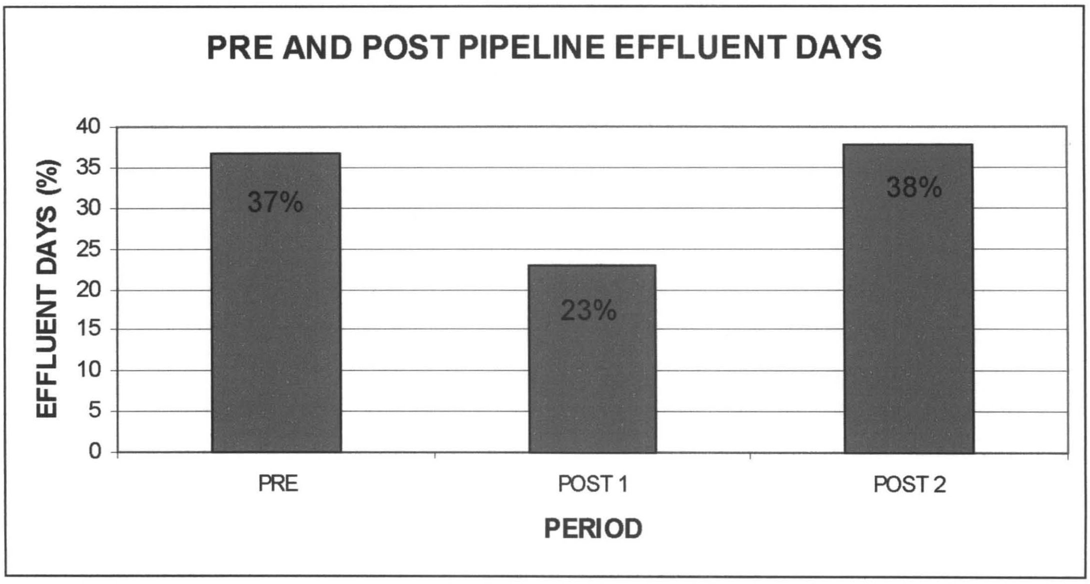

Figure 5.13: Effluent comparisons before and after the pipeline extension

The following hypotheses, the null hypothesis (H_o) and the alternative hypothesis (H_1) were stated:

H_o: There is no significant difference between the number of effluent days before and after the pipeline was extended.

H_1: There is a significant difference between the number of days before and after the pipeline was extended.

The following Chi squared equation was used such that the significance of the difference could be assessed. (see Table 5.8)

$$X^2 = \sum \frac{(O-E)^2}{E}$$

Where O = Observed frequencies

E = Expected frequencies

And the degree of freedom, df = (r – 1) (c – 1)

The number of effluent days for the different periods is the observed frequencies while the number of no effluent days is the expected frequencies. (see Table 5.10)

Table 5.10: Number of effluent days before and after the pipeline extension

	EFFLUENT DAYS	NONE EFFLUENT DAYS	TOTAL
PRE	78	134	212
POST	129	296	425
TOTAL	207	430	637

Table 5.11: Calculation of the chi-squared value

	O	E	O-E	$(O-E)^2$	$\frac{(O-E)^2}{E}$
PRE	78	$\frac{212 \times 207}{637}$	9.11	82.99	1.2
	134	$\frac{212 \times 430}{637}$	-9.11	82.99	0.58
POST	129	$\frac{425 \times 207}{637}$	-9.11	82.96	0.6
	296	$\frac{425 \times 430}{637}$	9.11	82.96	0.29
Σ					2.67

df = (r – 1) (c – 1)

= (2 – 1) (2 – 1)

= 1

Xcrit = 3.84, and Xcalc = 2.67

Xcrit > Xcalc, Hence H_0 is accepted.

There is no significant difference in the number of effluent days before the pipeline was extended and after.

The difference between the pre and post periods has been proven insignificant, hence it can be concluded that the 6% decrease in the number of effluent days after the pipeline extension does not imply a definite improvement in the number of recorded effluent days. This could be coincidental due to the inconsistency in the effluent records between the different dive charter groups. Table 5.10 and Figure 5.13 both show that before the pipeline was extended 37% of the days were recorded as effluent days, and this dropped to 31% after the pipeline was extended. However when looking at the data more closely this improvement is not very apparent. Figure 5.13 shows a significant drop in the number of effluent days from 37% before the pipeline extension (pre period) to 23% in post 1, followed by a 15% increase in post 2. This shows a rather unstable trend, from which the pipeline extension does not seem to have improved the situation overall. This instability can be attributed to the inconsistency in the data collection methods, varying weather conditions and ocean currents, and Sappi Saiccor's production variations from the lignosulphonate plant. It may also reflect that the pipeline has not resulted in an improvement in the number of effluent days on the Aliwal Shoal.

Judgement on the presence of effluent and the manner in which it is recorded depends on individual discretion since there is no set or predefined protocol to be followed. This raises questions such as, 'How are the records, "effluent present" and "little effluent" different from each other? Do they mean the same to all dive charter groups? These questions are very important since only records that stated "effluent present", were considered when determining effluent days while all the "little effluent" records were not considered. Another probable explanation for this instability could be the limited pre-pipeline data, which is not a true reflection of the situation before the pipeline was extended.

5.5.2 Visibility Comparisons

Visibility records are also a good measurement against which the performance of the pipeline can be assessed. Simple graphical presentations were done to show how visibility varied before and after the pipeline was extended. In the previous sections (section 5.4.1), no pattern was established in the visibility trends over time, although there was no emphasis on any particular time span. This section looks at the data more closely concentrating only on the Pre, and Post periods as explained in Table 5.1.

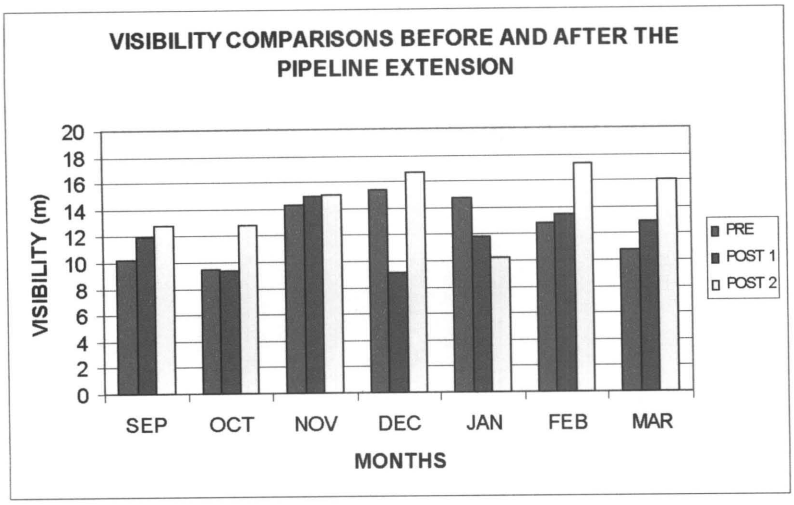

Figure 5.14: Average monthly visibility comparisons before and after the pipeline extension

From the graph above (Figure 5.14) there seems to be a trend of improvement except in December and January. There is a need to look at Sappi Saiccor's production level, weather and current conditions to explain this. Table 5.12 below shows visibility distributions over the periods before and after the pipeline extension at a 95% confidence interval. Since the periods Pre, Post 1 and Post 2 represent cumulative data, it is important to know how the data was distributed within those periods, such that more holistic assessments can be made.

Table 5.12: Pre and Post-Pipeline Comparisons at a 95% Confidence Interval

	AVERAGE VISIBILITY (m)		STANDARD DEVIATION (δ)		-2δ	-1δ	+1δ	+2δ	C.I. RANGE	C.I. VALUE
PRE	12.68		2.6		7.48	10.08	15.28	17.88	7.48 – 17.88	10.4
POST 1	11.92	13.16	2.85	3.07	6.22	9.07	14.77	17.62	6.22 – 17.62	11.4
POST 2	14.39		3.29		7.81	11.1	17.68	20.97	7.81 – 20.97	13.16

From Table 5.12 above the average monthly visibility seems to have improved from 12.68m, before the pipeline extension to 13.16m after the extension. At a 95% confidence interval, Post 2 has the highest maximum visibility record of 20.97m compared to the 17.88m and 17.62m for the Pre and Post 1 periods respectively. The improvement can further be noted in the range values where Post 2 has a range value of 13.16 compared with the 10.4 and 11.4 values for the Pre and Post 1 periods respectively. At the same confidence interval however, the minimum visibility records for all three periods is below 8m. This implies that at a 95% confidence interval, the average monthly visibility for all the periods can be either bad or excellent. Figure 5.15 below shows a frequency distribution comparison between these three periods, where a pronounced shift to the right can be noted for the Post 2 period marking a definite improvement in the visibility.

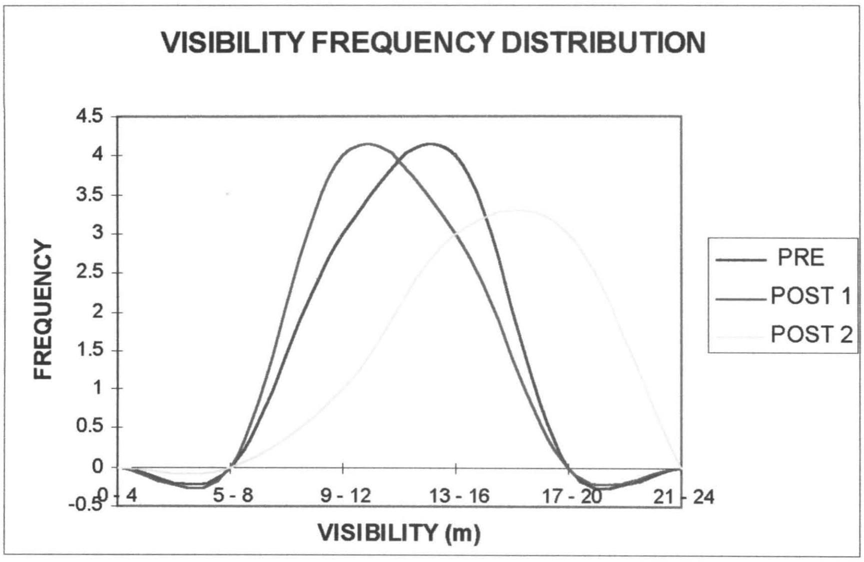

Figure 5.15: Pre and post-pipeline visibility comparisons

The same trend can be seen when looking at the median, which is more resistant than the mean as it can not be influenced by extreme values, and the distribution of the records from the median as shown in Figure 5.16 below. The records are more evenly distributed for the Pre and Post 1 periods, while for the Post 2 most figures lie below the median. There is however a marked improvement in Post 2 where the lower bound is 12.02 and the upper one is 16.76. This is high compared to the Pre and Post 1 periods, with lower bounds of 10.33 and 9.95 and upper bounds of 14.73 and 13.89 respectively (Appendix IX).

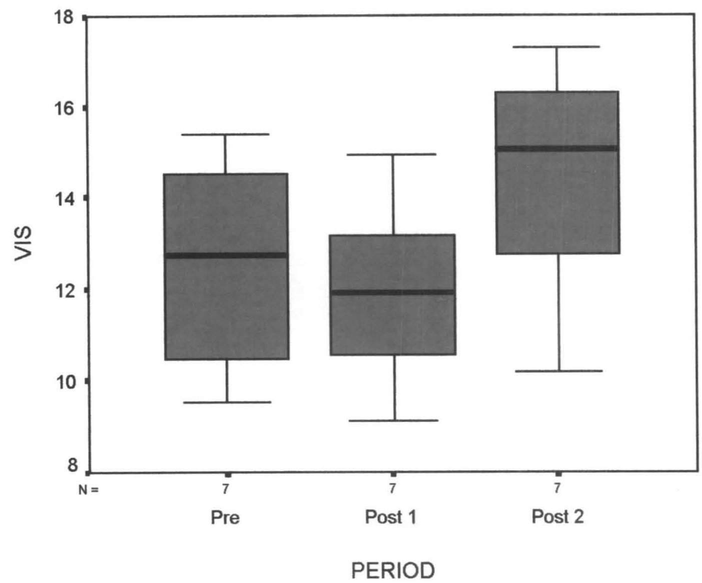

Figure 5.16: Box plot showing the median, lower and upper quartile ranges for the periods before and after the pipeline extension.

When looking at the data more closely however this improvement is not so apparent. The visibility decreased from 12.68m for the Pre period to 11.92m for the Post 1 period. This paints a rather uncertain picture as far as deciding the effectiveness of the pipeline extension. Due to this uncertainty, there was need for more tests to be completed to assess the significance of the differences in the visibility records between these periods, hence the application of a simple Student T-test.

This test was done to assess whether the difference in the visibility records before and after the pipeline extension are significant. That is, to test there is a definite improvement in the visibility or whether the differences are purely due to chance given the subjectivity of the data itself. The following hypotheses, the null (H_o) and the alternative (H_1) hypothesis were stated:

H_o: There is no significant difference between the underwater visibility before and after the pipeline was extended from 3 km to the present 6.5 km.

H_1: There is a significant difference in the underwater visibility before and after the pipeline was extended from 3 km to the present 6.5 km.

$$t = \frac{\left|\bar{x}_a - \bar{x}_b\right|}{SE(x_a - x_b)}$$

Where;

$$SE(xa - xb) = \sqrt{\frac{S^2}{n_a} + \frac{S^2}{n_b}}$$

$$SE(xa - xb) = \sqrt{\frac{2.6^2}{7} + \frac{3.07^2}{14}}$$

$$= \sqrt{0.9657 + 0.6732}$$

$$= 1.28 \quad \text{Therefore,} \quad t = \frac{12.68 - 13.15}{1.28}$$

$$t = 0.37$$

$t_{crit} > t_{calc}$, hence Ho is accepted.

There is no significant difference between the underwater visibility before the pipeline extension and after. As in the case of the number of effluent days the difference in the visibility records can be attributed to a number of reasons such as varying weather and oceanic conditions, Sappi Saiccor's production levels, and the limited data for the period before the pipeline was extended. The fact that the data is being collected by different people in this case does not have a great bearing on the results since it has been proven that the data is consistent between the different dive charter groups, hence can be used to make conclusive statements about the status of underwater visibility.

As mentioned by Norgaad (1984) and in the IIRR (1996), local knowledge has to be systematically collected and scientifically verified before it can be accepted as a valid data source. The statistical analysis performed in this study has verified the divers subjective data such that it can be validated and hence be used to make inferential conclusions about the real situation. Contrary to the findings of Mike Bentley, which showed an improvement of about 80% (PAP minutes, 12/2001) the statistical analysis in this study does not show major improvements in the visibility and effluent presence after the pipeline was extended to the present 6.5 km. However in the case of the effluent records this is based on the worst case scenario. This study has shown the differences in both these parameters before and after the pipeline was extended to be insignificant to mark any improvement between these two periods, hence the fluctuations can be attributed to the following,

- *Varying weather conditions*: storm water after heavy rainfall from the river Umkomaas can result in decreased underwater visibility. Furthermore low water temperatures can result in less mixing of the water, hence decreased dispersion and dilution rates of the effluent resulting in thick effluent plumes being seen in the water and impacting on the underwater visibility.
- *Oceanic conditions*: Wind direction and ocean currents can result in the effluent plume being forced to take a particular direction, limiting its dispersion rate, hence it can be concentrated on one particular spot, impacting negatively on the underwater visibility. The strong south-flowing warm Agulhas current running parallel to the shore predominantly influences the KwaZulu-Natal south coast. Since the pipeline is north of the Aliwal Shoal along the coastline (Figure 4.1), the effluent concentrations at the Aliwal Shoal could further be exacerbated by this current.
- *Variability in Sappi Saiccor's production*: The lignosulphonate plant, which is responsible for extracting excess lignin from the effluent, hence reducing the colouring in the effluent can vary in its production for various reasons. The production of the plant is dependent on the international market for lignin. When the markets are bad, production is decreased, resulting in more of the lignin being disposed into the sea. The plant may also be shut down for maintenance or due to technical problems.
- *Subjective nature of the data*: The data is subjective since it is based on individual discretion. There is also no set protocol that is followed when individual records are collected and there is also no method used to standardise these records. This is however not a problem for the visibility records, which have been proven to be coherent for all the dive charter groups. The issue of effluent presence is more complex since effluent can manifest itself in different quantities and forms. Presently the records do not take into consideration these different facets of the effluent, hence the records are limited in their description of the situation. A finer grained range of effluent types would allow for more consistent data collection.

Although the statistical analysis does not show any improvement in the presence of effluent and underwater visibility since the pipeline extension, this could be an underestimation of the real situation due to the data limitations as discussed in section 5.2.1. It should also be borne in mind that the inclusion of datasets with a lot of missing values could have lead to an underestimation of the actual situation, hence the improvement in the under water visibility and presence of effluent brought about by the pipeline extension could have been toned down. This statistical analysis also excludes the socio-cultural dimension of this problem. This marks a shortcoming of the scientific epistemology where purely scientific methodologies fail to address an issue holistically. In such cases it is always best to resort to other knowledge sources such as the local people, who are familiar with the local conditions, to complement scientific input.

The first part of the analysis has addressed the first two research questions. Alternative methodologies for the collection and analysis of data have been developed and an assessment of the performance of the new pipeline has also been done. This has outlined the successful integration of local and expert knowledge in the monitoring process to achieve a more holistic and inclusive process (of all the stakeholders, especially the ones directly affected). The last research question deals with an assessment of the role of this study in dealing with conflict within the PAP. This is addressed in the next section.

5.6 ROLE OF THE VISIBILITY (INDEPENDENT) MONITORING SYSTEM

As criticisms of the positivistic approach of the 1960s escalated, so did criticisms of statistical analysis in geography. It was argued that the view that geography as a study of spatial relations dependent on qualitative methods only was an incomplete and unsatisfactory view of the discipline, telling only part of the complex story. This was coupled with the 'rediscovery' of culture by cultural geographers and also the engagement with new theories such as humanism and postmodernism. Qualitative techniques were therefore increasingly recognised as central to geographic investigations. Qualitative techniques are essentially descriptions of people's representations and constructions of what is occurring in their world (Robinson, 1998).

The Sappi Saiccor effluent issue is a complex issue, therefore quantitative statistical analysis can only address part of it. Qualitative techniques are adopted to supplement the quantitative methods such that a more holistic view of the problem can be achieved. Although the Sappi Saiccor effluent problem is perceived to be a biophysical issue, it is important to assess its socio-cultural dimension such that the problem can be addressed holistically. Since this study was commissioned due to the conflict and mistrust between the PAP members, another important aspect of this study is therefore to assess the role of this study in resolving this conflict.

The issue of monitoring of the impacts of effluent on visibility due to its distinct dark colour has been an issue of hot debate charged with emotion between the different stakeholders within the PAP. This issue raised questions pertaining to what knowledge is appropriate or valid enough to assess this impact. Different ways of measuring this impact, such as satellite imaging were proposed, but were found to be not viable due to cost implications.

After much debate, it was eventually agreed that the divers would collect data that would then be analysed statistically by an independent body. This decision was made after it was realised that the issue of visibility was a subjective one irrespective of who was collecting the data. However it was deemed important that the divers should be the ones to collect the data in an attempt to provide for community involvement in the monitoring process. (See chapter 3 for more background information).

5.6.1 Value of the divers' monitoring system

As was anticipated when the divers' data was accepted as a valid data source, this analysis increased transparency within the monitoring system, since an independent body had conducted the analysis of data. Most members of the PAP feel that this analysis has made a major contribution in resolving the conflict and building trust between the panel members (Connell A. and Sadler M., pers. Comm., 28/05/2001). Furthermore it has added credibility to the analysis, which has been done by Sappi Saiccor's environmental team.

From the questionnaires that were administered to the PAP members (see Appendix X for the responses of the questionnaire), it was however apparent that there are some people who are still very sceptical about the validity of the divers data as an objective way of assessing the performance of the pipeline, hence cynical of the impact this monitoring system will have. Undermining communities' confidence in their local knowledge can result in them losing hope and interest in the whole process. This can also widen the already existing communication wedge between the stakeholders, especially the community, giving rise to myths, lack of trust and confidence and eventually conflict (Rajasekaran, 1993). Disregarding or devaluing local input may result in the inefficient allocation of resources and manpower to inappropriate planning strategies that have little to do with addressing the socio-cultural dimension of the problem.

The PAP remains in a situation of a tug-of-war by 'being participative' and doing 'rigorous monitoring', which are normally characteristic of community expectations and conventional scientific methods respectively. This leads to the question of what the losses and gains are of adopting a participatory monitoring system. The answer to this question lies in the level at which monitoring information is needed and by whom it is used. Communities normally need methods that can explain issues and give direction at a local level; hence data that is 'good enough' to serve this purpose should be satisfactory. If the data needs however extent to higher levels, beyond the local setting, the question of validity at all levels becomes more pressing. The PAP serves to satisfy both levels, hence the constant conflict and confrontations in trying to strike a balance.

Some people pointed out that this system has its strengths and weaknesses. They acknowledged that this monitoring system would give an indication of the difference the new pipeline has made on the disposal of effluent, although it will not be able to quantify the percentage reductions. Mr. Swinford-Meyer (pers. comm. 27/11/01) stated that since the data that they collect (dive operators) is subjective and has "too many loop holes", it is hard to argue a case based on it since its credibility is always questioned.

The importance of the dive operators reports was however emphasized by some arguing that this is the best method available under the circumstances and any effort to change it may, in hindsight be regretted due to the much more limited scope of a single individual or organisation collecting the data. Dr. Scott (pers. Comm. 17/11/01) complained that the divers monitoring system was not as independent as was originally agreed, since the data was still being collected through Sappi Saiccor. She however stated that this system is the best that can be adopted since it monitors the effluent impacts and helps to address the issues of conflict and mistrust between the stakeholders. Furthermore she stated that the success of this system is dependent on its acceptance by all stakeholders, arguing that industry does not seem to have fully accepted this system. It would seem that more scientific methodologies are preferred since other more scientific alternatives such as the now proposed modelling of light penetration[1] are sought.

Although the concern on this disposal of effluent into the sea has a strong emphasis on the ecological impacts, it also has strong socio-cultural implications. In order for the ecological aspect to be addressed effectively, these socio-cultural implications also have to be addressed. Scientific methods may be precise in quantifying the level of improvement, but they fail to redress the socio-cultural issues inherent in environmental impacts. Furthermore, given that people invest much time, money and effort in participatory monitoring, it is important to know if it is worthwhile, hence the decision to start a participatory monitoring system is not to be taken lightly and should certainly not be seen as a token effort. Token efforts can be very demoralising and demeaning to the people who were tasked to do them. For anyone to be enthusiastic about what they do, they need to feel that what they are doing is valuable and is contributing towards the decision-making process.

The PAP and the establishment of the dive operators' monitoring system were meant to increase transparency and accountability in the monitoring of marine water quality, and ultimately resolve the conflict between the PAP members. The dive operators' monitoring system is therefore an important element in the problem solving process and hence should be maintained even though the sea conditions are believed to have improved.

This monitoring system is not only important for the quantification of the improvement due to the new pipeline, but also in terms of the attitudinal changes required between the PAP members and towards the problem itself. As Allen (2000a) argue, change is the outcome of learning. Although the assessment of the marine water pollution is important, there are other issues, such as trust among the different stakeholders that are equally as important to allow for easier communication and dialogue, and ultimately an appreciation of each others' value systems and perceptions.

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[1] The CSIR has been commissioned to model light penetration at the Aliwal Shoal, taking into account all the factors that can impede on light, of which the effluent is one, among other physical phenomena.

5.6.2 Functioning of the PAP

The PAP was formed as a way of providing for public participation. When this decision was taken however, there were no clearly set steps to follow, since there were no public participation specialists. The whole process has been a learning curve for all those involved. The PAP has therefore evolved through the different types of community participation (see Table 2.1). It has evolved from being passive, where the community was involved in as far as attending the meetings. At that stage they did not have any role in the monitoring process itself. This has progressed to the functional stage where the divers were given a more active role of collecting data. In this type of participation, community participation is viewed as a means of achieving project goals.

The PAP also portrays a partnership between the community, industry, NGOs and the authorities. When using the Environmental Partnership Map from Long and Arnold, (1995), this partnership started off as a pre-emptive partnership (see Figure 2.6). This partnership was forged under very strained relationships, especially between the community and industry. The conflict level was high and the community had gone public with their concerns when they embarked on a bumper sticker campaign claiming, "Saiccor is polluting their sea" (Dr. D. Scott, pers. comm, 15/06/2000). This partnership was deemed important since all the parties involved felt the situation had to be addressed. The community was eager for the pollution to stop while industry was eager to stop the public from making any more public statements. As mentioned by Long and Arnold, (1995), a partnership that is established under these conditions is normally clouded with hostility and mistrust, due to the long history of conflict, and the partnership tends to have little or no impact. As the effluent impacts along the shore and to a lesser extend at the Aliwal Shoal decreased, so did the level of conflict and the perceived core relevance of the partnership. The partnership within the PAP has thus evolved from being pre-emptive to coalescing. Since this is still an ongoing process, this partnership could evolve further into more opportunistic types of partnerships, where all parties involved make a modest attempt to environmental improvements.

Although the PAP is clouded with high conflict levels, hostility and a lot of disagreements, it is still viewed by some of the PAP members as a useful panel since it has at least managed to bring industry, the government and the people together to start negotiating and working together towards solving the marine pollution problem. The PAP has set the platform for information sharing and facilitating capacity building hence some stakeholders now claim to have "a balanced view" of the problem. The PAP was further complemented for the role it has played in bringing together former rivals (industry and the community) to a point where they can have dialogue and ultimately resolve the conflict that prevailed before. It is also believed to have made regulatory institutions aware that if they do not control the permit, they will have to answer to the public.

There were however some concerns that were raised. The first concern was that of representation, where most people felt that the PAP was dominated by Sappi Saiccor representatives and very few members of the public, i.e. the sea users, diver operators, workers and residents in the area. The issue of representation has always been a problem and Dr. Scott (pers. Comm. 17/11/01) said she feels that this issue could have been addressed by giving the facilitator the task of liasing with all the stakeholders through appropriate avenues. Lately however, due to the remarkable improvement in the effluent and foaming along the beaches and to a lesser extent the reef, it is argued that the PAP will further be less represented as the NGO and business sector lose interest. Although the PAP was generally viewed as a good panel some dive operators felt it was not really worth much. Mr. Swinford-Meyer called the PAP, "a dog without teeth" (pers. Comm., 27/11/2001), arguing that the PAP is heavily dominated by Sappi Saiccor, the scientists are biased, and the regulatory body (DWAF) is very weak hence they feel intimidated, and their opinions are not taken seriously.

The PAP displays some of the symptoms of a process breakdown as suggested by Long and Arnold (1995), such as demonstrations of anger and/or frustrations with the process and with proposals being put forward by other participants. This is reflected in the PAP minutes where members complain that the PAP is not meeting its goals (PAP minutes, 28/09/1999). Many of the dive operators felt the process was not really yielding any significant results, and they said that the PAP was used by others to achieve their own agendas. This also reflects a breakdown in the process.

The fact that members regularly rehash issues that were apparently resolved at earlier stages is said to be another symptom of a failing process. Furthermore, the decision taken by the PAP to have meetings less frequently, together with the decreased participation of some stakeholders could be interpreted that the panel is declining in importance. Dr. Scott stated that the decision to reduce the frequency of the meetings devalues the role of the PAP. As a member of the PAP she voiced her dissatisfaction that she was not consulted about this decision (pers. comm. 17/11/01).

However, the constraints experienced within the PAP are common constraints to all participation processes. As Edgerton *et al.* (2000) state, diverse perceptions by the different stakeholders concerning the participation process and the issue of concern can lead to more conflict and less trust, and ultimately to a process breakdown. Finally, one of the major constraints in community participation is an exaggerated expectation of the participation process by some of the stakeholders. When these expectations are not fulfilled people then say that the process was useless and a total waste of time.

There is a general sense of consultation fatigue among the stakeholders especially the divers who claim that the process takes too much of their time, arguing that they are self employed business people and can therefore not afford to take the time off. Consultation fatigue coupled with exaggerated expectations can lead to people thinking that the process was a failure. This feeling can lead to the development of feelings of mistrust and myths, where people start accusing each other of the failure. This is evident within the PAP where some members still feel that they were undermined throughout the whole process and that the process was a waste of time. Others claim that they have given up, arguing that they are tired of fighting big industry. Others have however said that they have come to accept that Sappi Saiccor is part of their lives and appreciate the improvement that has been brought about by the extended pipeline. Another interesting aspect that was raised was that some felt that the pollution issue is not only of concern to them as direct users of the sea, but pointed out that there are international environmental groups that will also put pressure on Sappi Saiccor to take further measures of improving the sea conditions (Ms. Labuschgne, pers. Comm., 27/11/2001).

5.6.3 Assessment of the impact of the new pipeline

All the dive operators interviewed acknowledged that there has been a significant improvement in underwater visibility at the Aliwal Shoal since the pipeline was extended, although they still believe that if the pipeline was to be extended a little further, then they would probably have no effluent at all at the reef (Mr. G. Swinford-Meyer, Ms. M.

Addison and Ms. Labuschagne and Ms. B. Hunter, pers. comm., 27/11/2001). The following PAP members and dive operators were quoted in the South Coast Sun (22/10/1999) concerning the improvement in the offshore waters. Dr. Allan Connell, a marine Biologist from the CSIR said,

> "*We have seen a significant improvement along the bathing beaches, both in terms of the stabilisation of foam and discolouration of the sea, since the pipeline was extended in April. Further offshore, there is evidence that some effluent is coming in over the shoal.*"

This was further echoed by Mr. Sadler, from the Durban South TLC, and Mr. Swinford-Meyer, a dive operator, who made the following statements respectively.

> "*Although fewer dives are being cancelled on the Aliwal Shoal due to the presence of effluent, there is a perception that the average number of days the water is crystal clear has decreased.*"

> "*We dived in either very bad or very good conditions and some days it was in between. This depended on the tide and current. Now we don't have very bad days but we mostly have days where visibility is grainy at about 8m*".

Mr. Powell, another dive operator said,

> "*...Now visibility may not be perfect but it hardly ever gets to the point where we have to cancel.*"

Based on the comments of the PAP members and divers, the PAP can be summarised as shown in Figure 5.17. The PAP started of as a pre-emptive partnership clouded with conflict. All the stakeholders deemed the partnership to be highly relevant in order to address the situation. As characteristic to all pre-emptive partnerships, this partnership was clouded with hostility and mistrust. Due to the willingness of all stakeholders to work together, and the willingness of industry to be more transparent in its dealings, the level of conflict has been seen to decrease. Furthermore, with the improvement in the effluent presence and foaming along the beaches, and to a lesser extend the reef, the conflict has been seen to diffuse. This however has also resulted in a decline in the participation levels especially the divers. As the effluent impacts lessen, so does the perceived relevance of the partnership. Some of the divers acknowledged that although they would prefer crystal clear waters, they know that it can never be, and Sappi Saiccor has done all that it can. Hence they don't see the PAP as having anything more to do.

The PAP has thus moved from being a pre-emptive partnership to a coalescing partnership. Although the stakeholders realise that they depend on each other to reach their goals, they seem to be competitive, and consequently defensive. Most stakeholders feel they have to "defend themselves and not give in to the opposition". Due to this competitiveness, there is therefore reluctance in acknowledging the efforts of others. There is a mixed sense of satisfaction with the PAP although there are still some feelings of mistrust. As Long and Arnold (1995) state, this partnership has the potential for hostility or disagreements. They argue that the challenge is to find a common vision, which the stakeholders can share and mutually support. With a bit more perseverance and commitment from the PAP members, the PAP could be well on its way to being an exploration partnership, where all the stakeholders attempt to research or investigate environmental issues of joint concern.

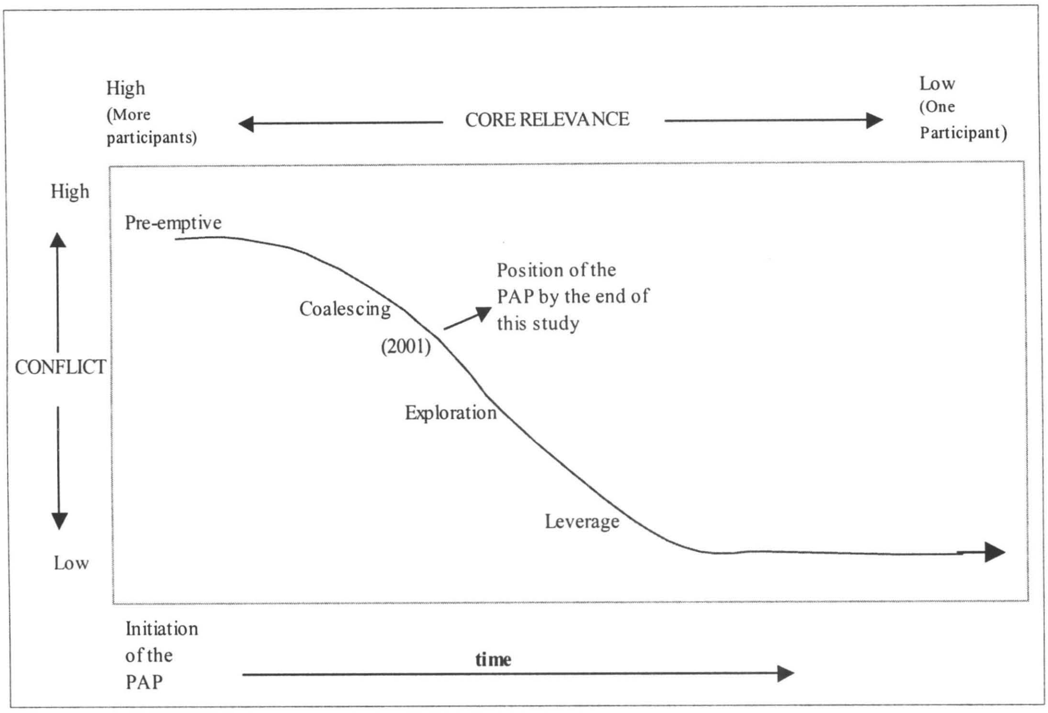

Figure 5.17: Partnership change within the PAP due to decreased conflict and perceived relevance.

CONCLUSION

Since the data being analysed in this study is subjective, without any standardised modes of data collection, the first task in this section was to validate the data such that its use can be justified and the conclusions made based on it accepted. In this regard the visibility records were found to be very consistent across the different dive charter groups and the One-Way ANOVA test proved this data to be valid enough to be used to make conclusive statements. The effluent records however were not as consistent between the different dive charter groups, and the One-Way ANOVA also supported this. For the purpose of this study however these effluent records were further used to assist in the development of alternative ways of collecting and analysing this data.

Simple correlation graphs showed a relationship between the presence of effluent and a decrease in the underwater visibility although it was hard to quantify this relationship due to the manner in which the effluent is being recorded. The effluent records do not specify the quantity or form of the effluent hence the correlation between the two cannot be quantified. No clear patterns of improvement in underwater visibility and the number of recorded effluent days can be seen. The differences in both of these parameters before and after the pipeline was extended were proven to be insignificant through the use of a chi-squared test and a t-test. In both cases the fluctuations can be attributed to varying weather conditions, oceanic conditions, variability in Sappi Saiccor's production and the subjective nature of the data.

Alterative methods of data collection and analysis have been suggested in this chapter.

- *Visibility records:* Since it was proven that the visibility records are consistent and valid data sources, no alternative data collection method is suggested. It is however suggested that more meaning, in terms of diving conditions, be attached to the visibility figures hence the following criteria was developed based on the bench marks as agreed upon by the PAP members;

  > 8m: Bad conditions for diving
  8 – 10m: Acceptable conditions
  11 – 15m: Good conditions
  < 15m: Excellent conditions

- *Effluent records:* Due to the more complex nature of the effluent, it is suggested that the records of effluent should recognise these different forms of effluent. The dive charter groups should come together and decide on these different facets and how best to record them, such that the records can be standardised between the different dive charter groups. From these records an effluent index has been developed to add more meaning to the records in terms of diving conditions (refer to section 5.43).

From the analysis, there appears to be no significant difference in the monthly average visibility and the number of effluent days pre and post the pipeline based on a worst-case scenario. There is a 6% and 4% improvement in the number of effluent days and underwater visibility respectively, which is insignificant compared to the 70% requirement in the Sappi Saiccor permit. The inclusion of datasets with a lot of missing values and the use of averages to summarise the data could have resulted in the underestimation of the actual improvement brought about by the extension of the pipeline, which is echoed by many of the PAP members and the divers. This improvement was echoed by many divers who stated that before the pipeline extension, the visibility varied quite drastically. They stated that the visibility ranged from very bad days (2m visibility), resulting in dives being cancelled, to very good days with a 20m visibility. They claim that these extreme situations are no longer experienced. Now the visibility is mostly within the range of 8m to 15m, hence no more dive cancellations on account of poor visibility due to the Sappi Saiccor effluent. Local people also claim that there has been an improvement that is most noticeable on the shoreline.

Role of this monitoring system within the PAP

Since an independent body carried out this analysis, there was a general feeling that the monitoring process is more transparent. Most of the PAP members feel that it has made a major contribution towards resolving the conflict and building the trust between the panel members.

The use of local knowledge in the monitoring system developed for the PAP has led to the achievement of some of the goals that are envisaged by Bosch *et al* (1996) and Allen (1996) when arguing for the inclusion of local knowledge in monitoring processes. There is a greater sense of ownership of the process by local people, the confidence and skills of the divers have been enhanced, participants have been empowered and there is greater consensus about how the impact of the effluent should be monitored. There is still a great deal of work to be done but the inclusion of local data and the development of a scientific method to validate this data had contributed to the transformation of knowledge construction in the PAP. This in turn has had a significant impact on the relationships and levels of conflict within this local environmental forum.

This has however been a long process, which has always been charged with heated emotional debates; hence the healing process is just beginning. There is a general agreement however among all the dive charter groups and the PAP members that there has been a significant improvement in the underwater visibility at the reef. Most however feel that because of this improvement the representation within the PAP will decrease further, as the affected parties will feel less compelled to attend. This feeling does not however imply that the PAP will be dissolved. The PAP is perceived by many as an important panel, which has to be operational even in the future for on going monitoring as per the DWAF protocol.

Although there are still some conflicting perceptions between the PAP members there is one thing they all agree on. They believe that this new method of analysis is the only way that the monitoring process will succeed. There is hope that this approach will lead to the development of new methodologies for collecting and analysing data, which will be acceptable to all (Swinford-Meyer G., Connell A., Saddler M., and Addison M., pers comm., 28/05/01).

REFERENCES

1. Primary and Secondary Sources

i) Minutes of the Sappi Saiccor PAP, 1/97 – 11/01.

ii) Sappi Saiccor Presentations and Correspondence, 1/97 – 11/01.

iii) Sappi Saiccor Permit, 1997

iv) Personal Communications

Addison M., 28/05/2001:	Owner of the Blue Wilderness Dive Charters.
Addison M., 27/11/2001:	Representative of the Blue Wilderness Dive Charters.
Bentley M., 07/12/2001:	Environmental Manager, Sappi Saiccor.
Connel A., 28/05/2001:	Marine Biologist, CSIR.
Hunter B., 27/11/2001:	Representative of Sea Fever Dive Charters.
Labuschagne H., 27/11/2001:	Representative of Umkomaas Lodge Dive Charters.
Saddler M., 28/05/2001:	Beach Manager, South Local Council, Durban Metropolitan Authority.
Scott D., 15/06/2000:	Lecturer at the University of Natal and a member of the Sappi Saiccor PAP.
Swinford-Meyer G., 28/05/2001 and 27/11/2001:	Owner of the Aliwal Dive Charters.

v) Newspaper Cuttings

South Coast Sun (22/10/1999) Lack of Unity in Dive Fraternity, Impact Supplement, 3, 5, pp. 1-4.

2. Literature

Abbot J. and Guijt I., 1998: *Changing Views on Change: Participatory Approaches to Monitoring the Environment*, SALR Discussion Paper No: 2., London, IIED.

Allen W. J. 1996: Shared Experiences: The Basis for a Cooperative Approach to Identifying and Implementing more Sustainable land management practices, *Proceedings of Symposium "Resource Management: Issues, Visions, Practice"* Lincoln University, new Zealand, 5 – 8 July.

Allen W. J., 1999: Why Involving People is Important: The Forgotten part of environmental Information System Management, *Proceedings: 2nd International Conference on Multiple objective Decision Support Systems for Land, Water and Environmental Management (MODSS '99),* Brisbone, Australia, 1 – 6 August (*in press*).

Allen W. J., 2000a: Future Directions for research into Collaborative learning – Helping people Maximise the Use of Technical information Within Multi-Stakeholder Environment Management Contexts, NRM-Change links, Working Paper No. 2.

Allen W. J., 2000b: The role of Action Research in Environmental Management, NRM Change links, Working Paper No. 3.

Allen W. J., Bosch O. J. H., and Gibson R. G., 1995: Farmers and Scientists Working Together to Achieve More Sustainable land Management, North American Farming Systems Research – *Extension Symposium: Linkages among Farming Systems and Communities*, Ames, Iowa, 5 – 8 November.

Allen W. J., Bosch O. J. H., Gibson R. G. & Jopp A. J., 1998: Co-learning our way to sustainability: An integrated and community-based research approach to support natural resource management decision-making, In EI-Swaify S. A and. Yakowitz D. S. (eds), *Multiple Objective Decision Making for Land, Water and Environmental Management*, Lewis Publishers, Boston.

Babbie E., 2001: *The Practice of Social Research*, 9th ed., Wadsworth/ Thompson Learning, USA.

Bailey K. D., 1978: *Methods of Social Research,* 2nd ed., Macmillan Publishing Co., Inc., New York.

Barnes T. J. and Duncan J. S., 1992: *Writing Worlds: Discourse, Text and Metaphor in the Representation of Landscape*, Routledge, London and New York.

Behnke R. H. and Scoones I., 1991: Rethinking range ecology: Implications for range management in Africa. *Overview of paper presentations and discussions at the technical meeting on savanna development and pasture production*, Woburn (UK), 19–21 November 1990. London, Commonwealth Secretaiat, Overseas Development Institute and International Institute for Environment and Development.

Borrini-Feyerabend G., 2000: *Co-management of Natural Resources: Organising, negotiating and Learning by Doing*, IUCN, Yaounde', Cameroon.

Bosch O. J. H., 1989: Rangeland inventory and monitoring: the African experience. Proceedings of the international conference and workshop on global natural resource monitoring and assessments: *Preparing for the 21st Century*, 1, pp 221-231

Bosch O. J. H., 1996: Monitoring and Adaptive Management, *The Rangeland Journal,* 18 (1): pp 23 – 32.

Bosch O. J. H., Allen W. J. and Gibson R. S., 1996: Monitoring as an Integral Part of Management and Policy making, *proceedings of Symposium "Resource management: Issues, Visions, practice",* Lincoln University, New Zealand, 5-8 July, pp 12 – 21.

Catley A., 1999: Monitoring and Impact Assessment of Community-Based Animal health Projects in Southern Sudan: Towards Participatory Approaches and methods, A Report for Veterinaires Sans Frontiers, Belgium and Veterinaires Sans Frontieres, Switzerland. PAVE Project, IIED and Vetwork UK.

Chechile R. A. and Carlisle S., 1991: *Environmental Decision Making: A Multidisciplinary perspective*, van Nostrand Reinhold, New York.

Cheema S. G., 1997: Capacity Development, Technical Advisory Paper 2, United Nations Development Programme – Management Development and Governance Division – Bureau for Policy Development, New York.

Clark W. A. V. and Hosking P. L., 1986: *Statistical Methods for Geographers*, John Wiley and Sons, New York.

Cloke P., Philo C. and Sadler D., 1991: *Approaching Human Geography: An Introduction to Contemporary Theoretical Debates*, Paul Chapman Publishing Ltd, London.

Crowther Campbell & Associates, 1997: Sappi Saiccor (Pty) Ltd Water Permit Requirements Environmental Assessment Report.

Denzin N. K. and Lincoln Y. S., 1994: *Handbook of Qualitative Research,* SAGE Publications, Inc., Thousand Oaks, Carlifornia.

Dryzek J. S., 1997: *The Politics of the Earth: Environmental Discourses*, Oxford University press Inc, New York.

Ebdon D., 1985: *Statistics in Geography*, Basil Blackwell Ltd, Oxford.

Edgerton J., McClean k., Robb C., Shah P. and Tikare S., 2000: Participatory Processes in the Poverty Reduction Strategy, Draft for Discussion, Washington D. C.: The World Bank, Accessed 20/04/2001.
(http://www.worldbank.org/poverty/strategies/chapters/particip/partn425.pdf).

Ekos Research Associates, 1998: Lessons Learned on Partnerships, Final Report, Submitted to Voluntary Sector Roundtable, Ottawa.

Esterella M., Blauert J., Campilan D., Gaventa J., Gonsalves J., Guijt I., Johnson D. and Ricafort R., 2000: *Learning from Change: Issues and Experiences in Participatory Monitoring and Evaluation*, Intermediate Technology Publications, London and international theoretical Development research Centre, Canada.

Everett J. and Neu D., 1999: Ecological Modernisation and the Limits of Environmental Accounting, University of Calgary, Accessed 10/10/25. (http://www.panopticon.csustan.ed/cpa99/html/everett.html).

Garner R., 1996: *Contemporary movements and ideologies*, McGraw-Hill, New York.

Greenwood D. J. and Levin M., 1998: *Introduction to Action research: Social Research for Social Change*, SAGE Publication, California.

Guijt I. And Gaventa J., 1998: *Participatory Monitoring and Evaluation: Learning from Change*, Institute of Development Studies (IDS), UK.

Hadley M., 1993: Grasslands for sustainable ecosystems, In Baker M. J. (ed) *Grasslands for our world*, SIR Publishing, Wellington, pp 12-18.

Hajer M. A., 1995: *The Politics of Environmental Discourse: Ecological Modernization and the Policy Process,* Clarendon Press, Oxford.

Hammond R. and McCullagh P., 1998: *Quantitative Techniques in Geography: An Introduction*, Clarendon Press, Oxford.

Hauck M. and Sowman M., 2001: Coastal and Fisheries Co-management in South Africa: an overview and analysis, *Marine Policy*, 25, pp 173-185.

Huber J., 2000: Towards Industrial Ecology: Sustainable Development as a Concept of Ecological Modernisation, *Journal of Environmental Policy and Planning,* Special Issue, 2, pp 269 – 285.

IIRR, 1996: Recording and Using Indigenous Knowledge: A Manual. International Institute of Rural Reconstruction, Silang, Cavite Phillippines.

Johnston R. J., 1983: *Philosophy and Human Geography: An Introduction to Contemporary Approaches*, Edward Arnold, London.

King L. J., 1969: *Statistical Analysis in Geography*, Prentice-Hall Inc. Englewood Cliffs NJ.

Kork N. F., McQueen R. J. and Scott L.J., 1997: Can Action Research be Made More Rigorous in a Positivist Science? The Contribution of an Interactive Approach, *Journal of Systems and Information Technology*, 1 (1), pp 1-24.

Long Frederick J. and Arnold Matthew B., 1995: *The Power of Environmental Partnerships*, Management Institute for Environment and Business, Harcourt Brace college Publishers, USA.

Lubell M., 2000: Cognitive Conflict and Consensus Building in the National Estuary Program, *American Behavioural Scientist,* 44 (4), pp 629-649.

Martin B. and Richards E., 1995: Scientific Knowledge, Controversy, and Public Decision-Making, In Jasanoff S., Markle G. E., Peterson J. C., and Pinch T. (eds); *Handbook of Science and technology Studies*, Newburg Park, CA: Sage. pp 506-516.

McClurg T. P., 1997: Studies on the Environmental Impact of Sappi Saiccor Effluent on the Natal South Coast, CSIR Report ECP-96-009.

McNiff J., 1988: *Action Research: Principles and Practice*, Macmillan Education Ltd, London.

Mowforth M., 1979: *Statistics for Geographers*, Harrap & Co. Ltd, London.

Nachmias D. and Nachmias C., 1976: *Research Methods in the Social Sciences*, Edward Arnold, London.

Norgaad R. B., 1984: Traditional Agricultural Knowledge: Past Performance, Future prospects, and Institutional implications, *American Journal of Agricultural Economics*, 66, pp 874 – 878.

O'Connor, 1986: The Influence of Science on the Use of Tussock Grasslands. Review: *Journal of Tussock Grasslands and Mountain Lands Institute*, 43, pp 15-78.

Oelofse C., 1999: The Geography of the Health Risk Associated with the Sappi Saiccor Pipeline, Umkomaas, Unpublished Paper Prepared for Sappi Saiccor, University of Natal.

O'Riordan T. and Cameron J., 1994: *Interpreting the Precautionary Principle,* Earthscan publications Ltd, London.

O'Riordan T., 1995: *Environmental Science for Environmental management*, Harlow, Essex.

O'Riordan T., 2000: *Environmental Science for Environmental Management*, Prentice Hall, Pearson Education Limited, UK.

PACT Publishing, 1989: Participatory Monitoring, Evaluation and Reporting: Online Manual, Accessed 25/02/2001
(http://www.worldbank.org/participation/partme4.htm).

Proctor R. N., 1991: *Value-Free Science: Purity and Power in Modern Knowledge*, Harvard University Press, Cambridge and England.

Rahman M. A., 1998: A Participatory DSS to Incorporate Local Knowledge for Resource and Environmental Management in Developing Countries, Ph. D. Comprehensive Examination Paper, University of Waterloo, Canada.

Rajasekaran B., 1993: A Framework for Incorporating Indigenous Knowledge Systems into Agricultural research, Extension, and NGO's for Sustainable Agricultural Development. Studies in Technology and Social Change No. 21, Ames, IA: Technology and Social Change Program, Iowa State University.

Robinson G. M., 1998: *Methods and Techniques in Human Geography*, John Wiley & Sons Ltd, England.

Rodal A. and Mulder N., 1993: Partnerships, Devolution and Power-sharing: Issues and Implications for Management, *Optimum* 24, pp 27 – 48.

Rouse J., 1992: What are Cultural Studies of Scientific Knowledge? *Configurations*, 1 (1), pp 57-94

Sibley D., 2001: The Binary City, *Urban Studies*, 38 (2), pp 239-250.

Silk J., 1979: *Statistical Concepts in Geography*, George Allen & Unwin Ltd, London.

Scheberle D., 2000: Moving Towards Community-Based Environmental Management, *American Behavioural Scientist*, 44, (4).

Scott D., 1999a: Is Public Participation in the Pipeline? A Social Impact Assessment of Marine Waste Disposal in Southern KwaZulu-Natal, *Water Science and Technology*, 39, pp 10 – 11.

Scott D., 1999b: Guidelines for Including Public Participation in the Permitting Process, Report No. KV 125/00, Water Research Commission, Pretoria.

Scott D., 1999c: Civic Science: The inclusion of local knowledge in the monitoring of marine water quality. Paper Presented at: *Third Biennial International Conference of the Society of South African Geographers*, Windhoek, Namibia.

Scott D. and Oelofse C., 1999: Public Participation in Environmental Decision-Making, Unpublished paper, University of Natal, Durban.

Tojman S., 1998: Partnerships: The Good, the Bad and the Uncertain, Paper presented at: *4th International Partnership Conference*, Trondheim, Norway, June 27 – July 1.

Webster A., 1991: *Science, technology and Society*, Macmillan.

Williams R. B. G., 1984: *Introduction to Statistics for Geographers and Earth Scientists*, Macmillan, London.

Websites

http://www.ceroi.net/reports/durban/issues/marine/presure.htm
http://www.kwazulu-natal.co.za
http://www.mbendi.co.za
http://www.nu.ac.za/focus/text/vol12no2/industry.txt
http://www.scuba.lia.net/scuba/html/aliwal_shoal.htm
http://www.Seafever.co.za
http://trochim.human.Cornell.edu
http://www.unece.org/env/pp/documents/cep43e.pdf

SAPPI SAICCOR PERMIT ADVISORY PANEL (PAP)

CONSTITUTION

1. PREAMBLE:

1.1. The Permit Advisory Panel is a requirement of the Department of Water Affairs and Forestry (DWAF) of the industries seeking permit renewals for the disposal of effluents via marine pipelines, to make recommendations regarding the permit requirements and monitor the industries' progress in meeting these requirements.

2. NAME:

2.1. The name of the Committee shall be The Sappi Saiccor Permit Advisory Panel (PAP)

3. OBJECTIVE:

3.1. To establish and facilitate a Permit Advisory Panel, consisting of at least representatives of the stakeholder groups identified in the Social Impact Assessment conducted by the University of Natal, Durban and/or in consultation with the Department.

3.2. The Permit Advisory Panel shall be tasked with making recommendations to the Regional Director regarding conditions to which SAPPI's Exemptions could be subject as well as monitoring the Exemptee's compliance with the conditions of the Exemption.

4. GUIDING PRINCIPLES:

The Panel accepts that it has as its guiding principles the following concerns based on the outcome of the Social Impact Assessment (SIA) of 1996):

4.1. to promote economic sustainable development
4.2. the need for a sustainable marine, coastal and estuarine environment;
4.3. the need for transparency, participation and information;
4.4. the need for timeous solutions to have forecasted plans and deadlines to resolve issues and concerns
4.5. the demonstration of on-going, objective and effective protection of the environment through regulation, education, commitment and responsible management;
4.6. a commitment to constructive relationships

5. COMPOSITION:

5.1. The Panel shall consist of at least, but not limited to, the stakeholders identified in the SIA who have an interest in the discharge of effluent from the marine pipeline and who wish to participate in making recommendations to the Minister of Water Affairs and Forestry regarding the permit for such pipeline and other issues related to the water permit.

5.1.1. The Panel shall consist of representatives drawn from the following stakeholders who have expressed such a wish;

Conservation Authority
Employees
Environment NGO's
Tourism
Local Authority
Small Business
Sea Users
Industry
Civic Associations
Research
Wildlife
Eco – Tourism

These stakeholders can be broadly grouped into Industry Community / Employees / Small Business and Authorities.

5.2. DWAF shall act as advisors and hold the position of a participant observer in the PAP.

5.3. The Panel may request the advice of technical expert advisors who will be invited to attend / contribute as observers as and when considered appropriate.

5.4. Each stakeholder group representative will have an alternate, and it is the responsibility of the representative to instruct his/her alternate to attend meetings if he/she is unable to do so. The contact numbers of representatives and alternates are to be furnished to the administrator of the Panel.

5.5. The absence of a representative from a stakeholder group for two consecutive meetings requires investigation as to whether the representative has withdrawn from the process. If so, it may become necessary to seek an alternative representative.

5.6. Prospective members wishing to become members of PAP must do so in writing to the administrator within reasonable time.

5.7. Anybody declined membership must be provided reasons thereof in writing by the PAP.

6. FUNCTIONS / TERMS OF REFERENCE:

6.1. The Panel serves in an advisory capacity to DWAF.

6.2. It is the responsibility of Sappi Saiccor to establish a Permit Advisory Panel, facilitate its functioning and support the necessary capacity-building of stakeholders in order that equal participation of all groups occurs. All reasonable costs or costs agreed by the Industry's representative incurred are to the account of industry according to the principle of "the polluter pays".

6.3. The function of the Panel is to allow the public participation in the process of issue of permits for effluent discharge via pipelines.

6.4. In order for participation to occur education of panel members on topics of their need is to occur.

6.5. Saiccor would sympathetically consider any requests for resources, which might be necessary in order to allow for participation and for the consultation of constituencies. This may vary according to the needs of the different stakeholder groups. These resources, in the form of administrative assistance, travel allowances, etc. is to be provided by the industry and agreed upon by all stakeholders.

6.6. Each representative will undertake to report to his/her constituency regarding the proceedings of the Panel meetings and obtain a mandate for any decisions, which need to be taken on their behalf.

6.7. The Panel seeks to advise DWAF of public perceptions and experience regarding the impacts of the effluent on both the biophysical environment and human activities and quality of life.

6.8. The further function of the Panel is to formulate an ongoing series of recommendations that will result in the continuous improvement of the quality of the effluent discharged.

6.9. Responses from the Panel on the following specific issues will be given by consensus:

6.9.1. All changes proposed to the permit
6.9.2. Any requests for extensions of application dates for permit renewal.
6.9.3. The compliance of the industry in meeting the conditions stipulated in the permit.

6.10. Responses to these issues will be regularly reported at the South Coast Marine Pipeline Forum (SCMPF) meetings and to the regional DWAF if issues arise in the interim.

6.11. The PAP shall also recommend monitoring procedures, protocol and criteria.

6.12. The PAP shall undertake an evaluation of itself to include inter alia its functioning, structure and related issues at least once a year.

6.13. Issues not identified under this section may be added to either category if agreed to by all parties represented on the Panel.

7. DECISION – MAKING

7.1. Decision-making regarding recommendations will be by consensus of all stakeholders where possible or alternatively, the majority decision accompanied by a minority statement from those parties not concurring.

7.2. Should any party be absent from any given meeting for which reasonable notice was given, "decisions" taken in their absence will be ratified at the next meeting. In the event of the said party being absent at the next meeting, decisions will be ratified by the attending parties.

7.3. A quorum shall consist of at least 6 stakeholder groups.

7.4. As participatory decision-making regarding permit recommendations is a lengthy and dynamic process, all stakeholders need to take this into account and allow for adequate consultation and negotiation to occur in a spirit of constructive engagement.

8. MANAGEMENT:

8.1. If in the majority opinion of the Panel an external Facilitator is required, one shall be appointed by due process, for the account of the industry. By majority opinion, the Panel can agree to dispense with such services if deemed no longer necessary.

8.2. In the event of the Facilitator not being present, the PAP shall appoint a Chairperson.

8.3. Most representatives on the Panel are already over-committed in terms of work responsibilities. The time of representatives on the Panel is often costly, both in financial and personal terms. It would be appreciated therefore if an efficient Administrator could be appointed and funded by industry. The tasks of the administrator are as follows:

8.3.1. The administrator will be accountable to the Panel and will act upon instruction from the Panel.

8.3.2. Take and circulate minutes of meetings.
8.3.3. Draw up and circulate agendas for Panel meetings.
8.3.4. Convene/call meetings of the Panel on behalf of the Panel.
8.3.5. Receive and distribute correspondence addressed to the Panel and reply to same on behalf and on instruction from the Panel.
8.3.6. Generally assist the Panel with all administrative and organisational tasks.
8.3.7. Engage in the process of networking to maximise participation by stakeholders.

8.4. For purposes of clarity and full understanding and to allow for equal participation, discussions at Panel meetings may require translation into Zulu. The assistance of an external translator may be called for if stakeholders require this service. The cost of this facility is to be borne by Sappi Saiccor.

8.5. The Panel shall meet at a venue acceptable to all participants.

9. AMENDMENTS :

9.1. This constitution may be amended after reasonable notice is provided to all bona fide members of the intention to do so.

9.2. This constitution can only be amended in a fully constituted PAP meeting with the required quorum.

PAP MEMBERSHIP:

STAKEHOLDER GROUP	MEMBER / ALTERNATE
1. CONSERVATION AUTHORITY	• Mr. Wayne Munger - KZN Nature Conservation Services • Ms. Sarah Allan - KZN Dept of Traditional & Environmental Affairs • Ms. Grineth Mageba - Metro Urban Strategy
2. EMPLOYEES	• Mr. Martin Mahlaba - Saiccor Union
3. ENVIRONMENT NGO'S	• Coastwatch - Ms. Nicky Demetriades WESSA
4. TOURISM	
5. LOCAL AUTHORITY	• Mr. Mickey Sadler - South Local Council • Mr. B. Somera - Umkomanzi TLC • Mr. Brett Daniels - Umzinto North / Scottburgh TLC • Mr. Divas Mncwabe - Magabheni LDC •
6. SMALL BUSINESS	• Mr. Grant Swinford-Meyer - Aliwal Dive Charters
7. SEA USERS	Michelle
8. INDUSTRY	• Mr. Mike Bentley - Sappi Saiccor • Mr. Sinclair Stone - Sappi Saiccor • Mr. Lourens Joubert - Sappi Saiccor • Mr. D. Khuzwayo - Sappi Saiccor
9. CIVIC ASSOCIATIONS	
10. RESEARCH	• Dr. Allan Connell - CSIR • Dr. Di Scott - UND Dept of Geographic & Environmental Sciences • Ms. Cathy Oelofse - UND Dept of Geographic 7 Environmental Sciences • Ms. Nicky Demetriades - Marine & Estuarine Research
11. ECO-TOURISM	• Eco Diving - Mr. Andrew Cobb

DWI

DEPARTEMENT VAN WATERWESE EN BOSBOU
DEPARTMENT OF WATER AFFAIRS AND FORESTRY
LEFAPHA LA METSI LE DIKGWA
UMNYANGO WEZAMANZI NEZAMAHLATHI

RESIDENSIEGEBOU BUILDING, SCHOEMANSTRAAT 185 SCHOEMAN STREET, PRETORIA

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Mr L.R. Gravelet-Blondin
(031) 306-1367
16/2/7/U100/B1

General Manager
Sappi SAICCOR (Pty)Ltd
PO Box 62
UMKOMAAS
4170

1997 -10- 31

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COMPANY: U.N.D.
FAX NO: 260139
FROM: PRAVIN SINGH
COMPANY:
FAX NO: 2055746
PAGE: OF:
DATE: 14/6/2000
PHONE NO: 2055746
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Sir

EXEMPTION GRANTED IN TERMS OF SECTION 21(4) OF THE WATER ACT, 1956 (ACT 54 OF 1956) IN RESPECT OF THE PURIFICATION OR TREATMENT OF WATER USED FOR INDUSTRIAL PURPOSES, INCLUDING ANY EFFLUENT RESULTING FROM SUCH USE AND THE DISPOSAL OF PURIFIED OR TREATED WATER, INCLUDING WATER RECOVERED FROM ANY EFFLUENT

I refer to your application regarding the above matter.

Attached hereto is Exemption 1750B, granted in terms of section 21(4) of the Water Act, 1956 (Act 54 of 1956) (the Act), whereby Sappi SAICCOR (Pty)Ltd is exempted from compliance with the provisions of sections 21(1)(a) and 21(1)(b) of the Act, to the extent and subject to the conditions specified in the Exemption.

Your attention is invited to the following:

(a) The responsibility for complying with the provisions of the attached Exemption is vested in the Exemptee and may not be ceded to any other person or body.

(b) Any person prejudiced by the Exemption may after notice in writing to the Exemptee, in terms of section 21(4)(c) of the Act, lodge with a Water Court an objection against the continuation of the Exemption and the Court may confirm or withdraw the Exemption or amend any condition to which it is subject.

Direkteur-generaal
Director-General

(c) The Minister of Water Affairs and Forestry may at any time in terms of section 21(4)(e) of the Act, withdraw the Exemption or render the continued validity thereof subject to such conditions as he may then determine, whether by the imposition of further or new conditions or by the cancellation or amendment of conditions then existing.

(d) In terms of section 21(5) of the Act, any contravention of or failure to comply with a condition of the Exemption, constitutes an offence.

(e) In terms of section 24(1)(a) of the Act, the Director-General: Water Affairs and Forestry and any person authorised thereto by him in writing may enter upon the premises of the Exemptee and conduct such investigation as the Director-General may determine.

Yours faithfully

DIRECTOR-GENERAL
31/10/97

- Apl 1997 → Panel.
- E.I.A. — Completed - Sept 97
→ T.O.R → Facilitator (x)
→ T.O.R → Consultation.

...gme process → drainage
→ standards
→

...presentation → 1° — consultancy
2° ...
3. closure

PHONE NO. : 0000000000

DEPARTEMENT VAN WATERWESE EN BOSBOU
DEPARTMENT OF WATER AFFAIRS AND FORESTRY
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"PERMIT"

Mr L.R. Gravelet-Blondin
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EXEMPTION NUMBER: 1750B

1997-10-31

EXEMPTEE: SAPPI SAICCOR (PTY) LTD

LOCALITY OF EXEMPTEE'S PREMISES TO WHICH EXEMPTION APPLIES:
UMKOMAAS

EXEMPTION GRANTED IN TERMS OF SECTION 21(4) OF THE WATER ACT, 1956 (ACT 54 OF 1956) IN RESPECT OF:

(a) THE PURIFICATION OR TREATMENT OF WATER USED FOR INDUSTRIAL PURPOSES, INCLUDING ANY EFFLUENT RESULTING FROM SUCH USE; AND

(b) THE DISPOSAL OF THE PURIFIED OR TREATED WATER, INCLUDING WATER RECOVERED FROM ANY EFFLUENT

A. By virtue of the powers delegated to me in terms of Government Notice 785 of 22 April 1994, I, Jacobus Louis Johannes van der Westhuizen, in my capacity as acting Chief Director: Scientific Services in the Department of Water Affairs and Forestry, hereby, in terms of section 21(4) of the Water Act, 1956, exempt the abovementioned Exemptee from complying with the provisions of sections 21(1)(a) and 21(1)(b) of the said Act, relating to the purification or treatment of water used for industrial purposes(which includes water used in any sewerage system or works) and any effluent produced by or resulting from such use and the disposal of the treated or purified effluent, including water recovered from any effluent, to the extent and subject to the conditions specified hereunder.

B. DEFINITIONS

In this Exemption -

"Act" means the Water Act, 1956 (Act 54 of 1956);
"Minister" means the Minister of Water Affairs and Forestry;
"Department" means the Department of Water Affairs and Forestry;
"Director-General"means the Director-General:Water Affairs and Forestry; and
"Regional Director" means the Regional Director: KwaZulu-Natal, Department of Water Affairs and Forestry, PO Box 1018, Durban, 4000.

1750B

C. CONDITIONS OF EXEMPTION

1. QUANTITIES OF EFFLUENT AND METHODS OF DISPOSAL

1.1 This Exemption authorises the disposal of the following quantities of effluent based on a maximum production rate of 584 000 tons per annum of dissolving pulp:

1.1.1 A maximum quantity of 45 000 000 (forty five million) cubic metres (m^3) of screened effluent per annum, by discharge via the existing 3 kilometre long sea outfall pipeline, based on an average of 122 400 m^3 per day and a maximum of 134 400 m^3 on any one day;

1.1.2 a maximum quantity of 6 210 000 (six million two hundred and ten thousand) m^3 per annum of cooling and washwater from the factory into the Mkomazi River, based on an average of 17 000 m^3 dry weather flow per day and a maximum of 18 000 m^3 on any one day based on dry weather flow; and

1.1.3 a maximum quantity of 6 570 000 (six million five hundred and seventy thousand) m^3 per annum of water purification plant backwash water into the Mkomazi River, based on an average of 18 000 m^3 on any one day.

1.2 Domestic effluent from the factory shall be discharged into septic tanks and the effluent from these tanks shall be discharged into the sea outfall pipeline.

1.3 The quantities of effluent authorised to be disposed of in terms of this Exemption may not be exceeded without prior written authorisation by the Minister.

1.4 No effluent, except as set out in conditions 1.1.2 and 1.1.3, may be discharged into the Mkomazi River via any stormwater system or other conduit on the Exemptee's premises.

2. QUALITY OF EFFLUENT

2.1 Sea discharge

2.1.1 The quality requirements specified in the General Standard, as prescribed by the Minister in terms of section 21(1)(a) of the Act and published in Government Notice 991 of 18 May 1984, as amended from time to time, are waived for the effluent discharged via the sea outfall pipeline (refer to condition 1.1.1), except for the following water quality variables which may not exceed the limits specified in conditions 2.1.2 and 2.1.3.

2.1.2 The water quality variables mentioned hereunder shall not exceed the following maximum limits:

pH	2 (minimum value)
pH	8 (maximum value)
Temperature	65°C
Chemical oxygen demand	31 000 mg/ℓ
Suspended solids	1 000 mg/ℓ
Colour	4 000 Hazen units
Lignin	7 500 mg/ℓ
Total dissolved solids	25 000 mg/ℓ

2.1.3 A 55 000 ton per annum lignosulphonate recovery plant shall be commissioned by 31 December 1998 and become fully operational by the 31 June 2000. Thereafter, the water quality variables mentioned hereunder shall not exceed the following maximum limits:

pH	2 (minimum value)
pH	8 (maximum value)
Temperature	65°C
Chemical oxygen demand	27 000 mg/ℓ
Suspended solids	900 mg/ℓ
Colour	3 600 Hazen units
Lignin	6 800 mg/ℓ
Total dissolved solids	23 000 mg/ℓ

2.1.4 Should the Lignosulphonate recovery plant be decommissioned for purposes of maintenance or in an emergency, the maximum limits shall temporarily revert to that in condition 2.1.2.

2.2 **River Discharge**

2.2.1 The cooling water and washwater from the factory discharged into the Mkomazi River shall at all times comply with the quality requirements specified in the General Standard as prescribed by the Minister in terms of section 21(1)(a) of the Act and published in Government Notice 991 of 18 May 1984, as amended from time to time, except for the following water quality variables which are relaxed to the extent indicated in condition 2.2.2.

2.2.2

Chemical oxygen demand	120 mg/ℓ
Oxygen absorbed	15 mg/ℓ
Suspended solids	250 mg/ℓ
Conductivity	150 mS/m above intake

2.2.3 Notwithstanding the relaxation granted in condition 2.2.1, the monthly average of the daily random grab samples required in terms of condition 3.4 shall comply with the General Standard, with the exception of suspended solids and electrical conductivity which are relaxed to the values set out in condition 2.2.2.

2.3 Impact Reduction Programme

2.3.1 The Exemptee shall in consultation with the Director-General, confirm the length (minimum 6,5 kilometres) of the proposed extended sea outfall pipeline by the 31 November 1997. The extended pipeline shall achieve a minimum reduction of 70% of the present aesthetic impact of discoloration and foaming and be fully operative by 31 December 1998. The Exemptee shall submit quarterly progress reports on the extension of the sea outfall pipeline.

2.3.2 Should the mitigation measures as specified in condition 2.3.1 not achieve the minimum 70% reduction, the Exemptee shall conduct the necessary work and make provisions in order to ensure a minimum reduction of 70% by 31 December 1999. The Exemptee shall further implement methods to treat the remaining 30% of the impacts of discoloration and foaming.

2.3.3 If the sea discharge continues to give rise to unacceptable aesthetic problems or causes unacceptable environmental impacts, the Exemptee shall implement other measures to eliminate these environmental impacts.

3. MONITORING OF EFFLUENT

3.1 Quantity

3.1.1 The quantity of the effluent discharged via the sea outfall pipeline shall be metered and recorded on a continuous basis at the monitoring point described in condition 6.1.1.

1.2 The quantity of the cooling and washwater discharged in terms of condition 1.1.2 into the Mkomazi River shall be metered and recorded on a continuous basis at the monitoring point described in condition 6.1.2.

.3 The daily quantity of backwash water discharged in terms of condition 1.1.3 shall be calculated.

Flow metering, recording and integrating devices shall be maintained in a sound state of repair and calibrated at least once every year by a competent person. Calibration certificates shall be kept available for inspection by the Regional Director.

Quality of effluent

A random grab sample of effluent discharged via the sea outfall pipeline shall be taken daily at the monitoring point described in condition 6.1.1. Each sample shall be analysed according to condition 5 for the following variables:

pH	
Electrical conductivity	in mS/m
Total dissolved solids	in mg/ℓ
Lignins	in mg/ℓ
Chemical oxygen demand	in mg/ℓ
Turbidity	in NTU
Colour	in Hazen units

and any other variables as may be required from time to time by the Regional Director.

3.3.2 A 24 hour composite sample of the effluent discharged via the sea outfall pipeline shall be taken weekly at the monitoring point described in condition 6.2.1. Each sample shall be analysed according to condition 5 for the following variables:

pH	
Electrical conductivity	in mS/m
Total dissolved solids	in mg/ℓ
Lignins	in mg/ℓ
Chemical oxygen demand	in mg/ℓ
Turbidity	in NTU
Colour	in Hazen units

and any other variables as may be required from time to time by the Regional Director.

3.3.3 The temperature of the effluent discharged via the sea outfall pipeline shall be metered and recorded every hour at the monitoring point described in condition 6.2.1.

3.3.4 A random grab sample of the effluent discharged via the sea outfall pipeline shall be taken monthly at the monitoring point described in condition 6.1.1. Each sample shall be analysed according to condition 5 for:

Biological oxygen demand	in mg/ℓ

3.4 A random grab sample of the cooling and washwater discharged to the Mkomazi River shall be taken daily at the monitoring point described in condition 6.1.2. Each sample shall be analysed according to condition 5 for the following variables:

Chemical oxygen demand	in mg/ℓ
Oxygen absorbed	in mg/ℓ
Suspended solids	in mg/ℓ

and any other variables as may be required from time to time by the Regional Director.

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3.5 The cooling and washwater discharged into the Mkomazi River shall be metered on a continuous basis at the monitoring point described in condition 6.1.2 for the following variables:

pH	
Temperature	in °C
Turbidity	in NTU
Electrical conductivity	in mS/m

3.6 A random grab sample of the water purification plant backwash water discharged into the Mkomazi River shall be taken weekly at the monitoring point described in condition 6.2.4. Each sample shall be analysed according to condition 5 for the following variables:

pH	
Temperature	in °C
Chemical oxygen demand	in mg/ℓ
Oxygen absorbed	in mg/ℓ
Suspended solids	in mg/ℓ
Electrical conductivity	in mS/m

and any other variables as may be required from time to time by the Regional Director.

3.7 A random grab sample of the combined stream of cooling and washwater effluent, water treatment plant backwash water and stormwater shall be taken daily at the monitoring point described in condition 6.2.5. Each sample shall be analysed according to condition 5 for the following variables:

pH	
Temperature	in °C
Chemical oxygen demand	in mg/ℓ
Oxygen absorbed	in mg/ℓ
Suspended solids	in mg/ℓ
Electrical conductivity	in mS/m

and any other variables as may be required from time to time by the Regional Director.

3.8 Any other monitoring for flow and quality which may be required from time to time by the Regional Director shall be carried out in accordance with condition 5 at monitoring points agreed upon between the Regional Director and the Exemptee.

4. MONITORING OF THE RECEIVING WATER AND INVESTIGATIONS

4.1 The Exemptee shall commission a suitably qualified consultant to investigate methods of monitoring the effects of the effluent discharge on the light penetration at Aliwal Shoal.

4.2 The Exemptee shall ensure that the operation of the present diffusers is optimised, operated and maintained in optimum working condition at all times.

4.3 The Exemptee shall investigate ways and means of improving both the effluent quality and methods of discharge, should the Water Quality Guidelines for the South African Coastal Zone, as amended from time to time, not be met in the receiving water.

4.4 The sea shall be inspected daily for visibility of the plume and foam incidence on the shore. Records shall be kept on a daily basis and a summary submitted monthly to the Regional Director.

4.5 A health monitoring program, aimed at the recreational water user sector shall be carried out by the Exemptee along the coastline impacted by the discharge.

4.6 The Exemptee shall commission recognised consultants to conduct a program of systematic chemical, bacteriological and marine biota investigations in the disposal zone of the effluent and surrounding areas (including the surf zone adjacent to the sea outfall and other impacted areas), annually.

4.7 The Exemptee shall commission, at least once per year, recognised consultants to conduct a program of biological and chemical investigations as to the condition of the Mkomazi estuarine environment.

4.8 The Exemptee shall implement and conduct other investigations and studies recommended in Section 8 of the Final Environmental Impact Report prepared by Crowther Cambell and Associates dated 30 September 1997.

4.9 The Exemptee shall commission a study to determine the various chemical constituents of the present effluent discharged through the sea outfall pipeline and their concentrations, with a view to future monitoring of these components.

4.10 The Exemptee shall investigate the allegations of the effluent plume reaching the Protea Banks south of Port Shepstone.

5. METHODS OF ANALYSIS

5.1 Analyses shall be carried out in accordance with methods prescribed by and obtainable from the South African Bureau of Standards (SABS), in terms of the Standards Act, Act 30 of 1982, or any other method approved of in writing by the Director-General.

5.2 The lignin concentration in the effluent shall be the Lussi and de Wilde lignin concentration as determined by the sodium/colourimetric method.

5.3 Methods of analysis shall not be changed without prior notification to and written approval by the Director-General.

6. MONITORING POINTS

6.1 Quantity

6.1.1 The quantity of effluent discharged via the sea outfall pipeline shall be metered at the Parshall flume situated approximately 50 metres from the inlet to the main effluent pipeline pumphouse.

6.1.2 The quantity of cooling and washwater discharged to the Mkomazi River shall be metered at the flow meter at the waterfall.

6.2 Quality

6.2.1 The daily composite sample to measure quality of effluent discharged via the sea outfall pipeline shall be metered approximately 24 metres upstream of the pumphouse.

6.2.2 The grab sample to measure quality of the effluent discharged via the sea outfall pipeline shall be metered at the Parshall flume situated approximately 50 metres from the inlet to the main effluent pipeline pumphouse.

6.2.3 The quality of the cooling and washwater discharged into the Mkomazi River shall be monitored at the waterfall.

6.2.4 The quality of the backwash water shall be monitored in the channel approximately 5 metres upstream of the confluence with the cooling and washwater channel.

6.2.5 The cooling and washwater, backwash water and stormwater shall be monitored in the combined channel, approximately 50 metres from the factory boundary fence.

6.3 The monitoring points shall not be changed without prior notification to and written approval by the Regional Director.

7. **STORMWATER AND EFFLUENT MANAGEMENT**

7.1 The Exemptee shall develop and implement a stormwater management system to ensure tl separation of the factory's effluent and stormwater systems. The Exemptee shall als investigate means of reuse and recycling of the wastewater streams which are discharged t the Mkomazi River.

7.2 Stormwater discharged into the Mkomazi River shall in no way be contaminated by ar substance, whether such substance is a solid, liquid, vapour or gas or a combination there which is produced, stored, dumped or spilled on the premises.

7.3 Until such time that compliance with conditions 7.1 and 7.2 are achieved, the quality of th stormwater shall at all times comply with the quality requirements specified in the Gener Standard as prescribed by the Minister in terms of section 21(1)(a) of the Act and publishe in Government Notice 991 of 18 May 1984, as amended from time to time, except for thos water quality variables which are relaxed to the extent as indicated in condition 2.2.2.

7.4 The Exemptee shall submit a bi-annual report on the investigations required in condition 7.1 and 7.2 to the Director-General.

8. **REPORTING**

8.1 A summary of the details required in terms of conditions 3 and 4.4 shall be submitte monthly to the Regional Director.

8.2 A report on the investigations done in terms of conditions 4.5, 4.6, 4.7, 4.8 and 4.9 shall be submitted to the Director-General and the Regional Director as soon as it become available.

8.3 A report on the stability, mechanical soundness and physical operation of the pipeline as specified in condition 9.2 shall be submitted monthly to the Regional Director.

8.4 A report on the stability, mechanical soundness and physical operation of the pipeline as specified in conditions 9.3 and 9.4 shall be submitted annually to the Regional Director.

8.5 Should anything in terms of conditions 9.2 and 9.3 be found to be wrong with the pipeline, it shall be reported to the Regional Director and repairs shall commence immediately.

8.6 A report on the progress and outcome of the investigations required in terms of conditions 2.3, 4 and 7.1 shall be submitted monthly to the Regional Director and presented to the Permit Advisory Panel.

1750B

8.7 A report summarising the information required in terms of conditions 3, 4.4, 9.2, 9.3, and 10 shall be compiled at least once per annum and submitted to the Regional Director

8.8 The Exemptee in consultation with the Regional Director shall commission an independ consultant to peer review the reports required in terms of conditions 4.5, 4.6, 4.7 and 4.8

8.9 The Exemptee shall provide to the Regional Director, on a monthly basis, a rep indicating the quantities of pulp produced at the factory.

8.10 The Exemptee shall at least once per annum make a public presentation of the repo required in terms of conditions 8.7 and 8.8.

9. PIPELINES

9.1 All stop-valves and taps on the pipelines conveying the effluent shall be isolated and secur or be of a type that can be opened and closed only by means of a loose wrench. Tl wrench shall be kept in the safekeeping of a responsible member of staff to preve unauthorised use thereof.

9.2 The pipeline from the Exemptee's premises to the beach and the pumping facilities shall l inspected on a weekly basis to check for any leaks or malfunctions and records shall be ke of such inspections.

9.3 The Exemptee shall have the sea outfall pipeline, diffusers and associated equipmer surveyed or checked annually by competent people to monitor the stability or an mechanical failure that may develop.

9.4 A visual record of the inspection of the submarine pipeline shall be produced either b photographic means or by video camera. This exercise shall also be performed upor request by the Regional Director, should reasonable doubt exist as to the condition o operation of the sea outfall pipeline or to the conditions prevailing in the sea.

10. MALFUNCTIONS

10.1 Accurate and up-to-date records shall be kept of all system malfunctions resulting in the disposal of effluent not in accordance with the requirements of this Exemption. The records shall be tabulated under the following headings with a full explanation of the contributory circumstances:

10.1.1 Operating errors;
10.1.2 mechanical failures (including design, installation or maintenance);
10.1.3 environmental factors (e.g. flood);

10.1.4 loss of supply services (e.g. power failure); and
10.1.5 other causes.

11. GENERAL

11.1 This Exemption is valid until 31 December 2002. Should, however, the minimum reduction of 70%, as referred to in condition 2.3.2 not be achieved, this Exemption is valid until 31 December 2000.

11.2 The Exemptee shall put into commission the extended sea outfall pipeline by 31 December 1998.

11.3 The Exemptee shall establish and facilitate a Permit Advisory Panel, consisting of at least representatives of the stakeholder groups identified in the Social Impact Assessment conducted by the University of Natal, Durban and/or in consultation with the Department. The Permit Advisory Panel shall be tasked with making recommendations to the Regional Director regarding conditions to which SAPPI's Exemptions could be subject as well as monitoring the Exemptee's compliance with the conditions of the Exemption.

11.4 No effluent from any other person or factory, except from the proposed Lignosulphonate Plant, shall be accepted by the Exemptee for discharge into the pipeline, unless suitable application and amendments to this Exemption have been made.

11.5 This Exemption shall not be construed as exempting the Exemptee from compliance with the provisions of the Health Act, 1977 (Act 63 of 1977), or any other applicable act, ordinance, regulation or by-law.

11.6 Contravention of this Exemption shall, under the continued validity of this Exemption, be subject to cancellation.

11.7 This Exemption supersedes Exemption 1735B issued to Sappi SAICCOR on 1 July 1997.

ACTING CHIEF DIRECTOR: SCIENTIFIC SERVICES
p.p Minister of Water Affairs and Forestry
31/10/97

Aliwal Dive Charters

Date: 12/02/2001

Dive Time	Location	U/W Vis. (metres)	Current Spd & Dir	Effluent Present	Location and width of Plume and other comments.
	ALIWAL	12m	S → N	YES	SOFT CORAL
					OLD

APPENDIX IV: QUESTIONNAIRE FOR THE PAP

QUESTIONNAIRE FOR THE PAP

How long have you been a member of the PAP?	YRS

Who are you representing?	SELF	ORGANISATION (state)

1. How did you/ your organisation become involved? i.e. how did you come to know about the PAP?
2. Are you clear about the objective(s) of the PAP? State them.
3. How do the above-mentioned objectives concur with yours or your organisations?
4. Are you happy about your role within the PAP? Elaborate.
5. Do you feel that your role/input/position within the PAP has changed over the years? If so how and what factors do you think let to this change?
6. How do you feel about the PAP in terms of the representation within it and its functioning?
7. Do you think the PAP has achieved or on the right track to achieving its goals? Elaborate.
8. Do you think there is a significant improvement on the Visibility offshore since the extension of the pipeline?
9. How do you feel about the present monitoring system? Elaborate.
10. What concerns you about the PAP?
11. How would you describe the future of the PAP?

APPENDIX V

A.: Data Capturing From the Divers' Log Sheets.

MONTH: JUL-01

	ADC		SEA FEVER		WHALER		UMKOMAA		BLUE WILD		CURRENT		COMMENTS
1	(15)	.	18	.	20	.	13	.			S		
2	(30)	.	18	.			25	.			0		
3	(30)	.	30	.	25	.	30	.			N		
4	(25)	.	25	.			25	.			N		
5	(20)	.	13	.			13	.			N		
6	(10)	.	13	.	18	.	(15)	E			N		
7	(15)	.	13	.	18		13	.			0		
8	(8)	E	7	E	10	E	8	E			S		
9			9	E			13	LE			S		
10	(11)	.	10	.			14	LE			0		
11	(15)	.	15	.			15	.			S		
12	(20)	.	11	E	15	.	15	LE			N		
13	(15)	.			15	.	15	E			N		
14	(18)	.	15	.	16	.	15	.			N		
15	(15)	.	13	.	15	.	10	LE			N		
16	(15)	E	9	E	9	E	15	E			N	L	
17			9	LE							N	L	
18					8	.	10	.			S		
19													
20													
21							13	.					
22													
23													
24													
25	(20)	E	10	.	15	.					N		
26	(20)	.	14	.	25	.					0		
27	(10)	.	12	.	9	.	14	.			S		
28	(8)	E	12	E	18	.	9	E			S		
29	(8)	E	9	E	13	E	10	E			S		
30			15	.	20	.					S	S	
31	(10)	E	13	.	15	E					S		
													Average vis
							Ave unaffected vis			15			Severity inde
						Current going south or zero						###	

MONTH: JUN-01

	ADC		SEA FEVER		WHALER		UMKOMAA		BLUE WILD		CURRENT		COMMENTS
1	20	.	9	?	10	.	8	LE			N	L	Patchy E
2			5	.	8	.					N		
3			14	.	11	.					N		
4					13	.					N		

							Ave unaffected vis			12			Severity inde
						Current going south or zero					###		

MONTH: MAR-01

	ADC		SEA		WHALER		UMKO		BLUE		CURRENT		COMMENTS
1			10	E	25	.	30	.	30	.	S	L	
2			13	.	25	.	20	.			S	L	
3					17	R	10	E	18	.	S	L	
4			20	.	23	.	20	.			S	S	
5					23	.			30	.	S	S	
6					23	.	20	.			S	S	
7							30	.			S	S	
8					13	.	15	.			S	S	
9					22	.	25	.			S	L	
10			18	.	20	.	11	.			S	L	
11			20	.	15	.	16	.			N		
12							8	.			N		Others cance
13			9	R	15	.					N		
14			3	E	3	E	3	.	3	E	O		
15			10	.	25	.	(25)	.			S	S	
16			15	.	15	.	13	E			S	L	
17			13	LE	10	.	12	E	13	.	S	L	
18			7	?	20	.	9	E	25	.	S	L	"green"
19			4	?			7	LE			N		On outside
20					4	E	2	ER			S		
21			14	.	14	.	18	.			S	S	
22			14	.	18	.	28	.			S		
23			30	.	18	.	25	.	18	.	S	S	
24			23	.			20	.			S	S	
25			20	.			13	.			S		
26					12	.					S	L	
27			10	E	20	.					NS		
28			20	.	20	.	25	.			S	L	
29					15	.	13	.			S	L	
30							9	LER	10	.	N	L	
31			5	.	10	.	12	.			N	S	
													Average vis
							Ave unaffected vis			17			Severity inde
						Current going south or zero					###		

Effluent days as decided by sappi saiccor;s environmental team.

Effluent days as decided through the adoption of the precautionary principle.

19					18	-	20	-			N	S	
20			9	LE	20	-	10	-			N		Patchy
21			12	-	15	-	(20)	-			N		
22			9	LE					8	-	N	S	
23			9	-	10	-			9	-	N	S	
24			15	-	15	-	13	.			N	S	
25			15	.			18	.			N		
26					15	.	13	.			N	L	
27					18	.	(15)	.			N		
28									8	.	N	M	
29									6	.	S		
30			10	.							0		
31			6	E							E		
													Average vis
							Ave unaffected vis			13			Severity inde
						Current going south or zero						###	

MONTH: APR-01

	ADC		FEVER		WHALER		MAAS		WILD		CURRENT		COMMENTS
1			13	LE	15	.	15	.	13	.	N		
2			12	.					10	.	N	M	
3			(8)	.			10	.	11	.	N		
4			(15)	.	15	.	15	.	15	.	N	M	
5			20	.	16	.	18	.			N		
6			20	.	25	.	20	.	20	.	N	L	
7			6	LE	4	R	1.5	R	5	R	O		
8			10	LE	20	.	10	R			N	L	
9			15	.			9	R			N	L	
10					5	.	9	R			N	L	
11			5	.	7	.	5	RE	6	R	O		
12			7	.	8	.	5	R			NS		
13			10	LE	10	.	8	R	5	.	N		18 Deg.
14			10	LE	12	.	9	R	9	.	N	L	24/18 Deg.
15			12	.	15	.	10	E	18	.	N		24/18 Deg.
16					18	.	25	LE	20	.	N	L	
17			13	.	15	.			15	.	N	L	
18			15	.	10	?	16	LE			N	L	
19			9	.			10	.			N	M	
20			11	.	13	.	13	.			N	L	R on Produc
21			10	.	7	.	7	RE			S		
22			10	LE	13	.	5	RE			S		
23							15	.			S		
24			10	.	10	.	6	E			0		
25			9	E	10	.	9	R	8	.	0		
26					20	.	30	.	18	.	S		
27					10	.	10	E	10	.	N	L	
28			18	.	15	.	10	E	8	.	N	S	
29			10	E	15	.	10	E	10	.	N		
30			8	LE	8	.			13	.	N		
													Average vis

5	15	.									N		
6					10	.	10	.			N		"Green dirty
7							9	LLE			N	S	
8									8	.	N	S	
9			(9)	E	13	.			10	.	N		() Produce
10									8	.	N	S	
11			8	.			5	E			N		
12							10	.			N		
13							10	.			N	S	
14					13	.	13	.			N	S	
15			10	LE	13	.					N		
16			10	LE	12	.	9	E			N		
17	13	.	(13)	LE	9	.	9	LE			N		
18			12	LE	13	.					S	L	E on surface
19	7	.	10	E			8	.			NS	S	
20					15	.	13	.			O		E Later
21			17	.			20	.			N		?
22			15	.	15	.	10	LE			O		
23			10	.	10	.	8	LE			S		
24			13	.	13	.	15	.			S		
25			9	LE	15	.					S		
26			13	.	15	.	10	LE			S		
27			(9)	.	7	.	10	.			S		
28			9	.			7	E			S		
29			10	.	15	.	18	.			S		
30			20	.			23	.			S	S	
													Average vis
							Ave unaffected vis			11			Severity inde
						Current going south or zero						###	

MONTH: MAY-01

	ADC		SEA FEVER		WHALER		UMKOMAA		BLUE WILD		CURRENT		COMMENTS
1			18	-	15	-	20	LE			N		
2					10	-	12	-			N	S	
3					11	-	15	LE			O		
4			(1)	(E)	8	-	5	E			O		Sea Fever on
5			7	-			8	-			S	L	
6			9	-	.						N		
7							20	-			O		
8							20	-			N		
9					15	-	20	-			N		
10					15	-					O		
11			18	-	20	-	20	-			S	L	Cold on botto
12			20	-	10	-	10	-			N	L	
13			15	-	15	-					N	L	
14					5	-			9	-	S	L	Patchy
15			10	-			5	E	20	-	O		
16			10	-	10	-			12	-	O		
17			9	LE					10	-	S	L	
18			(18)	(-)	18	-	14	LE			O		

B.: Summary of the Divers' Data

MONTH: JUL-01

	ADC	SEA FEVER	WHALER	AS LODGE	BLUE WILD	Average	Std. Dev.	CURRENT		MMENTS			
1	(15)	18	20	13		17	3.6056	S			1	17	
2	(30)	18		25		21.5	4.9497	0			2	22	
3	(30)	30	25	30		28.33	2.8868	N			3	28	
4	(25)	25		25		25	0	N			4	25	
5	(20)	13		13		13	0	N			5	13	
6	(10)	13	18	(15)		15.5	3.5355	N			6	16	
7	(15)	13	18	13		14.67	2.8868	0			7	15	
8	(8)	7	10	8		8.333	1.5275	S			8	8	7
9		9		13		11	2.8284	S			9	11	4
10	(11)	10		14		12	2.8284	0			10	12	
11	(15)	15		15		15	0	S			11	15	
12	(20)	11	15	15		13.67	2.3094	N			12	14	
13	(15)		15	15		15	0	N			13	15	
14	(18)	15	16	15		15.33	0.5774	N			14	15	
15	(15)	13	15	10		12.67	2.5166	N			15	13	
16	(15)	9	9	15		11	3.4641	N	L		16	11	4
17		9				9		N	L		17	9	
18			8	10		9	1.4142	S			18	9	
19											19		
20											20		
21				13		13					21	13	
22											22		
23											23		
24											24		
25	(20)	10	15			12.5	3.5355	N			25	13	
26	(20)	14	25			19.5	7.7782	0			26	20	
27	(10)	12	9	14		11.67	2.5166	S			27	12	
28	(8)	12	18	9		13	4.5826	S			28	13	2
29	(8)	9	13	10		10.67	2.0817	S			29	11	4
30		15	20			17.5	3.5355	S	S		30	18	
31	(10)	13	15			14	1.4142	S			31	14	
CONSISTENCY	0	23	18	20	0	14.57	2.532						
					MIN. VALUE	8.33333				Average vis		15	
MONTHLY AVERAGE		13.609	15.7778	14.75		14.71	1.085			Severity index			21
									56%				

MONTH: JUN-01

	ADC	SEA FEVER	WHALER	AS LODGE	BLUE WILD	Average	Std. Dev.	CURRENT		MMENTS		Avg vis
1	20	9	10	8		11.75	5.5603	N	L	Patchy E		12
2		5	8			6.5	2.1213	N				7
3		14	11			12.5	2.1213	N			1	13
4			13			13		N			2	13
5	15					15		N			3	15

	ADC	SEA FEVER	WHALER	AS LODGE	BLUE WILD	average	Std. Dev	CURRENT		COMMENTS			
30		8	8		13	10	2.8868	N			30	10	
CONSISTENCY	0	23	25	27	18	11.93	2.325				31		
					MIN. VALUE	4.125				Average vis		12	
MONTHLY AVERAGE		11.435	12.64	11.5	11.889	11.87	0.5536			Severity index			0
								27%					

MONTH: MAR-01

	ADC	SEA FEVER	WHALER	AS LODGE	BLUE WILD	average	Std. Dev	CURRENT		COMMENTS		Average Vis	
1		10	25	30	30	23.75	9.4648	S	L		1	24	
2		13	25	20		19.33	6.0277	S	L		2	19	
3			17	10	18	15	4.3589	S	L		3	15	
4		20	23	20		21	1.7321	S	S		4	21	
5			23		30	26.5	4.9497	S	S		5	27	
6			23	20		21.5	2.1213	S	S		6	22	
7				30		30		S	S		7	30	
8			13	15		14	1.4142	S	S		8	14	
9			22	25		23.5	2.1213	S	L		9	24	
10		18	20	11		16.33	4.7258	S	L		10	16	
11		20	15	16		17	2.6458	N			11	17	
12				8		8		N		Others	12	8	
13		9	15			12	4.2426	N			13	12	
14		3	3	3	3	3	0	O			14	3	14
15		10	25	(25)		17.5	10.607	S	S		15	18	
16		15	15	13		14.33	1.1547	S	L		16	14	
17		13	10	12	13	12	1.4142	S	L		17	12	
18		7	20	9	25	15.25	8.6554	S	L	"green	18	15	
19		4		7		5.5	2.1213	N		On out	19	6	
20			4	2		3	1.4142	S			20	3	14
21		14	14	18		15.33	2.3094	S	S		21	15	
22		14	18	28		20	7.2111	S			22	20	
23		30	18	25	18	22.75	5.8523	S	S		23	23	
24		23		20		21.5	2.1213	S	S		24	22	
25		20		13		16.5	4.9497	S			25	17	
26			12			12		S	L		26	12	
27		10	20			15	7.0711	NS			27	15	
28		20	20	25		21.67	2.8868	S	L		28	22	
29			15	13		14	1.4142	S	L		29	14	
30				9	10	9.5	0.7071	N	L		30	10	
31		5	10	12		9	3.6056	N	S			9	
CONSISTENCY	0	20	25	26	8	15.99	3.832			Average vis		16.0	
					MIN. VALUE	3				Severity index			28
MONTHLY AVERAGE		13.9	17	15.9231	18.375	16.3	1.8884	81%					

19			18	20		19.00	1.4142	N	S		18	19
20		9	20	10		13.00	6.0828	N		Patchy	19	13
21		12	15	(20)		13.50	2.1213	N			20	14
22		9			8	8.50	0.7071	N	S		21	9
23		9	10		9	9.33	0.5774	N	S		22	9
24		15	15	13		14.33	1.1547	N	S		23	14
25		15		18		16.50	2.1213	N			24	17
26			15	13		14.00	1.4142	N	L		25	14
27			18	(15)		18.00		N			26	18
28					8	8.00		N	M		27	8
29					6	6.00		S			28	6
30		10				10.00		O			29	10
31		6				6.00		E			30	6
CONSISTENCY	0	16	19	17	8	12.79	2.257			Averag	31	12.7
				MIN. VALUE		6				Severity index		
MONTHLY AVERAGE		11.438	13.8421	14.2941	10.25	12.46	1.9325		45%			

MONTH: APR-01

	ADC	SEA FEVER	WHALER	AS LODGE	BLUE WILD	Average	Std. Dev	URRENT		COMMENTS		Avg vis
1		13	15	15	13	14	1.1547	N			1	14
2		12			10	11	1.4142	N	M		2	11
3		(8)		10	11	11	0.7071	N			3	11
4		(15)	15	15	15	15	0	N	M		4	15
5		20	16	18		18	2	N			5	18
6		20	25	20	20	21	2.5	N	L		6	21
7		6	4	1.5	5	4	1.9311	O			7	4
8		10	20	10		13	5.7735	N	L		8	13
9		15		9		12	4.2426	N	L		9	12
10			5	9		7	2.8284	N	L		10	7
11		5	7	5	6	6	0.9574	O			11	6
12		7	8	5		7	1.5275	NS			12	7
13		10	10	8	5	8	2.3629	N		18 Deg	13	8
14		10	12	9	9	10	1.4142	N	L	24/18	14	10
15		12	15	10	18	14	3.5	N		24/18	15	14
16			18	25	20	21	3.6056	N	L		16	21
17		13	15		15	14	1.1547	N	L		17	14
18		15	10	16		14	3.2146	N	L		18	14
19		9		10		10	0.7071	N	M		19	10
20		11	13	13		12	1.1547	N	L	R on P	20	12
21		10	7	7		8	1.7321	S			21	8
22		10	13	5		9	4.0415	S			22	9
23				15		15		S			23	15
24		10	10	6		9	2.3094	0			24	9
25		9	10	9	8	9	0.8165	0			25	9
26			20	30	18	23	6.4291	S			26	23
27			10	10	10	10	0	N	L		27	10
28		18	15	10	8	13	4.5735	N	S		28	13
29		10	15	10	10	11	2.5	N			29	11

6			10	10		10	0	N		"Green	4	10
7				9		9		N	S		5	9
8					8	8		N	S		6	8
9		(9)	13		10	11.5	2.1213	N		() Prod	7	12
10					8	8		N	S		8	8
11		8		5		6.5	2.1213	N			9	7
12				10		10		N			10	10
13				10		10		N	S		11	10
14			13	13		13	0	N	S		12	13
15		10	13			11.5	2.1213	N			13	12
16		10	12	9		10.33	1.5275	N			14	10
17	13	(13)	9	9		10.33	2.3094	N			15	10
18		12	13			12.5	0.7071	S	L	E on su	16	13
19	7	10		8		8.333	1.5275	NS	S		17	8
20			15	13		14	1.4142	O		E Later	18	14
21		17		20		18.5	2.1213	N		?	19	19
22		15	15	10		13.33	2.8868	O			20	13
23		10	10	8		9.333	1.1547	S			21	9
24		13	13	15		13.67	1.1547	S			22	14
25		9	15			12	4.2426	S			23	12
26		13	15	10		12.67	2.5166	S			24	13
27		(9)	7	10		8.5	2.1213	S			25	9
28		9		7		8	1.4142	S			26	8
29		10	15	18		14.33	4.0415	S			27	14
30		20		23		21.5	2.1213	S	S		28	22
CONSISTENCY	4	17	19	20	3	11.45	2.062					
					MIN. VALUE	6.5				Average vis		11
MONTHLY AVER	13.75	11.412	12.1053	11.25	8.6667	11.44	1.8376			Severity index		
									40%			

MONTH: MAY-01

	ADC	SEA FEVER	WHALER	AS LODGE	BLUE WILD	Average	Std. Dev.	CURRENT		MMENTS	Avg Vis	
1		18	15	20		17.67	2.5166	N				18
2			10	12		11.00	1.4142	N	S		1	11
3			11	15		13.00	2.8284	O			2	13
4		(1)	8	5		6.50	2.1213	O		Sea Fe	3	7
5		7		8		7.50	0.7071	S	L		4	8
6		9	.			9.00		N			5	9
7				20		20.00		O			6	20
8				20		20.00		N			7	20
9			15	20		17.50	3.5355	N			8	18
10			15			15.00		O			9	15
11		18	20	20		20.00	0	S	L	Cold o	10	20
12		20	10	10		13.33	5.7735	N	L		11	13
13		15	15			15.00	0	N	L		12	15
14			5		9	7.00	2.8284	S	L	Patchy	13	7
15		10		5	20	11.67	7.6376	O			14	12
16		10	10		12	10.67	1.1547	O			15	11
17		9			10	9.50	0.7071	S	L		16	10
18		(18)	18	14		16.00	2.8284	O			17	16

C.: Summary of the Effluent Data

MONTH: JUL-01

	ADC	SEA FEVER	WHALER	AAS LODGE	BLUE WILD	Average	Std. Dev.	CURRENT		MMENTS	Average Visibility on Aliw		
6	(10)	13	18	(15)		15.5	3.5355	N			6	16	
8	(8)	7	10	8		8.3333	1.5275	S			8	8	7
9		9		13		11	2.8284	S			9	11	4
12	(20)	11	15	15		13.667	2.3094	N			12	14	
13	(15)		15	15		15	0	N			13	15	
16	(15)	9	9	15		11	3.4641	N	L		16	11	4
25	(20)	10	15			12.5	3.5355	N			25	13	
28	(8)	12	18	9		13	4.5826	S			28	13	2
29	(8)	9	13	10		10.667	2.0817	S			29	11	4
31	(10)	13	15			14	1.4142	S			31	14	
COUNT 10						12.467	2.5279						
										Average vis		12	
MONTHLY AVERAGE		10.333	14.2222	12.1429		12.233	1.946			Severity index			21
									56%				

MONTH: JUN-01

	ADC	SEA FEVER	WHALER	AAS LODGE	BLUE WILD	Average	Std. Dev.	CURRENT		MMENTS	Avg vis	
9		(9)	13		10	11.5	2.1213	N		() Prod	7	12
11		8		5		6.5	2.1213	N			9	7
16		10	12	9		10.333	1.5275	N			14	10
19	7	10		8		8.3333	1.5275	NS	S		17	8
28		9		7		8	1.4142	S			26	8
COUNT 5						8.9333	1.7424					
										Average vis		9
MONTHLY AVER	7	9.25	12.5	7.25	10	9.2	2.2458			Severity index		
									40%			

MONTH: MAY-01

	ADC	SEA FEVER	WHALER	AAS LODGE	BLUE WILD	Average	Std. Dev.	CURRENT		MMENTS	Avg Vis	
4		(1)	8	5		6.5	2.1213	O		Sea Fe	3	7
15		10		5	20	11.667	7.6376	O			14	12
31		6				6		E			30	6
COUNT 3												
						8.0556	4.8795			Averag	31	8.1
										Severity index		
MONTHLY AVERAGE		8	8	5	20	10.25	6.6521		45%			

MONTH: APR-01

	ADC	SEA FEVER	WHALER	AAS LODGE	BLUE WILD	Average	Std. Dev	URRENT		COMMENTS		Avg vis	
15		12	15	10	18	13.75	3.5	N		24/18	15	14	
25		9	10	9	8	9	0.8165	O			25	9	
27			10	10	10	10	0	N	L		27	10	
28		18	15	10	8	12.75	4.5735	N	S		28	13	
29		10	15	10	10	11.25	2.5	N			29	11	
COUNT 5						11.35	2.278				31		
										Average vis		11	
MONTHLY AVERAGE		12.25	13	9.8	10.8	11.463	1.4361			Severity index			0
								27%					

MONTH: MAR-01

	ADC	SEA FEVER	WHALER	AAS LODGE	BLUE WILD	average	Std. Dev	URRENT		COMMENTS		Average Vis	
1		10	25	30	30	23.75	9.4648	S	L		1	24	
3			17	10	18	15	4.3589	S	L		3	15	
14		3	3	3	3	3	0	O			14	3	14
16		15	15	13		14.333	1.1547	S	L		16	14	
17		13	10	12	13	12	1.4142	S	L		17	12	
18		7	20	9	25	15.25	8.6554	S	L	"green'	18	15	
20			4	2		3	1.4142	S			20	3	14
27		10	20			15	7.0711	NS			27	15	
COUNT 8						12.667	4.1917			Average vis		12.7	
										Severity index			28
MONTHLY AVERAGE		9.6667	14.25	11.2857	17.8	13.251	3.5778	81%					

APPENDIX VI: DESCRIPTIVE STATISTICS FOR DATA DISTRIBUTION BETWEEN THE DIVE CHARTER GROUPS.

GROUP

Case Processing Summary

		Cases					
		Valid		Missing		Total	
	GROUP	N	Percent	N	Percent	N	Percent
VIS	ADC	31	88.6%	4	11.4%	35	100.0%
	Sea Fever	35	100.0%	0	.0%	35	100.0%
	Whaler	35	100.0%	0	.0%	35	100.0%
	Umkomaas	35	100.0%	0	.0%	35	100.0%
	Blue Wild	31	88.6%	4	11.4%	35	100.0%

Descriptives

	GROUP			Statistic	Std. Error
VIS	ADC	Mean		11.5187	.4096
		95% Confidence Interval for Mean	Lower Bound	10.6822	
			Upper Bound	12.3553	
		5% Trimmed Mean		11.4735	
		Median		11.7100	
		Variance		5.201	
		Std. Deviation		2.2807	
		Minimum		7.43	
		Maximum		16.36	
		Range		8.93	
		Interquartile Range		3.2600	
		Skewness		.335	.421
		Kurtosis		-.621	.821
	Sea Fever	Mean		12.0091	.3540
		95% Confidence Interval for Mean	Lower Bound	11.2898	
			Upper Bound	12.7285	
		5% Trimmed Mean		11.9936	
		Median		11.4400	
		Variance		4.386	
		Std. Deviation		2.0942	
		Minimum		8.04	
		Maximum		16.04	
		Range		8.00	
		Interquartile Range		3.3100	
		Skewness		.184	.398
		Kurtosis		-.664	.778

Descriptives

	GROUP			Statistic	Std. Error
VIS	Whaler	Mean		12.9831	.3912
		95% Confidence Interval for Mean	Lower Bound	12.1881	
			Upper Bound	13.7782	
		5% Trimmed Mean		12.9594	
		Median		12.6400	
		Variance		5.357	
		Std. Deviation		2.3146	
		Minimum		8.36	
		Maximum		17.67	
		Range		9.31	
		Interquartile Range		3.4000	
		Skewness		.342	.398
		Kurtosis		-.483	.778
	Umkomaas	Mean		13.2446	.4497
		95% Confidence Interval for Mean	Lower Bound	12.3306	
			Upper Bound	14.1585	
		5% Trimmed Mean		13.1378	
		Median		13.2000	
		Variance		7.079	
		Std. Deviation		2.6605	
		Minimum		9.14	
		Maximum		19.79	
		Range		10.65	
		Interquartile Range		3.5000	
		Skewness		.679	.398
		Kurtosis		-.001	.778
	Blue Wild	Mean		12.6213	.6539
		95% Confidence Interval for Mean	Lower Bound	11.2858	
			Upper Bound	13.9568	
		5% Trimmed Mean		12.4181	
		Median		12.0000	
		Variance		13.256	
		Std. Deviation		3.6409	
		Minimum		7.17	
		Maximum		22.50	
		Range		15.33	
		Interquartile Range		4.4800	
		Skewness		.850	.421
		Kurtosis		.370	.821

VIS

Stem-and-Leaf Plots

```
VIS Stem-and-Leaf Plot for
GROUP= ADC

 Frequency    Stem &  Leaf

     1.00        7 .  4
     4.00        8 .  5889
     4.00        9 .  2556
```

```
     5.00       10 .  01379
     3.00       11 .  077
     7.00       12 .  0123448
     2.00       13 .  77
     1.00       14 .  0
     3.00       15 .  014
     1.00       16 .  3

 Stem width:        1.00
 Each leaf:         1 case(s)
```

```
VIS Stem-and-Leaf Plot for
GROUP= Sea Fever

 Frequency    Stem &  Leaf

     3.00        8 .  079
     2.00        9 .  07
     6.00       10 .  022349
     8.00       11 .  33344447
     4.00       12 .  1166
     6.00       13 .  014679
     2.00       14 .  59
     3.00       15 .  038
     1.00       16 .  0

 Stem width:        1.00
 Each leaf:         1 case(s)
```

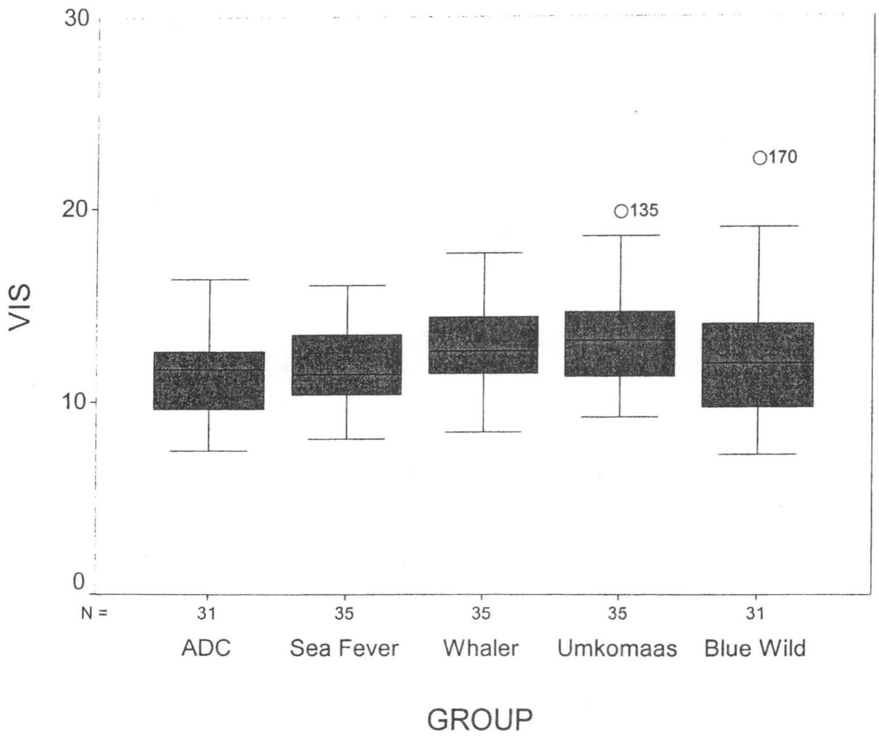
```
VIS Stem-and-Leaf Plot for
GROUP= Whaler

 Frequency    Stem &  Leaf

     1.00        8 .  3
     2.00        9 .  79
     2.00       10 .  02
     7.00       11 .  0114589
     9.00       12 .  112336677
     4.00       13 .  1588
     2.00       14 .  08
     3.00       15 .  247
     2.00       16 .  07
     3.00       17 .  016

 Stem width:        1.00
 Each leaf:         1 case(s)
```

```
VIS Stem-and-Leaf Plot for
GROUP= Umkomaas

 Frequency    Stem &  Leaf

     3.00        9 .  117
     5.00       10 .  56778
     5.00       11 .  23558
     3.00       12 .  234
     8.00       13 .  02222557
     4.00       14 .  2577
     2.00       15 .  59
     1.00       16 .  8
```

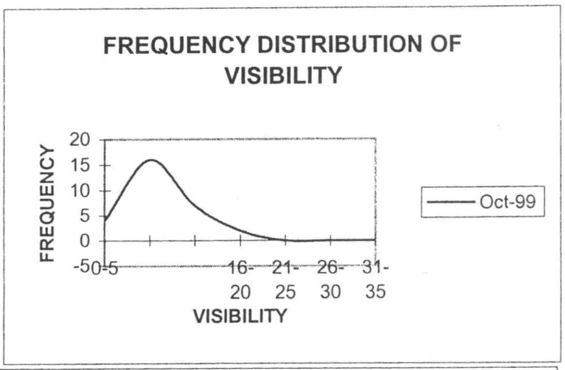
```
     2.00        17 .  59
     1.00        18 .  5
     1.00 Extremes     (>=19.8)

 Stem width:       1.00
 Each leaf:        1 case(s)
```

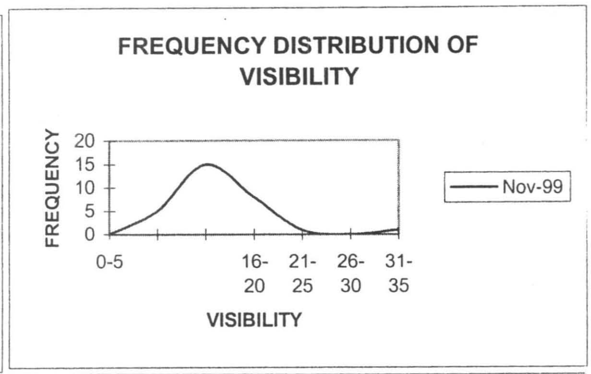
VIS Stem-and-Leaf Plot for
GROUP= Blue Wild

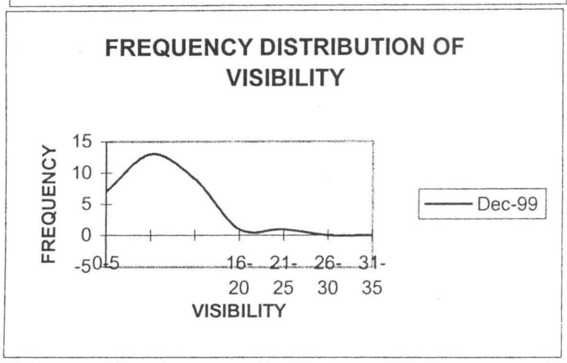
```
 Frequency    Stem &  Leaf

     1.00        0 .  7
     8.00        0 .  88889999
     6.00        1 .  000011
     7.00        1 .  2223333
     3.00        1 .  445
     3.00        1 .  667
     2.00        1 .  89
     1.00 Extremes     (>=23)

 Stem width:      10.00
 Each leaf:        1 case(s)
```

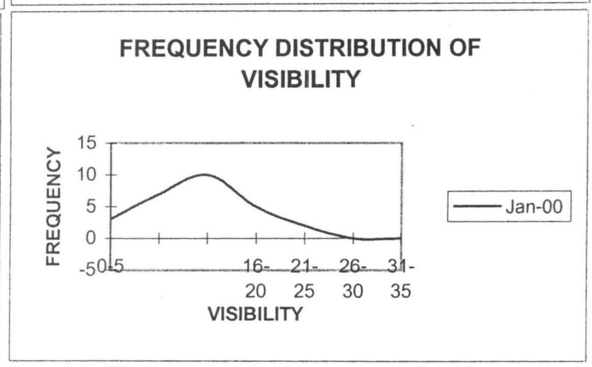


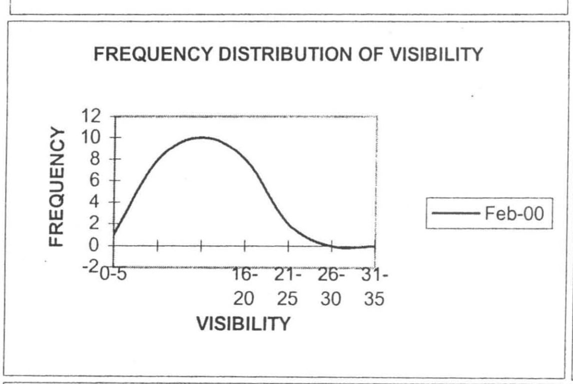
APPENDIX VII: Monthly Visibility Frequency Distributions

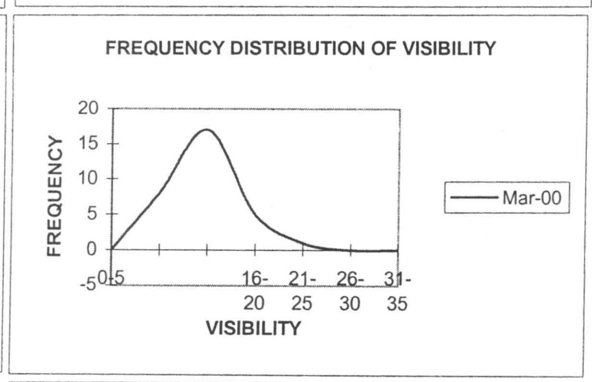


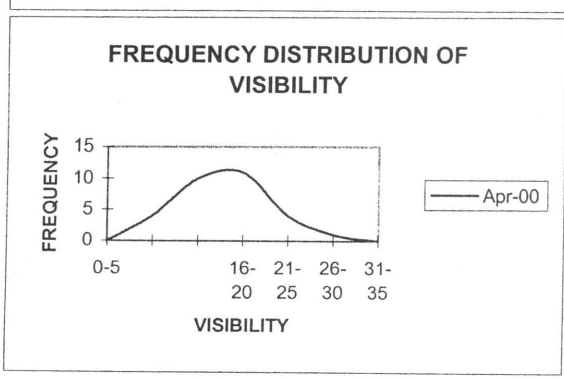


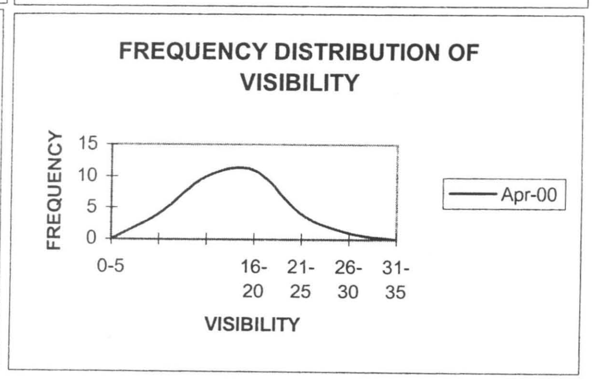


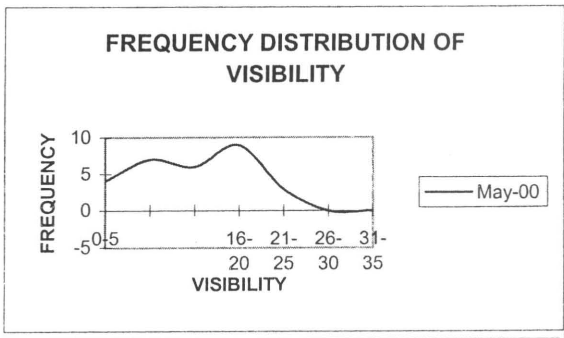


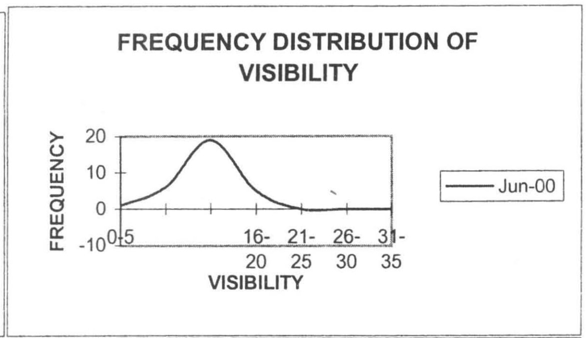


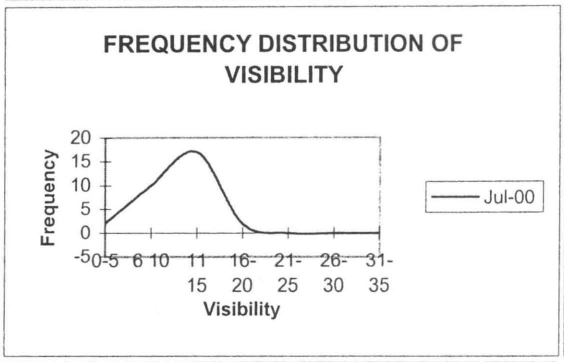


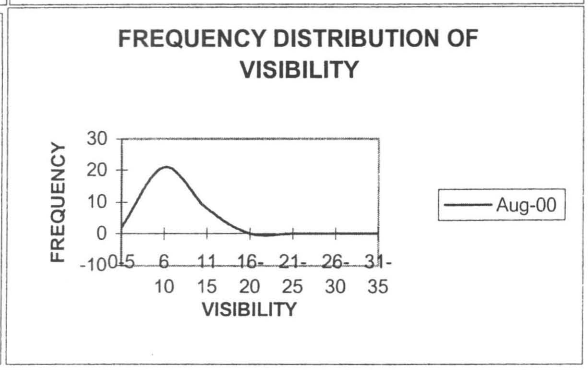


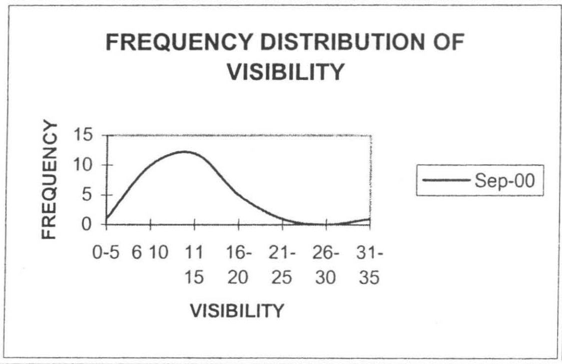


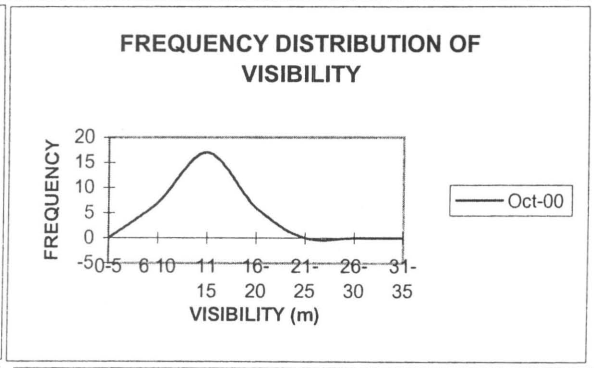

FREQUENCY DISTRIBUTION OF VISIBILITY
FREQUENCY
10
5
0
-5
0-5
16- 20
21- 25
26- 30
31- 35
VISIBILITY
May-00

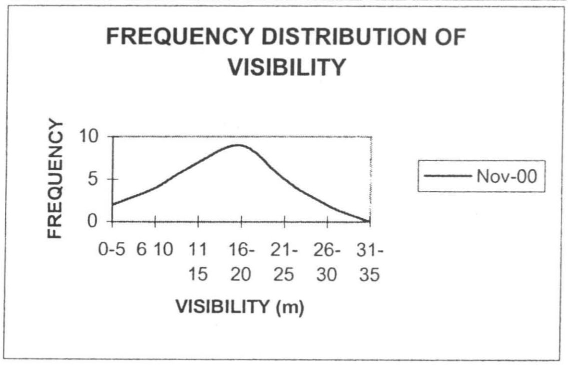

FREQUENCY DISTRIBUTION OF VISIBILITY
FREQUENCY
20
10
0
-10
0-5
16- 20
21- 25
26- 30
31- 35
VISIBILITY
Jun-00

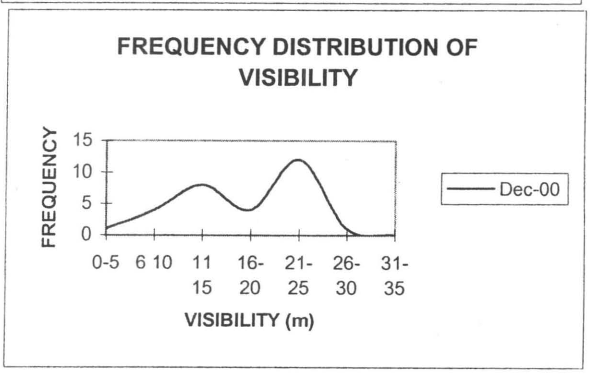

FREQUENCY DISTRIBUTION OF VISIBILITY
Frequency
20
15
10
5
0
-5
0-5
6 10
11 15
16- 20
21- 25
26- 30
31- 35
Visibility
Jul-00


FREQUENCY DISTRIBUTION OF VISIBILITY
FREQUENCY
30
20
10
0
-10
0-5
6 10
11 15
16- 20
21- 25
26- 30
31- 35
VISIBILITY
Aug-00


FREQUENCY DISTRIBUTION OF VISIBILITY
FREQUENCY
15
10
5
0
0-5
6 10
11 15
16- 20
21- 25
26- 30
31- 35
VISIBILITY
Sep-00


FREQUENCY DISTRIBUTION OF VISIBILITY
FREQUENCY
20
15
10
5
0
-5
0-5
6 10
11 15
16- 20
21- 25
26- 30
31- 35
VISIBILITY (m)
Oct-00


FREQUENCY DISTRIBUTION OF VISIBILITY
FREQUENCY
10
5
0
0-5
6 10
11 15
16- 20
21- 25
26- 30
31- 35
VISIBILITY (m)
Nov-00


FREQUENCY DISTRIBUTION OF VISIBILITY
FREQUENCY
15
10
5
0
0-5
6 10
11 15
16- 20
21- 25
26- 30
31- 35
VISIBILITY (m)
Dec-00

EFFLUENT LOG

CHARTER OPERATOR…………………………………… **DATE…………………………**

DIVE TIME	LOCATION	U/W Visibility (m)	CURRENT Speed & Direction	EFFLUENT PRESENCE				COMMENTS
				E	LE	SE	OE	

APPENDIX IX: DESCRIPTIVE STATISTICS FOR DATA DISTRIBUTION BETWEEN DIFFERENT TIME PERIODS

PERIOD (Pre = Before the pipeline extension, Post 1 & 2 = After the pipeline extension)

Descriptives

	PERIOD			Statistic	Std. Error
VIS	Pre	Mean		12.5300	.8982
		95% Confidence Interval for Mean	Lower Bound	10.3322	
			Upper Bound	14.7278	
		5% Trimmed Mean		12.5383	
		Median		12.7500	
		Variance		5.647	
		Std. Deviation		2.3764	
		Minimum		9.51	
		Maximum		15.40	
		Range		5.89	
		Interquartile Range		4.5500	
		Skewness		-.084	.794
		Kurtosis		-2.131	1.587
	Post 1	Mean		11.9171	.8047
		95% Confidence Interval for Mean	Lower Bound	9.9482	
			Upper Bound	13.8861	
		5% Trimmed Mean		11.9040	
		Median		11.8900	
		Variance		4.532	
		Std. Deviation		2.1289	
		Minimum		9.12	
		Maximum		14.95	
		Range		5.83	
		Interquartile Range		4.1600	
		Skewness		-.170	.794
		Kurtosis		-.885	1.587
	Post 2	Mean		14.3886	.9690
		95% Confidence Interval for Mean	Lower Bound	12.0175	
			Upper Bound	16.7596	
		5% Trimmed Mean		14.4584	
		Median		15.0500	
		Variance		6.573	
		Std. Deviation		2.5637	
		Minimum		10.21	
		Maximum		17.31	
		Range		7.10	
		Interquartile Range		3.9000	
		Skewness		-.566	.794
		Kurtosis		-.813	1.587

Case Processing Summary

	PERIOD	Cases					
		Valid		Missing		Total	
		N	Percent	N	Percent	N	Percent
VIS	Pre	7	100.0%	0	.0%	7	100.0%
	Post 1	7	100.0%	0	.0%	7	100.0%
	Post 2	7	100.0%	0	.0%	7	100.0%

VIS

Stem-and-Leaf Plots

```
VIS Stem-and-Leaf Plot for
PERIOD= Pre

 Frequency    Stem &  Leaf

     1.00        0 .  9
     5.00        1 .  00244
     1.00        1 .  5

 Stem width:     10.00
 Each leaf:       1 case(s)
```

```
VIS Stem-and-Leaf Plot for
PERIOD= Post 1

 Frequency    Stem &  Leaf

     2.00        0 .  99
     5.00        1 .  11234

 Stem width:     10.00
 Each leaf:       1 case(s)
```

```
VIS Stem-and-Leaf Plot for
PERIOD= Post 2

 Frequency    Stem &  Leaf

     3.00        1 .  022
     4.00        1 .  5667

 Stem width:     10.00
 Each leaf:       1 case(s)
```

ondents	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
1 SIR)	Ongoing research on the Sappi Saiccor effluent disposal.	Yes. To advice DWAF on structure and application of permit and voice concerns of stakeholders.	CSIR's commitment to sustainable development	Yes. Though defend Sappi Saiccor often due to misinformation and misunderstandings tabled at the PAP meetings. Role hasn't changed.	Lower level of interest since effluent on the beaches and at the Aliwal has decreased. With the expansion of the plant it may decrease further, leading to a reduced frequency of the PAP meetings.	Yes, in terms of the water colour and diving issue. Other aspects of the permit however may need more attention.	Yes.	It is the best available under the circumstances.	Sappi saiccor too heavily represented, harping back on issues leading to frustrations and lack of progress, otherwisw good forum for information sharing	Will be less attended as the diving fraternity perceives the discolouration issue to have been largely solved.
2 ıst watch)	As a trustee of the SCMPF and AOS PAP.	As a statutory DWAF requirement to review effluent performance against permit requirements.	Transparent and essential for public involvement and awareness.	No. The real issues remaining are the improvement of marine water quality and estuarine stabilisation.	No. The PAP has not stabilised.	Local affected parties and council representation poor.	Yes. There is however concern about the 30 m water column, where it is believed that there are less larvae and comb-jellies.	Not happy. Happy if Dr. Connel set the methodology and interpreted it.	Meeting attendance poor due to being self employed.	It's a statutory requirement. Sappi Saiccor should get its CARE committee functional and include the PAP.
3 (Local ouncil & self)	Concern over effect of pollution on marine environment. Involvement with the SCMPF.	Yes. To assist in setting improved conditions for environments. (sustainable industry & environments).	As a sea user, concern for my work also an interest in environmental issues. For future generations.	Reasonably. More progress on other issues of the permit.	Yes. Have a much more balanced view of the situation (industrial & environmental). More transparency.	Public representation lacking.	Yes. Made industry and the regulator aware of the public's role in their decisions. Also an improvement in the marine pollution.	A huge improvement in the inshore water. Not confident that the offshore improvement is as perceived.	Happy there is a monitoring in place though not confident in the quality of the data. (data collection at different places and times by	Lack of representation of key players, e.g sharksboard, divers, fishermen, & general sea users. Lack of real progress.

									different people).	Key players getting stale. Need to focus on other permit issues.
4 WAF)	S the regulating body.	To advise DWAF on the thoughts and views of the public/ stakeholders in the matter relating directly to Sappi Saiccor's permit.	DWAF would like to be transparent by egaging the views of the public in its decision-making.	Yes. As the regulator DWAF is involved in the PAP only as an observer.	No.	Representation is a problem (its hard to get people to attend the meetings), and its going to worsen as with the scale of impact being reduced substantially.	Yes. Serves as a forum for interaction for stakeholders, information sharing, and capacity building. No. it does not represent the views of as wide a range of stakeholders as would be preferred.	Yes.	Will give an indication of the difference the new pipeline has had on pollution reduction, however will not be able to quantify the % reductions.	Individuals negotiating with threads and high emotions, leading the whole process astray.
5 search nisation)	Invited by Dr. D. Scott after knowing about my involvement in the estuarine studies.	Yes. Advise DWAF on permit compliance as per the conditions outlined in the permit.	The same.	Yes, provided there is a clear understanding of my position to give objective scientific advice.	No. Only changed the organisation I represent.	Representation is fine, efforts should only be made to have alternates to represent the various sectors.	Yes. More recently functioning has been better.	I believe so.	Important to maintain the historical long-term data sets. Difficult however to comment at this stage without seeing some comprehensive analysis and interpretation.	The PAP is one of the best ways (Participative) of operating, hence it still has an important role to play.