Current and Future Challenges in the Great Limpopo Transfrontier Conservation Area – A Scenario Planning Approach*

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Acknowledgement

Introduction

The mid to late 1990's saw the advent of the TFCA concept in southern Africa and one of the first and most ambitious of these was the development of the Great Limpopo Transfrontier Conservation Area (GLTFCA). It was not the first time that this idea had been mooted. In the 1970's the idea of a "super" national park extending to the Indian Ocean had been presented by Tinley and others. However, these ideas were put on hold as the de-colonisation process and liberation struggles raged in Mozambique, Rhodesia (Zimbabwe) and South Africa. The area of the GLTFCA was central to these conflicts and the legacy of war remains evident today with minefields and old battlefield sites still visible.

With the end of apartheid and a democratic dispensation in South Africa, the idea of transfrontier conservation was rapidly resurrected and endorsed by the respective governments as a means of stimulating development in remote and economically depressed rural areas. A major proponent in this process was the Peace Parks Foundation (PPF), which succeeded in getting high-level political support for the TFCA concept. The primary motivation for the PPF and other conservation agencies was the expansion and conservation of "wild" areas which in many cases had been de-populated during the preceding conflict period. The basic concept behind the GLTFCA of linking conservation areas in Mozambique, South Africa and Zimbabwe is relatively straight forward and simple. The implementation of this has proven to be far more difficult and has exposed a range of complexities that the original planners did not envisage or perhaps chose to ignore.

The result is that the GLTFCA has only been partially implemented, is underfunded, poorly understood, and hardly recognised at local levels. To compound this problem, the role of the state has changed in all three countries in the past ten years with state agencies unable to implement their own policy objectives without external technical and financial support. When looking at the achievements in the GLTFCA over the past five years, most have required some form of external intervention and the role of the donor and NGO has created an institutional layer on top of existing state and local level institutions. In many cases the GLTFCA has become synonymous with donor and NGO projects and programmes raising the question as to whether concepts like the GLTFCA are at all feasible without this type of assistance. Given the short-term funding cycles and the external priorities of donor institutions, there is clearly a serious disconnect between the different institutional actors in the GLTFCA.

In the scenario planning exercises undertaken in the WCS-funded AHEAD programme, the institutional "dialectic" was clear from the beginning. The scenario planning work has shown clearly the importance of scale – both temporal and physical. For the GLTFCA to work, funding needs to be less programmatic and spread over a much longer timeframe to address local policy objectives and needs. Such type of funding is difficult to secure because it requires a long lead time to produce "results". Donors on set funding cycles related to their own institutional objectives therefore find it difficult to support this type of approach where they need to demonstrate "results" in the short-term in order to secure more funding. Funding in the GLTFCA has therefore been very programmatic, time specific and supportive of the project rather than the process. This has created a "wicked problem", where short-term funding and project solutions are by their own nature generating problems in dealing with long-term issues and creating thematic or institutional imbalances as financial resources are not equitably distributed. However, the greater problem lies with the national governments of the three GLTFCA countries, who having set the TFCA as a national and regional policy priority, have not invested the requisite technical and financial support to achieve that policy. This failure to provide the long-term funding referred to earlier has left an institutional and funding space that NGOs, academic institutions and donors are attempting to cover without the ability to make long-term commitments. The Shell Global Scenarios to 2025 allude to this at a much larger scale and in a globalised context where they identify a "trilemma" of the market, state and community (Veer, 2005).

The "crisis in the wings" for the GLTFCA is a reflection of this trilemma at a smaller scale with an additional ecological/environmental driver. Looking at current approaches within the GLTFCA it is clear that the rapidly changing socio-economic and political conditions will have a direct bearing on the ecological health of the GLTFCA. Much of this report examines the human, wildlife and livestock interface and demonstrates the challenges and complexity in addressing factors that are impeding the implementation of the "One Health" concept in the GLTFCA. From a veterinary perspective, even if there are technical solutions to addressing an increasing array of disease threats, doing so in the absence of supporting social, political and financial commitments may be akin to "rearranging the deck chairs on the Titanic". The use of the scenario planning approach does not in itself offer a magic bullet. Yet, by exposing those who are involved at different levels in decision-making or practice to the complexity and drivers of the socio-ecological system they live and work in, it does provide the opportunity for more conscious and informed planning and decision-making processes.

1. Background to the Great Limpopo Transfrontier Conservation Area – GLTFCA

The Great Limpopo Transfrontier Conservation Area (GLTFCA) covers *roughly* 100,000 km^2 of Mozambique, South Africa and Zimbabwe (Fig. 1)**.** The area includes several land use/land tenure regimes including national parks, state and private safari and hunting areas, conservancies and game ranches on freehold land, small-scale agro-pastoral farming areas under communal tenure, large scale commercial irrigation schemes, and smaller irrigation schemes within the communal areas. About 35% of the area is comprised of state-protected areas and a further 10% approximately is freehold land under wildlife. Most of the remaining land, the matrix between the designated national parks, is under communal tenure with varying forms of small scale agro-pastoralism. The international treaty to establish the Great Limpopo Transfrontier National Park (GLTNP) was signed by the presidents of Mozambique, South Africa and Zimbabwe in December 2002. Agreement has been reached on creating a transfrontier conservation area (TFCA) that encompasses the Great Limpopo Transfrontier National Park (GLTFNP) and the intervening matrix of conservancies and wildlife ranches on freehold land, together with the communal farming areas. The precise boundaries of this vast TFCA remain undefined, but the primary land use in the matrix is expected to be wildlife-based tourism with reasonably unimpeded movement of wildlife and tourists (Cumming, 2004).
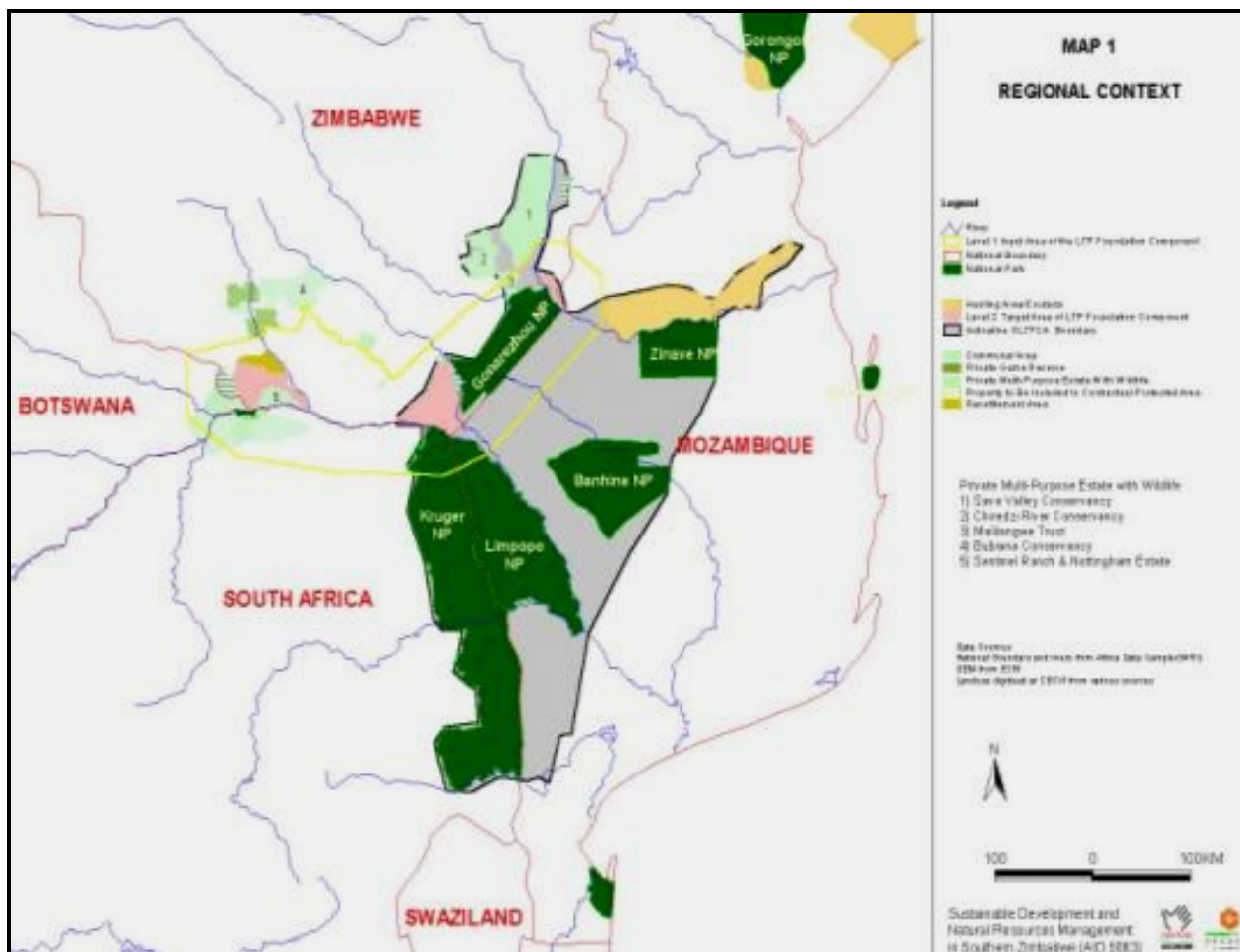
Figure 1 – The Great Limpopo Transfrontier Conservation Area

2. Scenario Planning Overview

*"Neither a wise man nor a brave man lies down on the tracks of history to wait for the train of the future to run over him." – **Dwight D. Eisenhower***

Large, multiple land-use systems like the GLTFCA are by nature a complex web of social and ecological interactions. Understanding and incorporating these complexities into research and management programs that guide and inform decisions and policy makers is a difficult task. In the GLTFCA, with three nations involved, the complexity is particularly high, perhaps one of the most complex socio-ecological systems in the southern African region (Murphree, 2008).

Figure 1 gives an indication of the scale of the GLTFCA. What is not shown on this map is how the conservation areas are nested in a range of private and communal land use regimes with urban centres based on mining, industry, agriculture, local administration and service supply. All of these areas of human activity and livelihood are integral to the complexity of issues facing the conservation areas of the GLTFCA.

Scenario planning, initially developed as a strategic military planning tool (Segal, 2007), is an approach that has evolved to become a widely accepted methodology in understanding and addressing management issues in complex systems. The scenario planning process has two main components. Firstly, it analyses the factors or drivers (Schwartz, 1996) that are influencing the system to build a "default" scenario (Hodgson, 2004) or picture of the current system and its complexities. Secondly, it extrapolates the current drivers into possible futures that can be used to guide research or management interventions.

The importance of the first step of identifying drivers and building the default scenario is that it creates awareness of current complexities and causal relationships that might not have otherwise been understood or realised. The second step of developing future scenarios is important for coping with uncertainty, determining research and management priorities, guiding interventions, supporting policy requirements and determining monitoring or surveillance needs.

The core of scenario planning is the identification of those elements that are shaping events or systems. These elements, known as "drivers", interact with each other often at different physical and temporal scales. Conventional planning often fails to adequately address change because it is based on the assumption that drivers are constant (or

predictable), and yet because of their interaction drivers are invariably in a state of change and this is often unpredictable. At times this driver interaction change is quick, and at other times the change may be slower.

Scenario planning is based on understanding what constitutes the current system drivers and the cause/effect relationship between the drivers. This understanding also helps to comprehend the scale (both physical and temporal) and impact that various drivers have on a system. Once the drivers are identified and their relationship understood, scenario planning provides a methodology for examining how the drivers might possibly interact in the future. Since driver interactions in socio-ecological systems are complex, the scenario planning process attempts to analyse possible and plausible future driver relationships, rather than creating predicted futures (Murphree, 2008).

While scenario planning may be used in different ways, as outlined above, there are certain consistent elements regarding the use of scenario planning:

- There is no one single scenario planning methodology and approaches will vary depending on the issues to be addressed and the scale of the scenario plan.
- Scenario planning is a systematic way of looking into and "rehearsing the future" without attempting to be predictive.
- Scenario planning helps us understand the "drivers" that are shaping the present and how they may influence the future.
- Scenario planning helps us understand that the future is not pre-determined. We can influence the future by understanding and managing current drivers. The example of carbon emissions and their effect on climate change is a case in point.
- Scenario planning helps us prepare for the uncertainties, shocks and surprises that will inevitably arise in any socio-ecological system.

It is important, however, to realise that scenario planning has its limitations, and as such scenario planning is not about predicting the future, nor is it necessarily a replacement for conventional forms of planning – in fact it has been argued by Segal and others that ".. it is not planning at all" (Segal, 2007). Scenario planning can be used by policy makers, planners, managers and communities to:

- Assist in testing existing plans and strategies in different futures.
- Identifying the key drivers for long-term monitoring in an adaptive management system.
- Guide short-term management responses where "rapid response scenario planning" is used.

- Assist communities in communicating their aspirations in large scale planning processes.
- To build understanding and consensus on key issues between stakeholders in order to work towards a common vision.
- Provide an understanding of system dynamics to recognise and address "wicked problems".

3. The Use of Scenario Planning in the AHEAD – GLTFCA

"He who knows not and knows not that he knows not is a fool. Shun him.

He who knows not and knows that he knows not is a child. Teach him.

He who knows and knows not that knows is asleep. Wake him.

He who knows and knows that he knows is a wise man. Follow him."

- **Arab proverb**

The use of scenario planning in the GLTFCA is linked to the development of the AHEAD (Animal Health for the Environment and Development) programme. In the GLTFCA the programme has brought together a range of research and management institutions to address the complexities of social, ecological and health dynamics within the GLTFCA. The AHEAD programme works closely with the veterinary sub- committee of the Joint Management Board of the GLTFCA with a major component of the programme involving the veterinary health and management implications of transfrontier conservation.

The decision to use scenario planning in the GLTFCA – AHEAD originated at an early meeting in Pretoria where it became clear that the complexity of issues and driving forces in the GLTFCA requires the type of analysis provided by scenario planning. The purpose of scenario planning has been to identify and understand the impact and relationship of drivers in the GLTFCA that are relevant to the overall AHEAD objective:

"Facilitate development and conservation success in the GLTFCA through integrated understanding based on innovative inter-disciplinary applied research, monitoring and surveillance at the interface between wild and domestic animal health, ecosystem goods and services, and human livelihoods and wellbeing" (Cumming, 2004.)

The AHEAD scenario planning process is focused on technical and administrative levels in the GLTFCA with the intention being to:
- Increase the level of awareness and understanding of the complexity of the socio-ecological system.
- Identify system drivers and their relationships.
- Develop an awareness of possible shocks and surprises in the future.
- Examine current plans and activities against a set of possible alternative futures.
- Identify a set of key drivers that will be important for monitoring, surveillance and adaptive management.

- Test the use of scenario planning as a tool for developing responses to management and research challenges in the GLTFCA.

Initially, a single scenario planning process was envisaged for the three countries of the GLTFCA. However, due to significant circumstantial differences this was subsequently modified to a three scenario planning process. This resulted in three scenario planning "type" workshop processes in Kruger National Park, Limpopo National Park and a multi-stakeholder workshop in the south east lowveld of Zimbabwe. However, it was only in Kruger that the process was developed over a period of time into a full scenario planning exercise, while in both Mozambique and Zimbabwe the exercises focused on specific veterinary issues. This report correspondingly emphasizes the scenario work in Kruger National Park.

While the scenario planning processes differed in the three countries, one product of the three exercises is a list of cross-cutting drivers. While the major drivers in the GLTFCA are not unexpected, what is interesting is how they interact with other drivers to create situations that are unique to each country. This is important when considering large scale planning over the GLTFCA landscape, since if the complexity and diversity of driver interaction at this larger scale is not understood or taken into consideration in the planning process, then the likelihood of these plans becoming rapidly redundant is high. In situations like the GLTFCA, collaboration and cooperation is only likely to occur where it suits the interest of each country, and management will tend to be reactive rather than proactive. If scenarios can be used to build an understanding of the uniqueness of the common drivers in each system, and this can then be used to shape larger scale plans, then it may be possible to plan more effectively at the larger scale (Murphree, 2008).

4. AHEAD – GLTFCA Scenario Building Approach

The flow diagram in Figure 2 shows the basic approach used in building scenarios. There are two components to this – the first is the construction and understanding of the default scenario and the second is the building of alternative future scenarios.
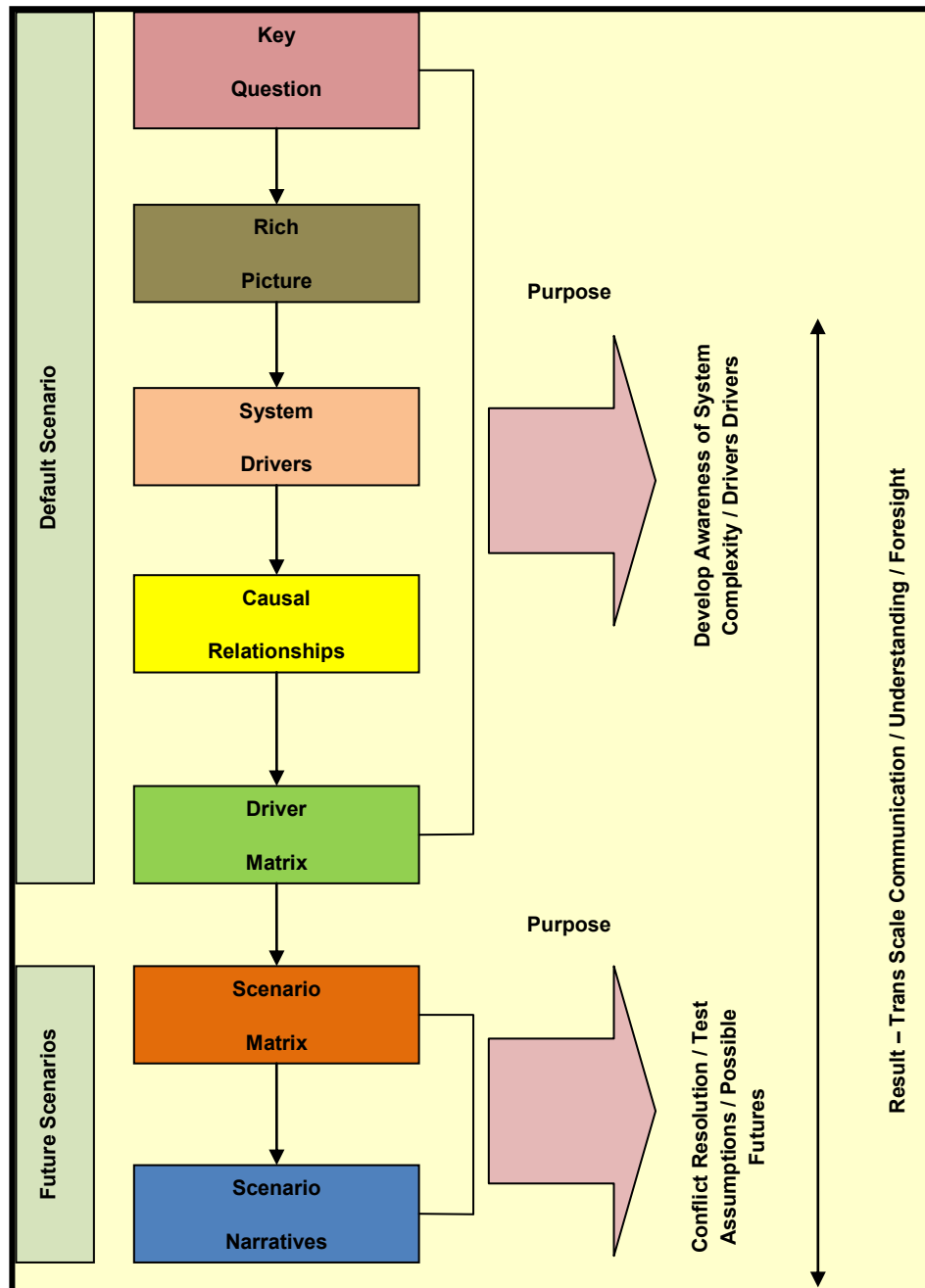

Figure 2 – Scenario Building Flow Diagram

Defining the Default Scenario

If scenarios can be described as scenes or pictures of the future, the "default scenario" is a picture of the current system. It is the starting point of the scenario planning process and involves understanding the drivers and their causal relationships as they currently interact which each other. Since there are a wide range of perspectives on the default scenario in any socio-ecological system, the scenario planning process relies on the inclusion of different key stakeholders in building the default scenario picture.

Setting the Key Question

The Key Question is a critical component of the scenario planning process. The question defines the process and serves as a reference point to prevent the analysis from losing its focus. This can be very important where the issue involves a wide range of drivers that operate at different scales. The key question therefore defines the following: **subject, physical scale and time scale** (sometimes referred to as the scenario horizon).

Rich Pictures

Rich Pictures are a graphic representation of the drivers that influence any given situation or system. They are a simple way of depicting complex interactions that are otherwise difficult or tedious to explain in text. Rich Pictures were developed as part of Peter Checkland's Soft Systems Methodology for addressing complex situations (Checkland, 1981; Checkland and Scholes, 1990). There are different ways of constructing Rich Pictures, depending on the scale or type of issue to be addressed. In most cases, Rich Pictures avoid the use of text, instead challenging the participants to graphically express themselves.

Driver Identification

Identifying the system drivers is a central part of the scenario planning process. There are several tools that can be used to do this such as "brain-storming" and SWOT analysis. The initial objective is to capture as many system drivers as possible, no matter how insignificant the driver may seem. System drivers may have different forms and be conceptual or physical in nature. The Rich Picture can also be a useful cross reference in driver identification.

Clustering Drivers and PESTEL Analysis

Once the drivers have been identified, they can be organized or "clustered" to aid analysis. Clustering techniques such as PESTEL analysis are useful tools in this process. In some cases, there may be a need for further clustering if there are too many drivers and analysis becomes too complex.

Plotting the Driver Matrix

The driver matrix is key to understanding and addressing the issues of uncertainty. *"As the fox so wisely said to Socrates, 'Life can surprise you and it is better to be aware of the surprises in advance or have a very fast reaction time if they do come out of the blue.'"* (Illbury and Sunter, 2005). The driver matrix is a simple tool for analyzing the **impact** and **predictability/responsiveness** of a driver. The impact of the driver is the level of influence the driver has on the system to either maintain or change the system. The predictability is how much is known about the driver and how it will influence the system in the future. In scenario development, understanding driver impact and predictability is especially important for drivers that have a higher impact and are less predictable in respect of their future influence on the system. If the driver matrix has too many drivers, it can become cluttered and may need to be re-clustered.

Driver Causal Relationship Diagram

The driver causal relationship diagram is a systems diagram that shows the relationship between driver clusters. The causal relationship diagram indicates through lines and arrows whether the relationship is a positive or negative relationship in respect of the key question developed at the outset of the exercise. In some cases, the relationship can be both positive and negative.

The causal relationship diagram is a schematic representation of the system and is very useful in showing interdependencies and levels of complexity within socio-ecological systems.

Stakeholder Analysis

The analysis of stakeholders is an important process in our understanding of the system that we are trying to manage. It goes further than simply identifying who should, or should not, be involved in the process and, amongst many things, it provides us with an insight into how people perceive the system to be operating.

Future Scenarios

*"When replying to the fox's question as to where his destiny would lead him, Socrates responded: 'That depends on the outcome of the trial. I could be found not guilty of any crime and continue to debate issues that intrigue me. I could spend the rest of my life in prison. I could be put to death. **Three scenarios for which there will be one outcome, but I must be prepared for all three**' "(Illbury and Sunter, 2005).* Once the default scenario has been identified, it is then possible to develop plausible future scenarios. As mentioned previously, the future scenarios are not predictions of the future, but are realistic possibilities of what might occur in a broad range of circumstances. The validity in the scenario development process is that the future scenarios are not just "guesses" about what might happen, but careful extrapolations of driver interactions in different circumstances. The scenarios are a way of analyzing not only "what if" questions, but understanding "why" certain futures might evolve. This is important in developing policy or management responses that need to consider a wide range of uncertain variables and outcomes. It is also important in challenging "institutional mindsets" or developing understanding between groups of stakeholders.

Driver Values

In developing the future scenarios it is important to examine the extreme value of each driver cluster. Each driver will have an extreme value to describe its state relative to the key question. For example if the driver is "water", then the extreme values may be described as "abundant" or "scarce".

Key Driver Determination

Plotting the Scenario Matrix

The scenario matrix is a mechanism for developing four possible futures based on two key drivers. Each driver forms one of the axes and the extreme values identified earlier provide the basis for each "scenario plot" and how much is known about how the driver will behave in the future. Using a four scenario matrix, one scenario will be predominantly positive, one will be predominantly negative and two will be mixed. The extreme values are used to determine the end point on each axis.

Scenario Plot Causal Relationship Diagrams

In each scenario plot, the driver clusters can then be examined in a causal relationship as was done in the default scenario. However, in the alternative scenario the driver

relationship may change and the participants will have to "think" about how each scenario plot will influence driver cause effect relationships. This process challenges current assumptions and forces participants to visualize possibilities that they would not normally consider. The strength of scenario planning is in this cognitive challenge since it takes the participant from the comfort of the known default scenario to the uncertainty of a future scenario.

Scenario Planning and Adaptive Management

For scenario planning not to become just another workshop activity it needs to be fed back into an adaptive management cycle. This may be done by incorporating scenario planning into the conventional planning process and by running regular scenario planning update workshops. A corporate scenario planner, Ian Wilson, stated that, "Scenario planning is not just another form of planning, it is a new way of thinking." This type of thinking needs to be reinforced if scenario thinking is to become part of an adaptive management approach.

The following diagram shows how the scenario planning approach used in the Kruger scenario planning process can be applied as part of an adaptive management cycle.
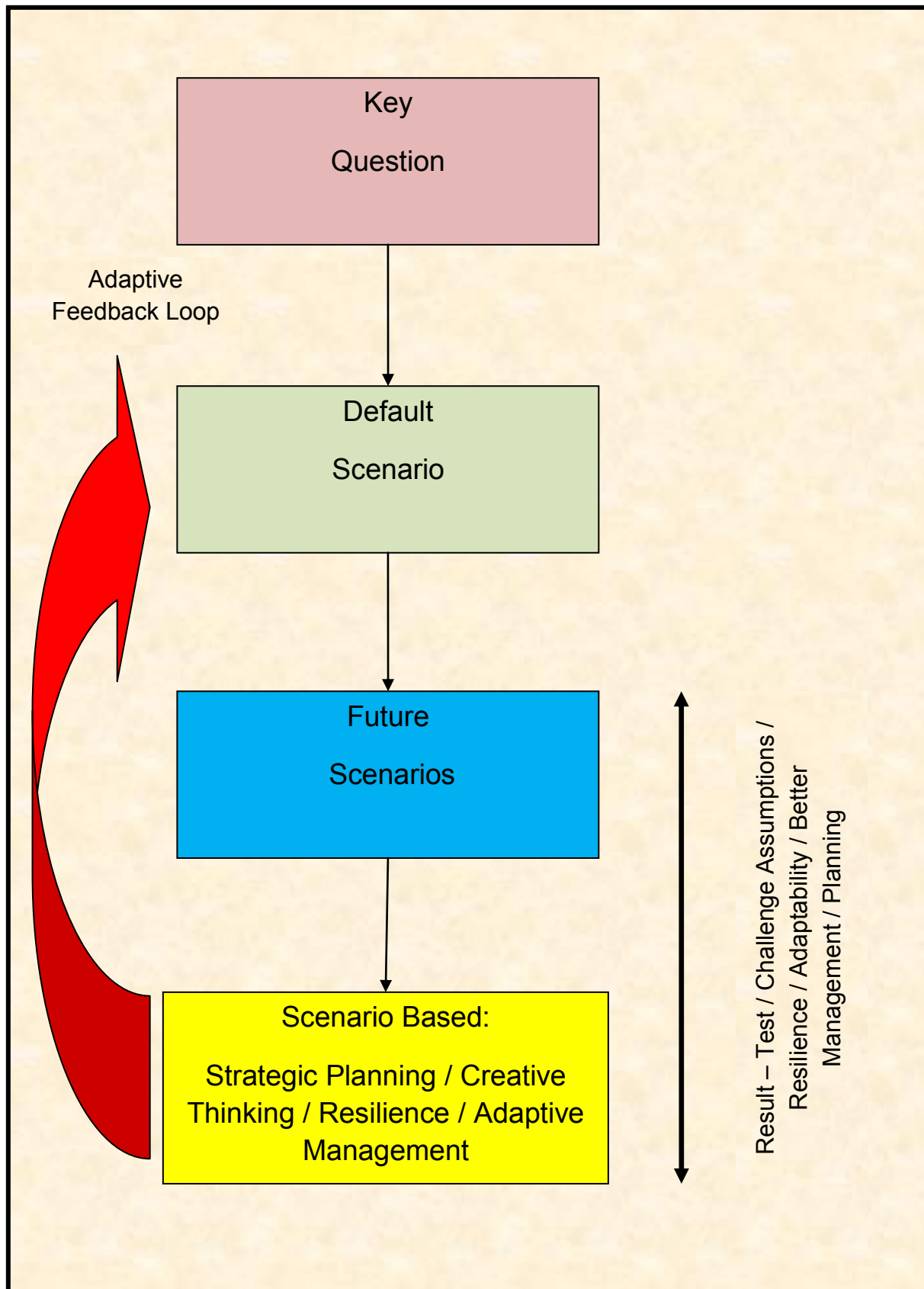
Figure 3 – Scenario Planning and the Adaptive Cycle

5. Scenario Planning In AHEAD – The Kruger Scenarios Phase One

The first phase of scenario planning in the Kruger scenario planning process ran from February 2006 to June 2008 and resulted in the following (Note: there are separate detailed reports for this process available upon request and therefore not all of the details are shown here):

Key Question

> *"What combination of land use and tenure will enhance system health, productivity and resilience (sustainability) of the Socio-Ecological system of the GLTFCA?"*

The key question was set in a twenty year time frame and at a scale of the GLTFCA.

Identification of System Drivers

The system drivers were identified and clustered into driver groups that could then be used in developing the driver matrix.
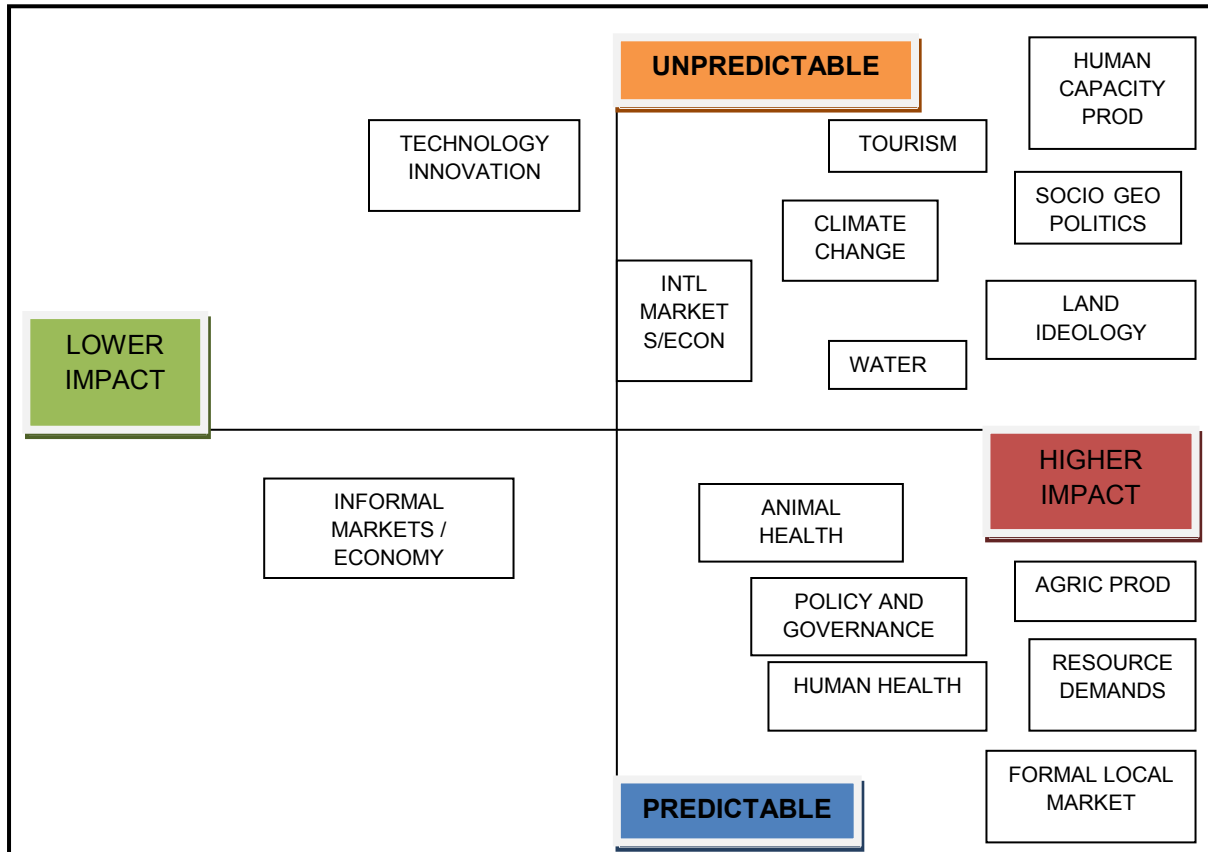
Cluster: Resource Demands **Drivers:** Population Growth Affluence Sustainability Ethic Medicinal Market/ Natural Products Market Water Use	**Cluster: Human Capacity/Productivity** **Drivers:** Education Quality Socio -economic Status HIV/AIDS/Human Health Availability of Information Social Capital Implementation Capital Adaptive Capacity Technology

Cluster: Formal Local Market
 Drivers:
 Broad Based Black Economic
    Empowerment
 Mineral Wealth
 Agriculture
 Tourism
 Light Industries
 Residential/Urbanisation
 Gentrification
	Cluster: Climate Change
	 Drivers:
	 Emissions
	    Kyoto Compliance
	    Reforestation/Carbon
	 Sequestration
	 Large Herbivore Population
	 Consumerism
	 Catastrophic Events

Cluster: Technology /Innovation **Drivers:** Access to Technology Current Technology Trends Scientific Investment Innovative Approaches Inter-disciplinarity Low Tech Solutions Animal Health Advances (Vaccines) Human Health Advances GMOs	**Cluster: Animal Health Interventions** **Drivers:** Agricultural Policy Fencing Issues Vaccination Status Movement Control Domestic Animal Demographics Cattle Wildlife Producer Conflict Primary Animal Health Alien Disease
Cluster: Informal Markets/Economy **Drivers:** Population Density Tourism Agriculture Illegal Bushmeat Trade Medicinal Plants Trade – "Muti" Market Asian Demand for Natural Resources Culture and Ethnicity Commercial Trade in Wildlife Products	**Cluster: International Markets/Economy** **Drivers:** Exchange Rates Globalisation Dependencies Foreign Investment International Finance International Conservation Finance Political Agendas International Natural Resource Demand
Cluster: Tourism **Drivers:** Tourism Levels International Terror Crime Type of Tourism Development Exchange Rates SMMEs (Small Micro and Medium Enterprises) Marketing	**Cluster: Land Ideology** **Drivers:** Land Restitution Affluence – Gentrification Conservation Imperialism – "Super Kruger" Conservation Planning Bio Regionalism NGO Land Agendas

Cluster: Socio-Geo Politics	**Cluster: Human Health**
Drivers:	**Drivers:**
Ethnic Tensions	HIV/AIDS
Wealth Disparities	Malaria
Xenophobia	Poor Sanitation
Immigration/Emigration	Water Supply
"Brain" Drain/Gain	Nutrition
Demographics	TB/Rabies/Zoonosis
Perceptions and Stereotypes	Education
Ethnicity	Income
Regional Political Security	Cultural/Religion
Regional Ecological Security	Employment
Legacy of Recent Wars	Housing
Regional Historical Events	Government Policy
International Boundaries	Access to Technology
Parochialism	Primary Health Care
	Human Wildlife Conflict
	Natural Products Health
	Alien Disease
Cluster: Water	**Cluster: Agricultural Production**
Drivers:	**Drivers:**
Dams	Output
Pollution	Resource Use (in Production)
Off-take	Crop Type
Flow	Pollution
Availability	Agro Industries
Ground Water	Labour
Rainfall	Climate Change
Climate Change	Land Policy
Erosion	
Policy	

Dealing with Uncertainty - Development of the Driver Predictability Matrix

The driver clusters were plotted onto the driver predictability matrix with discussion on their impact and the predictability within the system.

	UNPREDICTABLE	HUMAN CAPACITY PROD
TECHNOLOGY INNOVATION	TOURISM	SOCIO GEO POLITICS
	CLIMATE CHANGE	
	INTL MARKET S/ECON	LAND IDEOLOGY
LOWER IMPACT	WATER	
		HIGHER IMPACT
INFORMAL MARKETS / ECONOMY	ANIMAL HEALTH	AGRIC PROD
	POLICY AND GOVERNANCE	RESOURCE DEMANDS
	HUMAN HEALTH	
	PREDICTABLE	FORMAL LOCAL MARKET

Development of the Scenario Matrix

The scenario matrix is developed by taking two of the driver clusters that are considered to have a high degree of impact and a high degree of uncertainty. Once these drivers are identified they form the two axes of the matrix and their extreme values identified. Each scenario quadrant is given a name, which will be used later in the scenario narrative process.
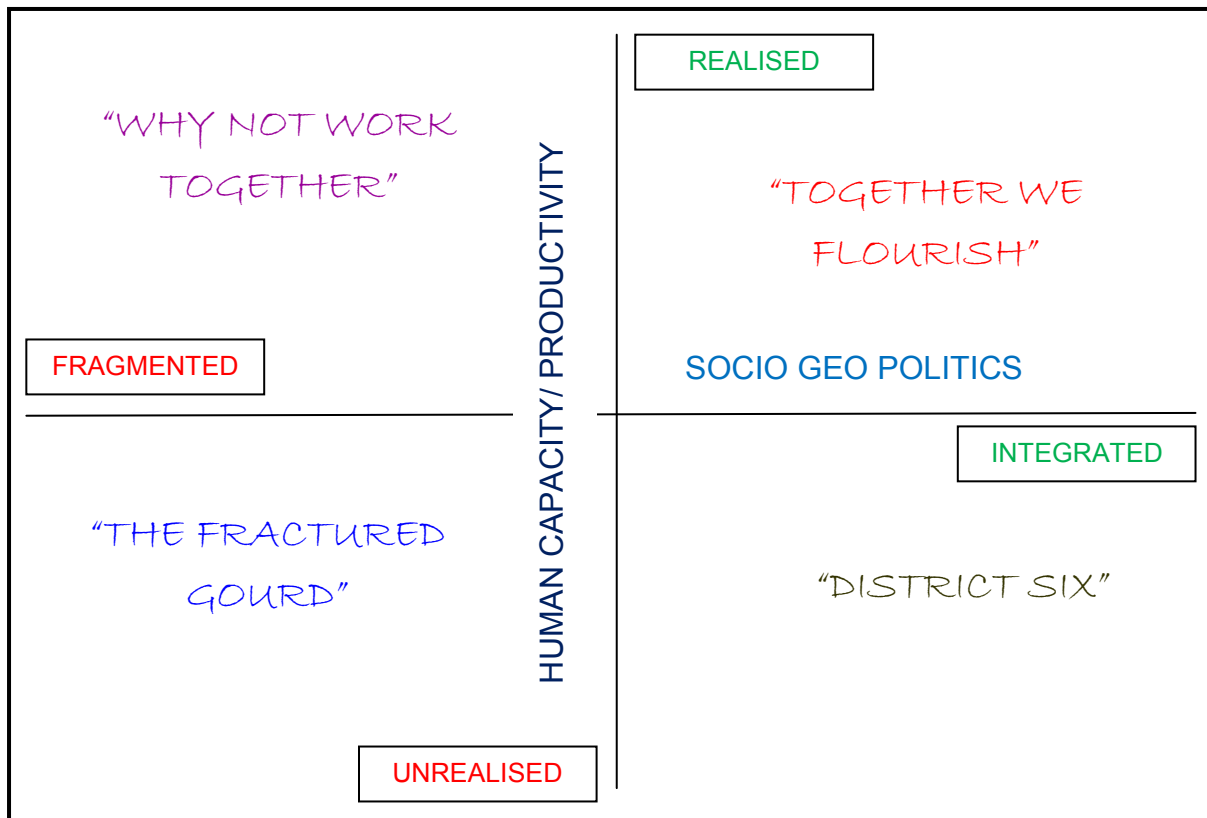
Causal Relationship Diagrams

For each of the scenario quadrants, a causal relationship diagram was developed to show the interaction of the driver clusters.

Quadrant 1 – Together We Flourish
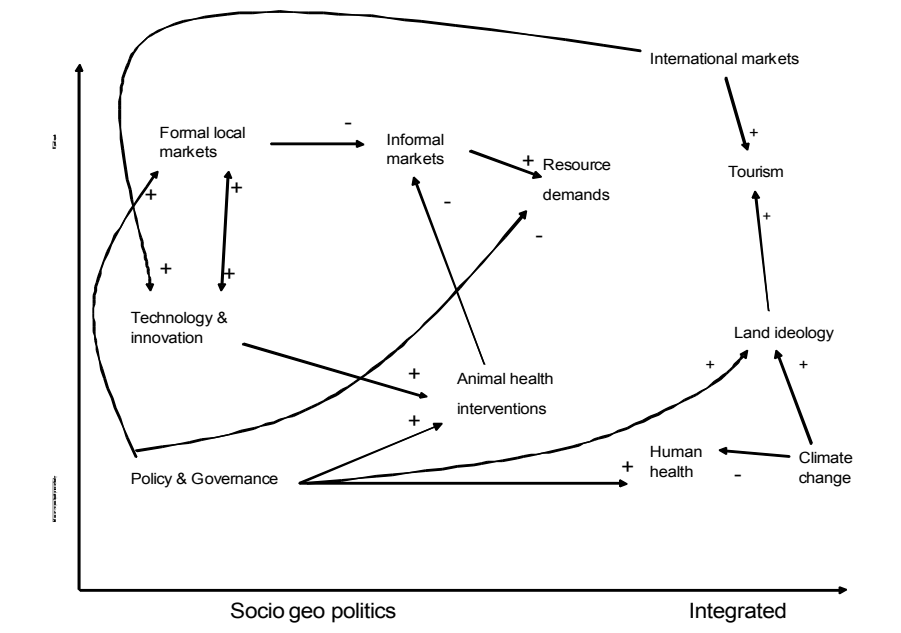
Quadrant 2 – District Six
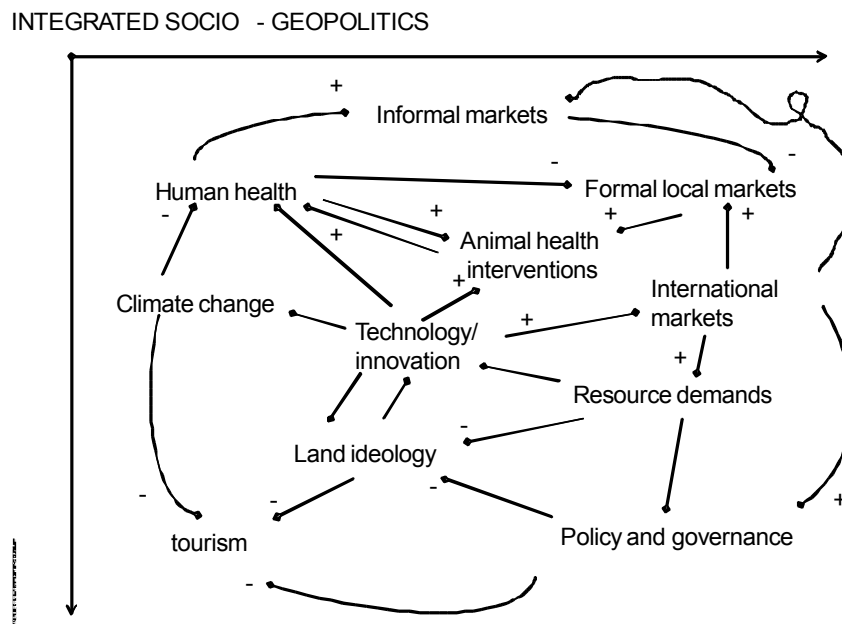
Quadrant 3 – Why Not Work Together?
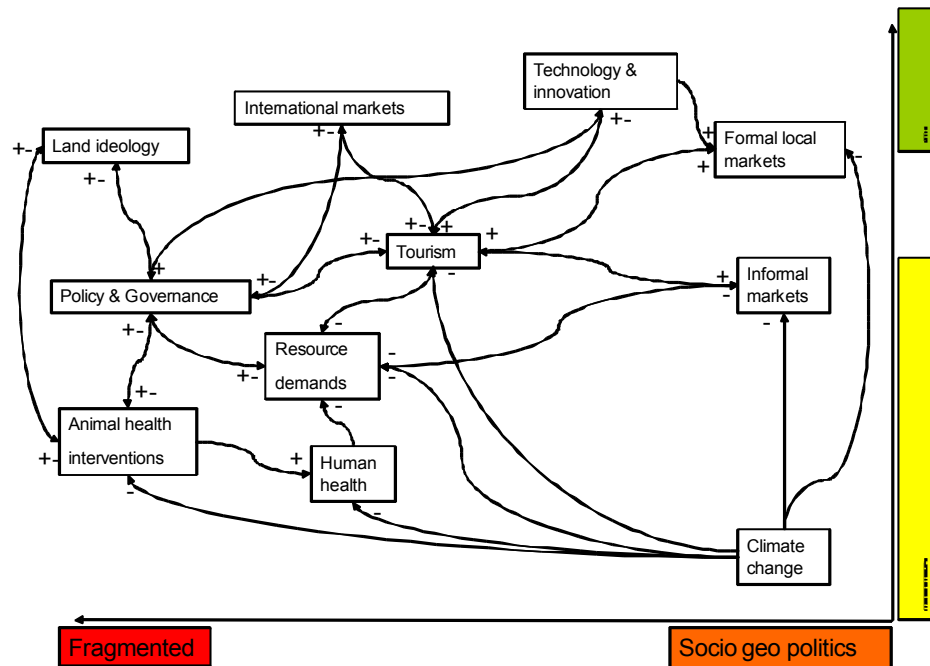
Quadrant 4 – Fractured Gourd
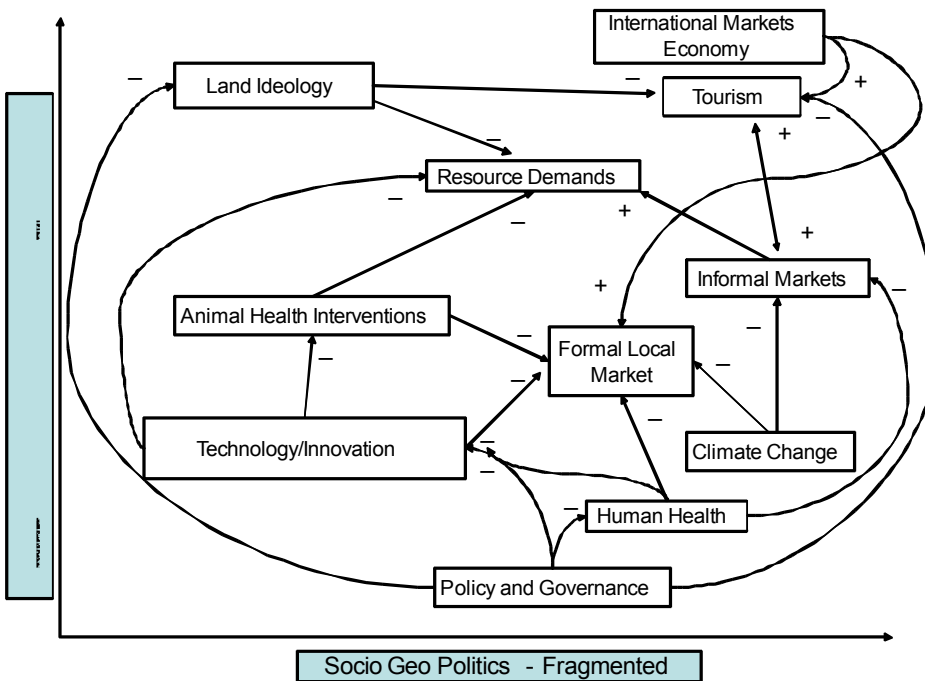
Development of Scenario Narratives

A descriptive analysis based on each scenario quadrant was developed as a scenario narrative. These are attached as Annex 1.

Monitoring Drivers for Management

Beyond the scenario narratives is the adaptive management component of the process that facilitates the identification and monitoring of key variables or drivers. In the 3rd workshop, ten driver areas were identified all of which relate back to the driver clusters on the predictability matrix. The following table shows the drivers and main indicators.

| Driver	Indicator
1. Land Use / Policy / Demographics / Change	Land Classification / Policy / Census Data
2. Animal Health	Stock Number / Specified Disease / Incidence / Condition Scoring / Production / Service Provision
3. Human Health	Infant Mortality / Certified Diseases / U5 Centile Charts / Life Expectancy / Education / Service Provision
4. Natural Capital	Degradation / NDVI / Bio Diversity Index including Aquatic / Silt Loads / Primary Production / Soil Fertility / Air Quality
5. Social Capital	Adaptive Capacity / Governance / Trust / Institutions / Social Grants / Quality of Education
6. Water	Flow / Groundwater / Quality / Use
7. Innovation	New Technology / Responses to Challenges
8. Financial Capital	GGP – Gross Geographic Product / Tourism Receipts / Household Income / Donor Inputs and External Subsidies
9. Physical Capital	Infrastructure / Electricity Supply / Telecommunications / Roads and Bridges / Dams / Fencing / Housing / Schools and Clinics
10. Aesthetic	Tourism / Culture / Arts

Following on from driver identification and indicators, three key areas were selected and the monitoring process assessed.

Driver	Monitoring Tools
Natural Capital	Landscape Function Analysis / GIS / Sedimentation in Dams, Rocky Outcrops and Gauging Weirs / Trend Analysis of Crop Production Nitrogen, Carbon, Phosphate Levels / Air Pollution Standards and Nitrogen Deposition
Land Use	Heterogeneity Index / Land Use Categories / Land Tenure Categories / Policy Analysis / Demographics / GIS / Surveys
Social Capital	"Working" Institutions / Cohesiveness / Crime / Measure of Inter-ethnic Conflict / Education Secondary and Tertiary Graduates

Identification of Key Subject Areas for Scenario Analysis

The final stage of the first phase of the Kruger scenario planning process involved the identification of five key subject areas for more detailed analysis. These subject areas were identified as:

Subject 1

1. Key question: How do we manage veterinary disease interventions in the GLTFCA over the next 10 years in order to promote the sustainable land use mosaic?
2. Scale / area GLTFP;

Subject 2

1. Key question: How can resettled communities achieve livelihood rehabilitation in LNP over the next 10 years?
2. Scale / area LNP;

Subject 3

1. Key question: How do we, in the next 10 years, promote surface and sub-surface environmental flows in the river basins of the GLTFCA?

2. Key components: land use, climate, human abstractions, impoundments, alien plants, riparian;

3. Scale/area GLTFCA and its catchment;

Subject 4

1. Key question: In which ways can human livelihoods effectively and innovatively dovetail with conservation objectives in the GLTFCA?

2. Scale GLTFCA;

Subject 5

1. Key question: In what ways can veterinary and human health support and promote each other in the GLTFCA over the next 10 years?

2. Scale GLTFCA.

6. Scenario Planning In AHEAD – The Kruger Scenarios Phase Two

A scenario planning workshop was held in Skukuza from the 20th to 21st of August 2009 with the goal of examining one of the key subject areas and how it might be approached. The exercise was experimental, but drew on the information and experience of phase one. Subject 1 – looking at the underlying needs for veterinary interventions and disease management – was chosen as the subject for this exercise. Due to the very limited time available and the considerable effort that was put into driver discussions and the casual relationships, it was not possible to develop the alternative scenarios at this workshop. (It is hoped that this can be done at some point in 2010). The results from this workshop, therefore, are as follows:

Key Question

Given the specific subject matter the key question varies from the wider scenario key question:

How do we enable the management of animal diseases in order to promote sustainable livestock and wildlife populations for a healthy land use mosaic in the convergence zone of the three GLTFCA countries over the next 10 years?

Driver Identification and Clusters

As expected, the driver lists developed in this exercise varied from earlier exercises due to the specificity of the subject. As a result, the clusters change accordingly.

List of drivers	Clusters
• Actual introduction of alien hosts / wildlife contact cited as major opportunity for spread (yet must increase under current scenario)	Ecological
• Clear understanding of webs (less disease)	Ecological
• Close contact between cattle and buffalo	Ecological
• Critical wildlife densities (eg. kudu and anthrax)	Ecological
• Impact of stocking rates	Ecological
• Natural ecological barriers	Ecological
• Quality of forage	Ecological
• Quality of nutrition	Ecological
• Unhealthy ecosystems (disease as reordering mechanism)	Ecological
• Vector load in environment	Ecological

List of drivers	Clusters
• Excessive reliance on fences >> drive to separate wildlife and livestock at all costs	Ecological Governance
• International market demand	Economics (Wildlife Industry)
• Local market demand	Economics (Wildlife Industry)
• Perceived value of the animal	Economics (Livestock trading)
• Tourism market demand	Economics (Wildlife Industry)
• Translocation of wildlife	Economics (Wildlife Industry)
• Market demands / incentives or regulations outside the system (eg. FMD is not a local problem per se)	Economics Governance
• Illegal movement / theft of livestock	Economics (Livestock Trading) Veterinary Capacity
• Simple vs. diverse (integrated) economic models	Economics
• Containment of wildlife	Governance
• Definition / management of grazing area	Governance
• Economic models that do not focus on local sustainability >> international economic drivers	Governance
• Health regulations	Governance
• Movement of cattle by cattle hustlers across international boundaries	Governance
• No inter-departmental focus on promoting sustainability of the GLTFCA	Governance
• Official vet control regulation (negative)	Governance
• Disease regulation in different countries	Governance Veterinary Capacity
• Livestock accumulation	Social
• Mental models of stakeholders regarding economics, sustainability, health, etc.	Social
• Perception of disease conditions without knowing the exact cause	Social
• Public perceptions and human values as to what is acceptable or that we can control everything	Social
• The 'need' of regulators to be 'in control'	Social
• Access to therapeutic drugs	Veterinary Capacity
• Availability of dip tanks	Veterinary Capacity
• Communication strategies and abilities of reaction to disease outbreaks in different countries	Veterinary Capacity

List of drivers	Clusters
• Disease epidemiology	Veterinary Capacity Ecological
• Fence integrity	Veterinary Capacity
• Integrated wildlife management (vet. services)	Veterinary Capacity
• Vaccination strategy against major disease	Veterinary Capacity
• Western boundary fence of KNP stopping contact between wildlife and livestock	Veterinary Capacity
• Access to health workers	Veterinary Capacity
• Basic disease monitoring in anticipation or prevention of disease outbreaks	Veterinary Capacity (Disease diagnostic)
• Existence of appropriate treatment drugs	Veterinary Capacity (Disease diagnostic)
• Vaccination advances	Veterinary Capacity (Disease diagnostic)
• Vaccination availability	Veterinary Capacity (Disease diagnostic)
• Vaccine technology, dip, fence	Veterinary Capacity (Disease diagnostic)
• Availability of vaccination	Veterinary Capacity (Disease diagnostic)
• Climate variation (eg. Drought)	Water and climate - stand alone -
• Marula fruiting season - movement of elephants >> fence damage	Water and climate
• Rainfall and damage to fences – movement of wildlife	Water and climate
• Riparian corridors	Water and climate
• Seasonality influencing vector distribution activity	Water and climate
• Water distribution	Water and climate (Water supply & distribution)
• Water supply	Water and climate (Water supply & distribution) Water pollution

Stakeholder Analysis

In this exercise a more detailed analysis of the stakeholders was undertaken and is shown in the diagram below:
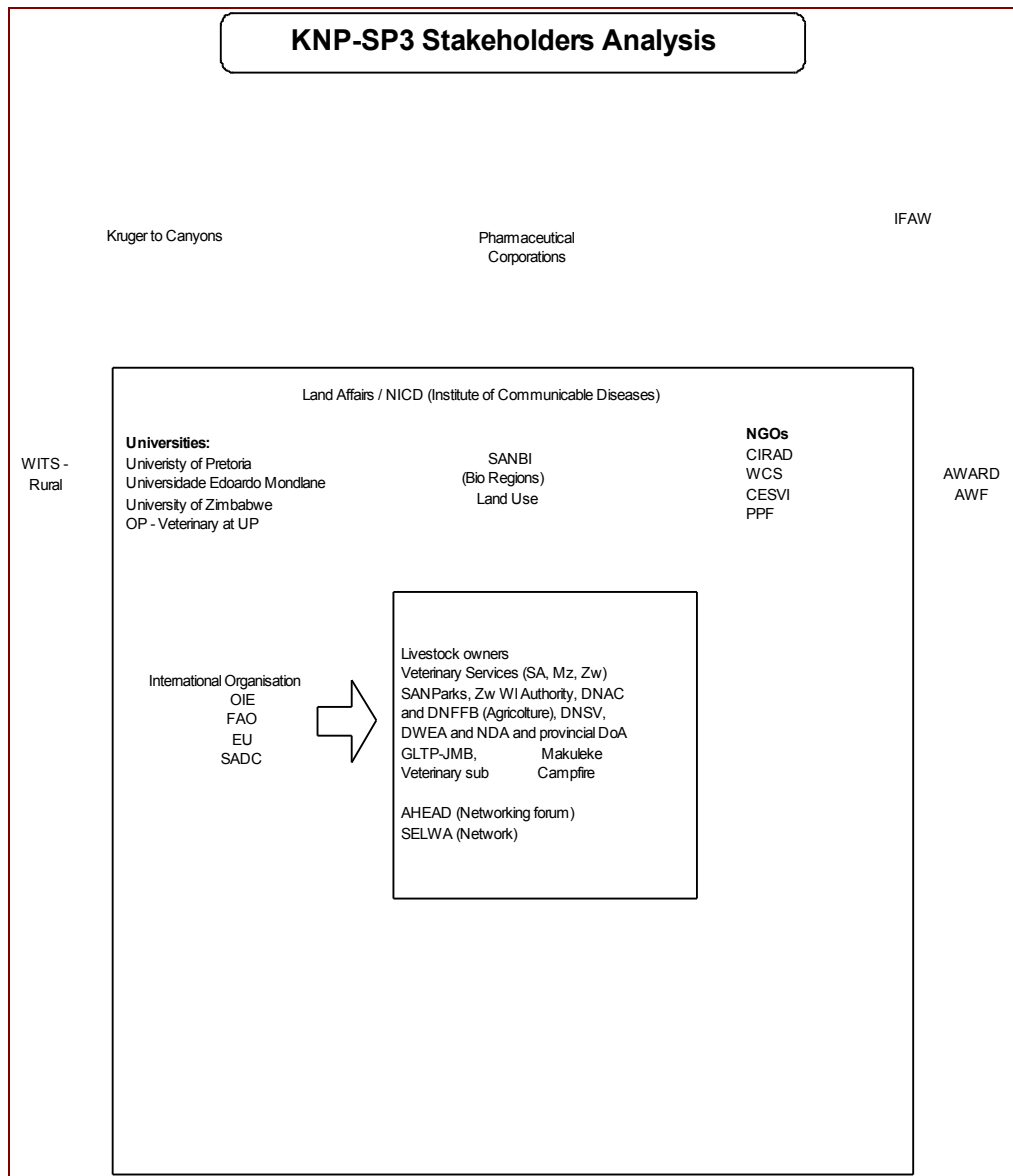
Driver Matrix

The driver matrix followed the same overall format as those developed earlier, and the driver clusters were plotted on to the matrix in respect of their level of predictability and impact. Important drivers in respect of the future scenarios are those that have a high impact and whose predictability is uncertain. In respect of the key question, the two critical (uncertain) drivers will be "Political Decision Makers" and "Sufficient Funding for Disease Management".
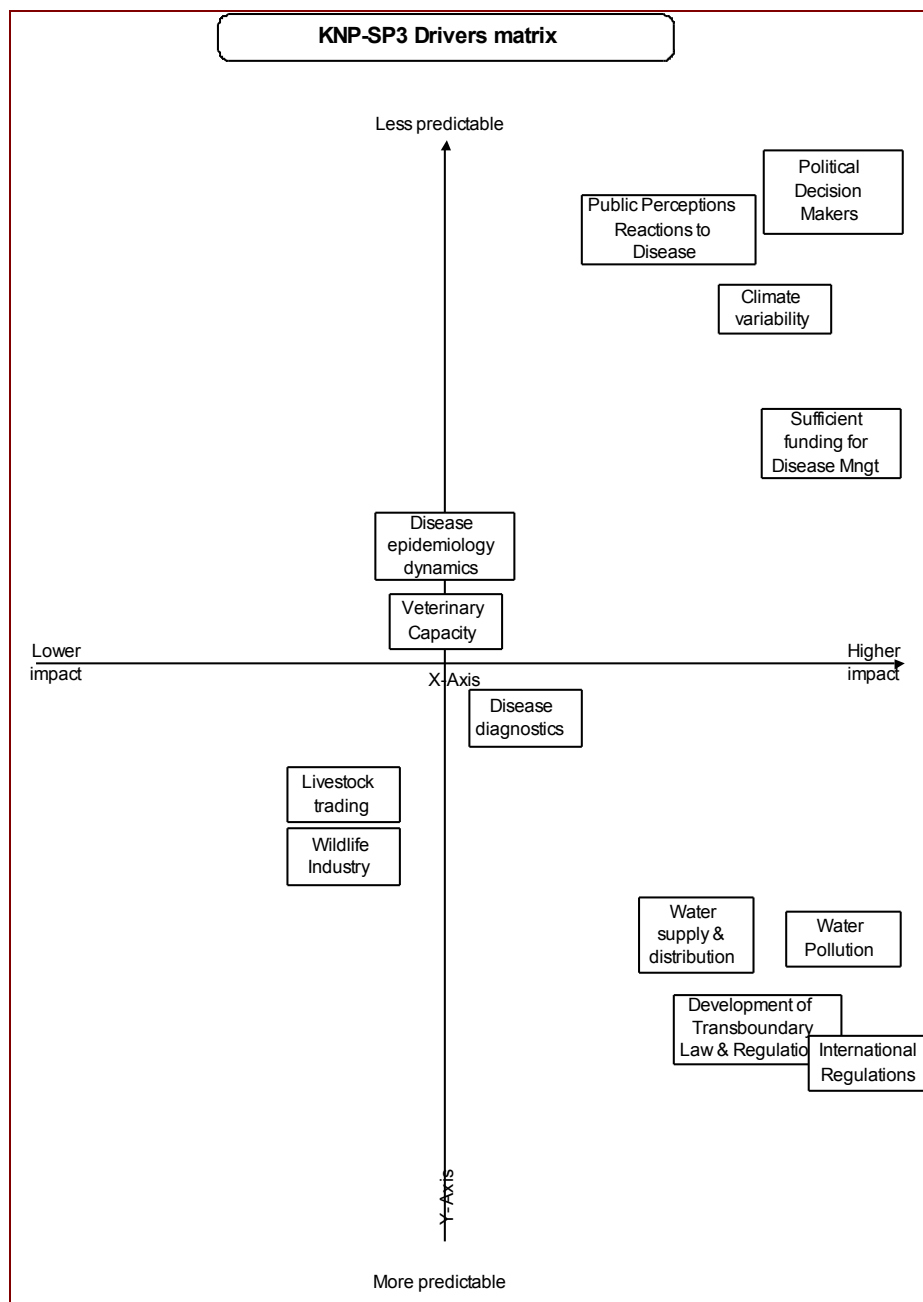
Cause Effect Analyses

Two cause effect relationship diagrams were developed at this workshop. The first demonstrating the overall cause effect relationship of the driver clusters around the key cluster of "Disease Epidemiology Capacity". The second cause effect relationship diagram was more experimental and developed to demonstrate driver interactions in relation to the key question. Both are important in understanding how the drivers interact with each other as part of a complex system. The cause effect analysis shown here relate to current time. These interactions will change when applied to alternative scenarios.
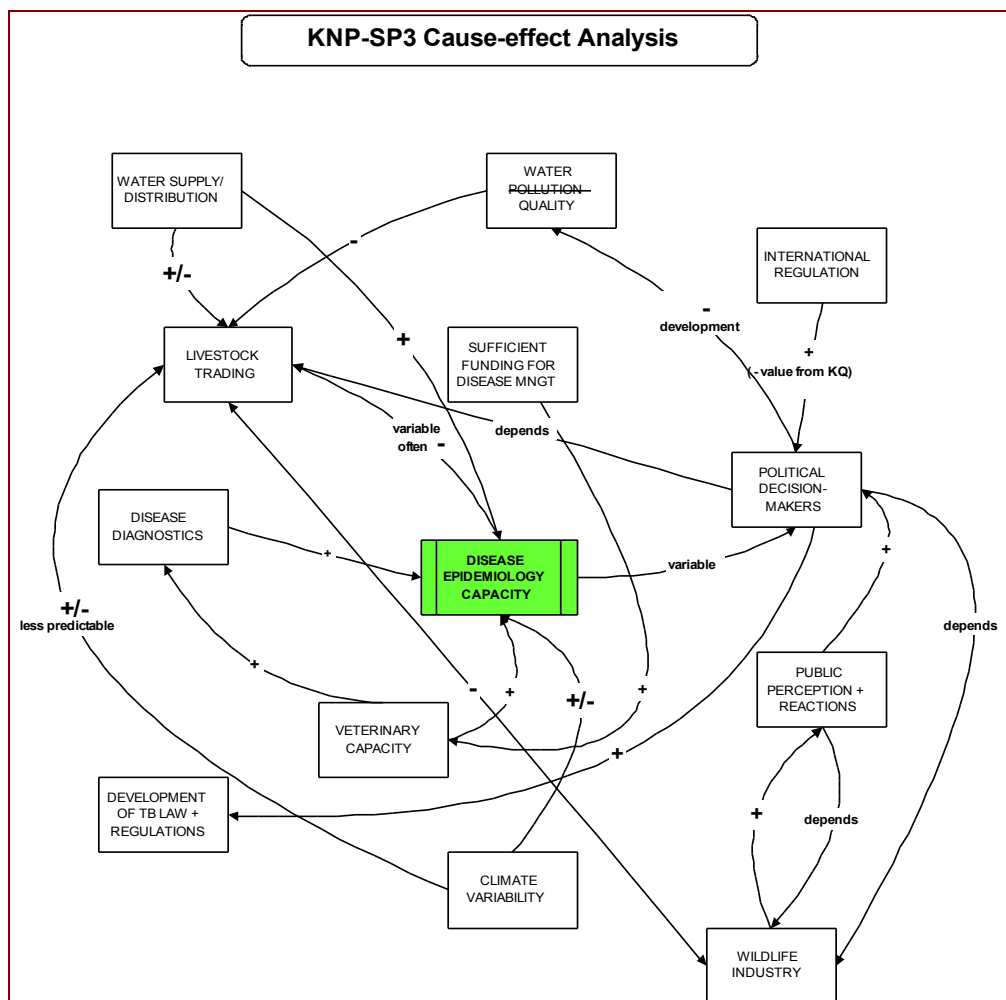
KNP-SP3 Cause-effect analysis II

DISEASE DIAGNOSTICS

INTERNATIONAL REGULATIONS

POLITICAL DECISION-MAKERS

+

+/-

+/-

DISEASE EPIDEMIOLOGY DYNAMICS

+

ANIMAL DISEASE MANAGEMENT

+/-

PUBLIC PERCEPTION

HARMONISED DEVELOPMENT OF TB LAW AND REGULATIONS

+

+

+

+

(rural communities)

SUSTAINABLE LIVESTOCK POPULATION

+/-

FUNDING FOR DISEASE MANAGEMENT

- (+)

+/-

-

SUSTAINABLE WILDLIFE POPULATION

CLIMATE VARIABILITY (view?)

+

LIVESTOCK TRADING (view?)

- (+)

HEALTHY LAND USE MOSAIC

WATER QUALITY

WILDLIFE INDUSTRY

-

SCARCENESS OF WATER SUPPLY DISTRIBUTION (view?)

NB: Unfinished business >> the links created exclude the links between each factor and the other three issues in the central box. These, however, are unimportant if there is no contribution to Animal Disease Management

7. Conclusion – Scenario Planning and "Wicked Problems"

"If you work in an organisation that deals with long-term social, commercial or policy related planning, then you've got wicked problems. You may not call them by this name, but you know what they are. They are those complex, ever changing societal and organisational planning problems that you haven't been able to treat with much success, because you haven't even been able to define and structure them properly. They are messy, devious, and reactive, i.e. they fight back when you try to "resolve" them."
*– **Ritchey, 2008***

In the introduction to this report, reference was made to "wicked problems". The scenario planning exercises undertaken so far have certainly revealed that the problems and issues being confronted in the GLTFCA exhibit the classic characteristics of wicked problems. Wicked problems were first described by Horst Rittel and Melvin Webber in 1973, when they defined the following ten characteristics of wicked problems, as enumerated by Ritchey below:

1. There is no definite formulation of a wicked problem.
"The information needed to *understand* the problem depends upon one's idea for solving it. This is to say: in order to *describe* a wicked problem in sufficient detail, one has to develop an exhaustive inventory for all the conceivable solutions ahead of time."

2. Wicked problems have no stopping rules.
In solving a tame problem, "… the problem-solver knows when he has done his job. There are criteria that tell when *the* solution, or *a* solution, has been found". With wicked problems you never come to a "final", "complete" or "fully correct" solution – since you have no objective criteria for such. The problem is continually evolving and mutating. You stop when you run out of resources, when a result is subjectively deemed "good enough" or when we feel "we've done what we can…"

3. Solutions to wicked problems are not true-or-false, but better or worse.
The criteria for judging the validity of a "solution" to a wicked problem are strongly stakeholder dependent. However, the judgments of different stakeholders …"are likely to differ widely to accord with their group or personal interests, their special value-sets, and their ideological predilections." Different stakeholders see different solutions as simply better or worse.

4. There is no immediate and no ultimate test of a solution to a wicked problem.
"… any solution, after being implemented, will generate waves of consequences over an extended – virtually an unbounded – period of time. Moreover, the next day's consequences of the solution may yield utterly undesirable repercussions which outweigh the intended advantages or the advantages accomplished hitherto."

5. Every solution to a wicked problem is a "one-shot operation"; because there is no opportunity to learn by trial-and-error, every attempt counts significantly.

"… *every* implemented solution is consequential. It leaves "traces" that cannot be undone … And every attempt to reverse a decision or correct for the undesired consequences poses yet another set of wicked problems …"

6. Wicked problems do not have an enumerable (or an exhaustively describable) set of potential solutions, nor is there a well-described set of permissible operations that may be incorporated into the plan.
"There are no criteria which enable one to prove that all the solutions to a wicked problem have been identified and considered. It may happen that no solution is found, owing to logical inconsistencies in the 'picture' of the problem."

7. Every wicked problem is essentially unique.
"There are no *classes* of wicked problems in the sense that the principles of solution can be developed to fit *all* members of that class." …Also, …"Part of the art of dealing with wicked problems is the art of not knowing too early which type of solution to apply."

8. Every wicked problem can be considered to be a symptom of another [wicked] problem.
Also, many internal aspects of a wicked problem can be considered to be symptoms of other internal aspects of the same problem. A good deal of mutual and circular causality is involved, and the problem has many causal levels to consider. Complex judgements are required in order to determine an appropriate *level of abstraction* needed to define the problem.

9. The causes of a wicked problem can be explained in numerous ways. The choice of explanation determines the nature of the problem's resolution.
"There is no rule or procedure to determine the 'correct' explanation or combination of [explanations for a wicked problem]. The reason is that in dealing with wicked problems there are several more ways of refuting a hypothesis than there are permissible in the [e.g. physical] sciences."

10. [With wicked problems,] the planner has no right to be wrong.
In "hard" science, the researcher is allowed to make hypotheses that are later refuted. Indeed, it is just such hypothesis generation and refutation that is a primary motive force behind scientific development (Ritchey, 1991). One is not penalised for making hypotheses that turn out to be wrong. "In the world of … wicked problems no such immunity is tolerated. Here the aim is not to find the truth, but to improve some characteristic of the world where people live. Planners are liable for the consequences of the actions they generate …" (Ritchey, 2008)

The "problem" with wicked problems is that they are not recognised as such, and therefore attempts by planners, managers and policy makers to address these problems tend to be done using conventional planning and strategic approaches. Where there is a high degree of complexity or uncertainty the wicked problem becomes a wicked project that is doomed from the outset to fail in meeting its objectives and may create even more problems and additional complexity. The only way to address a wicked problem is to "tame" it.

To tame a wicked problem, it must first be identified and understood. The scenario planning approach that has been used in the GLTFCA is one approach to taming the wicked problem. By identifying the nature of complexity and its components, the planner/manager begins to understand the nature of the system in which the problem(s) exist.

Thomas Chermack, in looking at the role of scenario planning in decision-making, has the following observations:

"Decision makers struggle with four important contributors to decision failure, namely, 1) bounded rationality, 2) a tendency to consider only external variables, 3) the stickiness and friction of information and knowledge, and 4) mental models that include decision premises or policies. Whether independent or combined, these decision problems can form the ultimate in decision error—folly....scenario planning is posited as a tool for preventing the impact of each, ultimately with an aim of avoiding folly." – (Chermack, 2004).

If a further crisis or folly is to be avoided in the GLTFCA (and other TFCAs such as KAZA), then there needs to be greater attention to understanding the range of wicked problems and the application of approaches such as scenario planning to support problem solving and long-term strategic planning.

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APPENDIX I:

"The Kruger Process"

A Brief Introduction to Scenario Planning

Scenario planning is a methodology that has its origins in post WWII military thinking. It was later applied to business planning by corporations such as Shell Oil, and in South Africa, by Anglo American Ltd. The South African experience also involved the use of scenarios as a conflict resolution tool, and their application facilitated a reasonably peaceful transition from apartheid to democracy in 1994.

What are scenarios?

- Scenarios are a way of looking into and rehearsing the future.
- Scenarios help us understand the "drivers" that are shaping the present and how they may influence the future.
- Scenarios help us understand that the future is not pre-determined, and that by understanding and influencing the drivers you can influence the future.
- Scenarios help us prepare for the uncertainties, shocks and surprises that will inevitably arise.

Scenarios are not:

- About predicting the future.
- Random guesses, since they are based on current realities.
- A replacement for conventional forms of planning.

How do they help managers and planners?

- Scenarios help managers and planners by providing an opportunity to "test drive" existing plans and strategies in alternating hypothetical futures.
- They work closely with adaptive management and provide a way of identifying the key drivers for long-term monitoring.
- Scenarios can be applied at a wide range of scales.

Use of scenario planning in the GLTFCA – AHEAD programme

The decision to use scenario planning in the GLTFCA developed out of the AHEAD programme and a meeting in Pretoria, where it became clear that there were so many issues and driving forces in the GLTFCA that "we" needed some way to analyse these issues and driving forces and the role they might play in the future. The concept of scenario planning was introduced and it was agreed to take this approach. It was also

accepted from the outset that the scenario planning process to be used in the GLTFCA would be experimental and adaptive to local needs and conditions.

The Kruger Process

Workshops
- The first workshop, held in August 2006, incorporated Kruger staff and other stakeholders. This workshop focused on understanding the current or "default scenario", setting the scenario parameters and driver identification.

- The second workshop, held in February 2007, included only Kruger staff and focused on the following:
    1. Review of previous scenario process
    2. Reassessment of the system drivers and clusters
    3. Reassessment of the predictability matrix
    4. Development of scenario quadrants
    5. Development of causal relationship diagrams
    6. Development of first-run scenario narratives

- The third workshop with Kruger staff concluded the initial scenario process with:

    1. Review of the scenario narratives
    2. Identification of the monitoring components for each driver set
    3. Test run of key issues through the different scenarios

The Scenario Narratives

A narrative is developed for each scenario quadrant to describe how the drivers play out over the specified time period. The narratives are very important because they are able to portray complex systems in a simple story. This is achieved by a range of underlying assumptions we have when we read or hear stories. The first story by Nicky Shongwe does this by describing technological changes that we may find incredulous today but who would have thought twenty years ago that almost everyone urban or rural would have a cell phone?

"District Six, phoenix revival?" – Narrative by Nicky Shongwe

The first rays of sunlight creep stealthily down the back street chasing rats and cats into holes only they have seen. Down the street, one way and the other, rows of overflowing rubbish bins are staggered all over. The household auto-disposal chutes are clogged again and the municipality has put the town on manual.

Old Bennie opens his door and with a coffee tube in one hand and a smoke in the other, he surveys the street as he has done every morning for the last 15 years. Fifteen years! – Sometimes he can't believe it, and he shakes his head until he sees his scuffed shoes, patchwork trousers and straggly string vest reflected in the glass panes of the display cabinet. It stands empty, by the way. Too many visitors over the years have meant that glasses have been chipped or broken and ornaments 'lifted' by lustful hands! There is really nothing left in the house worth displaying. Everyone uses the cabinet now as a place to drop keys, sunglasses and smokes as they move in and out of the house.

Just as he observes himself, Tina, his daughter swishes into the house in high heels with her silvery bag trailing behind her. She has been out all night, like most nights, but you wouldn't tell from the spring in her step. Her tummy is beginning to show. "What did Ronnie say, then – is he gonna marry you?" "Oh, not now dad, for goodness sake!" she is already in the next room. Didn't even look up from the visi-phone TV thing she was cradling in her palm. His head drops in disappointment. Pity, he thinks. Ronnie is a nice lad with a good solid job as a petrol mechanic. She could do a lot worse. There's many young men can't get a decent job these days – not that they seem to mind. It's all parties, parties, parties – is that all young people think of these days – it's all who's who, who went with who and who done what - those Angolans, they're a bad influence. They can party all week! And the way they all fuss over appearance – you'd think they were all working. But how do you get a good job if all you've got is high school?

At least she doesn't have AIDS, he thought. I mean she couldn't have, could she? She looks so well. He shuddered and frowned as he thought of all the people who had died of AIDS, "after a long illness". It had really got to the youth. They didn't seem to want to get things done, to plan for the future or think too hard, even.

He spotted Ma Ramabota walking down the other side of the street – she raised her hand in greeting. Always a cheerful smile on her face. She runs the kitchen at the centre for integrating child refugees from central Africa into society, or something. It's tough on those kids, he thinks - not easy them speaking that funny language and different skin colour and all. She's a good woman! Soon, she will have found foster homes for most of them. People have kind hearts here, man.

"Bennie!" – It's Duma Buthelezi yelling his daily greeting – he's an interesting one. Did real well in school. Became a teacher. Then went off to Japan to teach for a couple of years. Thought we'd lost him, but now he's back – all bright eyed and all, and talking about starting up an international school. Excuse me, mr big ideas…!

It must be 7 a.m. Sunil Ali rolls up the door of his green grocer. It's been in the family 5 generations now. Nothing's changed. And like clockwork, before Bennie can blink, he starts his daily chant "Fifty rand a bag, very cheap, very cheap madam, one for you, yes?" "Fifty rand a bag, sir?!"

Time has forgotten this street. The few cars cough and jerk their way along. Most people are on foot, faces warm and radiant in the morning sun. A group of older boys is huddled up the road. They appear to be shadow dancing, each plugged into the same cranky MP8 player via their own headphones. They're singing and dancing and hooting, and taking turns to show off their skills – to the sound of silence. Only the little children in their navy uniforms are walking purposefully towards the school gates. Such a mix of faces – brown, pink yellow, black all giggling together and shining diligently with Vaseline. A picture of hope, thinks Bennie. For a grade 10 if they are lucky, huh!

"Bennie! Bennie my love, come on in – I've made your favourite – astronaut's eggs – like you had them on the space shuttle…!" Yeah, he actually went into space once, imagine…but the government – promises, promises…

He takes one last long draw of his smoke, holds his breath in for a moment and finds himself smiling as he thinks of this town he calls home. And then he turns and follows his wife's voice in.

"Fractured Gourd" – Narrative by Peter Buss

THE FAILURE OF THE GREATER LIMPOPO TRANFRONTIER CONSERVATION AREA, SOUTHERN AFRICA

LONDON TIMES NEWSPAPER

4th March 2027

The establishment of the first Transfrontier Conservation Area involving South Africa, Mozambique and Zimbabwe (GLTFCA) earlier this century heralded a new era in the conservation of wildlife, the upliftment of rural communities and collaboration between neighbouring countries. It was envisioned that the joining of large transboundary tracks of land into a single conservation area would provide much needed space in which the wildlife of the region would be protected and flourish. It was believed that this would act as a magnet for local and foreign tourists bringing and injecting much needed capital into the economy. It was also expected to provide a forum for collaboration between the three countries that had, until fairly recently, been engaged in subversive guerrilla wars. Yet 20 years on, these dreams and high ideals lie in tatters.

The governments of the three countries, and especially South Africa, failed to recognize the longer term impact that HIV/AIDS would have on their economies through the loss of human capital. The rural communities of the GLTFCA have been especially affected due to the migrant labour movements between this area and various industrial centers in search of work. This increased movement of people, especially men, has facilitated the spread of the disease. The high infection rates due to the virus have caused a breakdown in social structures – increased numbers of orphans, households existing without adults, a reduction in the production of food, both crops and livestock, and ever declining levels of education in these communities. This in turn, has driven the levels of crime to ever increasing heights as people became ever less able to support themselves. The easiest and most vulnerable targets have been the very tourists that were expected to bring prosperity to these areas. The brutal abduction, rape and murder in May 2015 of three young doctors (two American and one British) working for a NGO at an AIDS clinic in Bushbuck Ridge resulted in most foreign funded agencies withdrawing their support of the area. It also precipitated the listing of South Africa, Zimbabwe and Mozambique as unsafe tourist destinations by most European and American governments.

The assassination of Robert Mugabe in 2012 sparked off a period of political instability in Zimbabwe which has resulted in a simmering civil war for the past 15 years. As political parties squabble amongst themselves as to who should govern the country, participation in the TFCA has fallen to the bottom of their list of priorities. As a result, Gonarezhou National Park has never been incorporated into the GLTFCA. The game of the area has been poached for food by starving local communities. The few remaining elephants shot for their ivory to assist in financing the purchase of arms. The increased human activity in this area has caused many animals, including buffalo, to move into surrounding communal lands and across into northern South Africa and north-western Mozambique. In all three countries this has resulted in outbreaks of Foot - And - Mouth Diseases which poorly funded and under staffed agricultural departments have been unable to contain or control. This has resulted in the loss of lucrative overseas export markets for meat and agricultural products.

The government established in Mozambique between Frelimo and Renamo following a crippling 18 year civil war initially appeared to be leading the country to economic recovery. However, the tensions between the two parties simmered under the surface with Frelimo progressively exerting its authority in the governing of the country. This eventually led to a coup in 2015, the president declaring himself president for life. The creation of a one party state has resulted in the uneven distribution of limited monetary resources between the various government departments – the allocation of money depending on personal alliances within government. The net result is that the Departments of Tourism and Agriculture have been poorly funded for the last 10 years. This has resulted in the limited development of infrastructure and capacity within the Limpopo National Park, and the expected flood of tourists has not eventuated. Rather, the poaching, especially of rhino and elephant originating from KNP, has escalated unhindered – which ironically has brought some local financial gains. The loss of capacity within the Agriculture Department, a condition also afflicting the equivalent departments in Zimbabwe and South Africa, has put further pressure on wildlife in the area. Due to a lack of control measures, Tsetse flies have re-established themselves in much of the range they occupied prior to the Rinderpest epidemic of the early 20th century. This has meant much of the area has become unsuitable for the raising of cattle and increased the consumption of wildlife by rural communities as an alternative protein source.

A small but lucrative industry, which has brought limited prosperity to the area, has managed to establish itself within the GLTFCA. For a fee, some of which goes to the paying of local officials, it is possible to hunt elephant bulls with trophy sized tusks.

Little now exists to show for the heady objectives that were to be achieved when the GLTFCA was first created. The crippling effects of AIDS, the political instability and corruption of the area, and the non-realization of tourist generated dollars have made sure that the original objectives have not been achieved.

"Together we flourish" – Narrative by Harry Biggs

The Pan-regional Tourism Board of Southern Africa has just issued its annual report for 2030, documenting the extraordinary growth of the industry and of the whole region in the last decade. The CE of the Board attributed this to remarkable stability and co-operation in the region, as well as the steady decline of HIV/AIDS since 2015, and general compliance to SADC education quality standards in the region. Nowhere was this booster effect clearer than in and around the Great Limpopo Transfrontier Conservation Area, after its shaky start 25 years ago, now the hub of ecotourism in southern Africa.

Land use has in the last fifteen years moved wholesale into ecotourism, with formal institutions being set up mainly by southern African residents, often locals. The latter has become possible because of the incredible success of responsible investment lending initiatives since the Bangladesh model was applied locally after 2010. Although rural villages still exist, they themselves have become centers of cultural tourism in the landscape, in and around the ecotourism locales, with more and more formal commercialization initiatives (mainly registered crafts shops) replacing the quaint informal stalls of yesteryear. The debates around land use have subsided in favor of this apparently invincible trend. All this has been underwritten by increasingly effective and co-operative governance particularly between Mozambique and South Africa, joined fully in 2015 by reformist Zimbabwe. The Board's report plays down warnings by land-use and resilience experts that the landscape is now overly dependent on one industry and hence vulnerable. The Board points out that no major drop of tourism occupancy has occurred for the last 8 years, and that the market risk outlook remains good.

International investment continues at a modest pace, tempered by the strong local participation clauses of the Board's Policy. However, overseas support of biotechnology and other innovation industries is surging, and this in turn fuels animal health innovations, especially those around the large remaining herds of livestock, now kept mainly for traditional, cultural and tourism needs. Resultant strict animal health restrictions (promising eventual eradication of major trade-related diseases) appear to be accepted with equanimity, but render the informal markets still existing even less viable – a price the Board considers worth paying, particularly since informal initiatives are becoming increasingly commercialized and can then comply. The Board points out the major increase in stocks of natural resources that has taken place as the result of

this demise of informal markets. A damper, however, still prevails because of the human health consequences of increased temperatures and a shifted seasonality of rain (a consequence of global climate change) with malaria still more prevalent than had been predicted ten and even five years ago. This in spite of regular announcements by the biotech industry of promising vaccines, none of which have ultimately made a big difference in practice. The Board reports that the consequence of this is a slight brake on tourism numbers, especially after a spate of a few cases is reported in a particular area.

"Why not work together?" – Narrative by Markus Hofmyer

An assessment of the current regional cooperation surrounding the GLTFCA:

By 2030 the socio - geo - political environment in the world had reverted back to a more nationalistic and anti-globalization stance, resulting in borders and nationalist sentiments dominating the political and economic front.

This resulted from over exploitation by strong nations of developing countries and a resultant backlash by local citizens against general globalization and free markets. Even locally this sentiment has resulted in much stronger nationalist laws and regulations, stifling cross-border cooperation. The good progress made within the GLTFCA in the early part of the century had maintained itself from an environmental perspective but economically each country had reverted back to protecting its markets and economies.

Another driving factor for this "inversion" of socio-geo-politics was the noticeable negative influence of global warming on human, animal and environmental health. Each country was restricting global use of its scarce resources like potable water and arable land.

Fortunately technology, innovation and the aggressive education policies of the southern African countries in the early part of the century has resulted in a high level of education and development of the average person living in these countries. This in turn has produced a very skilled labor force, who was very innovative at improving their local situations, particularly with regards to tourism.

Tourism is the one world market that has boomed despite the generally retraction of free trade and globalization. This has resulted in strong tourism developments and products available at different levels in all three countries involved with the GLTFCA. Due to the protective and internally focused laws and regulations these tourism operations functioned independently of each other but nevertheless at a reasonably successful rate. Better cooperation regionally would, however, be able to streamline product ranges for specific regions and result in easier GLTFCA tourist experience rather than the current irritation that tourists experience of having to book independently for each country involved in the GLTFCA.

Due to climate change and the general aridification of the GLTFCA area, agricultural practices have declined and population growth has stabilized – partly because of the severe impact of HIV-AIDS and malnutrition of poorer communities. The only successful development in the area is increased tourism and this has to a larger degree offset the otherwise massive humanitarian crises that would be present in that area if there was no wildlife area that could sustain these tourism activities.

In conclusion it is clear that the educational and development programs initiated in the early part of the century has had a positive effect on the overall GLTFCA because people have locally benefited from improved technology and innovation and the constant tourism boom. The unfortunate reality of the nationalistic and inwardly focused regulations of each country has prevented the GLTFCA from reaching its full potential.

The overall regional strategy could easily be streamlined and made more effective if the highly skilled and focused human capacity surrounding the GLTFCA could use their combined intelligence and drive to maximize on the fantastic wildlife product and healthy ecosystem, which make-up the GLTFCA. It is the unfortunate reality that climate change will force people to work together to equitably share the very rare and life essential resources like water and arable land. The other alternative is anarchy, war and chaos, which will reverse in a short time the phenomenal progress that was made in the early stages of the open-minded regional cooperation regarding the development of the GLTFCA.

Remaining Issues

Following on from the three workshops, the following remaining issues or challenges will have to be addressed:
- Development of an appropriate monitoring and tracking system, which can be easily applied in the GLTFCA,
   in which no more than five key variables are involved.
- Scale remains an issue in the wider GLTFCA, and the scenario process may need to be applied at other scales and time frames.

Next Steps

* Complete and distribute this report after comments from participants and others.
* Compile the three country scenario reports.
* Develop a longer term monitoring and tracking programme based on scenarios for the GLTFCA. This could be part of a three- to five-year funding proposal on scenario planning in the GLTFCA AHEAD programme.

Rapid Response Scenario Planning Exercise to Examine the Problem of Pansteatitis Related Mortalities in Crocodiles in the Olifants River of Kruger National Park

June 14 2008

Participants:

Dr. Danie Pienaar
Dr. Roy Bengis
Dr. Harry Biggs
Dr. Peter Buss
Dr. Danny Govender
Dr. Rina Biggs
Mr. Craig McCloughlan
Mr. Michael Murphree (Facilitator)

Process Followed

1. Key Question

- What are we dealing with?
- Do we know what is causing the problem?

2. Rich Picture

- Map of areas of incidence
- Possible internal or external origins of the problem

3. Driver Analysis

- Identify likely drivers of the problem
- Identify what we know
- Identify what we want to know – and how
- Causal relationships

4. Consequences

- Possible consequences of this event

5. Actions and Responses

- What research / management responses are being undertaken?
- What research /management responses are still required?

1. Key Question –

"What causal factors are triggering pansteatitis in crocodiles in the Kruger National Park with an emphasis on the Olifants River?"

2. Rich Picture –

Key Points from Rich Picture discussion:
. Relationship to pansteatitis in the Loskop Dam in September 2007?
. Contamination of the water source? From where?
. Crocodile mobility and movement?
. Crocodile age structure and population?
. Lack of detected fish mortality in the system
. Movement of crocodiles to Massingir?
. Crocodile mortality in Massingir?
. Massingir Dam level?
. Reported fish mortality in the Middle Letaba River?
. Any reported fish mortality in gill nets?

3. Driver Analysis

Possible Drivers:

- Microcystins
- Vitamin E deficiency, Selenium deficiency
- Adiposity
- Cold Temperatures – fat metabolism
- Infections – bacterial, mycoplasmal, fungal, viral
- Physico-chemical – trauma, stress

- Environmental Oxidants
- Plant Toxins – algae
- Vasculopathy – vasculitis
- Organic toxins
- Consumption of dead fish
- Heavy metals
- Toxins accumulated in mud – to fish – to crocodiles
- Poisoning of crocs from Mozambican fishermen
- Crocodile size differential
- Sediment Dynamics Change in Olifants Gorge – Geomorphic changes
- Top of Food Chain – accumulative agent
- Fat Crocodiles
- High crocodile population densities
- Water quality – magnesium, calcium levels

What We Know:

- Aprox 50 crocodile mortalities detected – mostly in Olifants Gorge some in Letaba River
- Pansteatitis occurs in crocs, fish and cats
- Similar event occurred in Loskop Dam (Sep 2007)
- Affected crocodiles ≥ 2m in length
- All crocodiles found dead are in good body condition, possibly obese
- Gastro intestinal tract is empty – motility of the intestine
- Vitamin E levels are very low
- Mobility of crocodiles is impaired
- Panteatitis kills crocodiles within 2 – 3 months (unconfirmed)
- Higher than normal summer flood in February in Olifants
- Silt deposited in the gorge by Massingir Dam (Feb 2008)
- Dam water decreased following 23rd May by 1.5m – problem with flood gate
- Change in river habitat due to mud deposits from Massingir

What We Want To Know:

ISSUE	ACTION (X Indicates in progress)
Are other scavengers affected by eating dead crocs?	Feed crocodile tissue to domestic cats
What is the body fat index of crocodiles?	Weigh and measure crocodiles in Olifants and Sabie Rivers
What are Mozambique fisherman liver function and Vit E and A levels? – related to consumption of same fish	Link with Mozambique health authorities and DNAC to survey
Are Humans at risk from Olifants water and eating Olifants fish?	Water quality analysis (X)
What is the status of healthy KNP crocodiles?	Sample crocodiles from a "clean" river like the Sabie
Is there a change in Fish densities or species composition?	Conduct a sample – by Andrew Deacon
Are there pollutants in the Olifants River?	Sample for organic and heavy metal toxins (X)
What are the changes in demographics of crocodiles in the Olifants River?	Survey the crocodile population
Have Mozambican fishermen observed any dead crocodiles or fish? Have there been any significant changes in fish caught in nets?	Link with LNP/DNAC/Arusul
What are the numbers of crocodile mortalities over time and location?	Conduct aerial surveys (X)
What is the pathology of affected crocodiles?	KNP vets to undertake PMs (X)
What is the pathology of fish caught in the Olifants River?	KNP vets to sample (X)
What fish are the preferred diet of crocodiles?	Confirm with Andrew Deacon
Is the syndrome (Pansteatitis) reversible in crocodiles?	KNP vets to capture and treat live crocodiles with antioxidants
Has there been a change in crocodile diet?	?
What information on the syndrome is available from crocodile farms?	Link with Chris Foggin and others
Can sick / affected fish cause Pansteatitis?	?
At what water temperature do crocodiles stop feeding?	Ask crocodile farmers
Is there a cause effect relationship with the flood gate incident at Massingir Dam?	?

Cause Effect Relationships:
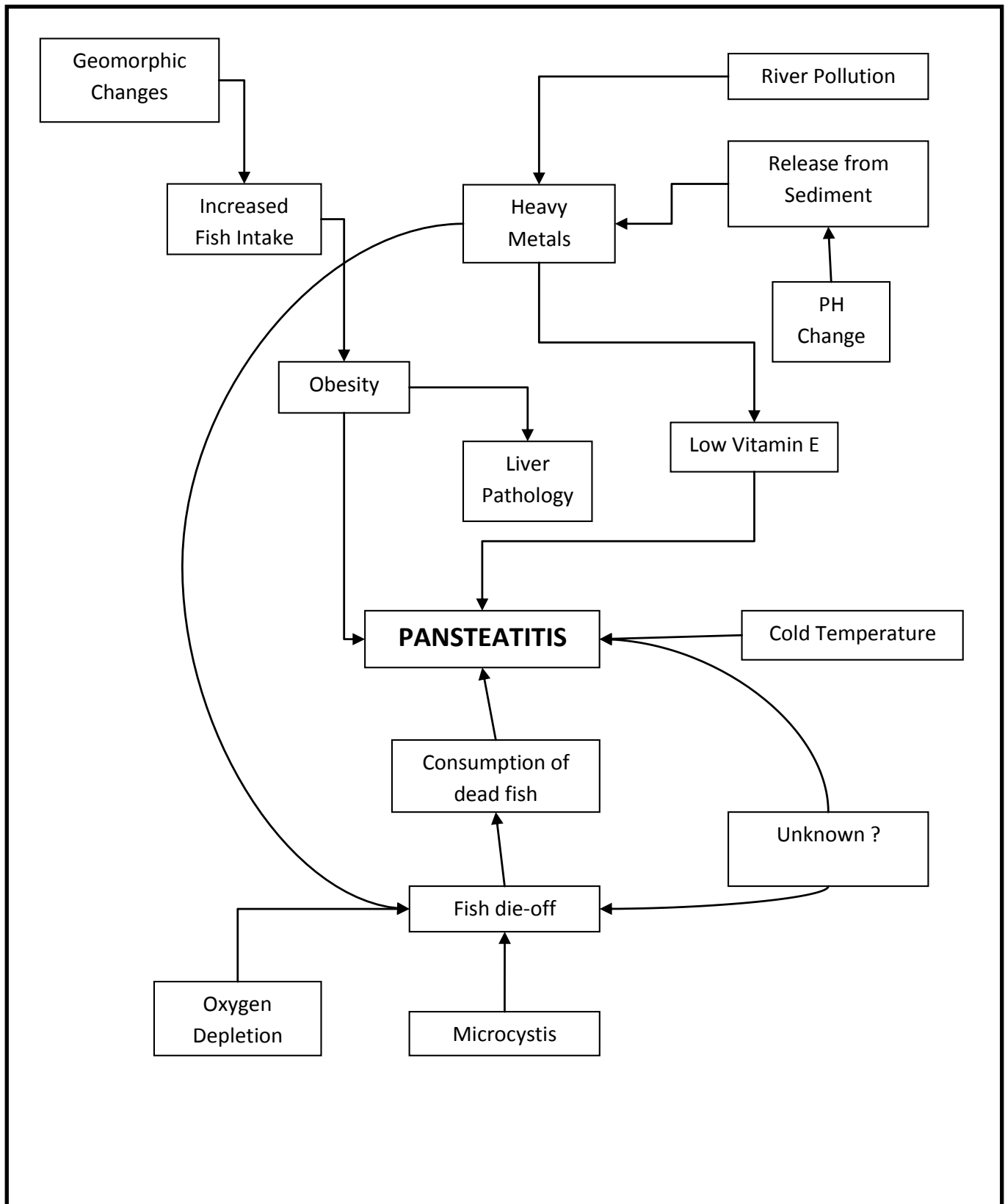
Comparison with Loskop Dam Event Sept 2007:

```
┌─────────────────┐                          ┌──────────────────────────┐
│ Pollution: Mine │                          │ Hypothesised Causal      │
│ acid and        │                          │ Factor Present           │
│ sewerage        │                          │ In Loskop                │
└────────┬────────┘                          └────────────┬─────────────┘
         │                                                │
         ▼                                                ▼
┌─────────────────┐                          ┌──────────────────────────┐
│ Loskop Dam      │                          │ Medium Flood in Olifants │
│                 │                          │ River February 2008      │
└────────┬────────┘                          │ carries Causal Factor    │
         │                                   │ down river               │
         ▼                                   └────────────┬─────────────┘
┌─────────────────┐                                       │
│ Phytoplankton   │                                       ▼
│ Bloom and Die-  │                          ┌──────────────────────────┐
│ off             │                          │ Water level in Massingir │
└────────┬────────┘                          │ Dam rises and backs up   │
         │                                   │ to Olifants Gorge        │
         ▼                                   └────────────┬─────────────┘
┌─────────────────┐                                       │
│ Oxygen          │                                       ▼
│ Depletion       │                          ┌──────────────────────────┐
└────────┬────────┘                          │ Causal Factor trapped in │
         │                                   │ sediment falls out at    │
         ▼                                   │ Olifants Gorge           │
┌─────────────────┐                          └────────────┬─────────────┘
│ Fish Die        │                                       │
└────────┬────────┘                                       ▼
         │                                   ┌──────────────────────────┐
         ▼                                   │ Crocodiles exposed to    │
┌─────────────────┐                          │ Causal Factor through    │
│ Consumption of  │                          │ consumption of fish      │
│ fish by         │                          │ and/or direct absorption │
│ crocodiles      │                          └────────────┬─────────────┘
└────────┬────────┘                                       │
         │          ┌─────────────────┐                   │
         └─────────▶│ Crocodiles Die  │◀──────────────────┘
                    │ of Pansteatitis │
                    └─────────────────┘
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Analysis of Causal Relationship (CR) and Loskop Comparison (LC) (facilitator's analysis)

1. (CR) Pansteatitis is caused by lower vitamin E levels – aggravated by obesity – evidenced when temperature drops and crocodiles start to metabolise fat.

2. (CR) Causal factor is unknown – possibly heavy metals or organic toxin – possibly dioxin (see attached article) – possibility that there is a link with fish.

3. (LC) The question raised by this analysis is whether the consumption of dead fish was the driver of the Pansteatitis in Loskop.

4. (LC) Why is there no evidence of dead fish or other deaths such as fish eagles, water monitors, etc. in the Olifants?

5. (LC) This analysis indicates a strong correlation between "flooding" the Massingir Dam back water and sediment deposits in the Olifants Gorge indicating direct ingestion/absorption of the causal factor.

6. (LC) A direct link between the Olifants event and the Loskop event is inconclusive. The timing of the two, however, does indicate a possible correlation.

Short Term Actions

1. Investigate the possibility of pansteatitis reversal by removing selected crocodiles from the Olifants Gorge.

2. Examine healthy crocodiles for symptoms of pansteatitis.

3. Examine and monitor crocodiles in other rivers.

4. Consider alternative feeding of crocodiles in core areas.

5. Weekly monitoring of crocodiles in the Olifants River.

6. Investigate threat to human health in Mozambique.

7. Continue to investigate causal factors/triggers.

8. Continue with water quality and sediment analysis.

Broader Questions

1. To what extent is this event of global conservation significance?

2. Can this event be used to improve the status of the aquatic ecosystem in KNP?

3. To what extent does this event signify a wider environmental health issue?

Possible Consequences

In a scenario where there is insufficient response to this event, the consequences may well include:

1. Continuation of chronic undesirable environmental health events of this kind

2. Poor learning

3. Detriment to the international image of SANParks

4. Development of a human health issue in Mozambique

5. Further unexpected downstream impacts

6. Forfeiture of the opportunity to leverage for conservation, river catchment management and sustainability issues

In a scenario where lessons are learned from this event, the consequences may well include:

1. Greater realization of the importance of healthy river systems

2. Greater public and corporate responsibility

3. Greater understanding of complex and fragile ecosystems

4. Improved water quality

Addressing the Key Question and Facilitator's Comments

"What causal factors are triggering pansteatitis in crocodiles in the Kruger National Park with an emphasis on the Olifants River?"

1. The triggering causal factor(s) remain(s) a mystery, but from this process undertaken, it is extremely **unlikely** that this is a **"natural"** event. There is a strong indication that this is linked to a wider problem of the aquatic ecosystem health of the Olifants River system - in particular, contamination of the system by inorganic pollutants.

2. While it cannot be demonstrated at this stage that there is a direct correlation with the Loskop Dam event in September 2007, the possibility remains that the two events do stem from the events that led to the pollution of Loskop Dam. The implication of this is that **IF** the Loskop and Olifants events are linked, then the causal factor has been addressed upstream and the causal factor is "working its way through the system". However, if they are **NOT** linked, then the causal factor may still be entering the system and continue to pose a threat.

3. If the Olifants event is **not** linked to the Loskop Dam event, but a result of contamination down stream, there is a possibility that it is linked to mining processes in Phalaborwa. One of the most common and deadly oxidizing agents in the world is *dioxin*. The most potent catalyst for dioxin is copper, and in animals, dioxin is accumulated in the fatty tissue. Given the proximity of copper mining to the event, this certainly cannot be overlooked as a potential source of the causal factor. Another source of dioxin are agro– and petro–chemicals.

4. From a scenario planning perspective, the possibility of a toxic agent like dioxin being present in the system is cause for concern – in respect of human health implications. The photograph below shows how people in Mozambique depend on alluvial silts and fish along the shoreline of the Massingir Dam. The responses must therefore consider the possibility of a potentially serious human health-threatening contamination and implemention of the surveillance measures identified in this exercise.

Agriculture on alluvial deposits and fishing are central to human livelihoods in Massingir – Mozambique

Possibility of a *Dioxin* contamination?

The major sources of dioxin are in our diet. Since dioxin is fat-soluble, it bioaccumulates, climbing up the food chain. **A North American eating a typical North American diet will receive 93% of their dioxin exposure from meat and dairy products** (23% is from milk and dairy alone; the other large sources of exposure are beef, fish, pork, poultry and eggs). In fish, these toxins bioaccumulate up the food chain so that dioxin levels in fish are 100,000 times that of the surrounding environment.

In EPA's dioxin report, they refer to dioxin as *hydrophobic* (water-fearing) and *lipophilic* (fat-loving). This means that dioxin, when it settles on water bodies, will rapidly accumulate in fish rather than remain in the water. The same goes for other wildlife. Dioxin works its way to the top of the food chain.

Metals as Catalysts for Dioxin Formation

Certain metals act as catalysts for dioxin formation, providing a surface upon which dioxins can readily form. This generally occurs during and after combustion processes on the fly ash in boilers and incinerators, but can also occur in other environments, such as in metals processing industries.

Copper (Cu) is the most potent catalyst for dioxin formation, but Iron (Fe), Zinc (Zn), Potassium (K) and Sodium (Na) have also been found in multiple studies to be correlated with increased dioxin/furan formation. Some studies have also indicated that Manganese (Mn), Magnesium (Mg) and Nickel (Ni) may also serve as catalysts for dioxin formation. Studies have conflicted on whether Aluminium (Al) encourages or inhibits dioxin formation. One study below indicated that Silicon (Si) is negatively correlated with dioxin formation.

The metal catalyst issue is the likely reason why secondary copper and aluminium smelters are among the largest known sources of dioxin pollution in the U.S. Copper electrical wiring, coated with chlorine-containing PVC plastic is a perfect recipe for dioxin formation, when homes and buildings burn, when the plastic-coated wire gets burned in an incinerator, or when any of this plastic or its residues get into a secondary copper smelter.

Other sources of dioxin pollution include metal-related industries with high temperature processes, such as iron ore sintering in the steel industry, aluminium recycling, copper ore melting, nickel refining, magnesium production, electrical cable splicing, and catalyst regeneration in the petroleum refining industry. [Kobylecki]

Dioxin/furan formation during any natural or human activity requires three basic ingredients: an organic starting material, a chlorine source, and, in processes with relatively low temperatures, a metallic catalyst. [Kobylecki]

Relevant Websites:

http://en.wikipedia.org/wiki/Polychlorinated_dibenzodioxins

http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=55264

http://www.gascape.org/index%20/Health%20effects%20of%20Dioxins.html

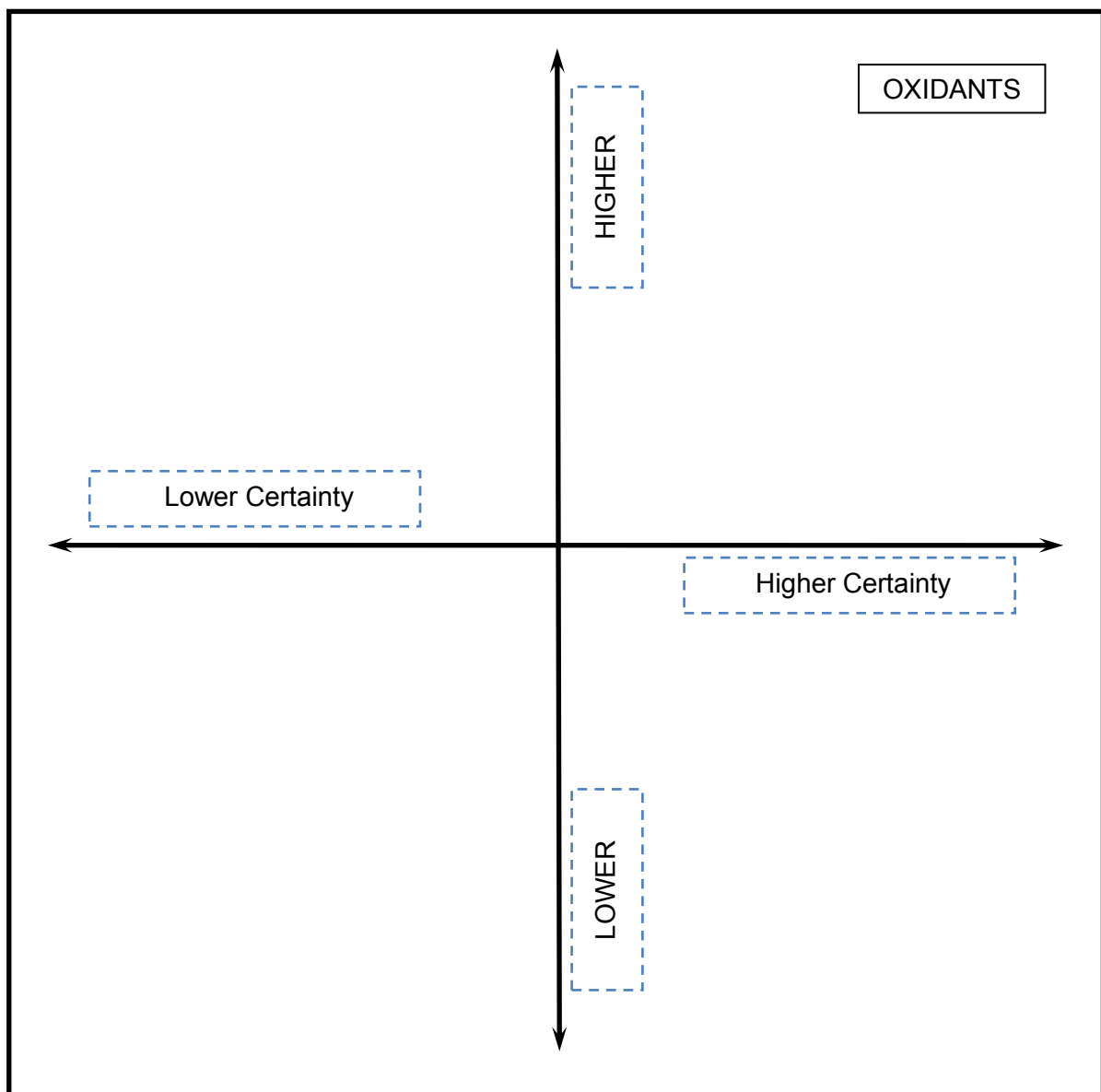http://www.ejnet.org/dioxin/catalysts.html#kobylecki

Why *Dioxin*? – The Aborted Driver Matrix

The incomplete driver matrix exercise contained only one key driver. Even if it is not *dioxin* this is the starting point of the investigation.

Facilitators Notes on the Rapid Response Scenario Planning Process

1. Unfortunately, time did not permit the full exploration of the scenario building process. As a result, at this stage the analysis is weak on the alternative scenarios. As pointed out by Harry Biggs, the formulation of the key question shaped the type of analysis undertaken – the result, so far, is more a problem analysis exercise than a full scenario planning exercise. This, however, has resulted in a considerable amount of useful and useable information with realistic responses and actions to be undertaken. It also guides the direction of immediate research needs.

2. It is recommended that at some stage in the future, a more detailed scenario planning analysis be undertaken once further information is available. This would be useful in examining the longer term implications of and responses to such events in a manner that informs park policy, research and management planning.